A Federal Approach to Contaminated Sites

Contaminated Sites Management Working Group

Government of Canada Gouvernement du Canada

Canada

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The Contaminated Sites Management Working Group (CSMWG) established under the auspices of the Federal Committee on Environmental Management Systems (FCEMS), is an interdepartmental committee established to investigate, propose and develop a common federal approach to the management of contaminated sites under federal custody.

The CSMWG is currently co-chaired by the Department of National Defence and Environment Canada. Activities of the working group are cost shared between participating departments.

Participating Departments

Agriculture and Agri-Food Canada
Canadian Heritage/Parks Canada
Department of Finance
Environment Canada
Fisheries and Oceans Canada
Foreign Affairs and International Trade
Indian and Northern Affairs Canada
National Defence
Natural Resources Canada
Public Works and Government Services Canada
Solicitor General/Royal Canadian Mounted Police
Transport Canada
Treasury Board Secretariat

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Glossary of Terms

A

Adverse Effect. An undesirable or harmful effect to an organism, indicated by some result such as mortality, altered food consumption, altered body and organ weights, altered enzyme concentrations or visible pathological changes.

Approach. The philosophy and procedures used by a regulatory agency to establish environmental quality criteria. The components of the approach can include the types of information considered, the management goal underlying the criteria, relative priorities assigned to various types of information and the ways that information is combined to set the criteria.

B

Background. An area not influenced by chemicals released from the site under evaluation.

Background Concentration. The concentration of a chemical substance occurring in media removed from the influence of industrial activity at a specific site and in an area considered to be relatively unaffected by industrial activity.

Blank. The measured value obtained when a specific component of the sample is not present.

C

Clean-up. The removal of a chemical substance or hazardous material from the environment to prevent, minimize or mitigate damage to public heath, safety or welfare, or the environment, that may result from the presence of the chemical substance or hazardous material. The clean-up is carried out to specified clean-up criteria.

Concentration. The amount of chemical or substance in a given environmental medium.

Conceptual Model. Our idealization of a hydrogeological system on which we can base a mathematical model. The conceptual model includes assumptions on the hydrostratigraphy, material properties, dimensionality, and governing processes.

Contaminant. Any physical, chemical, biological or radiological substance in air, soil or water that has an adverse effect. Any chemical substance whose concentration exceeds background concentrations or which is not naturally occurring in the environment.

Contaminated Site. A contaminated site is defined as a site at which substances occur at concentrations: (1) above background levels and pose or are likely to pose an immediate or long-term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations.

Contamination. The introduction into soil, air or water of a chemical, organic or radioactive material or live organism that will adversely affect the quality of that medium.

Criteria. Numerical standards that are established for the concentrations of chemical substances in soil, groundwater, surface water, and sediments that relate to the suitability of a site for specific land uses and land use categories. Criteria are also often referred to as guidelines.

D

Decommissioning. The closure of an industrial facility followed by the removal of process equipment, buildings and structures.

E

Ecological Risk Assessment. The process of defining and quantifying risks to non-human biota and determining the acceptability of those risks.

Environmental Site Assessment (ESA). A systematic due diligence process that includes studies, services and investigations to plan, manage and direct assessment, and decommissioning and clean-up actions.

Exposure. The contact between a contaminant and an individual or population.

Exposure Pathway. The route by which a receptor comes into contact with a contaminant. Exposure pathways include ingestion, dermal absorption or inhalation.

G

Generic Criteria. Numerical values for the concentration of chemical substances in soil, groundwater, surface water and sediments considered safe for a broad range of receptors, site conditions and regions under defined land uses.

Groundwater. All subsurface water that occurs beneath the water table in rocks and geologic formations that are fully saturated.

Guideline-Based Approach. The remediation of a site to generic soil, groundwater, sediment and surface water criteria developed by federal or provincial or other regulatory authorities. Under this method, established environmental quality guidelines are adopted "as is" as the site-specific remediation objectives.

H

Hazard. The adverse impact on health or property which results from the presence of or exposure to a substance. The significance of the adverse effect depends on the nature and severity of the hazard and the degree to which the effect is reversible.

Human Health Assessment. The process of defining and quantifying risks and determining the acceptability of those risks to humans.

M

Media. The fundamental components of the environment including water, sediment, soil and biota.

Migration. The movement of chemicals, bacteria and gases in flowing water or vapour in the subsurface.

Model. A conceptual, mathematical or physical system intended to represent a real system. The behaviour of a model is used to understand processes in the physical system to which it is analogous.

Monitoring. Observing the change in geophysical, hydrogeological or geochemical measurement with time.

Monitoring Well. A well that is used to extract groundwater for physical, chemical or biological testing, or to measure water levels.

N

Natural Environment. The air, land and water, or any combination or part thereof.

O

Objective. A numerical limit or narrative statement that has been established to protect and maintain a specified use of soil or water at a particular site by taking into account site-specific conditions. The numerical limits or narrative statement that are established to protect and maintain the specified uses of water, sediment or soil at a particular site. Objectives may be adopted from generic criteria or formulated to account for site-specific conditions.

P

Pathway. The route along which a chemical substance or hazardous material moves in the environment.

Permafrost. Perennially frozen ground in areas where the temperature remains at or below 0°C for two or more years in a row.

R

Receptor. The person or organisms, including plants, subjected to chemical exposure.

Remedial Action Plan. A plan to bring about the restoration or clean-up of a site.

Remediation. The improvement of a contaminated site to prevent, minimize or mitigate damage to human health or the environment. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to receptors of concern.

Remediation Criteria. Numerical limits or narrative statements pertaining to individual variables or substances in water, sediment or soil which are recommended to

protect and maintain the specific use of contaminated sites. When measurements taken at a contaminated site indicate that the remediation criteria are being exceeded, the need for remediation is indicated.

Restoration. Improvement of the quality of, remediation, clean-up, or other management of soil, groundwater or sediment so that the site will be suitable for the intended use.

Risk Assessment. The scientific examination of the nature and magnitude of risk to define the effects on both human and other receptors of the exposure to contaminant(s).

Risk-Based Approach. An approach based on a detailed evaluation of hazard and exposure potential at a particular site. Risk assessment is an important tool to use where, for example, national criteria do not exist for a contaminant, where clean-up to guideline-based criteria is not feasible for the targeted land use, where guideline-based objectives do not seem appropriate given the site-specific conditions, where significant or sensitive receptors of concern have been identified or where there is significant public concern, as determined by the lead agency.

Risk Management. The selection and implementation of a strategy of control of risk, followed by monitoring and evaluation of the effectiveness of that strategy. Risk management may include direct remedial actions or other strategies that reduce the probability, intensity, frequency or duration of the exposure to contamination. The latter may include institutional controls such as zoning designations, land use restrictions, or orders. The decision to select a particular strategy may involve considering the information obtained from a risk assessment. Implementation typically involves a commitment of resources and communication with affected parties. Monitoring and evaluation may include environmental sampling, post-remedial surveillance, protective epidemiology, and analysis of new health risk information, as well as ensuring compliance.

S

Saturated Zone. The zone where voids in the soil or rock are filled with water at greater than atmospheric pressure. In an unconfined aquifer, the water table forms the upper boundary of the saturated zone.

Screening. A rapid analysis to determine if further action (e.g. detailed analysis or clean-up) is warranted.

Site Management/Remediation Strategy. The implementation of a strategy or measures to control or reduce the level of risk estimated by the risk assessment.

Site-Specific Clean-up Criteria. Numerical values for the concentration of chemical substances in soil, groundwater, surface water, and sediments that relate to the suitability of a site for specific land uses and land use categories.

Site-Specific Remediation Objectives. The process of applying environmental quality guidelines at the site level to establish remediation or clean-up targets for the site. Site-specific remediation objectives may be adopted from existing guidelines (generic criteria), modified from existing guidelines, or developed using a risk assessment approach

Soil Gas. The vapour or gas that is found in the unsaturated zone.

Surface Water. Natural water bodies, such as rivers, streams, brooks and lakes, as well as artificial water courses, such as irrigation, industrial and navigational canals, in direct contact with the atmosphere.

T

Test Pit. A shallow pit, made using a backhoe, to characterize the subsurface.

Toxicity. The production of any type of damage, permanent or temporary, to the structure or functioning of any part of the body. The conditions of exposure under which toxic effects are produced — the size of the dose and the duration of the dosing needed — vary greatly among chemicals.

W

Water Table. The upper limit of the saturated zone. It is measured by installing wells that extend a few feet into the saturated zone and then recording the water level in those wells.

1 Introduction

1.1 Background

This Approach document has been developed by the Contaminated Sites Management Working Group (CSMWG) to provide a common federal approach to managing contaminated sites under federal custody.

In the context of sustainable development, pollution prevention and the need for effective budgetary considerations, the CSMWG, an interdepartmental committee, was established in the summer of 1995 to provide advice on federal contaminated sites to the Federal Committee on Environmental Management Systems (FCEMS).

In pursuit of its mandate, the CSMWG has developed a generic definition and a policy statement for contaminated sites:

Definition:

A *contaminated site* is defined as a site at which substances occur at concentrations: (1) above background levels and pose or are likely to pose an immediate or long-term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations.

Policy:

"*Contaminated sites on federal lands shall be identified, classified, managed and recorded in a consistent manner*."

1.2 Objective and Scope

This Approach has been developed to support and augment the above CSMWG's Policy. It will assist the CSMWG mandate in establishing a consistent and uniform government-wide approach to the management of contaminated sites.

The Approach serves as a proactive management tool so that the necessary steps are taken to characterize, classify and prioritize contaminated sites and to ensure environmental site management initiatives are implemented in a timely and cost-effective manner. The Approach comprises a significant supporting tool in attaining sound overall due diligence in the management of federal contaminated sites. This systematic approach will ensure that limited resources are allocated to the most high-risk sites.

The potential benefits as a result of meeting the Approach's objective include:

1) a consistent federal approach to environmental site management;
2) long-term strategic planning of overall investigation and clean-up efforts;
3) more effective allocation of federal resources between departments;
4) better selection of cost-effective site management strategies; and
5) implementation of risk-based clean-up criteria and management options.

1.3 Intended Use

The intended audience for the Approach is managers and operational personnel who are responsible for managing contaminated sites on federal lands. Each step in the Approach process is designed to stand alone and to outline key components for investigating, managing and remediating contaminated sites. References to specific source documents for additional information are found in each of the steps. The Approach was developed mainly to build upon these source documents and provide guidance for their use within the context of the federal contaminated site management process.

The appendices supplement information found within the Approach. Appendix A references the numerous scientific tools, guidance documents and generic remediation objectives that have been developed by the Canadian Council of Ministers of the Environment (CCME), the National Contaminated Sites Remediation Program (NCSRP), Environment Canada and Health Canada to

provide direction in the management of contaminated sites. Generic Statements of Work are provided in Appendix B–E to assist proponents in developing Statements of Work for specific projects.

1.4 Approach Process

The Approach incorporates a risk-based approach to the management of contaminated sites. The objectives of a risk-based environmental management approach are to assess risks to human health and the natural environment under the current and intended land use scenarios and to implement risk management solutions considered to be protective of those risks. This involves identifying the contaminants of concern, identifying potential receptors, determining potential exposure pathways, and estimating the level of risk based on the pathways. In addition, the risk-based approach implies a prioritized allocation of resources within the federal departments.

The risk-based approach incorporates several components including site identification and characterization, detailed site investigations and risk assessment, evaluation of different risk management strategies, implementation of a selected management strategy, assessment and monitoring. These components are realized through a 10-step process known as the Steps for Addressing a Contaminated Site, which are briefly described below and are illustrated in Figure 1. These steps identify scientific tools and documents that are available for use in the management of federal contaminated sites. Each step is explained in further detail in the following section.

1.5 Reporting Requirements

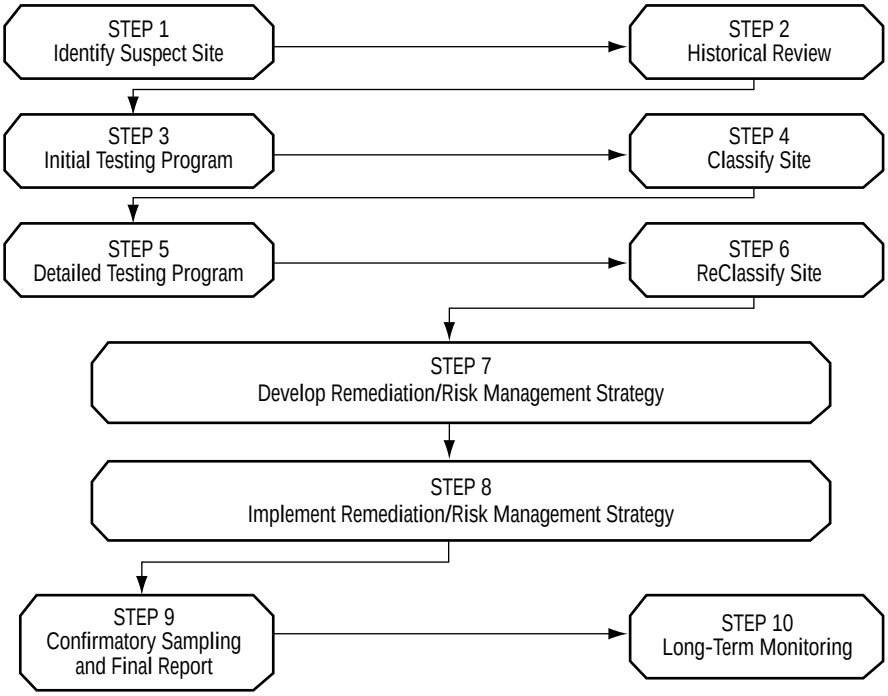
Treasury Board Secretariat has developed two policies that need to be considered in the management and reporting of contaminated sites. The *2000 Contaminated Sites Inventory Policy* and the *1999 Draft Policy on Accounting for Costs and Liabilities Related to Contaminated Sites* provide details on the reporting requirements.

The *2000 Contaminated Sites Inventory Policy* requires all federal departments to establish and maintain a database of their known contaminated sites and their solid-waste landfills and to provide this information to Treasury Board Secretariat for incorporation into a central Federal Contaminated Sites Inventory and Federal Solid Waste Landfills Inventory within the Directory of Federal Real Property.

The *1999 Draft Policy on Accounting for Costs and Liabilities Related to Contaminated Sites* requires all federal departments to account for all costs and liabilities related to management and remediation of their contaminated sites. Departments are to report these costs to the Treasury Board Secretariat on an annual basis.

More information about these two policies is available from the Treasury Board Secretariat web site (www.tbs-sct.gc.ca).

Figure 1 Steps for Addressing a Contaminated Site



NOTE: The steps shown above illustrate the complete process involved in dealing with contaminated sites. There will be instances where some of the steps may not be required.

Step 1 — **Identify Suspect Sites:** Identifies potentially contaminated sites based on activities (past or current) on or near the site.

Step 2 — **Historical Review:** Assembles and reviews all historical information pertaining to the site.

Step 3 — **Initial Testing Program:** Provides a preliminary characterization of contamination and site conditions.

Step 4 — **Classify Contaminated Site Using the CCME National Classification System:** Prioritizes the site for future investigations and/or remediation/risk management actions.

Step 5 — **Detailed Testing Program:** Focuses on specific areas of concern identified in Step 3 and provides further in-depth investigations and analysis.

Step 6 — **Reclassify the Site Using the CCME National Classification System:** Updates the ranking based on the results of the detailed investigations.

Step 7 — **Develop Remediation/Risk Management Strategy:** Develops a site-specific plan to address contamination issues.

Step 8 — **Implement Remediation/Risk Management Strategy:** Implements the site-specific plan that addresses contamination issues.

Step 9 — **Confirmatory Sampling and Final Reporting:** Verifies and documents the success of the remediation/risk management strategy.

Step 10 — **Long-Term Monitoring:** If required, ensures remediation and long-term risk management goals are achieved.

2 Steps for Addressing a Contaminated Site

2.1 Step 1 — Identify Suspect Sites

The implementation of the Approach requires sound technical expertise and professional judgement. At each step, the necessary site information is gathered to enable effective management decisions to be made. At some sites, however, it may not be necessary to complete all the steps before making a final management decision. For instance, sufficient information relating to a specific step may already be available, or sufficient information may become available after undertaking only a few of the steps. Additionally, some steps may be combined to make the Approach more efficient. In other cases, at sites where complex contamination issues are identified, it may be necessary to undertake certain steps in sequence to obtain the necessary information before effective management decisions are made. It must also be recognized that each site may present a unique set of circumstances; different approaches, techniques and/or prioritizations may be required to characterize and remediate sites on a site-specific basis.

OBJECTIVE

The objective of Step 1 is to identify suspect sites with relation to environmental issues of concern. A process to facilitate identification of suspect sites will ensure that Environmental Site Assessments (ESAs) are undertaken in a cost-effective and timely manner and that resources are applied where the most benefit will be realized. This step also helps establish the scenarios under which further investigations of a site may be warranted due to past or current activities at or near a site. Finally, this step will assist in screening out sites that do not present a potential risk to human health and/or the environment.

METHODOLOGY

For the most part, contaminated sites are typically associated with commercial, industrial and waste disposal activities and are commonly the result of improper chemical storage practices, spills, leaks and waste disposal. Some contaminated or potentially contaminated sites are obvious, such as sanitary landfills, while others may be innocuous, with the potential for hidden underground contamination. For example, an underground storage tank facility may contain one or more tanks which could be leaking.

How do I identify my potential sites?

There are several different avenues by which potentially contaminated sites may be identified. The majority of these avenues are contingent upon previous investigations and/or reports that may have been generated for the site. As a preliminary overview, useful information regarding the site may be obtained from the following sources:

- previous environmental record(s);
- internal environmental programs;
- complaints by citizens;
- off-site impacts;
- similarities to other known contaminated sites;
- visual or olfactory evidence of previous leaks, spills or discharges; and
- the nature of current or past activities at the site or adjacent properties.

The identification of a suspect site is an integral first step of the Approach. The purpose of the preliminary overview is to ensure that a review of the site has been carried out and that areas of environmental concern have been properly considered. From the information gathered so far, it may be decided that:

- There are sufficient environmental data or evidence about the site such that the Historical Review (Step 2), Initial Testing Program (Step 3) and/or Detailed Testing Program (Step 5) are not required. The next task will then be to Classify the Site Using the CCME National Classification System (Step 4); or

- Further investigations are required to identify and characterize the types, concentrations and extent of contamination. It is then necessary to proceed with the next step, the Historical Review (Step 2).

However, there might be instances for which there are sufficient environmental data or evidence to properly identify the site as not being suspect (e.g. properly constructed and decommissioned landfill sites, documented contaminants stored, handled and disposed of according to regulations, buried inert construction wastes, etc.).

Suppose I am not confident with the information I have?

If the review of the site is inconclusive as to whether the site is potentially contaminated, or if the areas of environmental concern are not properly addressed, then a Historical Review (Step 2) should be carried out to obtain the necessary background information.

It is also important to keep in mind that the physical geography of sites may have changed significantly over time, particularly with sites that have a long-term operational history or had a change in land use. Consequently, there may be no visual indications of remnant or historical activities at the site that may have led to contamination. For instance, closed landfills, waste pits or dump sites may have been regraded to green space, to make them more aesthetically pleasing, or to blend them in with the existing site development.

OUTPUT

Upon completion of the site identification, you will be able to assess whether you have a suspect site. If the site is suspected of being contaminated, but more historical and current information is required, you need to proceed with a Historical Review (Step 2).

2.2 Step 2 — Historical Review

OBJECTIVE

The objectives of the Historical Review, also known as a Phase 1 Environmental Site Assessment, are to assemble and review all available historical and current information pertaining to the site. The Historical Review activities may be undertaken to:

1) identify potential contaminants and environmental concerns at a site;
2) identify the need for further investigation, particularly at sites where little existing information is available; and/or
3) establish the preliminary site characteristics and develop a program or work plan for subsequent site investigations.

METHODOLOGY

Following the identification of a suspected contaminated site in Step 1, the next step is to identify the necessary background information through the completion of a Historical Review. It may be necessary to conduct a Historical Review even if information documenting the site's environmental conditions already exists, depending upon the nature of that information. Examples of such instances would be:

- A previous environmental investigation was not representative of the entire site conditions.
- Previous site investigations were undertaken without the benefit of a Historical Review.
- An unknown element or uncertainty identified in Step 1 requires further qualification.

What will the Historical Review tell me?

The Historical Review will identify, through an assessment of available existing information, the suspected areas of potential environmental concern and the need for further investigation. Additional investigations may be required if the existing available information is inadequate to evaluate general or site-specific concerns, or if available information suggests that there is an elevated risk of potential contamination.

The Historical Review will help to determine whether contamination exists on the property as well as the potential source, nature and location of the contamination. At this stage of the Historical Review, cursory information is also gathered upon which a conceptual model can be developed later.

What does the Historical Review include?

The Historical Review generally comprises three principal components:

1) a literature review;
2) a site visit or walk-through; and
3) interviews with informed persons.

For more information on conducting a Historical Review, the Canadian Standards Association (CSA) document *CAN/CSA Z768 Phase 1 Environmental Site Assessment* (CSA, 1994) outlines a standard approach to conducting a Historical Review, or Phase 1 Environmental Site Assessment. In addition, the CCME publication *Guidance Document on the Management of Contaminated Sites in Canada* (CCME, 1997b) outlines the phased approach to conducting environmental site assessments, including the elements to be addressed in the initial phase of an environmental site assessment.

Where can I get the information I need to do a Historical Review?

1) Literature Review. Historical information pertaining to the site may be obtained from a literature review of a variety of sources including:

- available reports (such as groundwater and geological reports, environmental baseline reports, incident reports and previous site investigation reports);
- aerial photographs;
- insurance maps and reports;
- property title searches;
- federal, provincial and municipal archives;
- regulatory agency records;
- company records;
- topographic and geological maps; and
- site plans and drawings.

The literature review should also include any and all data which may have been gathered for legal, transactional or environmental reasons. If the information is available, it should also provide information on the types of suspected contaminants, where the contamination is likely to be found, and the subsurface conditions of the site. The information gathered is used to plan any further activities at the site.

2) Site Visit. A site visit is primarily a visual inspection of the property. It is used to verify the information gathered during the literature review and identify any undocumented site conditions that may impact on the site investigations. The walk-through will also identify areas of potential environmental concern including: vegetation stress, key ecological receptors, leachate breakout, and contaminant discharge. The site visit essentially brings the historical review up-to-date with respect to the current land use(s).

3) Interview with Informed Persons. Discussions should also be held with key site personnel at both the subject and surrounding lands. An interview is used to corroborate information gathered during the literature review and site visit. It also helps identify any gaps in the scope of the literature review and site visit. For many of the older federal operations, significant historical data may be obtained from former or retired employees who worked at the site. In addition, local residents may be knowledgeable about the site's history and conditions and may also provide valuable information.

Completing the Historical Review will establish the following preliminary characteristics for the site:

- Facility characteristics: a current and a historical description of the site and its facilities, including site infrastructure. This should also include prior site uses and surrounding land uses.
- Contaminant characteristics: identifies contaminants that may be present at the site.
- Physical site characteristics: examines the geology, hydrology and geomorphology using current information.

A generic Statement of Work for conducting a Historical Review is included in Appendix B.

OUTPUT

The site's historical information is now assessed with regard to potential contaminants, pathways and receptors. This information will establish whether additional site investigations are required. Where additional investigations are warranted, the preliminary information obtained in the Historical Review will be used to develop a site characterization work plan.

RELATED DOCUMENTATION

1. CAN/CSA Z768 Phase 1 Environmental Site Assessment (CSA), 1994
2. Guidance Document on the Management of Contaminated Sites in Canada (CCME), 1997b

2.3 Step 3 — Initial Testing Program

OBJECTIVE

The objective of the Initial Testing Program, also known as a Phase II Environmental Site Assessment, is to determine the presence or absence of suspected contaminants and to characterize the physical site conditions, including geology, hydrogeology and hydrology. If the results of the Historical Review have identified a potential environmental concern, an Initial Testing Program should be undertaken to qualify and quantify those concerns. Where present, the Initial Testing Program will provide a preliminary assessment of the degree, nature and extent of the contamination. The Initial Testing Program should also provide the necessary level of information to support management decisions regarding future investigation needs and requirements. The more information that is known about the site, the better the site classification and site prioritization with respect to the form of action required to meet remediation/risk management objectives.

METHODOLOGY

An Initial Testing Program, may be undertaken in one or more stages, depending upon site and contaminant characteristics, the specific objectives of the study and the Initial Testing findings.

The Initial Testing Program consists of six principal stages:

1) planning;
2) field investigation and sampling;
3) sample analyses;
4) data interpretation and evaluation;
5) risk identification; and
6) conceptual model development.

The Canadian Standards Association (CSA) document *CAN/CSA Z769 Phase II Environmental Site Assessment* (CSA, 1998) outlines a systematic approach to conducting an Initial Testing Program, or Phase II Environmental Site Assessment. Additional information concerning the development and planning of Initial Testing Programs is provided in the CCME documents *Guidance Document on the Management of Contaminated Sites in Canada* (CCME, 1997b) and *Subsurface Assessment Handbook for Contaminated Sites* (CCME, 1994).

1) Planning. The first step in undertaking an Initial Testing Program is to develop a suitable work plan. The work plan should be based on the findings and/or uncertainties identified in the Historical Review (Step 2). In developing the work plan, the Initial Testing Program should incorporate the use of technically sound sampling procedures, quality assurance/quality control procedures and laboratory analytical procedures. The importance of collecting a sufficient number of samples cannot be over-emphasized at this point, as collecting enough samples may reduce potential remediation costs.

Information on these procedures and the planning and implementation of Field Testing Programs can be found in the CCME documents *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites — Volume 1: Main Report* (CCME, 1993a) and *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites — Volume II: Analytical Method Summaries* (CCME, 1993b).

The Initial Testing Program may be carried out using a combination of (1) non-intrusive and (2) intrusive techniques. (1) Typical non-intrusive techniques used as initial site investigation methodologies include geophysical and soil vapour (gas) surveys. These techniques are used to rapidly identify subsurface contamination that may be in solid, liquid or gas form, thus allowing a more focused intrusive investigation approach. (2) Typical intrusive techniques include a combination of hand augering, test pitting and drilling procedures to retrieve soil and groundwater samples for subsequent field screening and laboratory analyses. Tightness testing of tanks, lines and pumps may be a component of the program and may be performed at storage tank facilities.

2) Field Investigation and Sampling. Once potential "hot spots" have been identified through the Historical Review (Step 2), a sampling program must be designed to

obtain more definitive information about the nature and extent of the contamination. The sampling program should clearly establish the appropriate sampling techniques and equipment, sample density, sampling media and analytical parameters. Appropriate sampling protocols and analytical methods must be developed to meet the needs of the investigation.

The Initial Testing Program should include surface and subsurface soil sampling, groundwater sampling and surface water sampling using approved sampling procedures (e.g. CCME). This program usually begins with one or two field-screening methods, which permit a closer identification of suitable locations for test pits, boreholes and groundwater monitors. Subsurface soil samples are routinely collected through the excavation of test pits, the use of hand augers and a portable drill or the drilling of boreholes. Groundwater samples are collected through the installation of monitoring wells at strategic borehole locations. Additional sampling, including sediment, plants or aquatic organisms, may be warranted under certain site-specific conditions. Quality assurance/quality control programs should be established at both the field sampling and analytical levels to ensure data integrity and confidence in the data quality. By following the *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites* (CCME, 1993a), a quality assurance program can be developed specifically for the assessment of individual contaminated sites.

3) Sample Analyses. In the Initial Testing Program, the sample analyses stage should address the range of possible contaminants identified in the Historical Review (Step 2). The analysis stage may become more refined as investigation activities proceed and the types of contaminants to be analyzed are properly identified, or areas of potential environmental concern discarded. Representative samples should be submitted to a Canadian Association of Environmental Analytical Laboratories (CAEAL) or *Ministère de l'Environnement (MENV*) *du Québec* accredited and certified laboratory, or an organization offering an equivalent level of accreditation, for quantification of suspected contaminant concentrations.

On-site methods allow samples to be screened for a variety of suspect contaminants in a cost- and time-effective manner. Samples with the highest contaminant concentration identified by the screening method should then be submitted to a laboratory for detailed analyses and confirmation of actual contaminant concentrations. Information from on-site methods is quickly available and can also determine the need for, and best location for, further drilling if required. Soil and water samples collected during the field testing program may be screened using a variety of techniques, as described in section 5.3.1 of the *Guidance Document on the Management of Contaminated Sites in Canada* (CCME, 1997b).

4) Data Interpretation and Evaluation. The interpretation of the laboratory data includes (1) a comparison between the data quality objectives and the findings presented in the field program, (2) an evaluation of the quality assurance/quality control data with the data presented and (3) an extrapolation of the information presented to a form that will truly represent site conditions. The gathered data must be representative of the contaminated site being investigated.

When a contaminated site has been identified and the Initial Testing Program has provided information on the nature and magnitude of contamination at the site, environmental quality guidelines can be used for the purpose of evaluating:

- the degree of contamination at the site;
- if further site investigations are required; and
- if management actions are necessary.

The environmental quality guidelines are guidelines for soil, water and sediments. Generic groundwater and surface water criteria have been developed for four water use scenarios: freshwater supporting aquatic life, water used for irrigation, livestock watering and human drinking water. Sediments quality guidelines have been developed for a variety of contaminants in freshwater and marine/estuarine sediments. The 1999 CCME Environmental Quality Guidelines provide generic soil remediation criteria for four different land uses: agricultural, residential/parkland, commercial and industrial. The applicable remediation guidelines will vary according to the prescribed land use, whether present or future.

Which guidelines do I use?

Many different soil quality criteria or guidelines are available, which can be confusing for site managers.

- The CCME released interim soil quality criteria in 1991 and recommended soil quality guidelines in 1997.

The 1991 criteria are provided for over 50 parameters, whereas the 1997 guidelines were released for 20 parameters. The 1997 CCME Soil Quality Guidelines have been developed to replace the interim values published in 1991 for specific contaminants. Any interim values for contaminants listed in the 1991 guidelines that have not yet been replaced in the 1997 guidelines will remain in effect.

- Since 1997, the word "guidelines" is being used instead of "criteria" for consistency purposes with other media.
- As a general rule, sites under federal custody are excluded from provincial jurisdiction, and consequently the CCME guidelines are recommended for use. However, when no CCME guidelines are available for a parameter, provincial or territorial guidelines can be used.
- The most recent CCME guidelines for a parameter should always be used since they were derived using the latest and most up-to-date scientific information.
- When no CCME soil quality guidelines are available for a parameter, the CCME 1991 interim criteria can still be used.
- In cases where no provincial or territorial guidelines are available, guidelines from international jurisdictions can be used.

In 1999, the CCME integrated all existing environmental quality guidelines and criteria for all media into one document entitled *1999 Canadian Environmental Quality Guidelines*. This document contains the most current environmental quality guidelines for water, soil, sediment, tissue and air, including updates and revisions to the existing environmental quality guidelines published to date. The 1999 CCME Environmental Quality Guidelines replace all previous guidelines.

Note: The proposed Canada Wide Standards for Petroleum Hydrocarbons (PHC) in soil will establish environmental quality guidelines for petroleum hydrocarbon contaminated sites. The application of this standard is still being developed. Additional information on the CWS is available on the CCME web site: www.ccme.ca

A site is generally considered contaminated when one or more samples contain contaminant concentrations in excess of the appropriate environmental quality guidelines. Data for these sites should be stored in a departmental reporting or inventory database for sites exceeding environmental quality guidelines. If contaminant concentrations do not exceed the guidelines, no further action is required (i.e. no classification required). There is no need to go any further in the Approach process.

A generic Statement of Work for an Initial Testing Program is included in Appendix C.

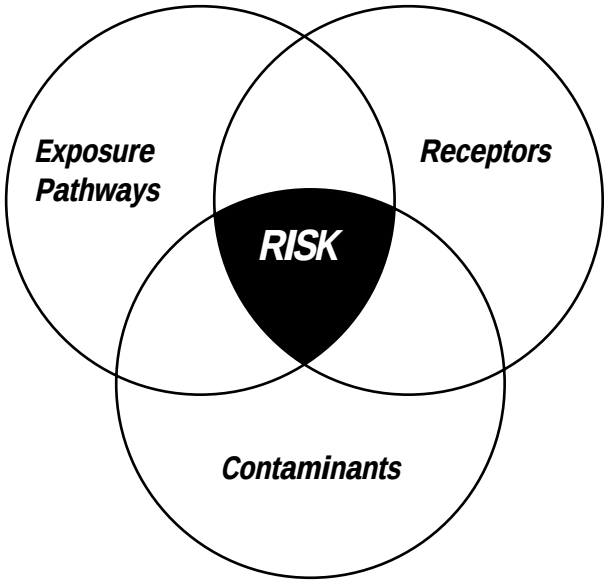
5) Identify Risks. The information obtained during the Initial Testing Program will provide valuable site information, including the nature and location of the contaminants with respect to the groundwater table, potential pathways for contaminant migration, the location of nearby sensitive receptors, and the potential for direct human exposure to the contaminants. These elements will allow development of a conceptual model for the site.

Undertaking a qualitative risk assessment as part of the Initial Testing Program establishes the three components of risk — contaminants, potential receptors, and exposure pathways — and focuses the data collection accordingly. Figure 2 shows the relationship of these three components. In cases where the risks associated with certain contaminants on a specific site are not known, further study of the risks to public health, safety or the environment may be required. This additional requirement would be part of the Detailed Testing Program in Step 5.

6) Develop Conceptual Model. The conceptual model is a desk-top approximation of the physical and chemical (contaminant) site conditions. Upon completion of the Initial Testing Program, it is important to have a conceptual site model of the site, which emphasizes the type and magnitude of the subsurface contamination, defines the pathways for contaminant migration and identifies potential receptors. Where additional investigations are likely to be required, the conceptual site model provides the foundation upon which to develop the subsequent stages of the work. It will also assist in indicating what types of information must be collected. Figure 3 is an example of a conceptual site model for the movement of contaminants to a receptor (human) that would be based on the site information gathered up to this step.

The three preliminary site characteristics (contamination, pathways and receptors), when viewed as a whole, constitute a conceptual site model. Both the Historical Review and Initial Testing Program must be thoroughly evaluated and documented to establish the

Figure 2 Risk Components Relationship

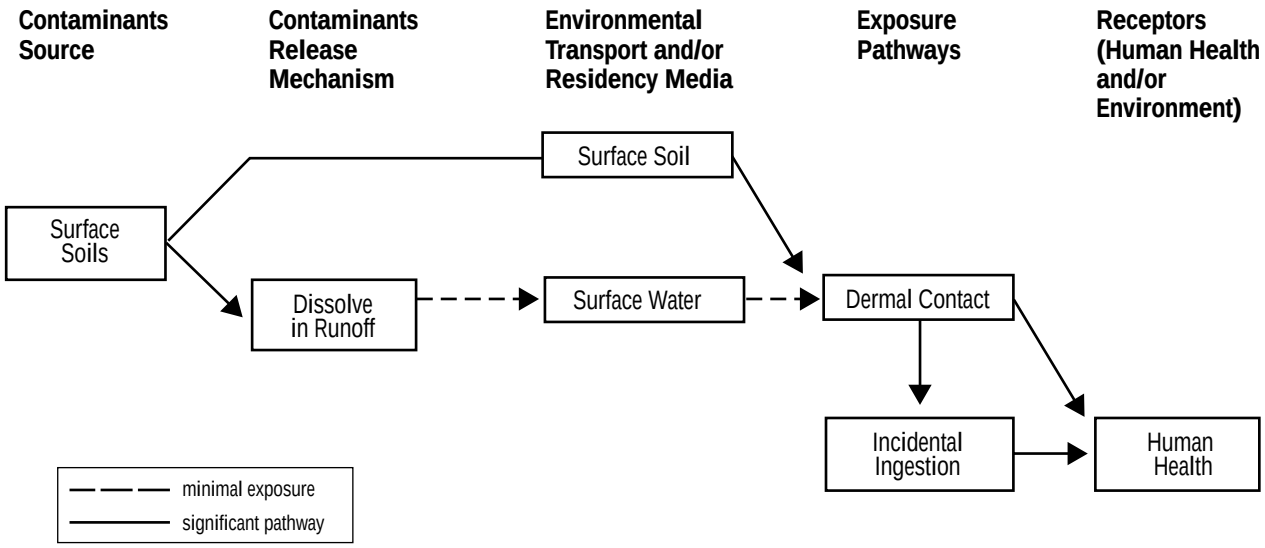


preliminary site characteristics and determine the potential for site contamination. The conceptual model should be established early in the process when addressing a contaminated site. This allows the resources and subsequent efforts to focus on the contaminants of concern as well as the receptors and pathways that are relevant to site remediation/risk management issues. Once the preliminary model is established, subsequent investigation programs and work plans can be developed to refine the model and to address any critical information gaps.

OUTPUT

The results of the Initial Testing Program will establish whether the site is contaminated. If contamination is present, the Initial Testing will identify the nature and magnitude of the contamination and provide the necessary information to develop future testing programs. Data obtained during the Initial Testing will allow development of a preliminary conceptual site model in relation to the type and extent of the subsurface contamination, the pathways for contaminant migration and potential receptors. It will also provide useful information that can be used for site classification (Step 4).

Figure 3 Example of a Human Health Conceptual Site Model for the Movement of Contaminant(s) Bound to Surface Soils to a Person



RELATED DOCUMENTATION

1. CAN/CSA Z769 Phase II Environmental Site Assessment, Canadian Standards Association, 1998 (CSA)
2. Guidance Document on the Management of Contaminated Sites in Canada (CCME), 1997b
3. Subsurface Assessment Handbook for Contaminated Sites (CCME), 1994
4. Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites — Volume 1: Main Report (CCME), 1993
5. Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites — Volume II: Analytical Method Summaries (CCME), 1993
6. Canadian Water Quality Guidelines (CCREM), 1987
7. A Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME), 1995
8. Recommended Canadian Soil Quality Guidelines (CCME), 1997c
9. Canadian Soil Quality Guidelines for Copper: Environmental and Human Health (CCME), 1997d
10. Canadian Soil Quality Guidelines for Pentachlorophenol: Environmental and Human Health (CCME), 1997e
11. Protocol for the Derivation of Canadian Tissue Residue Guidelines for the Protection of Wildlife that Consume Aquatic Biota (CCME), 1997f
12. Canadian Environmental Quality Guidelines (CCME), 1999

2.4 Step 4 — Classify Contaminated Site Using the CCME National Classification System

OBJECTIVE

The objective of Step 4 is to classify the contaminated site(s) identified in Steps 1 through 3, using the CCME National Classification System. If more than one contaminated site has been identified, this initial classification will aid in indicating the level of concern due to each site. It will then be possible to establish relative priorities for the upcoming detailed testing program, if required, and the subsequent remediation/risk management strategy. Assigning relative priority enables resources to be directed to areas of greatest concern.

The National Classification System (NCS) for Contaminated Sites was developed by the CCME in 1992 to aid in the evaluation of the level of concern and the development of management priorities for contaminated sites. The NCS provides a well-documented and uniform approach to classifying sites as high, medium or low risk. Once sites have been classified, priorities for action can be assigned to address contaminated sites on a technical basis. The NCS is not a qualitative or quantitative risk assessment, but rather is a tool designed to screen a site with respect to the need for further action (characterization, risk assessment, remediation, risk management, etc.) to protect human health and the environment.

METHODOLOGY

Once a contaminated site has been identified in Steps 1 through 3, the next step is to classify the site using the NCS **Detailed Evaluation Form**. The NCS Detailed Form provides a "first kick" ranking system so that sites can be prioritized with respect to the level of risk they represent. Following the Initial Testing Program (Step 3), the environmental data and information accumulated so far may be sufficient to undertake classification of the site using the Detailed Evaluation Form. Sites lacking sufficient information, as is the case for most initial environmental investigations, will likely require additional investigations, as described in the following step (Detailed Testing Program), to properly complete the NCS.

The NCS **Short Evaluation Form** should be used only where sufficient information documenting the site's environmental conditions already exists and serious adverse impacts are known to be occurring. The majority of sites, however, will require completion of the Detailed Form.

Where can I get a copy of the NCS form?

The NCS form is available in electronic format and may be downloaded from the CSMWG home page (www.ec.gc.ca/etad/csmwg/index_e.html). The electronic format serves as a database allowing storage, retrieval and

updating of information on numerous sites. A hardcopy is available from the following address:

CCME Documents
c/o Manitoba Statutory Publications
200 Vaughan Street
Winnipeg, Manitoba R3C 1T5
Web site: www.ccme.ca

How do I complete the Detailed Evaluation Form?

Under the NCS, sites are assigned one of the following classes:

- Class 1: Action Required
- Class 2: Action Likely Required
- Class 3: Action May Be Required
- Class N: Action Not Likely Required
- Class I: Insufficient Information

The Detailed Evaluation Form consists of a series of questions related to three factors:

1) Contaminant Characteristics — the relative hazard of contaminants present at a site;
2) Exposure Pathways — the route a contaminant may follow (e.g. groundwater, surface water, direct contact and/or air) to a receptor. There are three sub-categories: (a) groundwater; (b) surface water; and (c) direct contact; and
3) Receptors — living beings or resources that may be exposed to and affected by contamination (e.g. humans, plants, animals, or environmental resources). There are two sub-categories: (a) human and animal; and (b) environment.

Under each of the three factor headings, there are evaluation factors that must be scored individually based on the specific site and contaminant characteristics. In Appendix D of the *National Classification System for Contaminated Sites* (CCME, 1992), there is a user's guide that presents a rationale for the score, guidelines for data interpretation of the environmental factors and sources of information to be reviewed for each factor. Based on the total score and total estimated score, the site can be classified.

What data are required to complete the Detailed Evaluation Form?

The NCS Detailed Evaluation Form may be applied to sites where sufficient information is documented about the site's environmental conditions. The minimum data requirements are described in *National Classification System for Contaminated Sites* (CCME, 1992) and include:

- description of site location;
- types of contaminants or materials likely to be present at the site (and/or description of historical activities);
- approximate size of the site and quantity of contaminants;
- approximate depth to water table;
- geologic map or survey information (soil, overburden, and bedrock information);
- annual rainfall data;
- surface cover information;
- proximity to surface water;
- topographic information;
- flood potential of site;
- proximity to drinking water supply;
- uses of adjacent water resources; and
- land use information (on-site and surrounding).

If there is insufficient information to properly classify the site, the Class I designation is used until additional information is obtained to address the gaps. There may also be a requirement to further refine the relative classification of sites within each priority category to come up with firm conclusions about the need and/or scenario for a remedial action. The additional information required will be obtained through Step 5: Detailed Testing Program. The NCS is a screening tool only and has limited application on northern sites and marine environment sites, in particular.

OUTPUT

The initial classification (Detailed Evaluation Form) should be completed for each contaminated site to identify those posing immediate risks to human health and/or the environment. Sites will be classified as 1, 2, 3, N or I, which correlate to high, medium or low priority for action. Such sites can then be prioritized for further investigation or remedial actions.

RELATED DOCUMENTATION

1. National Classification System for Contaminated Sites (CCME), 1992

2.5 Step 5 — Detailed Testing Program

OBJECTIVE

The objective of the Detailed Testing Program is to further define the nature of the site contamination and to address outstanding issues with respect to the development of an effective site management strategy.

The specific objectives of the Detailed Testing Program are:

1) to target and delineate the boundaries of identified contaminants;
2) to define, in greater detail, site conditions required to identify all contaminant pathways, particularly with respect to risk assessment;
3) to provide contaminant and other information necessary to finalize remediation guidelines or risk assessment; and
4) to provide all other information required to develop a Remediation Plan and input to specifications and tender documents.

These specific objectives will provide useful input in the implementation of (1) Step 6: Reclassify the Site Using CCME National Classification System; and (2) Step 7: Develop Remediation/Risk Management Strategy.

METHODOLOGY

If the results of the Initial Testing Program indicate that significant contamination exists at the site, a Detailed Testing Program may be required. Generally, the Detailed Testing Program (Step 5) will concentrate only on those areas of concern identified by the Initial Testing Program (Step 3) and address issues such as information gaps and data deficiencies.

A Detailed Testing Program may not be required if the Initial Testing Program:

- was adequate to scope a remedial action plan; or
- did not identify contaminants at concentrations that exceed CCME Environmental Quality Guidelines.

In these cases, proceed to Step 7: Develop Remediation/Risk Management Strategy. For example, limited contamination may be identified in the vicinity of an underground storage tank location. In many such cases, these impacts can be addressed during the tank decommissioning stage as part of Step 7, without the need for additional subsurface investigations.

For substances that are not addressed in the 1999 CCME Environmental Quality Guidelines, it may be appropriate to seek advice from Environment Canada or the provincial regulatory authority.

What does the Detailed Testing Program include?

The systematic approach to the Detailed Testing Program (Step 5) is similar to the Initial Testing Program (Step 3) in that the same investigative techniques and protocols are employed. The data collected during the Detailed Testing Program should be sufficiently representative of the site conditions to finalize the conceptual site model and to provide input to the development of an effective risk management and/or remedial strategy.

As in the case of the Initial Testing Program, the scope of work during the detailed investigation stage will likely incorporate a multi-task, multi-phased approach. Specific activities may include:

1) additional intrusive investigations to quantify all contaminants and concentrations;
2) computer modelling to establish contaminant distributions and/or migration patterns; and
3) other activities required to obtain the necessary information to develop a suitable site management/remedial strategy.

The Detailed Testing Program should also build upon data management, quality assurance/quality control programs, and other systems developed for the Initial Testing Program (Step 3).

The sampling and analytical programs will focus on contaminants of concern identified by the Initial Testing Program. While a smaller suite of chemicals may be

analyzed, a greater number of samples are usually collected to quantify the extent of contamination.

The CCME publications *Subsurface Assessment Handbook for Contaminated Sites* (CCME, 1994) and *Guidance Document on the Management of Contaminated Sites in Canada* (CCME, 1997b) provide further details on developing Detailed Testing Programs.

How much site information do I really need?

There is no "cut and dried" answer to this question. The answer will be specific to the site conditions and issues at hand. During the detailed investigation stage, additional information should be gathered about the soil characteristics, site geology, site hydrogeology, the types and concentrations of contaminants present and the rate of contaminant migration. The investigation should comprise of a sufficient scope of work to fully determine the extent (horizontal and vertical) of soil and/or groundwater contamination.

As a baseline, the level of information gathered in this step should be sufficient to enable final confirmation of the classification of the site as per CCME National Classification System Detailed Evaluation Form (Step 6).

A generic Statement of Work for a Detailed Testing Program (Step 5) is included in Appendix D.

OUTPUT

The nature and extent of the site contaminant conditions, including the horizontal and vertical distributions of contaminants, should be thoroughly established. A finalized conceptual site model that emphasizes the type and extent of the subsurface contamination should define the pathways for contaminant migration and identify potential receptors relative to human health and/or the environment. As a result, the nature of a contaminant, its transport mechanism and its impact on human health and/or the environment is combined with site geological, hydrogeological and topographical information to produce a comprehensive model of how contaminants may be disbursed from a source to a receptor. An example is shown in Figure 4.

RELATED DOCUMENTATION

1. Subsurface Assessment Handbook for Contaminated Sites (CCME), 1994
2. Guidance Document on the Management of Contaminated Sites in Canada (CCME), 1997b

2.6 Step 6 — Reclassify the Site Using CCME National Classification System

OBJECTIVE

The objective of Step 6 is to confirm the previous site classification performed in Step 4 or to reclassify a site based on the data obtained in Step 5: Detailed Testing Program. Based on the additional information obtained, the NCS Detailed Evaluation Form that was initially filled out in Step 4 can be finalized.

METHODOLOGY

After completing the Detailed Testing Program (Step 5), the additional information available will help confirm or update the National Classification System score obtained in Step 4. Sites lacking sufficient information, as is the case following most initial environmental investigations, likely require additional investigations as described in the preceding step, Step 5: Detailed Testing Program, to properly complete the NCS.

OUPUT

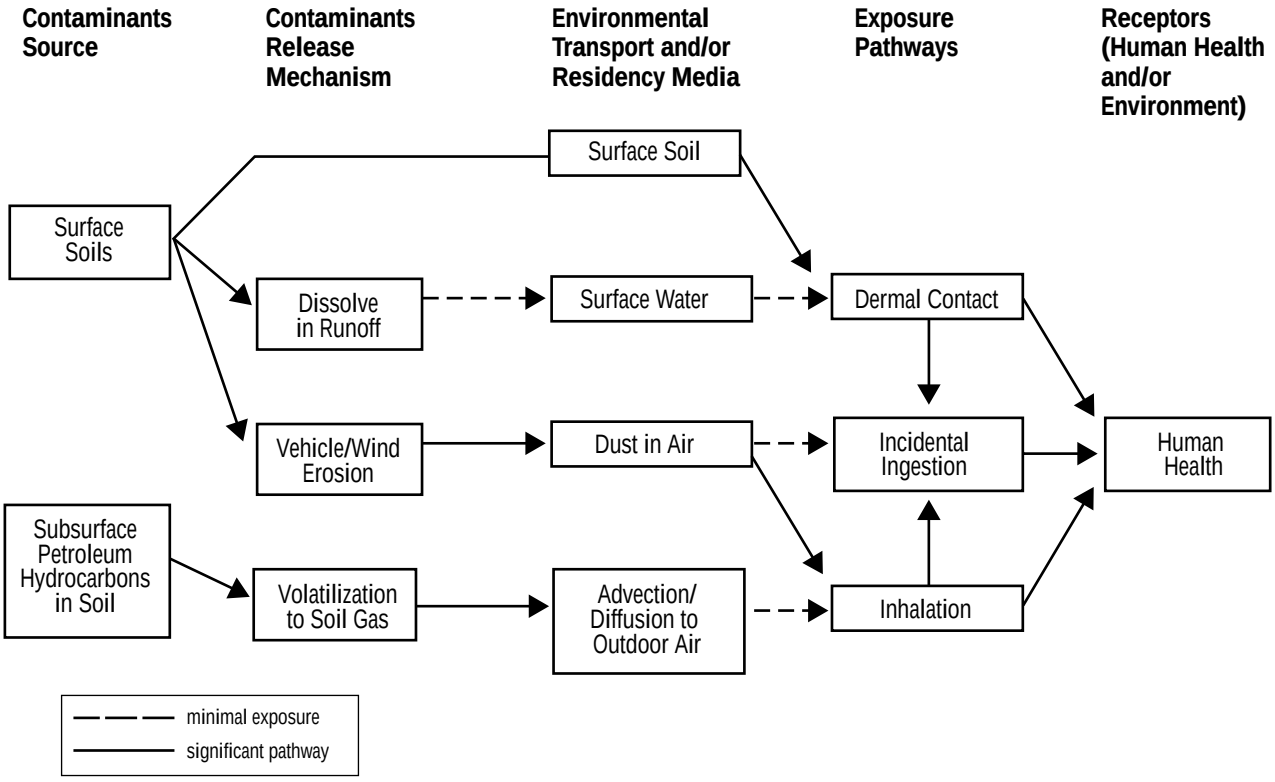
The output after this step should be a finalized Detailed Evaluation Form and a site classified as 1, 2, 3, I or N, according to the potential risk to human health and/or the environment.

2.7 Step 7 — Develop Remediation/Risk Management Strategy

OBJECTIVE

The objective of Step 7 is to establish remediation/risk management goals and thus develop an environmental site management strategy such that the levels of, or potential

Figure 4 Example of a Human Health Conceptual Site Model



exposure to, contaminants is reduced to meet those goals. Information gathered from previous steps is evaluated against the proposed remediation objectives to obtain a remediation level for the site. Integration with other management issues should be considered and an appropriate management strategy should be developed.

METHODOLOGY

Prior to the development of a Remediation/Risk Management Strategy, it must be determined whether the field results obtained from Step 3 (Initial Testing Program) and Step 5 (Detailed Testing Program) exceed generic 1999 CCME remediation guidelines. If contaminant concentrations at the site do not exceed the established guidelines, no further action may be required. If contaminant concentrations meet or exceed the generic guidelines, the process summarized in Figure 5 may be used to develop (1) a Remediation Strategy and/or (2) a Risk Management Strategy.

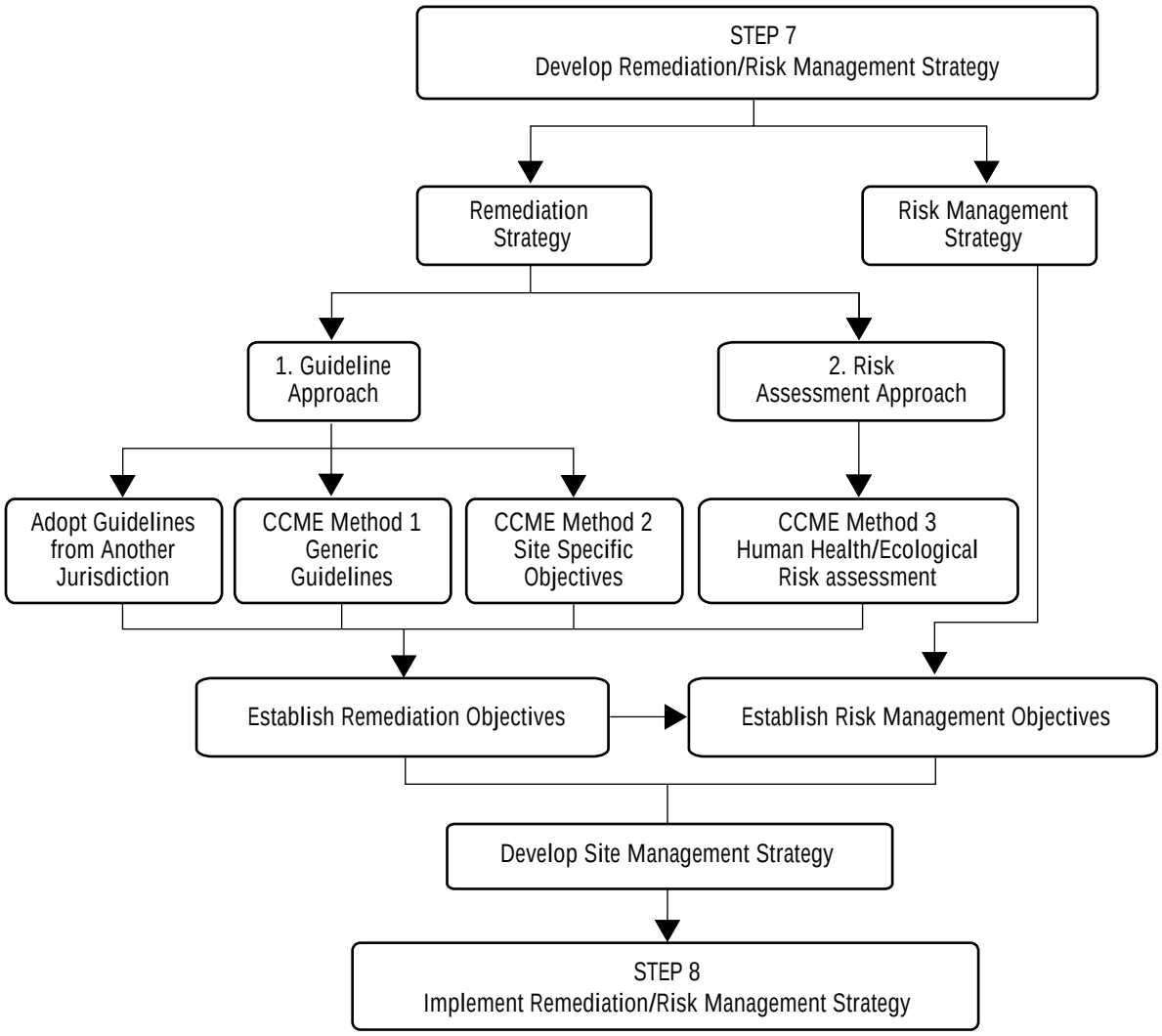
A) Remediation Strategy

The process of developing numeric remediation objectives that will protect both human health and the environment necessitates appropriate use of both generic and site-specific information. As shown in Figure 5, there are two approaches to development of remediation objectives for a site:

- the Guideline Approach; and
- the Risk Assessment Approach.

Because contaminated sites can present specific conditions that are not always accounted for in the development of “generic” guidelines, site-level information must be taken into account when applying guidelines at a site. The process of applying environmental quality

Figure 5 Stages in the Development of a Remedation/Risk Management Strategy (Step 7)



guidelines at the site level is known as establishing site-specific remediation objectives. In the Guideline Approach, remediation objectives can either be adopted directly from the published guidelines (CCME Method 1 — Generic Guidelines) or be developed from modifications to the guidelines to take into account site-specific conditions (CCME Method 2 — Site-Specific Objectives). The Risk Assessment Approach involves development of remediation objectives through the use of a site-specific human health and/or ecological risk assessment (CCME Method 3 — Human Health/Ecological Risk Assessment).

Risk Assessment. Risk Assessment is described in the *Proceedings of the Workshop on the Management of Federal Contaminated Sites* (CSMWG, 1997c) as a process that evaluates the likelihood that adverse effects will occur or are occurring as a result of exposure to one or more stressors. Risk Assessment is the scientific and technical activity that makes use of a detailed evaluation of hazard and exposure potential at a particular site in order to recommend a remediation level will meet the goals of the Site Management Strategy.

The CCME publication *Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada* (CCME, 1996b) identifies conditions under which the various methods described above may be utilized and provides guidance on the implementation of the methods. Generally speaking, the Guideline Approach requires fewer resources while providing a scientifically defensible basis for protection that is sufficiently flexible to account for certain site-specific factors. The Risk Assessment Approach can be more complex and more costly, and is generally utilized when a guideline-based approach is not suitable for a site.

Do CCME guidelines exist for the contaminant of concern present at the site?

If the answer to the above question is "yes," the CCME generic guidelines may be adopted directly as the site-specific remediation objectives (CCME Method 1). However, if the answer is "no," adopting guidelines from other jurisdictions is another course of action. If no other guidelines or options are available, in all likelihood a risk assessment will have to be performed to develop site-specific remediation objectives.

2.7.1 The Guideline Approach (CCME Method 1 and CCME Method 2)

CCME Method 1. Guidelines establish conservative, generic numerical concentrations of a contaminant that are considered to be safe (non-toxic) for a broad range of receptors, conditions and regions under defined land uses. Objectives are numerical concentrations selected or derived to define acceptable levels of residual contamination at a specific site. They provide an effective basis for protecting and restoring land and water uses at contaminated sites and are generally viewed by financial institutions as providing the lowest level of risk.

Once the environmental data and evidence for the site are sufficient, following the Initial or Detailed Testing Programs (Steps 3 or 5), it is necessary to assess the degree of contamination at the site. Adopting the generic CCME soil and groundwater remediation guidelines for the relevant land use is the primary approach recommended. The guidelines used for soil and groundwater are the 1999 CCME *Canadian Environmental Quality Guidelines*. If there are no CCME guidelines available, guidelines from other jurisdictions may be adopted.

The following questions need to be answered in order to adopt the generic quality guidelines:

- What are the contaminants?
- What is the current and intended land use?
- What type of media is affected (e.g. soil, groundwater, etc.)?
- Is the groundwater being used for drinking water or agricultural purposes?
- Are the assumed exposure scenarios and receptors significantly different from those defined by the CCME?

CCME Method 2. Adoption of remediation objectives from modified guidelines may be utilized in situations where site conditions, land use, receptors or exposure pathways differ only slightly from the protocols used in the development of the CCME *Recommended Canadian Soil Quality Guidelines* (CCME, 1997c). Due consideration should be given to the following factors:

- natural background levels of priority substances;
- possible movement of contaminants in soil to groundwater, air or dust;
- relevance of the toxicological data that were used to derive the generic guidelines to the site under consideration; and
- land uses and receptors of concern under those land uses.

The circumstances under which the soil quality guidelines can be modified and the methods of modification are explained in the *CCME Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada* (CCME, 1996b). This method should be considered first in the establishment of site-specific remediation objectives before planning the use of CCME Method 3: Human Health/Ecological Risk Assessment.

2.7.2 The Risk Assessment Approach (CCME Method 3)

CCME Method 3. When site conditions are unique or particularly sensitive, performing a risk assessment forms the basis for developing site-specific remediation objectives. A risk assessment approach may be utilized when the generic guidelines or modified guidelines under CCME Method 2 are not suitable for a site and/or

guidelines from other jurisdictions are not available. Other factors of concern that may justify the use of a risk assessment method are:

- it is a large site;
- little information is available about the contaminants of concern;
- land/water use categories may not accurately reflect the exposure pathways at the site;
- sensitive species or habitats are present; and
- costs of remediation to guidelines may be too high.

To determine if risk assessment is appropriate, answer the following questions. If the answer to any of the questions is "yes," a risk assessment may be needed.

- Do you have critical or sensitive habitats (e.g. wetlands)?
- Do you have any transport media for the contaminants (e.g. drinking water supply)?
- Do you have any rare, threatened or endangered species or ecosystems?
- Is the existing or intended land use a natural park or nature preserve?
- Are there one or more chemicals present about which little is known in relation to behaviour and toxicity?
- Are there any unusual site conditions, such as fractured or karstic bedrock or permafrost, lending uncertainty as to the fate of the contaminants?
- Is the nature or thickness of the soil/overburden cover at the site amenable to leaching of contaminants into the bedrock?
- Is there an absence of environmental quality guidelines for the chemicals of concern?
- Are there unusual soil pH conditions (<5 or >9) that may lead to increased mobility of some contaminants?
- Is the cost of remediation to meet remediation objectives established from generic or modified guidelines too high?
- Are there any exposure pathways of the contaminants in the ecosystem that are not considered by the generic guidelines scenarios or that are not understood?
- Will there be a change in the intended land use?

If the following additional site characteristics have not already been identified in Steps 2, 3 or 5, the appropriate action should be taken to collect this information:

- groundwater presence and usage;
- age of people frequenting the site;
- presence of sensitive habitats;
- species of biota that frequent the site;
- land usage of the site — agricultural or residential;
- surrounding land use; and
- presence of basements.

There are two basic types of risk assessment: (1) Human Health Risk Assessment and (2) Ecological Risk Assessment. One or both of these may be required in the development of site-specific remediation objectives. To ensure the protection of both humans (Human Health) and the environment (Ecological), the two types of assessments are required as advocated by the CCME. In situations where both types of risk assessment are used, the lowest site-specific remediation objectives resulting from the assessment process should be selected for the purposes of site remediation.

If a Risk Assessment Approach has been chosen, it is likely that you will have to hire a qualified consultant with the necessary technical and scientific expertise to perform the work. The risk assessment will have to be conducted in accordance with the CCME protocols for ecological risk assessment and human health risk assessment. These include *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* (CCME, 1996a) and *A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life* (CCME, 1991c).

For more information on ecological risk assessment as the basis for developing site-specific remediation objectives, consult the CCME document *A Framework for Ecological Risk Assessment: General Guidance (CCME, 1996c) and A Framework for Ecological Risk Assessment: Technical Appendices* (CCME, 1997a).

A generic Statement of Work for a Quantitative Human Health/Ecological Risk Assessment is included in Appendix C. This Statement of Work will have to be adapted to properly cover the specific aspects encountered at the site.

B) Risk Management Strategy

While the Remediation Strategy developed in Step 7 constitutes the scientific approach towards a site management strategy, it needs to be complemented with a risk management aspect to make the overall site management effective. While the Remediation Strategy (using CCME Methods 1, 2 or 3) will establish which clean-up objectives are most appropriate, the Risk Management Strategy will determine if remedial action is required at a contaminated site. If so, an appropriate remedy will be selected. "Appropriateness" is influenced not only by the degree to which a remedial action reduces risk, but also by the degree that the action meets technical, economic, social and political needs specific to the contaminated site and potentially affected stakeholders.

Risk Management. Risk Management (RM) is the decision-making process in which an action or a policy is developed once a remediation level has been determined. It integrates the Remediation Strategy with technical, political, legal, social and economic considerations to develop risk reduction and prevention strategies. It is the active process of reducing risk associated with a contaminated site to "acceptable" levels or objectives. These acceptable levels are usually defined by regulators in conjunction with site managers, owners and other stakeholders. Generally RM involves a combination of one or more of the following:

- contaminant removal or reduction;
- modifying or limiting use by receptors; and
- interception or removal of exposure pathways.

This ensures that risks to human health and/or the environment are minimized through the effective management of one or more of the three risk components (contaminants, receptors and exposure pathways).

Some of the initial considerations in the establishment of an RM Strategy are:

- departmental mandates and policies;
- solicitation of public and stakeholder input;
- setting protection goals based on land and water use;
- identifying resources and logistics restrictions; and
- outputs from Steps 1 through 6.

The input from decision makers, technical consultants, regulators and other stakeholders is important in the development of an RM Strategy, particularly as it pertains to:

- regulatory permits and approvals;
- public or stakeholder perception and acceptability;
- direct impacts and risks to public and/or worker health and safety;
- direct impacts on the environment;
- risks to the environment;
- other socio-economic impacts (noise, traffic, etc.);
- costs associated with remedial alternatives;
- long-term liability;
- impacts on the value of land or the flexibility of future development options; and
- impacts on or disruption of future operations.

Once the initial management considerations have established the need for remediation and identified the specific problem(s) at the site, a clear statement of the problem requiring further action should be formulated and the goals for site management identified. It is critical that goals be established for the remediation of the contaminated site. The effectiveness of RM decisions can be judged only when the results of these decisions are compared to the goals established for the site.

The remediation objectives for a site need to be established in conjunction with the RM objectives in order to meet site management goals for the current or intended beneficial land use of the site. It may be that at some point there will be no requirement to remediate a site, but simply to monitor it, as part of the RM Strategy. In a property transfer scenario, remediation to intended land use requirements is usually negotiated with the new land purchaser.

C) Cost-Benefit Analysis

Cost-benefit analysis and risk assessment are important components of Remedial Action Plans. A cost-benefit analysis will help to determine the optimum remediation/risk management strategy. In addition, where there are a large number of sites, a cost-benefit analysis will assist in prioritizing the sites for remediation. Primary consideration in prioritizing sites should be given to their NCS score and risk to human health and environment. In

cases where human health or a sensitive environment is affected, the cost-benefit analysis would be used to compare options, not to justify action. Risk assessment is important in cases where human health or a sensitive environment is affected, as described for CCME Method 3 (Risk Assessment Approach).

The following questions establish the framework for any cost-benefit analysis:

- What events, activities or aspects will change as a result of the action?
- What is the estimated value of the environmental and human health benefits that will come about as a result of the action?
- What are the estimated costs associated with and created by the action?
- Given the estimated benefits and costs, is remedial action justified?

Notwithstanding the answers to these questions, the decision-making process might also be driven by difficulties in properly quantifying some of the factors as well as defining the qualitative aspects (i.e. when dealing with sensitive receptors or wetlands).

OUTPUT

A Remediation/Risk Management Strategy is developed for the contaminated site to meet established remediation goals. Both strategies will ensure that the remediation goals are attained more effectively, efficiently and economically.

RELATED DOCUMENTATION

1. Proceedings of the Workshop on the Management of Federal Contaminated Sites (CSMWG), 1997
2. Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada (CCME), 1996b
3. Recommended Canadian Soil Quality Guidelines (CCME), 1997c
4. Canadian Water Quality Guidelines (CCREM), 1987
5. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME), 1996a
6. A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life (CCME), 1991
7. A Framework for Ecological Risk Assessment: General Guidance (CCME), 1996c
8. A Framework for Ecological Risk Assessment: Technical Appendices (CCME), 1997a

2.8 Step 8 — Implement Remediation/Risk Management Strategy

OBJECTIVE

The objective of Step 8 is to implement the Remediation/Risk Management Strategy developed in Step 7. This step includes the following items, which should be examined prior to selection of a technology:

- evaluating applicable technologies, including the use of treatability studies where appropriate. These studies are performed where there is a need to confirm the effectiveness of a particular technology under specific site conditions;
- conducting a cost-benefit analysis;
- preparing a remedial action plan, including a worker health and safety plan and tender documents;
- selecting a contractor; and
- maintaining proper documentation, quality control, and communication with stakeholders during implementation of the remedial action plan.

Which of the preceding items need to be addressed will be dictated by the Site Management Strategy developed as a result of Step 7.

METHODOLOGY

Technology Evaluation

Following the site investigation, it is necessary to determine the remedial options. This step is an essential

part of the decision-making process and provides the justification for any action or inaction and comparison of remedial alternatives. The *CCME Guidance Document on the Management of Contaminated Sites in Canada,* Section 7 (CCME, 1997b) outlines a process for the preparation and implementation of risk management or clean-up plans. Depending on the operational history of the specific site and the complexity of contamination problems, remediation can range from being a straightforward and simple clean-up to a complex, expensive project over an extended period of time. Comprehensive evaluation of alternatives, careful planning of remediation, and controlled yet adaptable implementation will facilitate effective, efficient and economical restoration of a contaminated site.

How do I identify and evaluate remedial technologies?

There are a few general remediation/risk management approaches that can be used to achieve the remediation objectives set in the Remediation/Risk Management Strategy (Step 7). The three main remedial approaches are:

- removal and disposal;
- containment or encapsulation; and
- treatment.

The principal methods of achieving any of the above remedial approaches are:

- *in situ* — contaminated material, such as soil and groundwater, is remediated in place on the site without removal;
- *ex situ* — contaminated material is removed by excavation or pumping, remediated on site and then replaced; or
- off-site — contaminated material is removed by excavation or pumping and transported off site to a licensed facility, for either remediation or disposal.

Any combination of the above may form the Remediation Strategy. The Remediation Strategy selected for a site should be a practical and safe approach to addressing the contaminants of concern. It should be cost effective and should mitigate environmental and health effects. Priority should be given to those technologies which have the potential of minimizing environmental impacts during implementation (construction, digging, hauling, etc.). *Site Remediation Technologies: A Reference Manual* (CSMWG, 1997d) is a good summary of various remediation technologies.

The following questions should be answered to evaluate the remedial technologies for your specific site and contamination matrix:

- What media are affected by the contamination present (e.g. soil, groundwater, surface water, debris, structures, etc.)?
- What is the contaminant type (e.g. inorganic, volatile organics, semi-volatile organics, radioactive materials, etc.)?
- What are the geological, hydrogeological, hydrological, ecological and climatic site-specific characteristics?
- Are there particular site restrictions due to the proximity of buildings, residential neighbourhoods, schools or sensitive receptors or wildlife habitat?
- What are the regulations regarding the substances of concern?

Research on various remedial technologies may be required to assess the effectiveness of the methods proposed for contaminant removal. It is advisable to carry out a literature review to determine the available technologies and their applicability to your site. Environment Canada has many publications that contain technical summary reports on various remediation technologies. Technical summaries are also available on-line from a variety of organizations and agencies including the Ground-Water Remediation Technologies Analysis Center (www.gwrtac.org); Remedial Technologies Network (www.remedial.com); U.S. Environmental Protection Agency Technology Innovation Office (www.clu-in.org); and the Ontario Centre for Environmental Technology Advancement (www.oceta.on.ca).

As there are hundreds of remediation technologies, selection is a demanding process. But keeping in mind the chosen remediation approach and site-specific conditions will narrow the list to a few acceptable alternatives.

Treatability studies, such as a bench scale test or pilot scale test, can be used to evaluate the performance and cost effectiveness of a particular technology on a given contamination matrix.

What should be included in the Remedial Action Plan?

The Remedial Action Plan should:

- summarize all data from previous site investigations;
- identify contaminants of concern;
- identify the media affected;
- identify, quantify and characterize the materials to be treated or removed;
- if required, summarize the remedial options evaluated and describe the methodology used to select the preferred strategy;
- describe in detail the process of remediation using the selected technology;
- detail an implementation plan including schedule and associated costs;
- identify control measures to minimize air emissions, control surface water, and minimize the risk to worker health and safety;
- detail a contingency plan in the event that contaminants are released into the environment;
- identify the fate of residual contaminants; and
- describe remedial verification and long-term monitoring plans.

Who should provide input to the Remedial Action Plan?

Depending upon the complexity and size of the project, you may want to conduct an independent technical review of the Remedial Action Plan, as well as solicit input from the public and stakeholders, such as public interest groups, through a public consultation process or public meetings. You may also want to consult regulatory agencies to determine the need for an environmental assessment in accordance with the *Canadian Environmental Assessment Act* (CEAA) prior to executing the plan, as well as identify regulatory requirements during implementation. In cases involving the partial remediation of a site or implementation of a strategy, regulatory agencies such as Environment Canada and Health Canada should be consulted prior to commencing the work to verify if the approach is acceptable from a regulatory perspective. If not, other alternatives should be examined.

What is included in the selection of a suitable contractor?

Preparing detailed specifications and tender documents and selecting a knowledgeable, experienced contractor is imperative to successful remediation activities. Both the primary contractor and subcontractors must be able to demonstrate previous successful experience using the recommended remediation technology in similar site conditions. A proper health and safety plan should also be developed for the site.

The specification and tender documents should contain the following:

- concise descriptions and specifications that outline each component of the implementation plan if not in the contractor's proposal;
- a clear statement of the Remedial Action Plan objectives;
- pertinent information regarding the site, including geology, hydrogeology, hydrology, surrounding land uses and contaminant distribution; and
- a request for unit rates for additional works that may be encountered but are unforeseen.

In addition, the bidders should be able to visit and walk through the site and have the opportunity to ask questions to the existing or previous site managers and users.

Proposals developed in response to the tender should include:

- a concise description that outlines each component of the implementation plan;
- a detailed work schedule;
- identification of the need for feasibility studies;
- bench scale tests;
- a site monitoring plan;
- deliverables;
- a health and safety plan;
- a quality assurance program;
- a reporting schedule (i.e., progress or status reports from the contractor); and
- a contingency plan.

How do I maintain control during implementation?

During the course of conducting remediation, it is critical to establish and maintain an organized, comprehensive record-keeping and documentation system as part of an overall quality assurance program. Reporting and documentation requirements as well as the chain of responsibilities should be clearly defined in tender and contract documents. Quality assurance activities may be executed by knowledgeable site personnel or a consultant.

Access to a contaminated site should be controlled during the site investigation and remediation. The site control methods used (e.g. fencing, posting of signs regarding restricted access, etc.) will depend on the scale of the project, land use, proximity to neighbouring properties, and site accessibility. Controlling access to the site will help minimize the exposure of workers, protect the public from site hazards, and prevent vandalism.

How should changes in the Remedial Action Plan be addressed?

During remediation, unanticipated developments frequently occur. Therefore, a Remedial Action Plan must be adaptable enough to respond to new site information. The specification and tender documents should include provisions to address these changes.

Changes to a Remedial Action Plan may require:

- increased or reduced treatment system capacity;
- personal protective equipment; and
- monitoring activities.

Depending on the nature of the project and the scope of the changes to the plan, stakeholder consultation or communication may be necessary.

OUTPUT

A definitive Remedial Action Plan that addresses the Remediation/RM Strategy objectives is established and implemented for the site.

RELATED DOCUMENTATION

1. Guidance Document on the Management of Contaminated Sites in Canada (CCME), 1997b
2. Site Remediation Technologies: A Reference Manual (CSMWG), 1997

2.9 Step 9 — Confirmatory Sampling and Final Reporting

OBJECTIVE

The objective of the Confirmatory Sampling and Final Reporting is to ensure that remedial objectives are met following the implementation of a Remedial Action Plan. In addition, the site conditions will be documented in a report for future reference.

METHODOLOGY

For sites that have been remediated or subjected to risk management, the confirmatory sampling is completed to demonstrate that the contamination has been removed or stabilized effectively and that the clean-up objectives have been attained. A final report documents all activities carried out during site decommissioning and clean-up, and includes drawings, records, and monitoring data (relevant in program and confirmatory data).

What are the steps involved in confirmatory sampling?

The following items are included in the confirmatory sampling of a remediated site:

- A sampling of contaminated media (soil and/or groundwater) is conducted to ensure that remediation or risk management objectives have been achieved.
- Sample results are compared with remediation objectives.
- If confirmatory sampling results indicate that remediation objectives were not attained, further remediation may be necessary.
- A final report is prepared to present data collected throughout the remedial process, including a record of sampling events.

- Reports and documents should be retained in perpetuity or until such time as the property is transferred from the federal government portfolio.

The completion of remedial activities and the adequacy of remediation technology is validated by confirmatory sampling. If sample results indicate that the clean-up objectives were not attained, further remediation is required or a change in the remediation technology may be necessary.

Who should conduct confirmatory sampling?

Sampling should be completed by a third party qualified to carry out such work, using standardized and consistent sampling methods. Personnel qualifications should be outlined in a confirmatory sampling plan. The contractor is responsible for covering the costs of the confirmatory sampling to demonstrate that (1) the technology used is adequate and (2) the deliverables (remediation objectives) are met.

Where should samples be analyzed?

Samples should be analyzed by a laboratory with an appropriate quality assurance/quality control (QA/QC) program and accreditation from the Canadian Association of Environmental Analytical Laboratories (CAEAL), the *Ministère de l'Environnement* (MENV) *du Québec* or an organization offering an equivalent level of accreditation. Ensure that consistent analytical methodologies are used, and avoid changing laboratories during the remediation process, if possible. Appropriate numbers of duplicate and blank sample analyses should be undertaken as well.

OUTPUT

Following the confirmatory sampling program, a final report recording sampling results and confirming that remediation/RM objectives were met will be produced. Alternatively, the report may state that there are levels of contamination above those addressed by the remediation objectives and that further remediation is required. Land use restrictions will be documented if the remediation objectives cannot be achieved, or a risk assessment may be performed to demonstrate that residual levels of contamination are acceptable.

2.10 Step 10 — Long-Term Monitoring (Optional)

OBJECTIVE

The objective of Long-Term Monitoring is to confirm that the nature and extent of the remediation activities have been carried out as per the site management goals.

Is long-term monitoring required at my site?

It may not always be possible to clean up a site to a level that results in removal of all significant concentrations of contaminants. This may lead to short- and long-term restrictions on intended land use for the site. The feasibility of clean-up may be limited as a result of:

- limitations in technology;
- accepted operating practices of the industry; and/or
- the nature of the contamination.

Depending on the nature and extent of remedial activities on the site, long-term monitoring may or may not be required. Each site must be evaluated according to potential risks for off-site migration and ongoing impact. Long-term monitoring is always required in cases where remediation activities utilized containment, *in situ* or isolation techniques. Generally speaking, long-term monitoring is an integral part of a Risk Management Strategy and allows the implementation of any contingency plan previously developed for the site.

METHODOLOGY

How do I develop a long-term monitoring program?

If a long-term monitoring program is required, the following questions should aid in its design and implementation.

- What are the key parameters that should be measured? These should be indicative of contamination or of migration of contamination and/or have significant impact on the ecosystem.
- Which sampling locations are indicative of containment status and mobility?
- Are these sampling locations going to be accessible during the sampling period?

- Are there particular, site-specific conditions that may affect contaminant migration, which should also be monitored (e.g. groundwater table elevation)?
- Do current or future land uses on or near the site have the potential to affect the ecosystem? If yes, what are the respective indicator contaminants?
- What is the rate of contaminant mobility and how is this rate affected by the time of year?
- What is the appropriate monitoring duration, based on the rate of contaminant mobility and the potentially affected land uses?
- Is it appropriate for the receptors that were identified in the ecological risk assessment to be sampled for indicator contaminants? If so, their life cycle and migration patterns should be considered.
- What monetary and personnel resources are available to conduct the long-term monitoring?

Monitoring programs must be developed on a site-specific basis, be periodic, and be conducted by qualified individuals. The long-term monitoring program may consist of:

- inspection of on-site containment and treatment facilities;
- groundwater, surface water and atmospheric sampling and analyses;
- inspection of stabilized structures; and
- inspection of restricted site access measures.

How do I interpret the results?

The long-term monitoring results must be evaluated against the site-specific remediation objectives developed in Step 7. In addition to comparing the long-term monitoring results with the remediation objectives, contaminant trends should be identified. A steady increase of a contaminant or an indicator over time could be indicative of contaminant migration or of additional contamination due to on-site or nearby activities. As well, site-specific conditions should be documented during sampling periods, and any possible effects of these conditions on contaminant migration should be noted.

To determine if the results of the long-term monitoring program are satisfactory or if follow-up measures are required, ask the following questions:

- Are there exceedances of the remediation objectives?
- Is there a general trend of increasing contamination concentration over time?
- Have site-specific conditions varied, which could increase contaminant migration?
- Has site redevelopment created an additional receptor or exposure pathway that must be considered?

If the answer to any of the above questions is “yes,” additional investigation, as outlined below, may be required.

What if the Risk Management Strategy needs to be modified?

If monitoring results indicate exceedance of remediation objectives, suitable action would include reporting the exceedances to the appropriate level of management, and re-evaluating the Remedial Action Plan so that the necessary contingency measures can be taken. There may also be a need to consider once again a remediation program through a re-evaluation of the Risk Management Strategy. If the results of the re-evaluation are not adequate, it may be necessary to go back to Step 7: Develop Remediation/Risk Management Strategy or Step 8: Implement Remediation/Risk Management Strategy.

OUTPUT

An optional long-term monitoring program will assess the effectiveness of a Remedial Action Plan identified as part of the Risk Management Strategy for the site.

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APPENDIX A:
Guidance Tools — Steps for Addressing Contaminated Sites

Numerous guidance documents and scientific tools focusing on the management of contaminated sites have been developed for the Canadian Council of Ministers of the Environment (CCME), Environment Canada and Health Canada. The Federal Approach was developed not to replace these tools, but rather to build upon and provide guidance in their implementation and effective use.

The Federal Approach serves as an overview document, linking the use of these tools and documents within the context of the federal contaminated site management process. A summary of the various scientific tools and documents and their application to the Federal Approach is presented below.

Guidance Tools for the Implementation of the Steps for Addressing Contaminated Sites

Guidance Document	Steps for Addressing Contaminated Sites									
	1	2	3	4	5	6	7	8	9	10
Environmental Quality Guidelines, CCME, 1999.			✔		✔	✔	✔		✔	
Procedures for Conducting Human Health Risk Assessments at Contaminated Sites in Canada, Health Canada, 1998.						✔	✔	✔		
A Framework for Ecological Risk Assessment: Technical Appendices, CCME, 1997.						✔	✔	✔		
Guidance Document on the Management of Contaminated Sites in Canada, CCME, 1997.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
A Risk Management Framework for Contaminated Sites, A Discussion Paper, First Draft, Environment Canada, 1997.		✔	✔		✔		✔			
Recommended Canadian Soil Quality Guidelines, CCME, 1997.					✔	✔	✔			
A Framework for Ecological Risk Assessment: General Guidance, CCME, 1996.					✔	✔	✔			
A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines, CCME, 1996.						✔	✔			
Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada, CCME, 1996.	✔	✔	✔							
Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, CCME, 1995.						✔	✔	✔		
Phase 1 Environmental Site Assessment, CSA Z768, Canadian Standards Association, 1994.		✔								
Subsurface Assessment Handbook for Contaminated Sites, CCME, 1994.	✔			✔	✔	✔	✔			
Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites - Volume I: Main Report, CCME, 1993.				✔	✔	✔				
Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites - Volume II: Analytical Method Summaries, CCME, 1993.					✔	✔				

Guidance Tools for the Implementation of the Steps for Addressing Contaminated Sites

Guidance Document	Steps for Addressing Contaminated Sites									
	1	2	3	4	5	6	7	8	9	10
Remediation Technologies Screening Matrix, U.S. EPA, 1993.						✔	✔	✔		
National Classification System for Contaminated Sites, CCME, 1992.		✔	✔							
National Guidelines for Decommissioning Industrial Sites, CCME, 1991.	✔			✔	✔	✔	✔	✔	✔	
Interim Canadian Environmental Quality Criteria for Contaminated Sites, CCME EPC-CS34, 1991.					✔	✔	✔			

APPENDIX B:
Generic Statements of Work for a Historical Review

PURPOSE
This Statement of Work (SOW) covers methods to be used and deliverables to be submitted by a consultant when conducting a Historical Review (also known as a Phase 1: Environmental Site Assessment, as per the Canadian Standards Association) of a suspected contaminated site for the [name of organization].

SITE INFORMATION
This SOW applies to a Historical Review to be conducted at [location]. [This section is to be filled out by the contaminated site manager and should include general information pertaining to the sites being examined. For example, it should include information on known suspected areas of contamination, the types of contaminants that the contractor can be expected to find, key problem areas, etc. This information should be general and will vary in content depending on the number of sites.]

GENERAL
The Historical Review includes compilation and review of sufficient information to identify and evaluate:

- the physical condition of the site and its geology, hydrogeology, facilities and surroundings;
- past and present site processes, operations, waste disposal practices, etc.;
- potential contaminant pathways and key ecological receptors;
- health and safety considerations;
- regulatory agency concerns;
- proposed future land use and adjacent land uses;
- potential problem areas and contaminants of concern; and
- the approximate scope of required site investigations.

REFERENCES
The following references are listed as guidance documents. This is not an all-inclusive list; therefore, the contractor shall ensure that all applicable references are used. Should more current versions become available during the life of the contract, they shall take precedence and be referred to in subsequent work/reports. With the exception of [federal department and section] policy documents and previous assessments completed for the property listed herein, copies of other references will not be made available.

i. [Federal department and section] policy documents;

ii. [Previous assessment reports such as environmental audits, environmental site assessments, environmental baseline studies, well drilling and geotechnical reports]; and

iii. Phase 1 Environmental Site Assessment, CAN/CSA Z768-94, April 1994.

SCOPE OF WORK
To meet the objectives of this mandate, contractors will carry out the following work, subject to site-specific environmental issues or other factors:

1. Compile and review all relevant information, including (but not restricted to) the following sources and types:

- previous reports/documents completed for the property, such as environmental audits, environmental site assessments, environmental baseline studies, well drilling and geotechnical reports (including test pits and borehole logs) for the property;
- geological, hydrogeological, soil and biological reports or surveys;
- aerial photographs and fire insurance plans;
- topographic maps and site drainage plans, including areas of fill or water course realignment;
- water quality records for surface water and groundwater;
- site climatological data (e.g. prevailing winds);

- interviews with current and former employees, as well as individuals with knowledge of the site and surrounding areas;
- facility plans, specifications and drawings;
- drawings and inventories of raw materials, product and fuel storage areas, and transfer points;
- details of waste storage, treatment and disposal areas, and operational and monitoring data;
- departmental and regulatory agency compliance files documenting historical on-site spill events and any remedial activities;
- rare/endangered species registry for the area;
- historical fire plans;
- asbestos and UFFI surveys;
- diagrams of any underground utilities, structures, piping, workings, injection wells or storage tanks, and their operational history;
- laboratory operational practices, chemicals used and waste handling and disposal methods;
- operation and maintenance procedures for all components of the facility, and materials utilized;
- information relating to past or existing equipment containing PCBs;
- pest and weed control practices used on the site, including types of biocides used, application area and disposal practices; and
- pertinent federal, provincial/territorial and municipal regulations.

2. Conduct a site visit to determine any visible signs of contamination and characterize the general extent of contamination.

3. The information gathered during the investigations in paragraph 1 of the present section shall be used by the contractor to determine the following:

- all areas of potential environmental concern located within the current site under investigation;
- the likely contaminants and the periods during which contaminant-producing activities likely occurred;
- locations of all hazardous waste storage or disposal sites that may or may not be contaminated but formerly contained substances of environmental concern;
- the locations of valued ecosystem components (VECs) including potential human and/or animal receptors; and
- the locations of monitoring and drinking water wells including the results of water quality testing.

4. Prepare a report describing the findings of the Historical Review activities. The report shall state whether no further investigation or an Initial Field Testing is warranted. Where the potential for site contamination is indicated by available site information, the report shall describe (a) the contaminant type and sources, and (b) the areas and media of concern that must be addressed by an Initial Field Testing.

SPECIAL REQUIREMENTS

1. Final reports shall be submitted in hard copy number of copies to be specified by Project Manager and/or electronic form (WordPerfect and/or Microsoft Word format), including electronic data copies of all tables and other data as specified by the Project Manager. Information is given in this format with the understanding that it will be used as a basis for subsequent work. Documents may be made available to other firms involved with subsequent proposal calls/tenders at the site.

2. Refer any queries about the project from the public, news media or others to the Project Manager.

3. The Project Manager shall be notified immediately of conditions that pose an imminent threat to human health and the environment.

4. There may be a special requirement for a qualitative preliminary risk assessment, which could be carried out during the course of the Historical Review. [Name of organization] reserves the right to include the requirement for this parallel qualitative risk assessment in the project Scope of Work. Specific requirements for this qualitative risk assessment will be determined by the Project Manager in consultation with the contractor.

GENERAL REQUIREMENTS

1. The Project Manager shall be a person from [name of organization] or a designated alternate.

2. *Work*
   The contractor is responsible for providing the people and resources to fulfil the terms of this SOW, including the necessary qualified personnel, office space, reference documents, data-processing supplies, computers and equipment to interpret the data and produce the final report. [At the discretion of the Project Manager, space may be offered at the site location to compile information. Provide details here.]

3. *Site Visits*
   The contractor is responsible for conducting a site visit of each potential contaminated site to identify immediate hazards, discrepancies in drawings, or surface contamination (e.g. new structures, areas with dead vegetation, or visual contamination).

4. *Liabilities*
   a. The contractor shall assume responsibility for any accident or damage caused by its employees or equipment to [name of organization] property or personnel.
   b. The contractor shall assume responsibility for the security of its equipment and materials during and after working hours. [name of organization] shall not be liable for any vandalism, theft or loss.

5. *Notifications/Permits*
   The contractor shall be responsible for making whatever representations are necessary to the pertinent organizations in order to obtain the maps, engineering reports, aerial photographs and other documents required to fulfil the terms of this SOW. The costs incurred in obtaining these documents shall be borne by the contractor.

6. *Progress Reporting and Meetings*
   a. Progress Reports. Written progress reports [specify page length] shall be provided to the Project Manager as determined by the Project Manager. The progress reports shall include a synopsis of work completed during the latest report period and the projected work plan for the following period. The contractor shall be prepared to meet with the Project Manager and discuss any matter concerning the progress and findings of the site investigation.

   b. Meetings. The contractor shall attend meetings as requested by the Project Manager. Personnel in attendance shall include the contractor's project manager and representative(s) familiar with all technical aspects of the project. The contractor shall prepare minutes of the meetings and send the draft minutes to the [Name of organization] Project Manager for review and approval prior to their dissemination for action. At the discretion of the Project Manager, the contractor may be required to maintain an action item list.

7. *Quality Assurance and Quality Control*
   The contractor is expected to identify and adhere to acceptable quality assurance and quality control (QA/QC) procedures throughout the project. QA/QC measures shall be explicitly identified in the contractor's work plans and project reports.

8. *Health and Safety Program*
   A detailed health and safety plan (HASP) shall be maintained on site at all times. Adherence to the health and safety measures specified in that plan shall be mandatory for all on-site personnel and all site visitors.

9. *Responsibilities and Communication*
   All formal communication (e.g. letters of direction, approvals, etc.) will be between the Project Manager and the contractor.

BIDDERS' CONFERENCE AND PROPOSALS

1. *Bidders' Conference*
   A bidders' conference will be held at [location] on [date, time] to communicate the requirements of the contract and address any concerns of the interested contractors. At the conference, contractors will be given access to the following information:
   a. [name of organization] policy documents;
   b. available site drawings; and
   c. previous environmental reports such as Environmental Baseline Studies (EBS)/compliance audits.

[Where possible, the Project Manager will make hard copies of the relevant information or provide the contractors with the information on computer disc. For information that will not be copied (i.e. environmental baseline studies), a schedule will be developed to permit contractors to view these documents.]

2. *Letter of Interest*
   Contractors wishing to bid on the work shall submit a Letter of Interest to the Project Manager at [location] on or before [date — a minimum of 2 weeks should be given to the contractors to review the pertinent information]. The letter is to provide a condensed version of the technical and management information requested in the full proposal (next section) and an overall cost estimate. The letter shall not be more than six (6) pages in length (3 leaves, double-sided) on 8½" x 11" paper, and the text shall be written in 12 point font. Only the first six pages will be reviewed and scored. The letter will be used to evaluate and select the contractor to carry out the work. If additional information is required prior to making a selection, the four (4) contractors with the highest score will be invited to submit full proposals.

   It is recognized that industry spends a great deal of time, effort and money to develop proposals. By taking this approach, [Name of organization] assures technical credibility and cost effectiveness without asking every contractor to expend time, money and resources to produce full proposals.

3. *Full Proposal [if required]*
   [Time period — 3 weeks is suggested] following the bidders' conference, four (4) contractors will be notified of their eligibility to submit their full proposals to [specified address] on or before [date/time]. The proposal is to be submitted in [three] copies outlining the approach to the Historical Review, a proposed work schedule, a detailed cost estimate for the work and the contractor's relevant experience in carrying out similar work. The proposal should display a logical, structured approach and include the necessary information to address the evaluation criteria.

EVALUATION CRITERIA

1. *General*
   Both the Letter of Interest and full proposal will be evaluated and scored in accordance with the following criteria. Contractors must cover each criterion. Proposals should expand on the requirements stated in the SOW and describe how the contractor plans on meeting the work requirements.

ITEM	CRITERIA	WEIGHT
1.	Understanding of Scope, Objectives and Possible Problems	15
2.	Approach and Methodology	35
3.	Level of Effort	20
4.	Managerial Experience	30
TOTAL		**100**

2. *Technical Proposal*
   a. **Understanding of Scope, Objectives and Possible Problems**. The bidder should demonstrate a comprehensive understanding of the project's scope and objectives. As well, the contractor must demonstrate that direct and peripheral problems have been anticipated. Proposed solutions to anticipated problems must be presented.

   b. **Approach and Methodology**. The proposed approach and methodology should follow an efficient and logical sequence that will fulfil the requirements of the Statement of Work. The proposal should describe the general approach to the historical review and the reference documents that will be used. The contractor should demonstrate its ability to competently evaluate the results and provide meaningful recommendations. A work schedule should show that the project milestones and objectives, both technical and administrative, will be met.

c. Level of Effort. The contractor should show that a sufficient level of effort will be applied to address the technical requirements of the project in an efficient and cost-effective manner. Proposals will be evaluated on their value-for-money, where value is interpreted as the quality and quantity of work to be done in direct support of the project. Full proposals shall include a breakdown of anticipated work by task and quantity, including:

- management and supervision;
- research; and
- disbursements.

3. *Management Proposal*
Managerial Experience. The contractor should demonstrate that its organization, including partners and subcontractors, has the necessary technical and managerial background and experience. Include the background, experience, geographic proximity to the project site and level of involvement by task for each key individual. The contractor should also demonstrate technical background and experience by citing projects of comparable scope and nature that show successful and timely completion (include client references and their points of contact). Indicate other tasks the key individuals may have during the project. The backup for key personnel should be named.

4. *Contractor Selection*
Selection. Selection of the contractor may take place based on the information provided in the Letter of Interest, or, depending on the complexity of the project, it may be necessary to ask contractors to submit their full proposals.

Letter of Interest (LOI). The bidder selected for contract award or invited to submit a full proposal will be the contractor that:

a. addresses each evaluation criterion in sufficient depth to allow proper evaluation;

b. obtains a proposal evaluation score of 75% or higher in each category;

c. meets all the mandatory requirements set out in the Request for Proposal; and

d. obtains the highest final score on 100, which includes both the technical proposal and cost. The technical proposal score obtained following the evaluation will be recalculated in relation to a maximum of 90. The lowest budgetary price will get a score of 10, with the next lowest getting 8, 6, 4, 2 and 0. Contractors should be prepared to commit to the budgetary price.

Full Proposal. If full proposals are requested, the four (4) highest scoring bidders will be asked to submit Full Proposals. Where more than four (4) LOIs score above 75% and where the scores are tightly grouped, up to six (6) bidders will be invited to submit full proposals. The successful contractor will be the one meeting the technical requirements specified in the previous paragraph and obtaining the highest score on 100, including both the technical proposal score and the cost score within the proper budget ceiling of $ [insert average budget price].

APPENDIX C:
Generic Statement of Work for an Initial Testing Program

PURPOSE
This Statement of Work (SOW) has been developed by [name of organization] to solicit consulting services for an Initial Testing Program (also known as a Phase II: Environmental Site Assessment as per the Canadian Standards Association).

SITE INFORMATION
This SOW applies to an Initial Testing Program to be conducted at [location]. [This section is to be filled out by the contaminated site manager and should include general information pertaining to the sites being examined. For example, it should include information on known suspected areas of contamination, the types of contaminants that the contractor can be expected to find, key problem areas, etc. This information should be general and will vary in content depending on the number of sites.]

GENERAL
The Initial Testing Program involves an initial characterization of on-site contaminants and/or identification of off-site contaminant source(s) that may have affected the site. The objectives of the Initial Testing Program are to identify:

- types and concentrations of contaminants, general locations of contamination, and affected areas; and
- detailed soil, geological, hydrogeological and hydrological conditions on and adjacent to the site.

REFERENCES
The following references are listed as guidance documents. This is not an all-inclusive list; therefore, the contractor shall ensure that all applicable references are used. Should more current versions become available during the life of the contract, they shall take precedence and be referred to in subsequent work/reports. With the exception of [contaminated site manager's organization] policy documents and previous assessments completed for the property listed herein, copies of other references will not be made available.

i. [Name of organization] policy documents [if any];

ii. [Previous assessment reports such as environmental audits, environmental baseline studies, well drilling and geotechnical reports that are available from the contaminated site manager's organization, if any];

iii. Draft Phase II: Environmental Site Assessment. CAN/CSA Z769;

iv. Canadian Environmental Quality Guidelines. CCME, 1999;

v. Canadian Soil Quality Guidelines for Copper: Environmental and Human Health. CCME, 1997;

vi. Canadian Soil Quality Guidelines for Pentachlorophenol: Environmental and Human Health. CCME, 1997;

vii. Guidance Document on the Management of Contaminated Sites in Canada, Section 5.3. CCME, April 1997;

viii. Recommended Canadian Soil Quality Guidelines. CCME, March 1997;

ix. Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. CCME, 1996;

x. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. CCME, 1996;

xi. Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products. CCME, August 1994;

xii. Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. CCME, March 1994;

xiii. Subsurface Assessment Handbook for Contaminated Sites. CCME, March 1994;

xiv. Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites, Volumes I and II. CCME, December 1993;

xv. Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products. CCME, March 1993;

xvi. Interim Canadian Environmental Quality Criteria for Contaminated Sites — Remediation Criteria for Soil and Groundwater. CCME, September 1991;

xvii. Guidelines for the Management of Wastes Containing Polychlorinated Biphenyls. CCME, September 1989; and

xviii. Canadian Water Quality Guidelines. CCREM, 1987.

SCOPE OF WORK

To meet the objectives of this mandate, contractors will carry out the following work, subject to site-specific environmental issues or other factors:

1. Design a field sampling and analytical program to characterize potentially contaminated areas identified by the Historical Review (Phase I: Environmental Site Assessment). The proposed program should include (but may not be limited to) the following:

- a Health and Safety Plan encompassing expected site hazards, location(s) and directions to the nearest aid facility, personal safety equipment requirements, personnel and equipment decontamination procedures, exclusion zones and restrictions to public access, site health and safety rules, and preventive measures;
- identification of media to be sampled and appropriate sampling equipment and procedures;
- sample preservation and shipping requirements;
- proposed analytical procedures;
- field and laboratory QA/QC procedures and measures;
- proposed sampling locations, with an explicit rationale for those locations;
- description of test pitting, borehole and monitoring well installation and development procedures;
- screening methods (e.g. photo-ionization detector (PID), olfactory, visual) to be used;
- non-intrusive investigation methods (e.g. geomagnetic, ground-penetrating radar) to be used;
- georeferencing of sample locations (e.g. land survey);
- expected end-point for data (e.g. hydrogeological/contaminant loading model; preliminary volumetric estimate of contaminated material, preliminary ecological risk assessment, etc.);
- communications between the contractor, land owner/tenant (if applicable), and the Project Manager;
- compilation, assessment and integration of any additional data or information; and
- Initial Testing (Phase II) investigation team, with alternates identified for key personnel.

2. After approval by the Project Manager, complete the sampling and analytical program. Prepare a report describing the program results, including a discussion of contaminated zones, the potential for contaminant migration, and effects of off-site contamination.

3. The field work undertaken during the investigations in paragraph 1 of the present section shall be aimed at:

- determining whether surface contamination is present in excess of (CCME) applicable guidelines or any other guidelines identified by the Project Manager by taking surface water and sediment samples from bodies of water in the immediate vicinity of the site (e.g. ponds, rivers, creeks, lakes or other runoff areas);
- determining whether subsurface contamination is present in excess of (CCME, provincial) applicable guidelines by taking subsurface soil and groundwater samples from the areas of potential environmental concern previously identified;
- gathering general information about the site, such as:
  a. soil characteristics;
  b. subsurface geology;
  c. site hydrogeology;
  d. surficial drainage patterns;
  e. location of nearest structures and down gradient monitoring and drinking water wells;
  f. probable source(s) of contamination; and
  g. other relevant topographical information.
- establishing background levels of contamination at sites where on-site contaminant levels exceed (CCME) applicable guidelines or any other applicable guidelines identified by the Project Manager; and
- developing a preliminary conceptual model identifying potential contaminants, exposure pathways and potential receptors of concern.

4. The report shall state whether (a) no further investigation is required, or (b) a Detailed Testing Program is warranted. Where the potential for site contamination is indicated by available site information, the report shall describe (a) the contaminant types, and the sources and extent of contamination, and (b) the areas, media and receptors of concern that must be addressed in a Detailed Testing Program or a Risk Assessment.

SPECIAL REQUIREMENTS

1. Sample location, topographical, hydrogeological gradient, and existing site layout plans included in the report shall be provided in electronic data format (or format specified by the Project Manager). Final reports shall be submitted in hard copy ([number of copies to be specified by Project Manager]) and electronic form (WordPerfect and/or Microsoft Word formats), including electronic data copies of all tables and other data as specified by the Project Manager.

2. Refer any queries about the project from the public, news media or others to the Project Manager.

3. The Project Manager shall be notified immediately of conditions that pose an imminent threat to human health and the environment.

4. Analysis of data will be in relation to agreed CCME guidelines or other guidelines identified by the Project Manager.

5. If remediation is required, determine and evaluate remedial action alternatives, based on the following parameters:
   a. effectiveness in meeting CCME or other criteria as appropriate;
   b. cost (broken down by major activity and type/capacity of equipment required);
   c. safety procedures to be followed during remediation;
   d. monitoring requirements and costs;
   e. reduction of risk as appropriate to site location, site land use(s), and human health and/or ecological receptors;
   f. commercial utilization of proposed technologies, preferably in regard to the geographic area;
   g. compliance of the processes with applicable environmental standards;
   h. acceptability of processes to involved regulatory agencies;
   i. time frame for completion;
   j. the degree of commercialization of the technology and competition expected in remediation contract bids; and
   k. costs, including engineering overhead and all foreseeable uncertainties and contingencies.

6. There may be a special requirement for a qualitative risk assessment, which could be carried out during the course of the Initial Testing Program. [Name of organization] reserves the right to include the requirement for this parallel qualitative risk assessment in the project Scope of Work. Specific requirements for this qualitative risk assessment will be determined by the Project Manager in consultation with the contractor.

GENERAL REQUIREMENTS

1. The Project Manager shall be a person from [Name of organization] or a designated alternate.

2. *Work*

   The contractor will be responsible for providing the people and resources to fulfil the terms of this Statement of Work, including the qualified personnel, office space, reference documents, laboratory and data-processing supplies, and machinery and equipment to:
   a. conduct the initial survey (e.g. geophysical survey, vapour survey, or other innovative techniques) where site conditions warrant;
   b. conduct the field work;
   c. dispose of surplus and contaminated excavated material in approved locations;
   d. take soil, groundwater and surface water samples as appropriate;
   e. ship samples to laboratories;
   f. analyze the samples;
   g. clean up sites on completion of work; and
   h. interpret the data and produce the required deliverables as specified in this SOW.

3. *Liabilities*
   a. The contractor shall assume responsibility for any accident or damage caused by its employees or equipment to [name of organization] property or personnel.

   b. The contractor shall assume responsibility for the security of its equipment and materials during and after working hours [name of organization] shall not be liable for any vandalism, theft or loss.

4. *Notifications/Permits*
   The contractor shall be responsible for making whatever representations are necessary to the pertinent organizations in order to carry out the work required to fulfil the terms of this SOW. The costs incurred in obtaining these documents shall be borne by the contractor.

5. *Progress Reporting and Meetings*
   a. Progress Reports. Written progress reports [specify page length] shall be provided to the Project Manager. The progress reports shall include a synopsis of work completed during the latest report period and the projected work plan for the following period. The contractor shall be prepared to meet with the Project Manager and to discuss any matter concerning the progress and findings of the site investigation.

   b. Meetings. The contractor shall attend meetings as requested by the Project Manager. Personnel in attendance shall include the contractor's project manager and representative(s) familiar with all technical aspects of the project. The contractor shall prepare minutes of the meetings and send the draft minutes to the [Name of organization] Project Manager for review and approval prior to their dissemination for action. At the discretion of the Project Manager, the contractor may be required to maintain an action item list.

6. *Quality Assurance and Quality Control*
   The contractor is expected to identify and adhere to acceptable quality assurance and quality control (QA/QC) procedures throughout the project. QA/QC measures shall be explicitly identified in the contractor's work plans and project reports.

7. *Health and Safety Program*
   A detailed health and safety plan (HASP) shall be maintained on site at all times. Adherence to the health and safety measures specified in that plan shall be mandatory for all on-site personnel and all site visitors.

8. *Responsibilities and Communication*
   All formal communication (e.g. letters of direction, approvals, etc.) will be between the Project Manager and the contractor.

BIDDERS' CONFERENCE AND PROPOSALS

1. *Bidders' Conference*
   A bidders' conference will be held at [location] on [date, time] to communicate the requirements of the contract and address any concerns of the interested contractors. At the conference, contractors will be given access to the following information:

   a. [Name of organization] policy documents;

   b. available site drawings; and

   c. previous environmental reports such as Environmental Baseline Studies (EBS) and environmental assessment or audit reports for the property.

   [Where possible, the Project Manager will make hard copies of the relevant information or provide the contractors with the information on computer disc. For information that will not be copied (i.e. baseline studies), a schedule will be developed to permit contractors to view these documents].

2. *Letter of Interest*
   Contractors wishing to bid on the work shall submit a Letter of Interest to the Project Manager at [location] on or before [date — a minimum of 2 weeks, where possible, should be given to the contractors to review the pertinent information]. The letter is to provide a condensed version of the technical and management information requested in the full proposal (next section) and an overall cost estimate. The letter shall not be more than six (6) pages in length (3 leaves, double-sided) on 8½" x 11" paper, and the text shall be written in 12 point font. Only the first six pages will be reviewed and scored. The letter will be used to evaluate and select the contractor to carry out the work. If additional information is required prior to making a selection, the four (4) contractors with the highest score will be invited to submit full proposals.

It is recognized that industry spends a great deal of time, effort and money to develop proposals. By taking this approach, [Name of organization] assures technical credibility and cost effectiveness without asking every contractor to expend time, money and resources to produce full proposals.

3. *Full Proposal [if required]*
   [Time period — 3 weeks is suggested] following the bidders' conference, four (4) contractors will be notified of their eligibility to submit their full proposals to [specified address] on or before [date/time]. The proposal is to be submitted in [number] copies outlining the approach to the Initial Field Testing Program, the technologies that will be used, a proposed work schedule, and a detailed cost estimate for the work. The proposal should display a logical, cost-effective approach, and include the necessary information to address the evaluation criteria.

EVALUATION CRITERIA

1. *General*
   Both the Letter of Interest and full proposal will be evaluated and scored in accordance with the following criteria. Contractors must cover each criterion. Proposals should expand on requirements stated in the SOW and describe how the contractor plans on meeting the work requirement.

ITEM	CRITERIA	WEIGHT
1.	Understanding of Scope, Objectives and Possible Problems	15
2.	Approach and Methodology	35
3.	Level of Effort	20
4.	Managerial Experience	30
TOTAL		**100**

2. *Technical Proposal*
   a. **Understanding of Scope, Objectives and Possible Problems**. The bidder should demonstrate a comprehensive understanding of the project's scope and objectives. As well, the contractor must demonstrate that direct and peripheral problems have been anticipated. Proposed solutions to anticipated problems must be presented.

   b. **Approach and Methodology**. The proposed approach and methodology should follow an efficient and logical sequence that will fulfil the requirements of the Statement of Work. The proposal should explain how sample results will be obtained and analyzed, how quality assurance and quality control will be maintained, and how the health and safety requirements will be met. The contractor should demonstrate its ability to competently evaluate the results and provide meaningful recommendations. A work schedule should show that the project milestones and objectives, both technical and administrative, will be met.

   c. **Level of Effort**. The contractor should show that a sufficient level of effort will be applied to address the technical requirements of the project in an efficient and cost-effective manner. Proposals will be evaluated on their value-for-money, where value is interpreted as the quality and quantity of work to be done in direct support of the project. Full proposals shall include a breakdown of anticipated work by task and quantity, including:

      - management and supervision;
      - analysis; and
      - disbursements.

3. *Management Proposal*
   Managerial Experience. The contractor should demonstrate that its organization, including partners and subcontractors, has the necessary technical and managerial background and experience. Include the background, experience, geographic proximity to the project site and level of involvement by task for each key individual. The contractor should also demonstrate technical background and experience by citing projects of comparable scope and nature that show successful and timely completion (include client references and their points of contact). Indicate other tasks the key individuals may have during the project. The backup for key personnel should be named.

4. *Contractor Selection*
   Selection. Selection of the contractor may take place based on the information provided in the Letter of Interest, or, depending on the complexity of the project, it may be necessary to ask contractors to submit their full proposals.

Letter of Interest (LOI). The bidder selected for contract award or invited to submit a full proposal will be the contractor that:

a. addresses each evaluation criterion in sufficient depth to allow proper evaluation;

b. obtains a proposal evaluation score of 75% or higher in each category;

c. meets all the mandatory requirements set out in the Request for Proposal; and

d. obtains the highest final score on 100, which includes both the technical proposal and cost. The technical proposal score obtained following the evaluation will be recalculated in relation to a maximum of 90. The lowest budgetary price will get a score of 10 with the next lowest getting 8, 6, 4, 2 and 0. Contractors should be prepared to commit to the budgetary price.

Full Proposal. If full proposals are requested, the four (4) highest scoring bidders will be asked to submit full proposals. Where more than four (4) LOIs score above 75% and where the scores are tightly grouped, up to six (6) bidders will be invited to submit full proposals. The successful contractor will be the one meeting the technical requirements specified in the previous paragraph and obtaining the highest score on 100, including both the technical proposal score and the cost score within the proper budget ceiling of $ [insert average budget price].

APPENDIX D:
Statement of Work for a Detailed Testing Program

PURPOSE
This Statement of Work (SOW) has been developed by [Name of organization] to solicit consulting services for a Detailed Testing Program (also known as a Phase II: Environmental Site Assessment as per the Canadian Standards Association).

SITE INFORMATION
This SOW applies to a Detailed Testing Program to be conducted at [location]. [This section is to be filled out by the Project Manager and should include general information pertaining to the sites being examined. For example, it should include information on known suspected areas of contamination, the types of contaminants that the contractor can be expected to find, key problem areas, etc. This information should be general and will vary in content depending on the number of sites.]

GENERAL
The Detailed Testing Program includes a detailed characterization of on-site contaminants and/or identification of off-site contaminant source(s) that may have affected the site. It should not be carried out unless previous investigations, such as an Initial Testing Program, have validated that:

- contamination is present at the site in concentrations exceeding established guidelines;
- the site has area(s) of environmental concern. Potential exposure pathways exist for contaminants to come into contact with valued ecosystem components (VECs); and
- further investigation is required prior to proceeding with a Remediation or Risk Management Strategy.

The objectives of a Detailed Testing Program are:

- to target and delineate the boundaries of identified contamination;
- to define, in greater detail, site conditions and to identify all contaminant pathways, particularly with respect to possible risk assessment;
- to provide contaminant and other information necessary to finalize environmental quality remediation guidelines or risk assessment; and
- to provide all other information required to develop a Remediation Plan and input to specifications and tender documents.

REFERENCES
The following references are listed as guidance documents. This is not an all-inclusive list; therefore, the contractor shall ensure that all applicable references are used. Should more current versions become available during the life of the contract, they shall take precedence and be referred to in subsequent work/reports. With the exception of [name of organization] policy documents and previous assessments completed for the property listed herein, copies of other references will not be made available.

i. [Name of organization] policy documents [if any];
ii. [Previous assessment reports such as Historical Review report, Initial Testing Program report, environmental impact assessments, environmental baseline studies, well drilling and geotechnical reports that are available from the Project Manager's organization [if any];
iii. Canadian Soil Quality Guidelines for Copper: Environmental and Human Health. CCME, 1997;
iv. Canadian Soil Quality Guidelines for Pentachlorophenol: Environmental and Human Health. CCME, 1997;
v. Guidance Document on the Management of Contaminated Sites in Canada, Section 5.4. CCME, April 1997;
vi. Canadian Environmental Quality Guidelines. CCME 1999;
vii. A Framework for Ecological Risk Assessment: Technical Appendices. CCME, March 1997;
viii. Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. CCME, 1996;

ix. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. CCME, 1996;

x. A Framework for Ecological Risk Assessment: General Guidance. CCME, 1996;

xi. Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products. CCME, August 1994;

xii. Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. CCME, March 1994;

xiii. Subsurface Assessment Handbook for Contaminated Sites. CCME, March 1994;

xiv. Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites, Volumes I and II. CCME, December 1993;

xv. Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products. CCME, March 1993;

xvi. Interim Canadian Environmental Quality Criteria for Contaminated Sites — Remediation Criteria for Soil and Groundwater. CCME, September 1991;

xvii. Guidelines for the Management of Wastes Containing Polychlorinated Biphenyls. CCME, September 1989; and

xviii. Canadian Water Quality Guidelines, CCREM, 1987.

SCOPE OF WORK

To meet the objectives of this mandate, contractors will carry out the following work, subject to site-specific environmental issues or other factors:

1. Design a field sampling and analytical program to further characterize contaminated areas identified by the Initial Testing Program (Phase II: Environmental Site Assessment). The proposed program should include (but may not be limited to) the following:
    - a review of previous Site Investigation Studies such as the Historical Review (Phase I) report and the Initial Testing Program report (Phase II) to determine the site's history, environmental setting and known environmental condition and to identify any gaps in the site's history and land use practices;
    - a Health and Safety Plan encompassing expected site hazards, location(s) and directions to the nearest aid facility, personal safety equipment requirements, personnel and equipment decontamination procedures, exclusion zones and restrictions to public access, site health and safety rules, and preventive measures;
    - the identification of previously undiscovered contaminant zones as a result of the gap analysis, if required, and delineation of both new and previously discovered zones;
    - the assessment of analyzed site contamination levels by comparing contaminant levels with appropriate federal or provincial criteria;
    - development of a thorough knowledge of the hydrology and hydrogeology of the area including soil permeability and groundwater flow gradients;
    - sampling of media using appropriate sampling equipment and procedures;
    - sample preservation and shipping requirements;
    - proposed analytical procedures;
    - field and laboratory QA/QC procedures and measures;
    - proposed sampling locations, with an explicit rationale for those locations;
    - description of borehole and monitoring well installation and development procedures;
    - screening methods (e.g. photo-ionization detector (PID), olfactory, visual) to be used;
    - georeferencing of sample locations (e.g. land survey);
    - assessment criteria;
    - expected end-point for data (e.g. hydrogeological/contaminant loading model; detailed volumetric estimate of contaminated material, preliminary ecological risk assessment, etc.);
    - communications between the contractor, land owner/tenant (if applicable), and the Project Manager;
    - compilation, assessment and integration of any additional data or information;

- identification and evaluation of remedial and/or risk management alternatives appropriate to site conditions, addressing the following considerations as a minimum:

a. expected effectiveness of each alternative in meeting federal regulatory requirements and applicable federal or provincial contaminant criteria;

b. technical feasibility of implementing each alternative;

c. estimated length of time to complete remediation/management of the site; and

d. estimated cost of implementing each remediation/management alternative to completion; and

- detailed testing investigation team, with alternates identified for key personnel.

2. After approval by the Project Manager, complete the sampling and analytical program. Prepare a report describing the program results, including a discussion of contaminated zones, the potential for contaminant migration, and effects of off-site contamination.

3. The field work undertaken during the investigations in paragraph 1 of the present section shall be aimed at:

- determining contaminant concentrations in surface water runoff areas in the immediate vicinity of the site;
- determining background levels of possible contaminants, as well as the natural composition of the soil and groundwater;
- establishing the subsurface geology of the site including the nature, thickness, heterogeneity, lateral extent and continuity of surficial deposits, depth to bedrock, changes in soil stratigraphy, and the presence of underground anomalies;
- establishing the physical and chemical properties of the soil. Sufficient samples should be taken from each stratigraphic unit affected by the contamination to determine the following:

a. effective grain size;

b. soil porosity;

c. soil density;

d. organic carbon content;

e. soil pH;

f. moisture content;

g. microbial density; and

h. chemical characteristics of the soil in terms of electron acceptors, nutrients, and metal content (i.e. SO_4, CO_2, total N_2, NO_2, NO_3, P, K, Fe^{+2}, Fe^{+3}, Mn, Zn, and Cu concentrations).

- establishing the hydrogeology of the site including the depth to the water table, local hydraulic gradient, soil permeability (e.g. slug tests), and the groundwater flow direction;
- establishing the chemical composition of the groundwater;
- characterizing the subsurface contamination by taking soil and groundwater samples at an appropriate number of locations to determine the type, form, concentrations, and horizontal and vertical extent of contamination;
- determining the contaminant sources and the surface and subsurface routes (i.e. past, present and estimated future) for contaminant migration. Retardation factors that may limit the rate of contaminant migration should also be identified; and
- revising the conceptual model of each contaminated site, created during the previous Initial Testing Program, to reflect the environmental knowledge attained during the Detailed Testing Program.

4. The report shall provide recommendations on remedial/risk management measures based on known technology. Recommendations should include the type and capacity of equipment required, the time required to complete the remediation and/or risk management measures, the safety procedures to be practised during implementation of the remediation/risk management measures, and costs broken down by major activity. If the property does not require remediation or risk management of the site contaminants, the contractor shall provide that conclusion in the Detailed Testing Program report.

SPECIAL REQUIREMENTS

1. Sample location, topographical, hydrogeological gradient, and existing site layout plans included in the report shall be provided in electronic data form

(AutoCad 14 [or format specified by the Project Manager]). Final reports shall be submitted in hard copy ([number of copies to be specified by Project Manager]) and electronic form (WordPerfect and/or Microsoft Word formats), including electronic data copies of all tables and other data as specified by the Project Manager.

2. Refer any queries about the project from the public, news media or others to the Project Manager.

3. The Project Manager shall be notified immediately of conditions that pose an imminent threat to human health and the environment.

4. Analysis of data will be in relation to agreed CCME guidelines or other guidelines identified by the Project Manager.

5. There may be a special requirement for a qualitative risk assessment, which could be carried out during the course of the Detailed Field Testing Program. [Name of organization] reserves the right to include the requirement for this parallel qualitative risk assessment in the project Scope of Work. Specific requirements for this qualitative risk assessment will be determined by the Project Manager in consultation with the contractor.

GENERAL REQUIREMENTS

1. The Project Manager shall be a person from [Name of organization] or a designated alternate.

2. *Work*
   The contractor will be responsible for providing the people and resources to fulfil the terms of this Statement of Work, including the qualified personnel, office space, reference documents, laboratory and data-processing supplies, and machinery and equipment to:
   a. conduct the site visit;
   b. conduct the surface and sub-surface investigations (i.e. drill boreholes, take soil samples, and put in place monitoring wells);
   c. dispose of surplus and contaminated excavated material in approved locations;
   d. take appropriate soil, groundwater, surface water and sediments samples;
   e. ship samples to laboratories;
   f. analyze the samples;
   g. clean up sites on completion of work;
   h. interpret the data and produce the required deliverables as specified in this SOW; and
   i. monitoring.

3. *Liabilities*
   a. The contractor shall assume responsibility for any accident or damage caused by its employees or equipment to [Name of organization] property, personnel and monitoring wells.
   b. The contractor shall assume responsibility for the security of its equipment and materials during and after working hours. [Name of organization] shall not be liable for any vandalism, theft or loss.

4. *Notifications/Permits*
   The contractor shall be responsible for making whatever representations are necessary to the pertinent organizations in order to carry out the work required to fulfil the terms of this SOW. The costs incurred in obtaining these documents shall be borne by the contractor.

5. *Progress Reporting and Meetings*
   a. Progress Reports. Written progress reports [specify page length] shall be provided to the Project Manager for periods determined by the Project Manager. The progress reports shall include a synopsis of work completed during the latest report period and the projected work plan for the following period. The contractor shall be prepared to meet with the Project Manager and to discuss any matter concerning the progress and findings of the site investigation.
   b. Meetings. The contractor shall attend meetings as requested by the Project Manager. Personnel in attendance shall include the contractor's project manager and representative(s) familiar with all technical aspects of the project. The contractor shall prepare minutes of the meetings and send the draft minutes to the [Name of organization] Project Manager for review and approval prior to their dissemination for action. At the discretion of the Project Manager, the contractor may be required to maintain an action item list.

6. *Quality Assurance and Quality Control*
   The contractor is expected to identify and adhere to acceptable quality assurance and quality control (QA/QC) procedures throughout the project. QA/QC measures shall be explicitly identified in the contractor's work plans and project reports.

7. *Health and Safety Program*
   A detailed health and safety plan (HASP) shall be maintained on site at all times. Adherence to the health and safety measures specified in that plan shall be mandatory for all on-site personnel and all site visitors.

8. *Responsibilities and Communication*
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   Contractors wishing to bid on the work shall submit a Letter of Interest to the Project Manager at [location] on or before [date — a minimum of 2 weeks should be given to the contractors to review the pertinent information]. The letter is to provide a condensed version of the technical and management information requested in the full proposal (next section) and an overall cost estimate. The letter shall *not* be more than six (6) pages in length (3 leaves, double-sided) on 8½" x 11" paper, and the text shall be written in 12 point font. Only the first six pages will be reviewed and scored. The letter will be used to evaluate and select the contractor to carry out the work. If additional information is required prior to making a selection, the four (4) contractors with the highest score will be invited to submit full proposals.

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3. *Full Proposal [if required]*
   [Time period — 3 weeks is suggested] following the bidders' conference, four (4) contractors will be notified of their eligibility to submit their full proposals to [specified address] on or before [date/time]. The proposal is to be submitted in [number] copies outlining the approach to the Detailed Testing Program, the technologies that will be used, a proposed work schedule, and a detailed cost estimate for the work. The proposal should display a logical, cost-effective approach, and include the necessary information to address the evaluation criteria.

EVALUATION CRITERIA

1. *General*
   Both the Letter of Interest and full proposal will be evaluated and scored in accordance with the following criteria. Contractors must cover each criterion. Proposals should expand on requirements stated in the SOW and describe how the contractor plans on meeting the work requirement.

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1.	Understanding of Scope, Objectives and Possible Problems	15
2.	Approach and Methodology	35
3.	Level of Effort	20
4.	Managerial Experience	30
TOTAL		**100**

2. *Technical Proposal*
   a. **Understanding of Scope, Objectives and Possible Problems**. The bidder should demonstrate a comprehensive understanding of the project's scope and objectives. As well, the contractor must demonstrate that direct and peripheral problems have been anticipated. Proposed solutions to anticipated problems must be presented.

   b. **Approach and Methodology**. The proposed approach and methodology should follow an efficient and logical sequence that will fulfil the requirements of the Statement of Work. The proposal should explain how sample results will be obtained and analyzed, how quality assurance and quality control will be maintained, and how the health and safety requirements will be met. The contractor should demonstrate its ability to competently evaluate the results and provide meaningful recommendations. A work schedule should show that the project milestones and objectives, both technical and administrative, will be met.

   c. **Level of Effort**. The contractor should show that a sufficient level of effort will be applied to address the technical requirements of the project in an efficient and cost-effective manner. Proposals will be evaluated on their value-for-money, where value is interpreted as the quality and quantity of work to be done in direct support of the project. Full proposals shall include a breakdown of anticipated work by task and quantity, including:

      - management and supervision;
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   Managerial Experience. The contractor should demonstrate that its organization, including partners and subcontractors, has the necessary technical and managerial background and experience. Include the background, experience, geographic proximity to the project site and level of involvement by task for each key individual. The contractor should also demonstrate technical background and experience by citing projects of comparable scope and nature that show successful and timely completion (include client references and their points of contact). Indicate other tasks the key individuals may have during the project. The backup for key personnel should be named.

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   Letter of Interest (LOI). The bidder selected for contract award or invited to submit a full proposal will be the contractor that:

   a. addresses each evaluation criterion in sufficient depth to allow proper evaluation;

   b. obtains a proposal evaluation score of 75% or higher in each category;

   c. meets all the mandatory requirements set out in the Request for Proposal; and

   d. obtains the highest final score on 100, which includes both the technical proposal and cost. The technical proposal score obtained following the evaluation will be recalculated in relation to a maximum of 90. The lowest budgetary price will get a score of 10, with the next lowest getting 8, 6, 4, 2 and 0. Contractors should be prepared to commit to the budgetary price.

   Full Proposal. If full proposals are requested, the four (4) highest scoring bidders will be asked to submit full proposals. Where more than four (4) LOIs score above 75% and where the scores are tightly grouped, up to six (6) bidders will be invited to submit full proposals. The successful contractor will be the one meeting the technical requirements specified in the previous paragraph and obtaining the highest score on 100, including both the technical proposal and the cost score within the proper budget ceiling of $ [insert average budget price].

APPENDIX E:
Generic Statement of Work for Human Health and/or Ecological Risk Assessment

PURPOSE
This Statement of Work (SOW) has been developed by [Name of organization] to solicit consulting services for a Human Health and/or Ecological Risk Assessment at suspect contaminated sites.

SITE INFORMATION
This SOW applies to a Human Health and/or Ecological Risk Assessment to be conducted at [location]. [This section is to be filled out by the Project Manager and should include general information pertaining to the sites being examined. For example, it should include information on known suspected areas of contamination, the types of contaminants that the contractor can be expected to find, key problem areas, etc. This information should be general and will vary in content depending on the number of sites.]

GENERAL
The Human Health and/or Ecological Risk Assessment includes an assessment of the risks posed by soil, groundwater, sediment and surface water contamination on human or ecological receptors. It may be carried out concurrently with either the Initial Testing Program or the Detailed Testing Program if it is established early in the contaminated site management process that Risk Assessment is warranted. The objectives of the Human Health and/or Ecological Risk Assessment are:

- to address significant ecological concerns that cannot be addressed otherwise;
- to close unacceptable data gaps such as:
  a. exposure conditions that are particularly unpredictable or uncertain;
  b. lack of information about receptors; and
  c. high degree of uncertainty about hazard levels; and
- to address site characteristics that are not amenable to other contaminated site management strategies.

REFERENCES
The following references are listed as guidance documents. This is not an all-inclusive list; therefore, the contractor shall ensure that all applicable references are used. Should more current versions become available during the life of the contract, they shall take precedence and be referred to in subsequent work/reports. With the exception of [project manager's organization] policy documents and previous assessments completed for the property listed herein, copies of other references will not be made available.

i. [Project Manager's organization] policy documents [if any];

ii. [Previous assessment reports such as Historical Review report, Initial and Detailed Testing Program reports if available, environmental impact assessments, environmental baseline studies, well drilling and geotechnical reports that are available from the project manager's organization, if any];

iii. Guidance Document on the Management of Contaminated Sites in Canada, Section 6.2.1.2. CCME, April 1997;

iv. A Framework for Ecological Risk Assessment: Technical Appendices. CCME, March 1997;

v. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. CCME, March 1996;

vi. Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites. CCME, March 1996;

vii. A Framework for Ecological Risk Assessment: General Guidance. CCME, March 1996;

viii. A Framework for Ecological Risk Assessment at Contaminated sites in Canada: Review and Recommendations. Environment Canada, 1994;

ix. Framework for Ecological Risk Assessment. United States Environmental Protection Agency (U.S. EPA), 1992;

x. CCME Environmental Quality Guidelines 1999; and

xi. Risk Assessment Guidance for Superfund — Volume 1: Human Health Evaluation Manual. United States Environmental Protection Agency (U.S. EPA), 1991.

SCOPE OF WORK

To meet the objectives of this mandate, contractors will carry out the following work, subject to site-specific environmental issues or other factors:

1. Conduct the Risk Assessment to determine the significance of contamination at the site(s) of concern;

2. Review the results of previous testing programs to verify that a contaminant exposure pathway exists that may present a human or ecological health concern. For each contaminant, pathway and receptor of concern the contractor shall:
   - review previous information about the site and gather the necessary data to conduct the Human Health and/or Ecological Risk Assessment;
   - conduct an exposure assessment to establish the complexity of the Risk Assessment, appropriate exposure amortization, characteristics of receptors, and the bio-availability of contaminants (as appropriate). The pathways by which individuals, flora or fauna may come in contact with the contaminants of concern will be identified and their exposure will be quantified;
   - conduct the toxicity assessment by classifying the contaminants of concern, establishing the toxicity assessment end-points for ecological receptors, and developing exposure limits, concentration limits and/or potency factors for contaminants of concern, as appropriate; and
   - conduct the risk characterization using equations appropriate to the contaminants of concern, provide a sample calculation of the results, and conduct an evaluation/interpretation of the risk estimates.

3. Based on the results of the previous investigations and the Risk Assessment, the contractor shall indicate the following:
   - if a human health risk exists at the site (i.e. Numerical Cancer Risk estimate is greater than 1×10^{-6});
   - if an ecological risk exists at the site based on discussions with regulatory agencies (i.e. Hazard Index is greater than 1);
   - whether the risks can be mitigated through the implementation of a risk management strategy;
   - whether the site will self-remediate over the long term through natural processes such as bioremediation;
   - whether site remediation is required; and
   - whether completion of remediation project is justified, and why.

4. After approval of the work plan by the Project Manager, complete the Risk Assessment process. Prepare a report, making recommendations regarding the action required at the site. If no unacceptable risk is found and there is evidence that the contaminants are naturally degrading, the contractor should indicate that no further work is required. The contractor shall also provide a rationale for the conclusions made in the Risk Assessment.

5. The work undertaken during the Risk Assessment shall be aimed at:
   - meeting the requirements laid out in the present Statement of Work by taking a logical, structured and cost-effective approach;
   - conducting a review of pertinent documentation related to the site to avoid repetition. The contractor shall also conduct an inspection of the site, noting any changes since the time of the earlier reports. The information gathered should be used to develop an understanding of the potential risks to human and ecological health, based on the types of contaminants, hydrogeological and topographical information, soil characteristics, habitat, habitat adjoining the property, and the current and proposed future land use of the site;
   - conducting an Exposure Assessment of the site(s). This involves determining the concentrations of contaminants in the appropriate environmental media in terms of either a point estimate (e.g. mean, 95th percentile, maximum) or a probability distribution function if a probabilistic approach has been chosen. The contractor shall amortize the exposure to the scenarios under investigation and characterize the receptors concerning the exposure

factors. Several steps in the Exposure Assessment will involve discussions with appropriate [Name of organization] personnel and regulatory officials to establish acceptable parameters for the assessment;

- conducting a Toxicity Assessment of the site(s). For human health risk assessments, this involves classifying each of the contaminants of concern with regard to their potential toxicity or carcinogenicity. For ecological risk assessments, the contractor will propose appropriate assessment end-points for the site, for discussion with the [Name of organization] Project Manager and appropriate regulatory officials. The contractor shall identify Toxicity Reference Values or Concentration Limits for human health assessments or derive limits using standard protocols if appropriate regulatory limits are not available. In the case of ecological assessments, the contractor shall identify or develop appropriate Toxicity Reference Values or Concentration Limits based on receptors of concern; and
- determining the risks associated with exposure to contaminants on the site for both ecological and human receptors as appropriate. Risks will be calculated as Hazard Quotients or Indices, Numerical Cancer Risk Estimates, or Exposure Ratios. The contractor shall evaluate and interpret the risk estimates and provide sources of uncertainty in the Risk Assessment process. The contractor shall also provide a sample calculation of risk estimates for both a threshold and non-threshold response contaminant.

6. The report shall outline the procedures, rationales and assumptions made during the assessment, and will clearly state the combinations of contaminants, receptors and pathways that may constitute a health risk. A Conceptual Model of the contaminant source, release mechanism, transportation and fate mechanisms, exposure media, exposure route and receptors will be included in the report for the contaminants that present an unacceptable health risk. The contractor shall make recommendations with regard to the action that should be taken at the site. If multiple sites present unacceptable health risks, the contractor shall prioritize the sites based on their associated risks. If it is determined that the site does not present an unacceptable health risk, the contractor shall recommend, with an appropriate rationale, to cease action at the site.

SPECIAL REQUIREMENTS

1. All new and existing site layout plans included in the report shall be provided in electronic data form (AutoCad 14 [or format specified by the Project Manager]). Final reports shall be submitted in hard copy ([number of copies to be specified by Project Manager]) and electronic form (WordPerfect and/or Microsoft Word formats), including electronic data copies of all tables and other data as specified by the Project Manager. Information, data, drawings, etc., gathered as part of the project shall be made available only to [name of organization] unless otherwise approved in writing by a representative of [name of organization]. The information, data, drawings, etc., provided will be used by the [name of organization] as it sees fit.

2. Refer any queries about the project from the public, news media or others to the Project Manager.

3. The Project Manager shall be notified immediately of conditions that pose an imminent threat to human health and the environment.

4. Analysis of data will be in relation to agreed CCME guidelines or other guidelines identified by the Project Manager.

GENERAL REQUIREMENTS

1. The Project Manager shall be a person from [Name of organization] or a designated alternate.

2. *Work*
   The contractor will be responsible for providing the people and resources to fulfil the terms of this Statement of Work, including the qualified personnel, office space, reference documents, laboratory and data-processing supplies, and machinery and equipment to:
   a. conduct the Human Health and/or Ecological Risk Assessment; and
   b. submit required reports and deliverables.

3. *Liabilities*
   a. The contractor shall assume responsibility for any accident or damage caused by its employees or

equipment to [Name of organization] property or personnel as a result of the contractor's activities.

b. The contractor shall assume responsibility for the security of its equipment and materials during and after working hours. [Name of organization] shall not be liable for any vandalism, theft or loss.

4. *Notifications/Permits*
The contractor shall be responsible for making whatever representations are necessary to the pertinent organizations in order to carry out the work required to fulfil the terms of this SOW. The costs incurred in obtaining these documents shall be borne by the contractor.

5. *Progress Reporting and Meetings*
   a. Progress Reports. Written progress reports in the form of 1- to 4-page faxes shall be provided to the Project Manager for periods determined by the Project Manager. The progress reports shall include a synopsis of work completed during the latest report period and the projected work plan for the following period. The contractor shall be prepared to meet with the Project Manager and to discuss any matter concerning the progress and findings of the site investigation.

   b. Meetings. The contractor shall attend meetings as requested by the Project Manager. Personnel in attendance shall include the contractor's project manager and representative(s) familiar with all technical aspects of the project. The contractor shall prepare minutes of the meetings and send the draft minutes to the [Name of organization] Project Manager for review and approval prior to their dissemination for action. At the discretion of the Project Manager, the contractor may be required to maintain an action item list.

6. *Quality Assurance and Quality Control*
The contractor is expected to identify and adhere to acceptable quality assurance and quality control (QA/QC) procedures throughout the project. QA/QC measures shall be explicitly identified in the contractor's work plans and project reports.

7. *Health and Safety Program*
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