SUSTAINABLE BROWNFIELDS REDEVELOPMENT

by

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ABSTRACT

This study outlines and describes the best process to use in Brownfields Redevelopment, particularly from the perspective of stakeholder engagement. The purpose of the process is to guide companies, government, and communities in the planning and implementation of sustainable Brownfields Redevelopment.

Brownfields are defined as abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination. Statistics show there are over 2,900 brownfield sites across Canada, of these 2,900 an estimated 1,000 are high-risk sites.

Brownfield sites often contain contaminants, which cause damage to human health and the environment. The three basic approaches for remediating a contaminated site are:

- Clean-up to background standards
- Clean-up to generic standards
- Clean-up to risk-based standards

The focus of this study is on the risk based approach since, it not only protects human health and the environment, but in most cases it is more economically feasible then the background or generic approaches for larger sites.

To achieve effective and efficient brownfields redevelopment, there are three critical elements that need to be addressed:

- Site Identification and Characterization
- Remediation Plan
- Public Involvement Program

Based on these three elements, the best contemporary practices, and current standards and guidelines available, a sustainable Brownfields Redevelopment process is presented. The process is an optimum process that describes the numerous decisions and activities that have to occur for each step of a Brownfields Redevelopment.

In order to verify this process and ensure its accuracy and practicality it is assessed against one of Canada's largest Brownfields Redevelopment, the Moncton Shops Project. There are many strengths to CLC's efforts at the Moncton Shops Project, and many lessons learned. A public survey was conducted, confirming the overall project is a success when viewed from the perspective of stakeholder "buy-in". The Moncton Shops Project is a model for New Brunswick and Canada of sustainable Brownfields Redevelopment that provides enduring environmental, social and economic benefits to a community.

These abandoned and contaminated lands must be recycled, since redevelopment provides economic, social, and environmental benefits; the cost of inaction is enormous. The optimum process presented in this study can be used by, companies, government, and communities as a guide to the planning and implementation of sustainable Brownfields Redevelopment.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Purpose

The purpose of this study is to determine the best process to use in Brownfields Redevelopment, particularly from the perspective of stakeholder engagement. The result is a process to guide companies, government, and communities in the planning and implementation of sustainable Brownfields Redevelopment. The process will integrate scientific, economic, environmental and social factors, thus guiding Brownfields Redevelopment in a way that achieves the following goals:

- To use contemporary scientific information and practices in risk analysis;
- To design clean-up objectives that are protective of the environment and human health (environmental factor);
- To provide remediation that is cost efficient (economic factor); and
- To gain acceptance by all stakeholders (social factor).

To achieve sustainable Brownfields Redevelopment the needs, visions, priorities, and interests of diverse people and cultures within a community needs to be addressed. It is not simply a technical or scientific challenge. (Cormick et al, 1996).

This study began with the review of existing literature, past practices, knowledge and opinions of decision-makers and authorities, to establish an optimum process to be used in future Brownfield Redevelopments. In order to integrate the practical application of sustainable development into Brownfields Redevelopment projects, much focus was on cleanup approaches and stakeholder engagement. Chapter 1 provides the background information relevant to the research methodology. Chapter 2 defines Brownfields Redevelopment. Chapter 3 describes the alternate approaches to establishing criteria to govern Brownfields Redevelopment. Chapter 4 describes past practices in public involvement activities and successful approaches. Chapter 5 identifies an effective and efficient approach to Brownfields Redevelopment. Chapter 6 suggests a generic process to guide sustainable Brownfields Redevelopment. The work by Canada Lands Company (CLC) at the Moncton Shops was reviewed and the process was critiqued against the generic sustainable Brownfields Redevelopment process developed in Chapter 6. Also, a survey was conducted to test the success of CLC's public involvement efforts and identify the lessons learned. Chapter 7 provides the analysis of 'The Moncton Shops Project' case study. Chapter 8 provides a summary and conclusion of the report.

1.2 Research Methodology

The approach adopted for this study was to collect, review and analyze as much information about Brownfields Redevelopment within the boundaries set by budget and schedule. The information gathering techniques employed included literature reviews, interviews and an analysis of one case study. Three sources of data and information were used to support this study:

Telephone Interviews

Telephone interviews were conducted with two consultants. They provided an overview of Brownfields Redevelopment from their own perspective, and provided advice on obtaining relevant resource information (literature, websites).

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Literature Review

Applicable literature pertaining to sustainable Brownfields Redevelopment was reviewed from various sources that included: the United States Environmental Protection Agency (USEPA) publications, Canadian government publications and documents, Canadian Council of Ministers of the Environment (CCME) reports, Canada Lands Company (CLC) studies and reports, American Standard for Testing and Materials (ASTM) reports, and the internet. The literature review was essential in analyzing past practices to identify strengths and weaknesses and for the development of the sustainable Brownfields Redevelopment process.

Case Study

Canada Lands Company (CLC) made it possible to examine the work on the Moncton Shops project, which is a leading edge example of Brownfields Redevelopment in Canada. The study involved the collection of information and review of the following:

- Preliminary site specific visit and follow-up visit
- In-person and telephone interviews
- CLC Literature
- Survey

2.0 WHAT ARE BROWNFIELDS?

2.1 What are Brownfield Sites?

The dynamics of an industrial economy produces cycles of business expansion, depression, and decay. At the lowest phase of these cycles, facilities that once housed manufacturing activities are often abandoned, leaving dormant contaminated sites. A century of industrialization has resulted in thousands of acres of abandoned or underutilized sites in urban areas throughout Canada, the US and other parts of the world (Table 2-1).

Table 2-1. Number of Brownfield Sites in the US, Canada & European Communities

Issue	United States	Canada	European Community
Estimated Number of Sites	450,000 sites	2,900 sites	-Germany 144,000 sites -The Netherlands 110,000 sites -UK 50,000-100,000 sites

Source: Salamone, T., *Setting the Scene for Investment in Brownfields. The International Public Policy Context.* Redeveloping Brownfields: A Difference Conservation – Proceedings of an International Symposium (Toronto: Ontario, 1998), A10.

The U.S. and many European countries have a far greater number of Brownfields than Canada. The fact that American and European industry began to flourish a century before Canada significantly increased the number of potentially contaminated industrial sites. There are currently more than 2,900 Brownfield sites in Canada, which are described in Appendix A. These sites exist in virtually all settings across the country, of these 2,900 an estimated 1,000 are high-risk sites (Dillon, 1996).

The definition of Brownfields is 'abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination' (Zausmer, 1998:1). They may be as small as a vacant 0.10 hectare corner service station with remaining underground storage tanks, or as large as several hundred hectares of abandoned factory land that may have dumped wastes on its property (Zausmer, 1998). Brownfields include such locations as decommissioned refineries, railway yards, abandoned gas stations, and dilapidated warehouses (Appendix B). Often, the sites (DELCAN, 1996):

- Are vacant or have buildings with little or no value;
- Are part of a former traditional industrial area;
- Are surrounded by urban development;
- Have a location associated with railways or harbours;
- Are near lakes or waterways;
- Are near downtowns; and,
- Have servicing infrastructure (e.g. roads, watermains, and sewers) in place.

Brownfields are largely due to past industrial practices that resulted in environmental degradation. Brownfields are also the result of the political, social, and economic history of the country (Gordon, 1998):

- Much of the former control of industry and the government was in the hands of an elite few with only a concern for their personal agendas;
- Lack of understanding about the effects of uncontrolled emissions; discharge of contaminants from industry was viewed as acceptable;
- A decline in demand for certain goods/services, causing manufacturing facility closures;
- Relocation of factories within the country and from Canada to other countries;
- Introduction of new industrial technologies;
- Competitive pressures on companies to cut costs, including costs of running large plants and facilities; and
- Cut back on public spending.

2.2 Brownfields Redevelopment

2.2.1 Definition

The definition of Brownfields Redevelopment is:

> Brownfields Redevelopment is development of an underutilized site that exhibits economically remediable contamination of its soils and groundwater and is located in a setting where existing services are readily available. A Brownfield Redevelopment would, except for the contamination issue, as far as planning and land use reasons are concerned, represent a desirable location for revitalization of the urban core at the same or higher land uses than presently exist on the site (Dillon, 1996).

2.2.2 Benefits Achieved by Brownfields Redevelopment

Brownfields sites are increasingly being seen as redevelopment opportunities. Through cooperative effort among stakeholders, many Brownfields sites are being redeveloped into facilities that support both the immediate neighborhood and the community as a whole.

There are many reasons why Brownfield sites should be redeveloped. Redevelopment of Brownfield sites (USEPA, 1996a):

- Makes use of existing municipal services such as transportation, sewer, water and utilities, and thus, generally makes it more cost effective to develop a Brownfield site than to develop a new suburban site;
- Contributes to the rejuvenation of the urban core;
- Reduces human health and environmental threats;
- Averts potential orphaning of a site;
- Restores property tax revenues to benefit the community and its ratepayers;
- Discourages urban sprawl;
- Reduces the need for energy-intensive transportation;
- Brings vitality and safety to otherwise underused inner-city areas;
- Prevents future contamination;
- Creates jobs; and
- Improves the aesthetic appearance of the surrounding community (Brownfields are often 'eyesores').

The redevelopment of Brownfield sites provides economic, social, and environmental benefits (Table 2-2); the cost of inaction is enormous. Left undeveloped, Brownfield sites generate little or no economic benefits, and are environmentally and socially detrimental to the surrounding communities.

Table 2-2. Potential Benefits of Brownfields Redevelopment

Type of Benefit	Discussion
Environmental Benefits	
Reduced ecological risks	Reductions in risks resulting from contamination and exposures.
Environmental Justice	Socio-demographic benefits of redevelopment.
Prevention/Reduction of air pollution	Due to curbing urban sprawl; most significant as commercial and industrial redevelopment occurs, providing jobs for city residents.
Groundwater protection and flood risk reduction	Due to reduction in urban sprawl; greenfield development replaces absorptive land with impervious surfaces and treated lawns, which can prevent clean rainwater from flowing into aquifers/streams.
Ecosystem and wetland restoration	Redevelopment plans may include wetland restoration and protection within urban areas; due to curbing urban sprawl.
Creation of green spaces	This applies to parks, open spaces, and community gardens redevelopment
Economic Benefits	
Improve labor market efficiency	Increasing urban infill may provide more job opportunities to city residents.
Increased property values in surrounding area and redeveloped Brownfield site	Increased property values will increase neighbouring owners' land values and the city's tax revenues.
Increased tax revenues	Due to returning property to productive use and increasing property values.
Spill-over economic effects	Redevelopment has the potential to improve neighborhood quality and overall business conditions in the area.
Reduces traffic congestion, accidents, & highway costs	Due to reduction in urban sprawl and commuting.
Prevent housing abandonment	Increasing the desirability to live in the city may result from urban infill. Commensurate benefits include avoiding expenses of new construction, preventing crime that often occurs in and around abandoned buildings, and improving the aesthetics in the area.
Increased utilization of existing infrastructure	Reduced pressure to provide infrastructure to outlying areas as urban sprawl is reduced; higher utilization of existing public utilities and transportation in the city.
Social Benefits	
Reduced health risks	Reductions in risks resulting from contamination and exposures.
Increase in easily accessible services	This applies to commercial development; many inner city neighborhoods do not have easy access to grocery stores or other important amenities.
Affordable Housing	For residential development only.
Improved city services	Increases in tax revenues generated by redevelopment may enable the city to provide better public services (e.g. schools, transportation, and recreation).
Restored sense of control & neighborhood empowerment; renewed sense of hope/pride	These types of benefits are most likely to result when there is a high degree of community involvement in Brownfield site cleanup and redevelopment planning.
Aesthetics	Improved appearance and overall neighborhood quality may result from all types of redevelopment projects (e.g. parks, open spaces, and community gardens).

Source: USEPA (United States Environmental Protection Agency). *An Integrated Approach for Brownfield Redevelopment.* U.S. Environmental Protection Agency, Urban and Economic Development Division – Office of Policy, Planning and Evaluation (Washington DC., 1996) pp. 47-51.

2.2.3 Challenges to Brownfields Redevelopment

The largest challenge to sustainable Brownfields Redevelopment is to ensure the public health and the environment are protected, while ensuring the redevelopment of the sites are economically feasible and productive.

According to Gordon, 'efforts to promote the redevelopment of Brownfield properties have resulted in conflict between environmental and developmental interests. The environmentalists hope to ensure that property developers assess the full costs of remedying environmental damages. However, developers are looking to redevelop sites at the lowest possible cost within the boundaries of legislation'. (Gordon, 1998:1)

At the crux of a public policy dilemma over how best to clean up Brownfields is a simple economic truth: Brownfields are competing against 'greenfields', parcels of land previously unused by industrial or commercial companies. 'Greenfields', lying on the outskirts of communities, offer lower land prices, lower taxes, and no clean-up costs. In terms of cost effectiveness, greenfield development is often preferable to Brownfield Redevelopment, since a developer cleaning up a Brownfield site may face (Gordon, 1998):

- Expensive site studies and clean-up costs;
- Complex regulations;
- Uncertain liability for past activities on the property;
- Urban issues, including crime, decaying utilities, deteriorating roads, possible contentious neighbors; and
- Future liabilities of contamination left on site or not identified.

3.0 ALTERNATIVE APPROACHES TO ESTABLISHING CLEANUP CRITERIA

3.1 Introduction

Brownfield sites often contain contaminants, which cause damage to human health and the environment. The potential effects of these contaminants on humans range from minor physical symptoms to life threatening diseases such as cancer. If a site does not pose a threat to humans, it still may have a serious impact on the environment. Brownfield sites can release contaminants, which can kill fish, impair the reproduction of birds, and contaminate the food web.

Prior to 1965, clean-up standards for contaminated sites were not protective of human health or the ecosystem (Imperial Oil, 1994). However, as environmental awareness grew in the sixties and seventies, the government reacted to increasing political pressure to protect the environment. During 1965 to 1985, the government began to address the contaminated land issue and set stringent standards for soil and groundwater quality (Imperial Oil, 1994). These standards went beyond protection of human health. Once the significant costs of remediating contaminated sites to these standards were identified, prospective purchasers avoided sites with soil contamination, and financial institutions adopted a non-participatory approach because of liability.

It wasn't until after 1985 that changes were made to clean-up standards (Imperial Oil, 1994). It was realized, that contaminant levels significantly in excess of background could often be tolerated by humans and the environment (Slmcleod Consulting, 1996). Therefore, after 1985, the goal of developing cleanup standards was to (BC MELP, 1997a):

- Ensure Environmental Protection – provide consistent ways to ensure that human health and the environment are protected;
- Establish Flexible Standards – provide practical options to ensure that soil remediation and contaminated soil relocation meet provincial standards; and
- Ensure cost efficiency.

Standards are the 'measuring stick' for contaminants in soil, surface water and groundwater. They tell us about the quality of the environment and determine 'how clean is clean' (BC MELP, 1997b). Standards for protecting human health and the environment are based on best-known science and political factors. A range of clean-up guidelines and regulatory standards exist across jurisdictions.

The three basic approaches for remediating a contaminated site are (Dillon, 1996):

- Clean-up to background standards – the background approach remediates the site to rural or urban background levels for the contaminants of concern;
- Clean-up to generic standards - the government establishes risk assumptions which may vary according to the proposed site use; and
- Clean-up to risk-based standards - developed using site-specific data and risk assessment tools.

3.2 Background Approach

The background approach involves the restoration of a site to naturally occurring background conditions, or ambient soil concentrations. Use of this approach will lead to restoration of the site to pre-contamination levels. This approach may be used at any contaminated site. Natural background concentrations or ambient levels of a chemical do not usually cause adverse effects (MOEE, 1996a).

The background criteria may be used when (MOEE, 1996a):

- Generic criteria for a particular land-use designation are not provided
- The site has been identified as a potentially sensitive site, which requires use of criteria more protective than the generic criteria, and a proponent does not wish to undertake a risk based approach

3.3 Generic Approach

The generic approach involves the use of criteria reflecting soil and groundwater quality developed to provide protection against the potential for adverse effects to human health, ecological health and the natural environment. The criteria has been developed using environmental exposure models which rely on conservative or protective assumptions about exposure to contaminants (MOEE, 1996a). However, many of the criteria for soil are not scientifically defensible and are now being updated based on current scientific information (CCME, 1997b).

The generic criteria may not always be appropriate for use at all sites. Potentially sensitive sites, because of unique physical site conditions, or because of the presence of unique site receptors, may require a higher level of protection than that provided through the assumptions used in the development of the generic criteria (MOEE, 1996a). Also, the generic criteria should only be used at sites where the site characteristics and exposure scenarios are compatible with the generic criteria, otherwise, the background approach or risk-based approach should be used.

3.4 Risk Based Approach

The risk-based corrective action approach is a framework that combines site assessment information, risk assessment, risk management and corrective action. This approach may involve the following (MOEE, 1996a):

(1) Modification of one or more of the components used in the development process for generic criteria to reflect site specific characteristics.
(2) A more comprehensive risk assessment and risk management process.

It uses site-specific information to assess health risks and to set cleanup goals according to those risks and to the proposed land use. There are no minimum clean-up levels with this approach; in other words, some contamination may be left in place if it poses no significant risk to human health or the environment. To have a risk, there must be exposure to the contaminant of concern. Without exposure there can be no risk, regardless of the toxicity of the contaminant (Johnson, 1998).

The risk-based corrective action process utilizes a tiered approach, in which assessment and remedial activities are appropriately tailored to site-specific conditions and risks (RBCA, 1997). It is based on three tiers – beginning at the first tier, then progressing to higher tiers if warranted. By progressing through each tier, the activities of subsequent tiers become more focused and efficient (Begley, 1996).

Some of the benefits to the risk-based approach are:

- It may reduce the price of cleanup and eliminate threats to human health and the environment (NSEIA, 1999).
- At some sites, it is impossible or impractical - due to technological, physical or financial constraints - to remove contaminants. The risk-based approach addresses the on-site management of contamination to ensure that they do not constitute a hazard to human health or the environment (Golder Associates Ltd., 1998).

One key weakness to the risk based approach is increasing the acceptable risk levels by leaving some contamination on site. While the approach offers short-term savings to the developer, contamination left on site does require ongoing monitoring to meet commitments and obligations to future generations (Slmcleod Consulting, 1996). Future research may determine that human health and the environment are more sensitive; or that a contaminant is more harmful than previously known; or the land use may change requiring future generations to re-do the clean-up at higher costs than that of the initial clean up (Slmcleod Consulting, 1996).

There are also administrative requirements when using the risk-based approach (MOEE, 1996a):

- A community based public communication plan should be developed and implemented.
- A qualified independent peer reviewer must review the documentation, including scientific references, scientific judgement and any identified areas of uncertainty associated with the risk assessment.
- A risk management plan must be provided that contains procedures for ongoing monitoring and maintenance of control measures, and procedures for ensuring corrective action will be taken in future if required. Corrective action may include repair, replacement, or removal of the control measure, or of the substance posing the adverse effect if control measures fail to achieve the desired reduction/elimination of exposure levels.

Risk Assessment

Ibbotson states that 'risk assessment is a tool that was seldom used until 1988 to evaluate and predict the severity of existing and potential future impacts from contaminants on site' (Ibbotson, 1998: Personal Interview). Although risk assessments are unique to the site for which they are prepared, every risk assessment will provide the following information (BC MELP, 1997c):

- Documentation of the contaminants location and the extent of any contamination occurring on and off site;
- Estimation of the size and likelihood of risks and hazards to human and non-human receptors on and off site; and
- Documentation and evaluation of the effectiveness of proposed contamination management.

The fundamental goal of a risk assessment is to estimate levels of risk to human and environmental health. It is important to stress that the mere presence of a contaminant at a site does not necessarily constitute a risk. In order for a risk to exist, the following three basic conditions must be met (BC MELP, 1997c):

- Contaminants must be present;
- These contaminants must have the potential to cause toxic or other adverse biological effects – that is, contaminants must be hazardous; and
- Pathways by which humans, animals or plants (receptors) may be exposed to contaminants must exist.

Risk Management

Risk management techniques do not reduce or remove contaminants through treatment, destruction or disposal but are usually (Atlantic PIRI, 1999):

- Institutional controls such as zoning, deed attachments governing land use or short term limitations on site activities, or
- Engineered controls that manage or control contaminants (caps, cutoff walls, hydraulic containment barriers).

3.5 Comparative Analysis

With limited resources to cleanup Brownfield sites (i.e. time, money, regulatory oversight, qualified professionals, and remediation technology), selecting a cleanup approach must be evaluated to ensure it protects human health and the environment, and is cost effective. Table 3-3 identifies the strengths and weaknesses of each approach.

Table 3-3. Strengths and Weaknesses of Cleanup Approaches

Issue	Background	Generic	Risk-Based Approach
Risk	(+) No risk	(+) Low risk	(+) Acceptable level of risk Uses site specific information to assess risks and focuses cleanup goals specifically on those risks
Soil Criteria	(+) Soil criteria are based on soil sampling and analysis of surrounding virgin land	(-) Soil criteria may not be scientifically defensible & may require updating based on current scientific information	(+) Soil criteria are based on most current scientific information
Contaminant	(+) No contaminants left on site	(+) No contaminants left on site	(-) Contaminants may be left on site
Time	(-) Slow cleanups	(-) Slow cleanups	(+) Fast cleanups
Cost	(-) Very costly for large, complicated sites	(-) Costly for large, complicated sites	(+) Cost savings for large, complicated sites Cleaning up to SSTL based on site conditions may reduce cleanup costs by as much as 60%
Size	(+) Best applied to smaller, less complicated sites	(+) Best applied to smaller, less complicated sites	(-) Very costly for small, less complicated sites
Flexibility	(-) No financial or technical flexibility	(-) No financial or technical flexibility	(+) Great financial & technical flexibility For example - onsite management of contaminants
Future	(+) Ensures no future cleanup will be required	(+) Very unlikely that future cleanup will be required	(-) Potential future cleanup may be required (additional cost in the future)
Stakeholders	(+) No stakeholder involvement is required	(+) No stakeholder involvement is required	(-) Demands a high level of stakeholder involvement
Peer Review	(+) Peer review is not required	(+) Peer review is not required	(-) Peer review may be required
Monitoring	(+) No ongoing monitoring	(+) No ongoing monitoring	(-) Requires risk management plan – includes ongoing monitoring

(-) Weakness (+) Strength

An approach needs to be selected that ensures environmental responsibility and makes economic sense. Based on a comparison of the three approaches, the background approach presents no risk, but is the least favorable approach because it can be very costly and time-consuming.

Developers favour the risk-based approach, which involves tailoring standards to the requirements of specific sites, rather than applying generic criteria on all properties. The risk-based approach can save considerable time and money while allowing flexibility. The generic approach is often very conservative and can hinder the redevelopment of Brownfields, allowing little flexibility.

When comparing two case studies - the Pacific Place (Vancouver) and the West Don Lands (Ataratiri, Toronto) sites - it is evident that the risk-based approach of Pacific Place led to a successful redevelopment while the generic clean-up criteria approach of Ataratiri did not (Brown, 1998).

The Pacific Place (a mixed use of development) used a risk-based approach. Consequently, a spot with subsurface contamination, near a leaking underground storage tank (UST), was developed as an underground parkade. The underground parkade's ventilation system (to remove car exhaust and gasoline fumes from the enclosed space) was also designed to vent soil gasses from where the UST was located, as part of a long-term reclamation plan (Brown, 1998).

The West Don Lands project (Ataratiri) required the entire site to be remediated to a generic background level and did not permit variable clean-up standards. As polluted as the site was, there was no evidence that it caused health problems for employees who had worked at the site before it was demolished. The cost to clean up the site to stringent provincial government guidelines for soil quality was an estimated $56 million. The high cost of clean up quickly derailed the Ataratiri project and the redevelopment was stalled indefinitely, leaving a contaminated site with no foreseeable remediation future (McAndrew, 1999).

Another example of successfully using the risk-based approach was at the Toronto Service Centre by Shell Canada. For sixty years, Shell Canada operated a 12-acre blending plant, fuel storage facility, and distribution centre. When Shell was looking to leave the site, an initial site assessment indicated that the principal contaminants were hydrocarbon fuels, pesticides, and traces of arsenic and other heavy metals. The estimated cost to clean up 63,000 cubic metres of soil to meet Provincial clean-up criteria for industrial/commercial use was more than $10 million.

Instead of cleaning up to generic criteria, Shell undertook a risk-based approach for the site. Almost 55,000 tons of soil was removed. Approximately 20% was treated off-site and then returned to the site. The rest of the soil was disposed off-site at a licensed landfill. To prevent off-site migration of contaminants, a gas collection system was installed under the building to collect and dissipate combustible gases. A monitoring system was also put in place.

The risk-based approach decreased the costs of site remediation over clean up to generic criteria by almost 50% without compromising health or safety.

The process developed in this study focuses on the risk based approach since, it not only protects human health and the environment, but in most cases it is more economically feasible than the background or generic approaches for large sites.

4.0 PAST PRACTICES IN PUBLIC INVOLVEMENT ACTIVITIES

In the past, the public was not consulted or involved in the decision-making process. The strategy in the 1960's and 1970's on environmental matters was to 'act secretly' and 'inform the public after all decisions had been made' (En-Quest, 1999). As a result, the general public increasingly began to distrust the politicians, governments, businesses and organizations. They became more aware and educated on how to use power to oppose, delay, and stop projects.

Roberts states that 'today public involvement is a necessity for project success. It is time for the developer to look for ways to bring the public on board and to develop greater buy in for projects' (Roberts, 1998:49).

4.1 What is Public Involvement?

Public involvement is the process of involving the public in a project. It is conducted in order to achieve the following objectives:

- To take into consideration the public's views and priorities;
- To improve the quality and effectiveness of decisions; and
- To enhance the publics' understanding of issues and activities.

Public involvement fosters trust among the public, and may save the developer time and money if the public disallows the initiation, continuation or completion of a project. True public participation, from the earliest stages of a redevelopment project, may prove to be the only effective option if a project is to be successfully completed.

According to Roberts, 'public involvement can be brought about through a series of approaches or techniques that range from consultation to participation, based on the degree to which those involved in the process are able to influence, share, or control the decision-making' (Roberts, 1998:41).

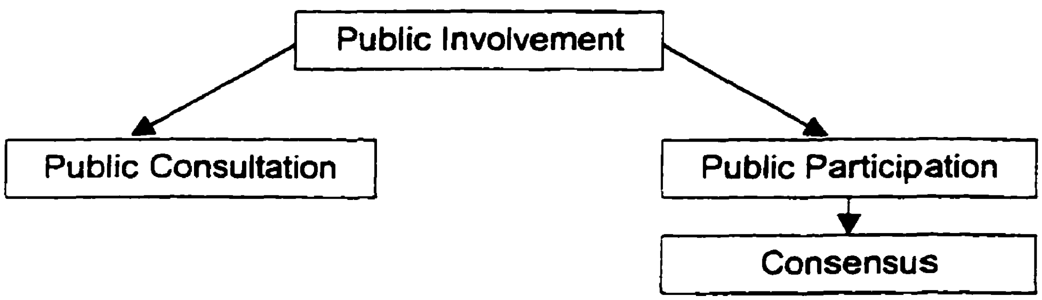


Figure 4-1. Components of Public Involvement

Public Consultation includes education and information sharing; the goal of public consultation is better decision-making by the organization. *Public Participation* brings the public directly into the decision-making process (Roberts, 1998).

4.1.1 Public Consultation

Public consultation is an on-going process of communication and interaction between the organization and the public. A good public consultation program will result in decisions that are sensitive and responsive to public concerns and values (MOEE, 1989).

Public consultation activities are the building blocks of a consultation program. There is no single 'best' consultation activity, since each has its own strengths and weaknesses. The consultation techniques that can be used are (MOEE, 1989):

- Public Information and Feedback
- Public Meetings
- Open Houses
- Workshops
- Toll-Free Telephone Lines
- Site Visits

4.1.2 Public Participation

Public participation allows the public to participate in the project decision-making process. It involves bringing many people with differing views and values to the table. This approach takes time, resources and commitment (Roberts, 1998).

4.1.3 Consensus

Consensus is a state of collective agreement, and the consensus process in Brownfield Redevelopment is one in which all those who have a stake in the outcome aim to reach agreement on actions and outcomes that resolve or advance issues related to environmental, social and economic sustainability (Cormick et al, 1996).

The consensus process is designed to ensure that all significant interests are represented and respected. It enables participants to deal with each other directly, and to give an effective voice to all participants. In terms of results, the consensus process can improve the working relationship of all interested parties and can ultimately lead to better informed, more creative, and more balanced decisions (Cormick et al, 1996). In conclusion, the consensus process ensures that the people affected are involved from the start, in identifying issues, sharing perspectives, and making choices.

5.0 ACHIEVING EFFECTIVE AND EFFICIENT BROWNFIELDS REDEVELOPMENT

5.1 Introduction

There are three key elements of sustainable Brownfields Redevelopment that are critical for achieving effectiveness and efficiency. They are:

- Site identification and characterization
- Planning for remediation
- Engaging the public

5.2 Site Identification and Characterization

The primary objective of this element is to ensure that accurate information has been obtained when conducting site assessments to identify the extent and nature of contamination.

Conduct Site Assessments to Identify Soil Contaminants

The degree of knowledge regarding the presence, type, source, extent, and severity of the contamination directly influences project success (USEPA, 1999). The early identification, accurate and effective characterization of the site is critical to the process of achieving sustainable Brownfields Redevelopment. The more information obtained at this stage, the greater the potential for success becomes. The information includes (USEPA, 1999):

- An accurate delineation of the site location, boundaries, historical use/ownership, and physical characteristics.
- An accurate representation of the nature of the contamination including type of contaminants, source(s), concentrations, location on site, extent and potential for migration, pathways of exposure to the public health and local biota, and relative toxicology or health threat.

5.3 Remediation Plan

In the past, the focus of site cleanup was to reduce the amount of contaminants present with the ultimate goal being the achievement of background levels, or very low criteria (generic criteria). In most cases these approaches were not the most cost effective and prospective purchasers avoided sites with soil contamination.

The potential cost of remediation is a major factor that has the potential to impact the final decision of the cleanup approach. The primary objective of this element is to select a remediation approach that is protective of human health and the environment, and cost effective.

Schwartz states that 'the recent mini-rush to buy Brownfields is partly due to the potential remediation cost savings from the use of a new risk-based tool called Risk Based Corrective Action (RBCA)' (Schwartz, p. 1). Because of RBCA, the Brownfields initiative and redevelopment market has arisen. Ultimately, RBCA may reduce the price of a Brownfield cleanup and reduce threats to human health and the environment. This approach is based on corrective action that is taken to reduce the risks to low, acceptable levels. This may be achieved by reducing the concentrations of contaminants, but may also involve reducing the potential of exposure through the application of engineered and institutional controls.

5.4 Public Involvement Program

Using the risk-based approach to develop site-specific clean-up criteria requires a broad-based public involvement program to provide the public with an opportunity to participate in the risk assessment process and the development of a remedial plan.

> 'A sustainable community needs to be developed by the people who make up the community. It cannot be designed by a consultant. It cannot be implemented by experts hired specifically for the project. It needs to be implemented everyday by the people who live and work in the community' (USEPA, 1998:35).

Sustainable Brownfields development implies that a Brownfields project should, in addition to addressing the problems of contamination at a site, also reflect the desires, values, and long term goals of the community.

An ongoing and meaningful public involvement program will help to reflect the desires and values of the community. To ensure that a sound public involvement program is developed, the following must be established:

- Comprehension of community
- Inform, involve and educate the stakeholders
- Translate scientific and technical information
- Involve the stakeholders as early as possible
- Incorporate community concerns into the decision-making process

Comprehension of Community

The development of information about the community is fundamental to understanding the community's needs, problems, and how the proposed development will ultimately affect the community. Overall, the sustainability of a proposed development depends heavily on the degree of 'fit' between the intended future uses of the site and the community's projected goals for the future (USEPA, 1998).

Techniques that can be used to develop this information include:

- Community surveys using standard questionnaires
- Interviews with community leaders and long-term residents
- Focus groups
- Public meetings

Inform, Involve and Educate the Stakeholders

In order to be sustainable, it is essential to assure that the stakeholders are educated and knowledgeable of the process. A structured mechanism for sharing information about the process with stakeholders and for exchanging information among various groups is a major component of this process. Failure to adequately inform and involve the stakeholders can cause significant delays as a result of public opposition to the project (USEPA, 1998).

Techniques that can be used to inform and educate the stakeholders include:

- Fact Sheets
- Public Meetings
- Open Houses
- Workshops
- Toll-Free Telephone Lines
- Site Visits

Translate Scientific and Technical Information

The key to the sustainability of a Brownfields Redevelopment is to ensure that the scientific and technical results are translated into a context that makes it both accessible and readily understandable to the general public. Complex technical jargon should be effectively translated to enable the general public to understand the common phases and mechanics of the site assessment and remediation process (USEPA, 1998).

Involve the Stakeholders as Early as Possible

It is essential that the stakeholders are involved in the decision-making early in the process and that involvement is maintained throughout the life of the project. The importance of informing and involving the community as early as possible in the process is reflected both in the effectiveness of the outcome and in the degree of confidence the stakeholders have in the process. Experience shows when stakeholders are not included early in the process, they are more likely to resist the decision, oppose its implementation and distrust the organization. Decisions in which stakeholders are involved early in the process are usually more effective and more durable (USEPA, 1998).

Incorporate community concerns into the decision-making process

Although the process must reflect the goals and vision of the stakeholders, the sustainability of the Brownfields project depends on the development of a working consensus among the stakeholders. Thus, the ultimate success of the project depends heavily on the development of a consensus, or 'buy-in', on the part of the community and all relevant stakeholders (USEPA, 1998).

The more directly the stakeholders are involved in the decision-making, the more likely the process will reflect their needs, requirements, goals, and vision of its future.

6.0 SUGGESTED GENERIC DESIGN OF THE PROCESS TO GUIDE BROWNFIELDS REDEVLOPMENT

6.1 Introduction

The end result of effective Brownfields Redevelopment is that local liabilities will be transformed into community assets.

Every Brownfield is unique because of its location, the extent and nature of contamination, and the surrounding political and socioeconomic factors. Due to the number of stakeholders with different objectives and the varying stages at which they become involved, implementation of a Brownfields Redevelopment project is no longer a single process. Instead, it represents an assortment of processes, each requiring its own unique management capabilities, technical and financial expertise, resources and technical tools (USEPA, 1998).

6.2 Synthesized Sustainable Brownfields Redevelopment Process

Four key guidelines and their approaches, listed in Table 6-4, were reviewed and synthesized to develop a six-step process to sustainable Brownfields Redevelopment.

Table 6-4. Key Guidelines and Approaches to Brownfields Redevelopment

Guideline	Approach	Ref
Guideline for Use at Contaminated Sites in Ontario	Step 1: Site Assessment (Phase I ESA) Step 2: Sampling & Analysis (Phase II ESA) Step 3: Remedial Work Plan Step 4: Completion	MOEE, 1996a
Guideline for the Management of Contaminated Sites	Step 1: Initial Notification Step 2: Initial Site Evaluation Step 3: Preparation of a Remedial Action Plan Step 4: Remedial Action Plan Review Step 5: Remedial Action Plan Implementation Step 6: Site Closure	NBDOE, 1999
National Guidelines for Decommissioning Industrial Sites	Phase I: Site Information Assessment Phase II: Reconnaissance Testing Program Phase III: Detailed Testing Program Phase IV: Development of Decommissioning & Cleanup Plans Phase V: Implementation of Site Decommissioning & Cleanup Phase VI: Confirmatory Sampling & Completion Reporting	CCME, 1991
All Canadian Jurisdictions	Step 1: Non-intrusive Assessment Step 2: Intrusive Characterization Step 3: Remediation Design and Implementation Step 4: Verification and Compliance Monitoring	DELCAN, 1996

This synthesis of the 4 guidelines led to identification of the following six steps:

Step 1:	Initial site assessment – Phase I ESA
Step 2:	Site characterization – Phase II ESA
Step 3:	Evaluation of remediation alternatives – Phase III ESA
Step 4:	Develop remediation/cleanup plan
Step 5:	Execute cleanup plan
Step 6:	Closure

Step 1

The initial site assessment or non-intrusive assessment is called a Phase I Environmental Site Assessment. For the most up-to-date and widely used standards for conducting Phase I ESA's refer to:

(i) ASTM (American Society for Testing and Materials) Designation E1527-97 – Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
(ii) ASTM Designation E1528-96 – Standard Practice for Environmental Site Assessments: Transaction Screen Process
(iii) CSA (Canadian Standards Association) Z768-94: Phase I Site Assessment

Step 2

Site characterization or intrusive characterization involves both sampling and analysis. It is often termed a Phase II Environmental Site Assessment. For standards on conducting Phase II ESA's refer to the:

- ASTM (American Society for Testing and Materials) Designation E1903-97: Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process.

Step 3

The evaluation of remedial alternatives or a Phase III Environmental Site Assessment was based on the 'Guideline for Use at Contaminated Sites in Ontario' and the 'Criteria for Managing Contaminated Sediment in British Columbia'. These guidelines outline three approaches to site remediation, which may be used by a proponent when dealing with a contaminated site. The three approaches are background, generic, and risk based (site specific risk assessment).

The risk-based approach or 'tiered approach' is commonly employed in most jurisdictions across Canada and is outlined in the following standards:

(i) ASTM (American Society for Testing and Materials) Designation E1599-94 – Guide for Corrective Action for Petroleum Releases

(ii) ASTM Designation E1739-95 – Guide for Risk Based Corrective Action Applied at Petroleum Release Sites
(iii) Atlantic RBCA (Risk Based Corrective Action) Reference Documentation for Petroleum Impacted Sites Version 1.0.

According to the 'Guideline for Use at Contaminated Sites in Ontario' and 'Criteria for Managing Contaminated Sediment in British Columbia' the Tier III of a Risk Based approach involves conducting a risk assessment followed by risk management. The risk assessment procedure outlined in this process was derived from the following:

- CANTOX Inc CKES 121 Toxicology Course (1997) in Toronto, Ontario
- NSEIA (Nova Scotia Environmental Industry Association in partnership with Atlantic PIRI Committee) Atlantic Canada Risked-Based Corrective Action Training Program – June 1999 in Dartmouth, Nova Scotia.
- EPA – Risk Assessment Guidance for Superfund Report (1989)
- CCME – Recommended Canadian Soil Quality Guidelines (1997)

The key risk management options outlined in this process were derived from the 'Atlantic RBCA (Risk Based Corrective Action) Reference Documentation for Petroleum Impacted Sites Version 1.0' and the 'Guideline for Use at Contaminated Sites in Ontario'.

Step 5

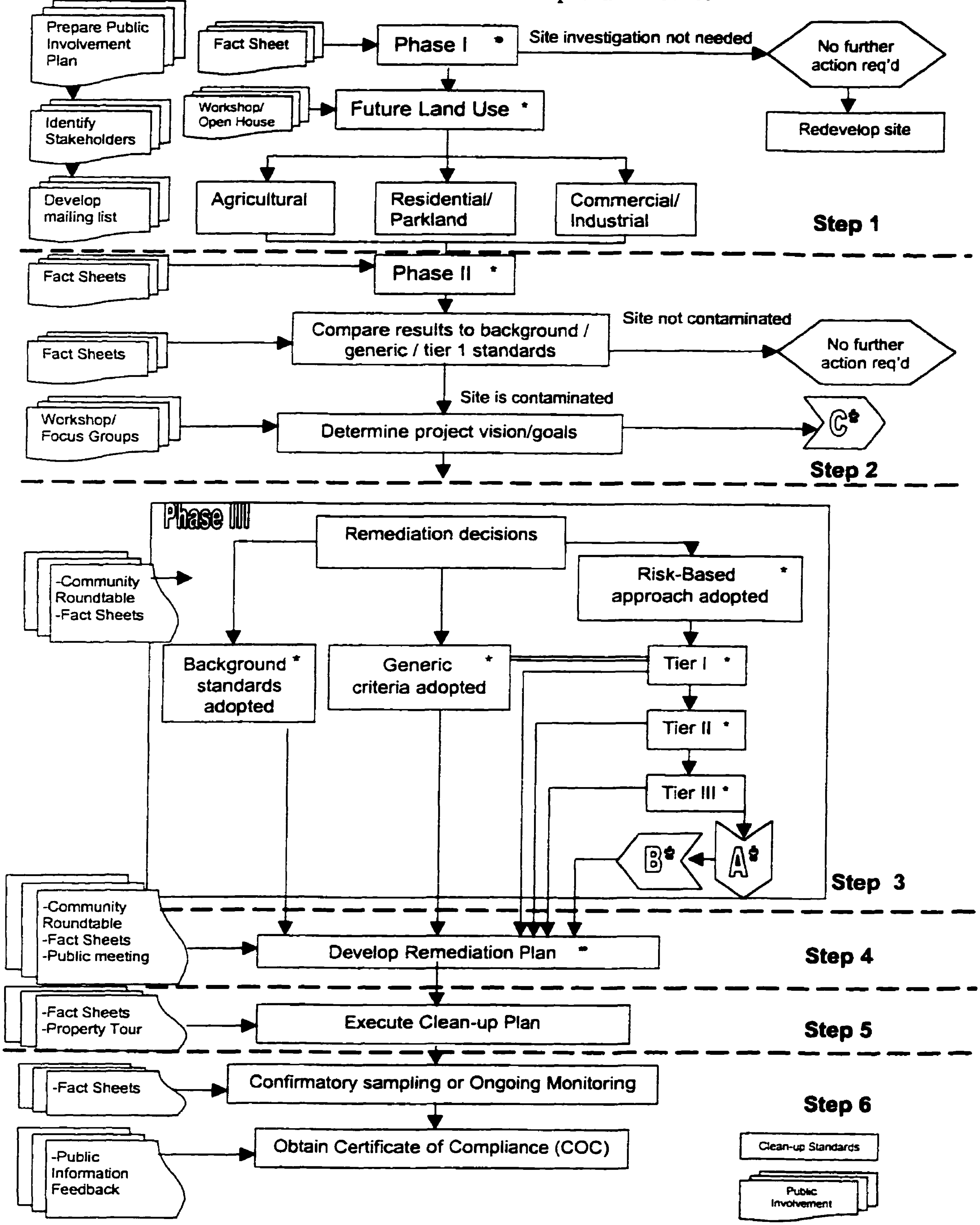
The 'Execute Cleanup Plan' process will be site-specific.

Step 6

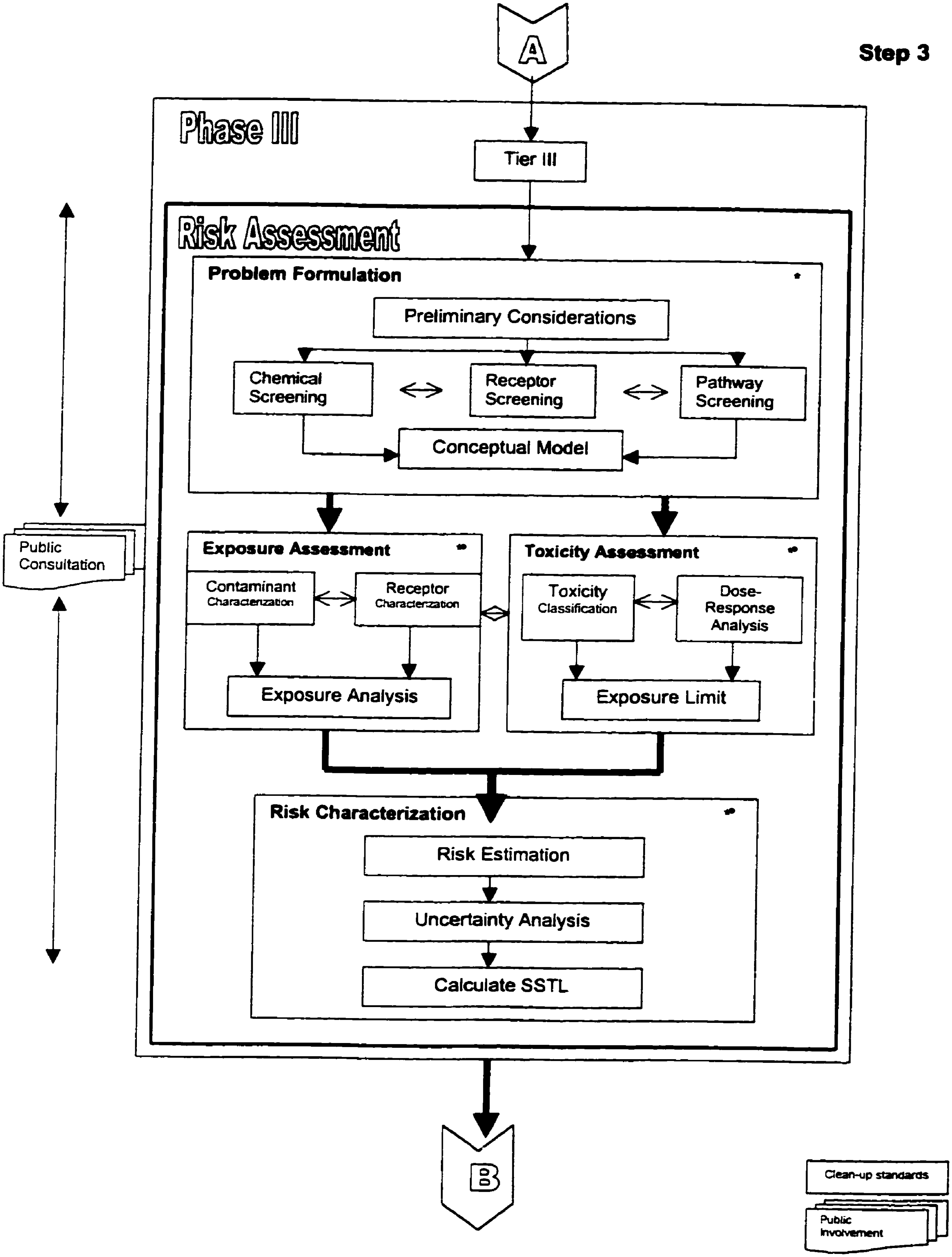
The 'Closure' process will vary by province.

Figure 2, outlines the synthesized generic process to sustainable Brownfields Redevelopment and details of the various elements are found following the figure. Since much of this study focuses on public involvement, each step comments on suggested public involvement activities.

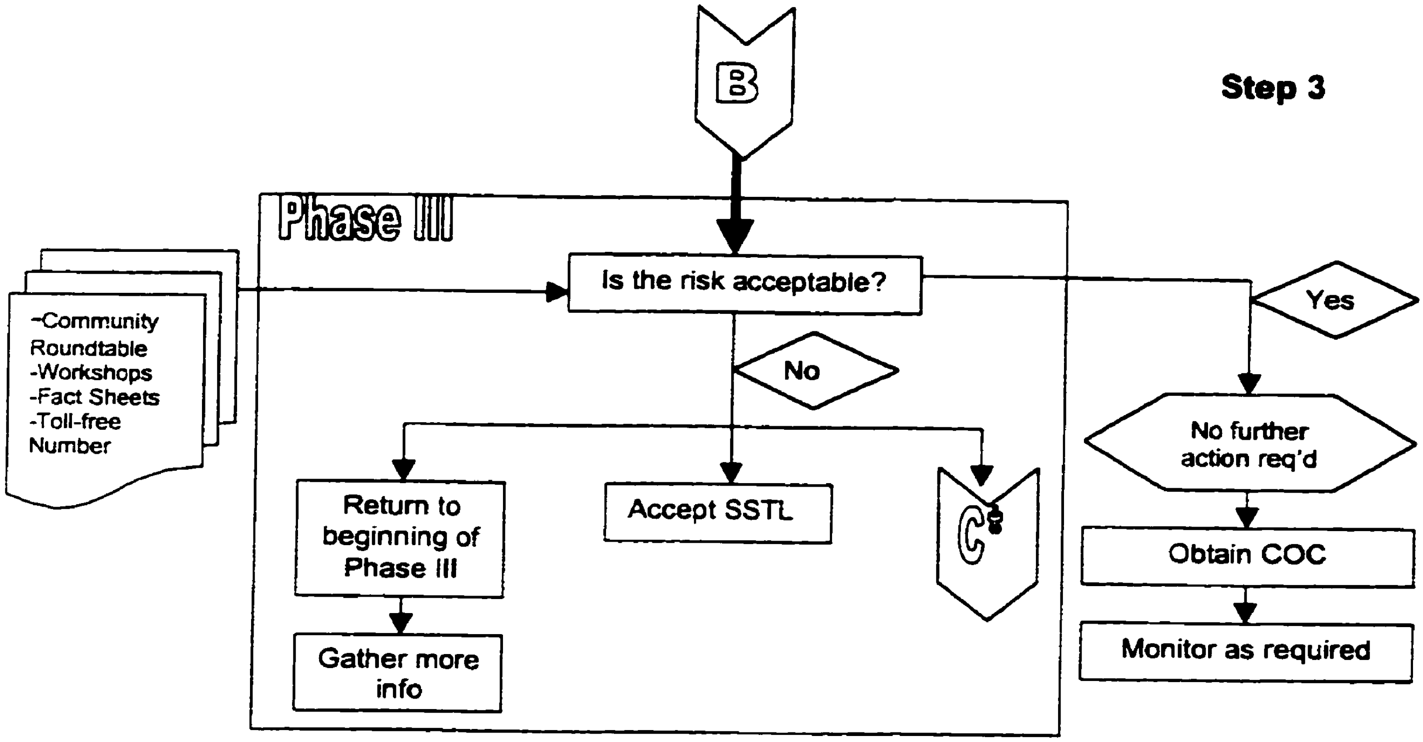
Figure 6-2. Sustainable Brownfields Redevelopment Process



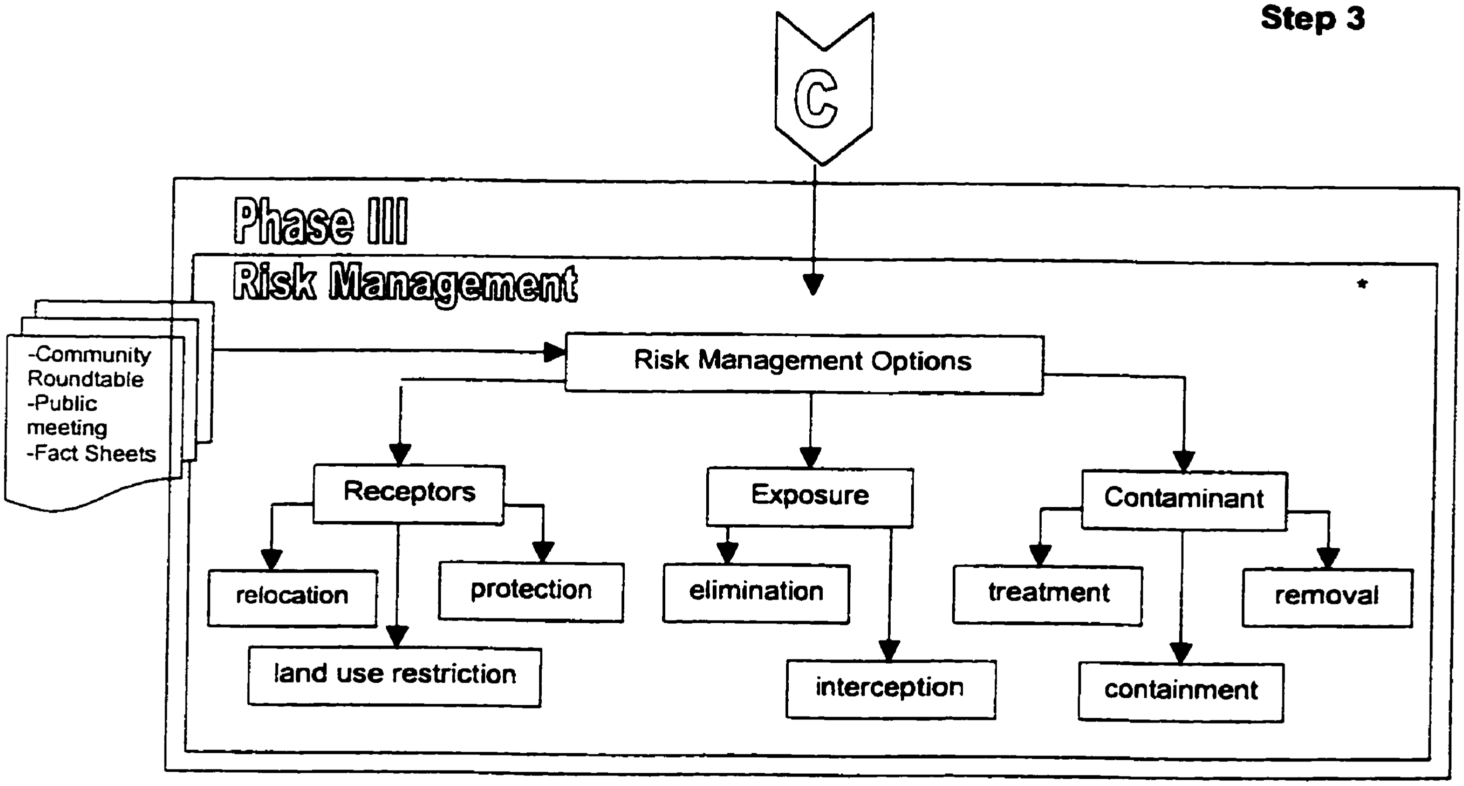
Step 3

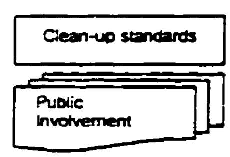

A
Phase III
Tier III
Risk Assessment
Problem Formulation
Preliminary Considerations
Chemical Screening
Receptor Screening
Pathway Screening
Conceptual Model
Exposure Assessment
Contaminant Characterization
Receptor Characterization
Exposure Analysis
Toxicity Assessment
Toxicity Classification
Dose-Response Analysis
Exposure Limit
Risk Characterization
Risk Estimation
Uncertainty Analysis
Calculate SSTL
Public Consultation
B
Clean-up standards
Public Involvement

Step 3


B
Phase III
Is the risk acceptable?
-Community Roundtable
-Workshops
-Fact Sheets
-Toll-free Number
No
Yes
Return to beginning of Phase III
Gather more info
Accept SSTL
C
No further action req'd
Obtain COC
Monitor as required

Step 3


C
Phase III
Risk Management
*
-Community Roundtable
-Public meeting
-Fact Sheets
Risk Management Options
Receptors
Exposure
Contaminant
relocation
protection
land use restriction
elimination
interception
treatment
removal
containment


Clean-up standards
Public Involvement

6.3 Step 1

6.3.1 Initial Site Assessment – Phase I ESA

A Phase 1 Environmental Site Assessment is the initial step in determining whether or not a site is contaminated. Phase I assessments are conducted to answer the question, 'Is it likely that there is some contamination on the site?' (E.P. Systems, 1997:19).

Phase I assessment does not involve digging or testing. Rather, it entails (E.P. Systems, 1997):

- Reviewing all available historical (past 30, 40 or more years) and current site information;
- Visiting the site to see if there are visible problems (e.g. distressed vegetation, 55-gallon drums on site, etc.);
- Discussions with current owners/occupants of the property;
- Discussions with local residents informed about the site and its history;
- Reviewing permits acquired for environmentally sensitive activities (storage tanks, waste incineration); and
- Examining existing records by using topographic maps and aerial photographs that display land contours, elevations.

Phase I assessment will either indicate that the site is clean and no further action is required, or indicate that there is some risk of past contamination, in which case a Phase II assessment will be required.

Appendix C outlines a detailed Phase I checklist.

6.3.2 Identifying Future Land Use

Anticipating the future land use will help determine the appropriate soil and/or groundwater contamination goals, the identification of human and ecological exposure, and the appropriate extent of necessary remediation. Agricultural and residential land uses are more sensitive exposures, therefore a greater level of protection from contamination is adopted than commercial or industrial land uses. These guidelines ensure there will be an acceptable risk to any person - child or adult - engaging in any activity on that soil (BC MELP, 1996). Table 6-5 defines the different land uses and the types of activities that occur on those sites.

Table 6-5. Definitions of Five Land Use Categories

Land Use	Definition
Agricultural	Land where the primary activity is related to food production (land for growing crops and producing livestock). This also includes lands that provide habitat for resident and transitory wildlife and native flora (e.g. transition zones)
Residential	All land permanently, temporarily or seasonally habitated by people. Institutions, hospitals, schools, daycare and playgrounds are also indicated under this land use.
Parkland	All land used for recreation and requiring the natural or human designed capability of the land to sustain recreational activity.
Commercial	Lands where the primary activity is related to commercial operations (e.g. shopping mall) and occupancy is not for residential or manufacturing purposes.
Industrial	Lands where the primary activity involves the production, manufacture or storage of materials.

Source: BCMELP (Ministry of Environment, Lands and Parks), Environmental Protection Department, *Overview of CSST Procedures for the Derivation of Soil Quality Matrix Standards for Contaminated Sites* (Victoria: British Columbia, 1996), p.5.

Examples of sources of information that will aid in determining the anticipated future land use include (USEPA, 1995):

- Visual inspection of the site and its surrounding area
- Discussions with local land use authorities
- Discussions with the public
- Current land use
- Zoning laws
- Population growth patterns and projections
- Site location in relation to urban, residential, commercial, industrial, agricultural and recreational areas

6.3.3 Suggested Public Involvement Activities

The site cleanup activities begin with the initial site assessment. At this stage, it would be important to develop a public involvement plan, identify the stakeholders, and develop a mailing list (USEPA, 1996b). A fact sheet that details the results of the assessment, and proposed future land use should be completed and distributed to individuals on the mailing list. If there is a high level of interest regarding the land use, an open house or workshop should be considered (USEPA, 1996b).

6.4 Step 2

6.4.1 Site Characterization – Phase II ESA

Phase II assessments involve tests to initially indicate the presence of contamination and to address the question 'How much contamination is there on the site?' The assessment includes (E.P. Systems, 1997:19):

1) Collecting isolated individual soil samples on site

There are several strategies for collecting samples, therefore an overall strategy needs to be developed that includes the following (USEPA, 1989):

- Determine sample size
- Establish sampling protocol
  - Random sampling – selecting sample locations in an unbiased manner
  - Systematic sampling – sample locations are established across an area of concern by laying out a grid of sampling locations that follow a regular pattern (a square pattern is often the best test)
- Determine types of samples
  - Grab sample
  - Composite samples

2) Conducting laboratory tests to identify the potential contaminants.

   Note: Environment Canada recommends the use of laboratories certified by the Canadian Association for Environmental Analytical Laboratories (CAEAL).

After comparing the Phase II ESA to generic or Tier 1 standards, it may be concluded that (ASTM, 1998):

(a) The Phase II ESA has provided sufficient information to render that there is no reasonable basis to suspect the presence of hazardous contaminants at the property, or

(b) The Phase II ESA has confirmed the presence of hazardous contaminants.

If the information developed in the Phase II ESA is insufficient to reach either of these conclusions, additional assessments may be required.

6.4.2 Suggested Public Involvement Activities

This element usually marks the possible beginning of the requirement for corrective action. At this stage, it would be appropriate to reevaluate community concerns and the level of public participation and to revise the public participation plan.

Developing and distributing fact sheets is an excellent way to keep in touch with the community. It would be a good idea to issue a fact sheet before the site characterization begins to explain the investigation's purpose and scope (USEPA, 1996b).

To ensure that results are made available to interested stakeholders, a summary of the site characterization should be distributed in the form of a fact sheet or project newsletter. The full report should be made available for review at the public library (USEPA, 1996b).

Community outreach is considered critical to establishing the project vision and goals. Workshops can be held to provide valuable forums for discussing community concerns (USEPA, 1996b). Focus groups should be conducted to assess the community's needs, ideas and goals. Also, focus groups should be considered to gauge public opinion before controversial activities or corrective actions are conducted.

6.5 Step 3

6.5.1 Evaluation of Remediation Alternatives - Phase III ESA

Phase III assessments involve a complete evaluation (including further intrusive investigations, if necessary) sufficient to better characterize the extent and degree of contamination. Phase III determines the remedial objectives by answering the question 'What are the alternative ways of cleaning up this site?' (E.P. Systems, 1997:19).

Background Standards

A contaminated site may be remediated to background concentrations. Background concentration refers to 'the concentration of a substance in an environmental medium in a geographic area, but it does not include any contribution from local human-made point sources' (BC MELP, 1998).

If regional background soil quality estimates for specified substances do not exist, site-specific local background soil quality can be determined by direct comparison to a carefully chosen reference site. The reference site must be free of any possible human-made sources and must be a close match to the contaminated site in the following areas (BC MELP, 1998):

a) Geographical characteristics (e.g. location, topography, size/area, climate, etc.),
b) Soil physical/chemical characteristics (e.g. soil particle size, pH, redox potential, mineral classification, organic carbon/clay content, bulk density, relative soil porosity, etc.), and
c) Hydrology.

In addition, potential background reference sites (BC MELP, 1998):

a) Located within city boundaries should be restricted to vacant land, naturally wooded areas, parks or large residential lots.
b) Must not be located next to or within the general vicinity of obvious contaminant point sources such as industrial facilities, bulk storage yards, etc.
c) With any obvious vegetation damage should be avoided.

Soil samples taken from the reference site and the contaminated site in question should be subjected to identical analyses using, whenever possible, the same chemical analytical laboratory (BC MELP, 1998).

Generic Standards

Generic standards are intended to protect human health and the environment at any site without consideration of site-specific features other than land use. Please see 'Generic based approach/Tier 1' below for more detail.

Risk-Based Approach

The Risk Based Corrective Action (RBCA) tool is based on three tiers, which begins at the first tier and then progresses to higher tiers, if warranted (RBCA Services, 1997). The decision to move to a higher tier is based on answers to the following questions (RBCA Services, 1997):

- Are the assumptions used in a lower tier appropriate, relative to site-specific conditions?
- Are the goals established from a higher tier's analysis likely to be less costly to achieve?
- Is the cost for additional analyses lower than the cost required to achieve the lower tier's goals?

Generic Based Approach/Tier 1

Tier 1 analysis assesses site conditions and contamination. It identifies the main compounds of concern, and the extent of contamination. The site conditions are then compared to generic standards (or risk based screening levels - RBSL) contained in a table (Begley, 1996). At that point, it is decided whether to institute remediation, do nothing, or move on to a Tier 2 analysis.

For the purpose of this report, the focus will be on the Canadian Council of Ministers of the Environment (CCME) generic standards. The CCME developed human health soil quality guidelines for threshold substances and non-threshold substances using the following equations:

(1) Non-carcinogenic Contaminants (Threshold) (CCME, 1997b:169)

$$SQG_{HH} = \frac{(TDI - EDI) \times SF \times BW}{[(AF_I \times IR) + (AF_D \times DR) + (AF_S \times SR)] \times ET} + [BSC]$$

Table 6-6 describes the parameters used in the CCME equation for threshold or non-carcinogenic contaminants.

Table 6-6. CCME Parameters for Non-carcinogenic Contaminants (Threshold)

Variable	Definition	Unit	Explanation/Source
SQG_{HH}	Human health soil quality guideline	mg/kg	
TDI	Tolerable daily intake	mg/kg bw/day	Contaminant specific
EDI	Estimated daily intake	mg/kg/day	EDI is the exposure to normal background levels for a particular contaminant (i.e. not including exposure, which may occur at a contaminated site). If there is no EDI value, a simple 20% apportionment of the TDI to soil would ensure an adequate level of protection.
SF	Soil allocation factor	unitless	
BW	Body weight	kg	Receptor specific
BSC	Background soil concentration	mg/kg	Site-specific
AF_I	Absorption factor for gut	unitless	Soil ingestion, dermal contact, and inhalation rates are multiplied by the corresponding absorption factors (AF), when these data are available. If data is not available, a value of 1 is substituted.
AF_D	Absorption factor for lung	unitless	
AF_S	Absorption factor for skin	unitless	
IR	Soil ingestion rate	kg/day	Receptor specific
DR	Inhalation rate	kg/day	Receptor specific
SR	Soil dermal contact rate	kg/day	Receptor specific
ET	Exposure term	unitless	The exposure term is defined as the exposure period, where the maximum exposure period is 24 hours/day x 365 days/year.

Source: CCME (Canadian Council of Ministers of the Environment). *Recommended Canadian Soil Quality Guidelines*. (Environment Canada, Ottawa: Ontario, 1997), 169.

(2) Carcinogenic Contaminants (Non-Threshold) (CCME, 1997b:170)

$$SQG_{HH} = \frac{RSD \times BW}{[(AF_I \times IR) + (AF_D \times DR) + (AF_S \times SR)] \times ET} + [BSC]$$

Table 6-7 describes the parameters used in the CCME equation for non-threshold or carcinogenic contaminants.

Table 6-7. CCME Parameters for Carcinogenic Contaminants (Non-Threshold)

Variable	Definition	Unit	Explanation/Source
SQG_{HH}	Human health soil quality guideline	mg/kg	
RSD	risk specific dose	mg/kg/day	Contaminant specific
SF	Soil allocation factor	unitless	
BW	Body weight	kg	Receptor specific
BSC	Background soil concentration	mg/kg	Site-specific
AF_I	Absorption factor for gut	unitless	Soil ingestion, dermal contact, and inhalation rates are multiplied by the corresponding absorption factors (AF), when this data are available. If data is not available, a value of 1 is substituted.
AF_D	Absorption factor for lung	unitless	
AF_S	Absorption factor for skin	unitless	
IR	Soil ingestion rate	kg/day	Receptor specific
DR	Inhalation rate	kg/day	Receptor specific
SR	Soil dermal contact rate	kg/day	Receptor specific
ET	Exposure term	unitless	The exposure term is defined as the exposure period, where the maximum exposure period is 24 hours/day x 365 days/year.

Source: CCME (Canadian Council of Ministers of the Environment). *Recommended Canadian Soil Quality Guidelines*. (Environment Canada, Ottawa: Ontario, 1997), 170.

The human health soil quality guidelines derived for both threshold and non-threshold contaminants were based on certain receptors and exposure pathways (Table 6-8).

Table 6-8. Receptor & Exposure Pathways Considered in the Derivation of Human Health Soil Quality Guidelines

Route of Exposure	Agriculture	Residential/ Parkland	Commercial	Industrial
Sensitive Receptor	Child (TC) Adult (NTC)	Child (TC) Adult (NTC)	Child (TC) Adult (NTC)	Adult (TC and NTC)
Exposure Period	24 hours/day 365 days/year	24 hours/day 365 days/year	10 hours/day 5 days/week 48 weeks/year	10 hours/day 5 days/week 48 weeks/year
Exposure Pathways	Ingestion Dermal contact Inhalation	Ingestion Dermal contact Inhalation	Ingestion Dermal contact Inhalation	Ingestion Dermal contact Inhalation

TC: Threshold Contaminant NTC: Non-Threshold Contaminant

Source: CCME (Canadian Council of Ministers of the Environment). *Recommended Canadian Soil Quality Guidelines*. (Environment Canada, Ottawa: Ontario, 1997), 168.

TIER 2

Tier 2 replaces the non-site specific, generic RBSLs (Tier 1 table), with site-specific target levels (SSTLs) and compares them with conditions at the site. Generating the SSTLs requires more involved data collection and analysis. Tier 2 SSTLs are derived from the same equations used to calculate Tier 1 RBSLs, except that site-specific parameters are used in the calculations (RBCA Services, 1997). Again, a decision is made about which way to proceed – institute remediation, do nothing, or move on to a Tier 3 analysis.

For example in 1997, the CCME developed the Canadian soil quality guidelines for copper (threshold substance). The soil quality guideline for the protection of human health is 4000 mg/kg for commercial land use. When calculating this value, the CCME assumed that the most sensitive receptor would be a child of preschool age, since a commercial site (e.g. an urban shopping mall) is fully accessible to all age classes. It was also assumed that the child would be on site 10 hours per day, 5 days per week and 48 weeks per year. The parameters that were included in the calculation for the soil quality guidelines for copper are described in table 6-9 (CCME, 1997a):

$$CSQC_{HH} = \frac{(TDI - EDI) \times SF \times BW}{AF \times IR \times ET} + BSC$$

Table 6-9. CCME Parameters Used to Derive Soil Quality Guidelines for Copper

Variable	**Definition**	**Unit**	**Values**
$CSQG_{HH}$	Commercial human health soil quality guideline	mg/kg	4,000
TDI	Tolerable daily intake	mg/kg bw/day	**100**
EDI	Estimated daily intake by ingestion	mg/kg bw/day	**66**
SF	Soil allocation factor	unitless	20% by default
BW	Body weight	kg	**13** (child)
BSC	Background soil concentration	mg/kg	22
AF_I	Absorption factor for gut	unitless	1 by default
AF_D	Absorption factor for lung	unitless	
AF_S	Absorption factor for skin	unitless	
IR	Soil ingestion rate	g/day	**0.08**
ET	Exposure term	unitless	0.2747

Source: CCME (Canadian Council of Ministers of the Environment). *Canadian Soil Quality Guidelines for Copper: Environmental and Human Health* (Winnipeg: Manitoba, 1997), 58.

However, there are many commercial sites where a child of preschool age does not come on site. In this case, a site would not necessarily have to be remediated to 4000 mg/kg for copper. If adults were the only receptor on site, the equation could be modified to develop a more site-specific target level. Table 6-10 outlines the values that were modified in the CCME equation to develop a more site-specific target level.

$$CSQC_{HH} = \frac{(TDI - EDI) \times SF \times BW}{AF \times SIR \times ET} + BSC$$

Table 6-10. Modified CCME Values to Develop a SSTL for Copper

Variable	Definition	Unit	Values
$CSQG_{HH}$	Commercial human health soil quality guideline	mg/kg	20,0000
TDI	Tolerable daily intake	mg/kg bw/day	**30**
EDI	Estimated daily intake by ingestion	mg/kg bw/day	**22**
SF	Soil allocation factor	unitless	**20% by default**
BW	Body weight	kg	**70** (adult)
BSC	Background soil concentration	mg/kg	22
AF_I	Absorption factor for gut	unitless	1 by default
AF_D	Absorption factor for lung	unitless	
AF_S	Absorption factor for skin	unitless	
IR	Soil ingestion rate	g/day	**0.02**
ET	Exposure term	unitless	0.2747

Source: CCME (Canadian Council of Ministers of the Environment). *Canadian Soil Quality Guidelines for Copper: Environmental and Human Health* (Winnipeg: Manitoba, 1997), 59.

By substituting the parameters, the commercial soil quality guideline for human health (adults) for copper is approximately 20,000 mg/kg. This value is significantly higher than the CCME commercial soil quality guideline for human health (preschool child) of 4,000 mg/kg. In this particular case, it would not be cost effective to clean the site to 4,000 mg/kg for copper.

TIER 3 or Site Specific Risk Assessment (SSRA)

Tier 3 raises the level of sophistication up to a full risk assessment to develop SSTLs (Appendix D). Although Tiers 2 and 3 involve developing site-specific goals, the major distinction between Tiers 2 and 3 is that Tier 2 analysis tends to be consistent with the level of site characterization data most often available. Tier 3 often involves a much more significant increase in site-specific data requirements (Begley, 1996). Overall, Tier 3 gives another, even more site-specific, set of SSTLs, which leads to another decision about how to proceed.

6.5.2 Suggested Public Involvement Activities

It is important to seek input from the community. A community roundtable or community advisory group can be a good way to increase community participation in the decision-making process and provide a voice for the rest of the community.

Holding workshops about the alternatives being considered will keep the community involved and informed. Fact sheets distributed at significant milestones during the evaluation can keep the community abreast of the progress that has been made (USEPA, 1996b).

The name and number of a contact person should be provided to the community (USEPA, 1996b). The contact person would be responsible for accepting comments and answering questions. If a large number of people call with questions, a toll-free telephone line should be established.

6.6 Step 4

6.6.1 Develop a Remediation Plan

Once the remediation decision has been decided (based on background standards, generic standards, SSTL's or manage the contaminants on site) a remediation plan can be developed. There are three options to remediate contaminants:

1. Soil Excavation with Land Disposal (MOEE, 1996b)

This option is widely used for lower concentrations of contamination. Excavation and landfill disposal allows for confirmed removal of all contaminants and if conducted to generic or background standards, will limit future liability.

2. In situ and ex situ Treatment (MOEE, 1996b)

In situ treatment deals with contamination in place and ex situ treatment deals with excavated contaminated material on-site or off-site. Treatment includes: bioremediation, low thermal desorption, soil washing, vapour extraction, reactant injection, and airsparging. Site remediation with these treatments may take considerable time and normally costs more than landfill disposal.

3. Risk Management

As indicated earlier, risk of contamination is dependent on three simultaneous situations: a contaminant is evident in harmful amounts, receptors that can be affected are in near proximity, and there are ways for the contaminant and receptor to come into contact. A risk management plan ensures the safety of receptors by reducing their exposure.

Risk management may include the following: (Ells, 1999:Personal Interview):

(i) Institutional Controls

Institutional controls protect human health and the environment by changing the land use thus preventing or reducing exposure. The most common and effective institutional control is a deed restriction because it is filed permanently as part of the property's land record. Deed restrictions or 'restrictive covenants' place limits and conditions on the use of land by informing prospective owners of the environmental status of the land and by ensuring compliance with actions necessary to protect human health and the environment. Deed restrictions specifically define the disallowed uses, allowed uses, and requirements and obligations of the owner (USEPA, 1998c).

(ii) Engineered Controls

Engineered controls are structures designed to prevent migration of contaminants that include caps, cutoff walls, and hydraulic containment barriers (USEPA, 1998c).

Caps (e.g. buildings, roads, parking lots) are protective covers that prevent infiltration of precipitation and surface water into a waste or contaminated area. Preventing infiltration reduces leachate generation and the migration of contaminants in surface water, in the subsurface soil and groundwater (USEPA, 1998c).

Cutoff walls are containment structures designed to prevent the migration of groundwater from or into a source area. Common types of cutoff walls include slurry trenches, sheet piling barriers, and grouted barriers (USEPA, 1998c).

Hydraulic containment barriers can consist of trenches, sumps, drains and wells designed to prevent the migration of contaminated groundwater (USEPA, 1998c).

(iii) Other Controls

- Land-use Restriction for Receptors - put up a fence / warning signs, or maintain security / surveillance to restrict access to the site.
- Receptor protection - develop Health and Safety policies and procedures for contractors handling contaminated soil
- Partial cleanup, with removal of high concentration source contamination, or areas that may be causing off-site migration of contaminants.

6.6.2 Suggested Public Involvement Activities

A fact sheet should be prepared and distributed explaining the selected remediation and the reasons for the selection (USEPA, 1996b). If the level of community concern is high, a public meeting should be held.

The community roundtable should still continue to be involved in the decision making process.

6.7 Step 5

6.7.1 Execute Cleanup Plan

The fifth step in this process involves the implementation of the cleanup plan to remove, treat or otherwise manage the contamination found on the site.

6.7.2 Suggested Public Involvement Activities

Executing the cleanup will often involve highly visible activities, such as transportation of large volumes of materials, and construction of new on-site containment systems. These activities may result in increased levels of public interest; therefore public consultation activities will be appropriate to inform the community of the corrective action's activities progress.

It may be useful to release periodic fact sheets to the community that reports on the progress of the cleanup. Also, it may be helpful to conduct a property tour to demonstrate or explain the activities involved in the remediation of the site (USEPA, 1996b).

6.8 Step 6

6.8.1 Closure

At this step, the proponent will have restored the site conditions (soil, groundwater and/ or sediment) so that it is suitable for the intended use. This is verified through the use of verification sampling, or ensuring that the risk management measures are performing effectively.

The final step of this process is documentation of the entire process followed and establishing a record of the final site conditions or 'certificate of compliance'. This documentation should outline what the goals of the restoration were, the approach used, the cleanup plan implemented to achieve these goals, and should clearly state whether the restoration was successful in achieving the goals. The documents should be retained by the property owner, so that they may be provided to those interested upon request (MOEE, 1996a).

6.8.2 Suggested Public Involvement Activities

Public information feedback techniques such as surveys should be used to solicit feedback to gauge public sentiment about the remediation, the effectiveness of the public involvement activities, and to find out if a high level of concerns still exists.

6.9 Public Involvement

Merging the public involvement process directly with the development of clean-up standards provides for a better redevelopment, and will contribute to 'buy in' by stakeholders and the public.

6.9.1 Developing a Public Involvement Plan

A public involvement plan is a valuable tool in involving project-affected groups and other stakeholders in the development and implementation of a project. Developing a plan at an early stage ensures that all issues are addressed and the appropriate course of action is taken.

A public involvement plan should include (Roberts, 1995):

- A list of the key stakeholders who will be informed and consulted
- A summary of the types of methods and activities to be used
- A schedule of activities
- An estimated budget for carrying out activities (e.g. hiring consultants, organizing meetings, translation, production and distribution of materials)
- Evaluation criteria for assessing the effectiveness of the public involvement plan

6.9.2 Identifying the Stakeholders

Before proceeding with a Brownfields Redevelopment project, it is essential to identify the key stakeholders. Individuals from many sectors of the community may be interested in the project and may be, directly or indirectly affected by the remediation and future development of the site. The different community sectors can be grouped into broad stakeholder levels, depending on the degree of potential impact they may experience, their geographic proximity to the site and their roles in the community. It is crucial that the identification of the stakeholders include all parties that have a stake in the outcome of the redevelopment process.

Stakeholders who may be affected by the project may include (IFC, 1998):

- People owning land impacted by the project, both on- and off-site
- People using agricultural land or natural resources, such as forests or rivers
- Organizations and institutions affected by the project, such as recreational groups, and women's groups
- Locally disadvantaged and voiceless groups, such as the poor

In addition to project-affected people there are other interested parties who may be able to influence the outcome of the project, either because they can contribute knowledge, or because they have political influence in the project that needs to be considered. These other relevant stakeholders may include (IFC, 1998):

- Politicians
- Local government authorities
- The media
- Local and national environmental and developmental non-governmental organizations (NGOs)
- Colleges and universities

6.9.3 Choosing a Public Involvement Method and Activity(s)

The degree of public involvement ranges from public consultation, the goal of informing the public about a decision, to inviting the public to participate and have input before a decision is made. The selection of an approach depends on the project's goals. Table 6-11 provides some guidelines in selecting between consultation and participation approaches.

There are many possible activities for both public consultation and public participation. Table 6-12 indicates which activities best meet particular needs.

Table 6-11. Public Involvement Methods

Public Consultation	**Public Participation / Consensus**
Issues have minor impact on the environment.	Issues have serious implications for the environment; significant economic and/or social impacts.
Narrow range of issues involved.	Wide range of complex issues involved.
A small number of people are interested in the situation, generally focused on a special area of interest.	Public is concerned with the issues.
Issues are urgent and must be dealt with in a short period of time (weeks or 2 to 3 months).	Issues are important but there is time available for planning (6 months to 1-2 years)
The public is concerned but is not demanding an extensive formal involvement program.	The public strongly desires a formal involvement program.
The organization has the capacity to support a modest program.	The organization has the capacity to support a complex program.

Source: Federal Environmental Assessment and Review Office, *Manual on Public Involvement in Environmental Assessment: Planning and Implementing Public Involvement Programs* (Ottawa: Ontario, 1988), vol. 3, 11.

Table 6-12. Public Involvement Approaches

	Provide Information To Public	Understand the Public	Discussions with Public	Public Influences Decision	Public Agrees to Decision
PUBLIC CONSULTATION					
PUBLIC INFORMATION					
Advertising	X				
Brochures	X				
Exhibits/Displays	X				
Newsletters	X				
Newspaper Inserts	X				
News Releases	X				
Publications	X				
Reports	X				
PUBLIC INFORMATION FEEDBACK					
Focus Groups		X	X		
Interviews		X	X		
Polls		X			
Questionnaires		X			
Surveys		X			
OPEN HOUSE	X	X	X		
PHONE LINES	X	X			
PUBLIC MEETINGS	X	X	X		
SITE TOURS	X	X	X		
WORKSHOPS			X	X	X
PUBLIC PARTICIPATION					
Roundtable			X	X	
Task Forces			X	X	
Public Committee			X	X	
CONSENSUS					
Arbitration				X	
Facilitation				X	X
Mediation				X	X

Source: Federal Environmental Assessment and Review Office, *Manual on Public Involvement in Environmental Assessment: Planning and Implementing Public Involvement Programs* (Ottawa: Ontario, 1988), vol. 3, 11.

Appendix E outlines the various public consultation and participation activities in detail.

7.0 MONCTON SHOPS CASE STUDY ANALYSIS

7.1 Introduction

The sustainable Brownfields Redevelopment process describes (Figure 2) a framework that is both generic and broad enough to encompass the smallest Brownfield site to the mega-project. The process was developed from contemporary practices, standards and guidelines. In order to verify this process and ensure its accuracy and practicality it is herein assessed against one of Canada's largest Brownfields Redevelopment project to 1998; the Canada Land's Company Moncton Shops Project (former CN Rail Car Shops) or better known as the Moncton Shops Project.

At the heart of Moncton, New Brunswick lies a testament to the city's industrial history, the Moncton Shops, a 280-acre industrial site stretching from the downtown core to the city's outskirts (CLC, 1998). The property helped build the communities of Greater Moncton from 1906 to 1986, as the site of the major rail car repair and machine shops for CN Rail. However, by the mid-1980's, CN Rail operations were significantly winding down, resulting in full closure of the site by 1989 and demolition of most of the buildings by 1991 (CLC, 1998c). The result was a fenced site covered with weeds and the concrete slabs of the former buildings.

With privatization of CN Rail in the early 1990's, Canada Lands Company (CLC), was given a mandate to remediate the environmental problems and fully reintegrate the property with the residential and business communities of Moncton. Thus, allowing the community to enjoy the benefits of environmental protection, economic growth and social development (CLC, 1998). The former CN Rail Car Shops Property was part of a portfolio of former rail lands transferred to Canada Lands for rehabilitation and sale. Because the Rail Car Shops were unique in their size and historic and economic links to the City, the remediation of the property became of considerable interest to citizens of Moncton and New Brunswick (MacKnight, 2000).

CLC's objective was to sustainably redevelop this Brownfield site. The Moncton Shops Project was the first instance of property remediation using a risk-based management approach, similar to the underlying philosophy of Risk-Based Corrective (RBCA), a model that had been adopted by all four Atlantic provinces early in the CLC Moncton Shops Project process (CLC, 1998c). CLC was strongly committed to a full and comprehensive public involvement process on both the environmental planning of the project and early consultation of the options for development (Chadwick, 2000). The reasons for this commitment were to ensure concerns and the interests of the public were addressed, and the public was satisfied with the RBCA process and the clean up levels (CLC, 1998b).

7.2 Approach

The Moncton Shops project was selected for the following reasons:

- Largest urban Brownfield Redevelopment project currently underway in Canada;
- At the forefront of Brownfields Redevelopment;
- Integrates scientific, economic, social and environmental goals in a long term, sustainable approach;
- Technically challenging; and
- Involves multiple stakeholders in developing strategies for redevelopment of the Brownfields site.

Information was collected, reviewed, analyzed and critiqued to determine the lessons learned. The information was gathered from the following sources:

Preliminary Site Specific Visit and Data Gathering

Initial research for the case study involved visiting the site, and collecting and reviewing all relevant Canada Lands Company documents such as:

- The Environmental Action Plan Reports;
- The Public Consultation and Information Plans; and
- Canada Lands Company – Moncton Shops Project website.

In-Person or Telephone Interviews

Detailed in-person or telephone interviews with a variety of people involved in the Moncton Shops redevelopment was conducted. Interviews were conducted with representatives from each of the following groups:

- Canada Lands Company
- Community Roundtable
- New Brunswick Department of the Environment
- City of Moncton
- Consultants used by CLC

Additional Literature Review and Follow-up

Follow-up phone calls were conducted for clarification and to obtain other relevant information.

- Harold Kenny - CLC, General Manager (Atlantic)
- Kevin Hocquard - New Brunswick Department of the Environment
- Don MacCullum - CLC, Project Manager
- Julia Chadwick – Info plexxus

- Loren Spieran - CLC, Project Coordinator
- Richard Landry - City of Moncton, Director of Administrative Services, Engineering
- Jacques Allard - Maritime Statistical Analysis Inc.
- Scott MacKnight – President, OCL Services Inc.

Site Re-visitation and Assessment

The site was re-visited to collect additional information, further interviews and tour the site without snow cover.

Survey

A telephone survey of the public and involved persons was conducted to assess CLC's public involvement effort (Appendix G).

Critique

The sustainable Brownfields Redevelopment process described in Figure 2, was developed from the best contemporary practices, and current standards and guidelines available. It is an optimum process that describes the numerous decisions and activities that have to occur for each step of a redevelopment. Because of the dynamic process of redevelopment, circumstances will occur where certain activities of the ideal process are not necessarily needed.

The Moncton Shops Project provided all the challenges that a Brownfield developer could face. A detailed critique of CLC's activities in PDU-1 (Property Development Unit) assessed against the sustainable Brownfields Redevelopment process is found in Appendix F and highlights are discussed below.

7.3 Adequacy of Site Identification and Characterization

Early identification and accurate and effective characterization of the site is critical to the process of achieving sustainable Brownfields Redevelopment. The more accurate the information obtained at this stage, the greater the potential for success becomes. CLC's Phase I and II Environmental Site Assessments were evaluated against the Phase I ASTM-E1527 and the Phase II ASTM-E1903-97, respectively, to determine the following positive and negative findings:

Positive Findings

- A site specific grid system and sampling methodology was developed that ensured a 95% confidence interval was consistently obtained for each trace metal sampled. The system and methodology were developed by interpreting a very detailed preliminary assessment and contracting a company specializing in statistical analysis to determine the sample size using statistical mathematical modeling.

- Accurate and concise record keeping of sampling locations and concentrations of contaminants was performed. They utilized the most contemporary technology available (GIS) to document their sampling and analysis efforts.

- A thorough analysis was performed to accurately determine background levels. They identified 95 background sample sites throughout the Moncton area and then analyzed for trace metals to obtain an accurate representation of the background levels.

Negative Findings

- A traditional Phase I ESA was not performed, instead the results of 34 studies conducted from 1986 to 1996 were summarized to determine the potential for environmental liability. As a result, a major deficiency was not addressed:

    - The presence and interference of remnant structures and footings, remnant drainage system and partially buried wastes was not considered in the earlier studies.

- All interview sources were not sufficiently documented to facilitate reconstruction of the research at a later date. Interviews or the sources were not documented.

- Identification of all contaminants in the soil was not performed. The Laboratoire de recherche pour l'industrie et l'environnement (LEIL/UdM) of the Universite de Moncton used an ICP/AES unit with a restricted element set and identified only 10 out of 22 inorganics. Another laboratory should have been selected.

- A rigorous QA/QC program was established, but the laboratory performing the analysis was not certified. Environment Canada recommends the use of labs certified by the Canadian Association of Environmental Analytical Laboratories (CAEAL).

7.3.1 Summary

CLC's technical efforts in the Phase II assessment was excellent. They developed a comprehensive sampling and analysis program. A thorough analysis of background levels was performed which allowed an accurate determination of actual contaminant levels on site. Utilizing the contemporary technology of GIS ensured precise and well-documented evidence of their sampling program. Some elements of their program however were lacking. Although a rigorous QA/QC program was established, a certified laboratory did not perform the lab analysis. Not having a certified laboratory perform the chemical analysis may shed doubt on the outcome of the assessment. This also holds true of their failure to identify all contaminants in the soil. Combining these two factors and their failure to document Phase I interviews left a gap in proving the validity of their assessments. Data obtained from the sampling and analytical process should be completely accurate since inaccurate information may lead to unnecessary environmental risk and economic cost.

7.4 Adequacy of Comprehensive Remediation Plan

The primary objective of this element is to select a remediation approach that is protective of human health and the environment, and is cost effective. CLC selected the risk-based approach to corrective action to ensure that human health and the environment were protected.

Positive Findings

- A range of remediation options was considered. Five remediation options were considered. Human health and environmental risks were assessed for each option and from this a final option selection was made.

- A Tier 2 was performed for lead, making the clean up more cost effective. The cleanup criteria for lead was increased from 260 mg/kg to 910 mg/kg based on the fact that the intended land use permits children far less exposure to the soil than envisaged under the CCME Commercial category - average for PDU-1 after remediation was 288 mg/kg (CLC, 1999).

- Appropriate experts conducted the risk assessments. Experts familiar with contemporary risk and exposure methodologies performed the risk assessments.

Risk Assessment

Two risk assessments were conducted each one having different objectives and parameters.

(1) The first risk assessment conducted by OCL Services Ltd. considered children of two age categories (7 months - 4 years and 5 - 11 years) and four scenarios for the conceptual model were developed. Each scenario was calculated for remediation option 2, 3 and 4. These calculations determined the 'upper limit' for soils, therefore, concentrations above such values were considered to be 'unacceptable'.

(2) The objective of the second risk assessment, conducted by JWEL, was to calculate SSTL's (site-specific target levels) for arsenic, cadmium, nickel, lead, copper and zinc based on the scenario that the land would be left undeveloped for a long period. The calculations were based on the following:

  - a pica child living adjacent to and playing on the property, and
  - an adult worker constructing a building on the property.

Risk Assessment #1

Risk assessment #1 was assessed against the process outlined in Figure 2 to determine the following positive and negative findings:

Positive Findings

- Each critical component of the risk assessment was adequately assessed to determine the quality of the risk assessment. The critical components were evaluated (high, medium and low) according to the amount and quality of data and knowledge available to support the analysis.

Negative Findings

- The selection of the contaminants was not based on reasonable criteria. No screening method was applied to select the contaminants of greatest concern.

- The rationale for the selection of the two age categories was not defined and the gender was not specified. The most sensitive receptor was not selected - a female preschooler is the most susceptible receptor.

- The synergistic effects of more than one chemical on human health were not considered. Non-carcinogenic effects posed by more than one chemical was not calculated.

Risk Assessment #2

Risk assessment #2 was assessed against the process outlined in Figure 2 to determine the following positive and negative findings:

Positive Findings

- The screening of the receptors was appropriate and well defined. Receptors were screened based on sensitivity. A pica child (15 to 30% of children display a behaviour known as pica in which 1,000 mg per year or more of soil may be deliberately eaten) was selected as the most sensitive receptor.

Negative Findings

- The selection of the contaminants was not based on reasonable criteria. No screening method was applied to select the contaminants.

- The synergistic effects of more than one chemical on human health were not considered. Cancer risk and non-carcinogenic effects posed by more than one chemical were not calculated.

- Uncertainty was not identified or summarized to assess the quality of the risk assessment (as was done in Risk Assessment #1).

Risk Management

Following the risk assessments, risk management options were considered.

Positive Findings

- Property covenants (an institutional control) are available for future reference. All information regarding the site will be made fully available to property buyers and the information will be 'registered' with the property to ensure future owners/operators are made aware of the results.

7.4.1 Summary

CLC performed a thorough analysis of the remediation options. They addressed long-term human health concerns and economic considerations. Experts in the risk assessment field performed the risk assessments, which established credibility of the process. There were some problems with each assessment, mainly regarding contaminant and receptor selection but overall the assessments were very good and the remediation choice process well performed.

7.5 Adequacy of the Public Involvement Activities

To identify the strengths and weaknesses of CLC's efforts, CLC's public involvement activities were analyzed against the process outlined in Figure 2 and EPA's guidelines, a set of minimum requirements for public information, public notification and public consultation activities (USEPA, 1979).

Positive Findings

- Stakeholders concerns were considered in the objectives of the public involvement activities. They established proactive objectives in their public involvement activities that ensured openness, transparency and an understanding of stakeholder needs and concerns.

- Public consultation activities began at the project inception. CLC's public consultation activities began well in advance - before site characterization and environmental work began on the property in mid-1997. It is important to start public consultation as early as possible, since consultation after any decision is made usually leads to nothing but resistance.

- Information was easily accessible and always available. A web site was designed to make information available to visitors with varying levels of interest and was kept up-to-date with weekly site manager's reports.

- Public input was sought through a public community roundtable. A key part of CLC's public consultation had been the work of the Community Roundtable. The Community Roundtable consisted of 10 local citizens (business people, academics, students and environmentalists) that functioned at an arm's length from CLC. The roundtable had several purposes that were essential: review technical data, make recommendations and serve as a link between the CLC and the public.

- The general public's advice was solicited by the roundtable members to allow better decisions to be made that incorporated community values. The community roundtable sponsored three town hall meetings to remain aware of the community attitudes to issues such as environmental remediation and risk assessment. The media was invited to the town hall meetings and videotapes of the meetings were made available to the public.

- The consensus approach provided people a fair and equal opportunity to input. The community roundtable chose to adopt a consensus decision-making model. A badly divided group serves little purpose. With consensus the group had greater impact on the decision-makers.

Negative Findings

- A Phase II public consultation and information plan was developed in January 1998 but it was not made available to the public for input or comments. Preparing a public involvement plan that outlines how objectives will be met to address community concerns requires public input for successful public involvement program.

- Interested stakeholders were not tracked over time. It is important to maintain an up-to-date list to keep interested members of the community informed. A list of persons/organizations who expressed an interest in or who may be affected by the project was developed. However, the list was not maintained or updated and did not contain telephone numbers that would aid in updating the list.

- CLC did not make documents fully accessible to the public. Copies of the eight PDU Environmental Action Plan Reports were placed in the Library of Universite de Moncton but were only available to members of the community roundtable and were withdrawn once the roundtable finished its work, in May 1998. Allowing the public access to documents ensures transparency.

- Membership on the community roundtable was not available to the general public. All segments of the public should have an opportunity to participate in the community roundtable. To ensure that the community's issues and concerns were heard and addressed, vocal critics of the project and residents adjacent to the site were actively recruited to be members of the Community Roundtable. By actively recruiting members, it can be interpreted that the group represented the interests of CLC.

- Community roundtable meetings were not open to the public. Meetings should be announced well in advance and open to the public to ensure trust and create an open process. Failure to do so creates a closed process.

- Minutes of the community roundtable meetings were not available to the general public. Distribution of such minutes ensures transparency.

- The life of the community roundtable was too limited. The community roundtable met once a week, from January to May 1998, to review the risk assessment and management strategy for remediation. The community roundtable should have been consulted throughout the life of the project. Although, groups have a tendency to outlive their usefulness, this roundtable did not, as many issues arose after its dissolution.

- The community roundtable was not involved in the decision-making process. Involving stakeholders in the decision-making process, will produce decisions that reflect their needs, requirements, goals, and vision of the future.

Public Perception Analysis of CLC's Activities

Canada Lands Company's (CLC) public awareness activities reached over 5,500 people (CLC, 1998b). It provided high quality comprehensive information, access to data, opportunities to provide input and to receive feedback, and engaged members of all community stakeholder groups.

A telephone survey was performed to a number of Moncton residents to assess the effectiveness of Canada Lands Company's public involvement program by determining the public's perception of CLC's efforts in achieving transparency and communication of the project. The public's perception of any project often determines its success. The survey methodology, questionnaire and detailed findings is found in Appendix G.

The survey had four objectives to ascertain the success of CLC's efforts. These objectives were to:

(1) test the success of CLC's public involvement work and communicating scientific data and information.

(2) measure people's awareness to potential risks associated with the Moncton Shops Land.

(3) determine the most effective method of communication.

(4) determine the relationship between the amount of information received by individuals to the level of comfort with the cleanup.

The results are summarized herein.

<u>Objective #1</u> - Test the success of communicating scientific data and information

91% of individuals surveyed from the mailing list felt that the scientific information was well communicated. Overall, particularly through attending open houses, the technical information was communicated very well. This is particularly noted when assessing the comfort of respondents willing to work and play on the site.

Those that participated in the community roundtable had 100% comfort with the way the technical information was communicated and all felt they understood the information well.

<u>Objective #2</u> - Measure people's awareness to potential risks associated with the site

Most people felt that they understood the potential risks associated with the site. 93% of the individuals surveyed off the mailing list felt they understood the information and 100% from the roundtable participants.

Objective#3 - Determine the most effective method of communication

The most effective method of communication and public comfort was through the use of the roundtable and attending open houses. If effectiveness is measured through comfort of spending time on the site then these were the best means of communication as over 70% of all members of roundtable and participants in the open houses were comfortable with living, working or allowing children to play on the site.

Objective #4 - Determine the level of communication volume with peoples comfort level with the site

As noted previously, those that sat on the community roundtable and those that attended open houses and site tours were at a higher comfort level than those that only received mailers or communication via the media.

7.5.1 Summary

CLC did a thorough job of their public consultation process. They provided fact sheets, newsletters, and developed a full disclosure website for community access. Open houses, public workshops, site tours, community roundtables, town hall meetings and constant media coverage were all part of their effort.

The scientific information and technical terms were well explained in a language that could be easily understood. The level of comfort of the community was dependent on the level of public involvement. Individuals that received more information or participated directly were more comfortable with the cleanup than their counterparts. Although there were some activities that were not properly carried out as noted in the negative findings, CLC was successful and very transparent in their approach.

7.6 Conclusion

Overall, CLC performed an excellent job of identifying and characterizing the site, developing a comprehensive remediation plan and performing public involvement activities. The key elements of conducting an effective Brownfields Redevelopment that were and were not performed by CLC are highlighted below.

Identifying the environmental conditions of a property is determined by conducting site identification [Phase I Environmental Site Assessment (ESA)] and site characterization (Phase II ESA). Professional judgement and interpretation are inherent in both assessments, which makes uncertainty of accurately detecting all environmental conditions on a property inevitable.

If an inadequate Phase I ESA is conducted, there is an increased risk of not accurately identifying all contaminants and their concentrations on the property, thus jeopardizing the quality of data on which judgements are made. To avoid as much uncertainty as possible, it is important to sufficiently document all sources to support the analysis, opinions and conclusions of the assessment.

Phase II ESA's also have inherent uncertainties and limitations. Any soil samples taken may or may not be representative of a larger population. Ensuring that samples collected can accurately be extrapolated to represent the larger population requires a detailed statistical based sampling program.

Quality control and quality assurance tests should be developed for the chemical analysis of soil samples. Contracting a laboratory certified by the Canadian Association for Environmental Analytical Laboratories (CAEAL) ensures the laboratory is formally recognized for proficient environmental analysis. A laboratory should be required to report any potential or actual problems experienced, or non routine events which may have occurred during the testing, so that such problems can be considered in evaluating the data. These problems should be identified in reports or documentation of the Phase II assessment.

Following the site identification and characterization assessments, remediation options should be considered. When selecting a risk-based approach to remediation a risk assessment is required.

It is impractical, costly and time consuming to assess all contaminants identified in the Phase II study and every receptor that could potentially be exposed to contaminants from the site and every exposure pathway. The contaminants, receptors and exposure pathways need to be screened and selected based on reasonable criteria. Once the contaminant(s), receptors(s) and exposure pathway(s) are selected a conceptual model can be properly developed.

Following the development of the conceptual model, exposure and toxicity assessments are to be calculated. Exposure assessments estimate the daily intake by the receptor(s) and toxicity assessments identify the effects posed by the chemicals. In some cases, it is important to calculate the synergistic effects posed by more than one chemical.

Throughout the life of a project, public consultation and participation activities need to be performed. It is fundamental to understand the community's needs and values which can be determined through community surveys, interviews, focus groups, and public meetings. It is also essential to assure that the stakeholders are educated and knowledgeable of the process through techniques such as fact sheets, open houses, site tours and workshops. To ensure confidence in the project by stakeholders, it is essential to involve the stakeholders as early as possible and to incorporate their concerns in the decision-making process. This can be achieved by forming a community roundtable. Community roundtable membership, meetings and minutes of meetings need to be open and available to the public to ensure transparency and public trust.

8.0 SUMMARY AND CONCLUSION

Initially, a Brownfields Redevelopment project appears as a straightforward process of reclaiming an abandoned or underutilized property, through the elimination or control of potential contaminants, and putting the land to some new use for the benefit of the community (USEPA, 1998). But, the moment that the process is begun, the Brownfields Redevelopment effort becomes connected to an extensive and complex web of ecological, economic, regulatory, and social systems, all of which influence not only what can be done with a specific property, but also how sustainable the outcome will be (USEPA, 1998).

The purpose of this study was to determine the best process to use in sustainable Brownfields Redevelopment, particularly from the perspective of stakeholder engagement. This objective was achieved by conducting a literature review of past practices to define the significant elements that could be all-inclusive of activities for any Brownfields Redevelopment. Once these elements were defined, it was possible to create a process that represented a sustainable Brownfields Redevelopment approach. This process was then assessed against the activities conducted at the Moncton Shops project.

Based on literature review and interviews, the best process to use in Brownfields Redevelopment, particularly from the perspective of stakeholder engagement, involves the following six steps, their elements and activities (Table 8-13).

Table 8-13. Brownfields Redevelopment Steps, Elements, and Activities

Steps	Elements	
	Site Identification and Characterization (technical)	**Public Involvement Activities (social)**
Initial site assessment	-conduct Phase I ESA -identify future land use	-develop public involvement plan -identify stakeholders -develop mailing list -develop & distribute fact sheets detailing results and proposed land use
Site Characterization	-collect soil samples -conduct laboratory tests to identify contaminants	-revise public involvement plan, if necessary -develop & distribute fact sheet explaining purpose & scope of investigation -make all reports available (e.g. in public library) -conduct workshops to discuss community concerns -conduct focus groups to assess community's ideas, needs & goals
	Comprehensive Remediation Plan (technical)	**Public Involvement Activities (social)**
Evaluation of remediation alternatives	-evaluate all three approaches (background, generic, risk based) based on human health/environmental protection & cost effectiveness -conduct risk assessment for risk based approach (economic)	-form a community roundtable to increase community participation in the decision making -develop and distribute fact sheets at significant milestones during the evaluation -assign a contact person to answer questions
Develop remediation plan	-select a remediation option: soil excavation with land disposal, in situ and ex situ treatment or risk management (economic)	-develop and distribute fact sheet explaining the selected remediation and reasons for selection -continue the involvement of the community roundtable in the decision making
Execute cleanup plan	-conduct confirmatory sampling or ongoing monitoring	-develop & distribute fact sheets to report on the progress of the cleanup -conduct property tours
Closure	-confirmatory sampling or ongoing monitoring -obtain certificate of compliance	-conduct surveys to get feedback from public

When critiquing CLC's activities at the Moncton Shops Project against the developed sustainable Brownfields Redevelopment process it becomes evident that there were many strengths in their approach. The thoroughness of their sampling program and use of current technology established their technical credibility. The risk assessment work performed by contemporary experts in the field and their thorough analysis of remediation options also greatly contributed to their credibility both in the technical world and in the public eye. The public involvement process was well resourced and commendably delivered. The public survey confirmed that overall this project is a success when viewed from the perspective of stakeholder 'buy-in'.

There were also weaknesses in CLC's activities at the Moncton Shops Project. Table 8-14 identifies the negative findings of the Moncton Shops Project when assessed against the process mentioned above and outlined in Figure 2.

Table 8-14. Negative Findings & Recommendations for the Moncton Shops Project

Elements	Negative Findings	CLC's Process Improvement Recommendations
Site Identification and Characterization	A traditional Phase I ESA was not performed.	Perform a Phase I ESA to identify all potential contaminants on site.
	Phase I interviews or their sources were not documented.	Document all sources (interviews, including sources that revealed no findings) to facilitate reconstruction at a later date.
	Contracted lab (LRIE) failed to identify all contaminants (only 10 out of 22) by using an ICP/AES with a restricted element set	Ensure contracted lab has technology to identify all contaminants of concern.
	Chemical lab analysis was not performed by a certified lab	Contract only certified labs.
Comprehensive Remediation Plan	No screening method was applied to select the contaminants of greatest concern.	Screen for the contaminants of greatest concern because it is impractical, costly and time consuming to assess all contaminants identified in the Phase II study.
	Cancer and non-carcinogenic effects posed by more than one chemical were not calculated.	Calculate the effects of more than one chemical to determine the synergistic effects on human health.
	The rationale for selection of the two age categories was not defined and gender was not specified. (Risk Assessment #1)	Select the most sensitive receptor(s) – in the CLC case a female preschooler was the most sensitive receptor.
	Uncertainty was not identified to assess the quality of the risk assessment. (Risk Assessment #2)	Assess each critical component of the risk assessment to determine the quality of the risk assessment.
Public Involvement Activities	Although a involvement plan was developed, it was not made available to the public for comment or revisions.	A public involvement plan outlining how objectives will be met and community concerns addressed requires public input for a successful program
	Interested stakeholders were not tracked over time.	Maintain an up-to-date list of persons/organizations who expressed an interest in or who may be affected by the project to keep them informed.
	Documents were not made fully accessible to the public.	Allow public access to documents to ensure transparency.
	Membership on the community roundtable was not available to the general public.	Allow all segments of the public an opportunity to participate in the community roundtable to create an open process.
	Community roundtable meetings were not open to the public.	Open community roundtable meetings to the public and announce community roundtable meetings well in advance to ensure trust and create an open process.
	Minutes of the community roundtable meetings were not available to the general public.	Distribute community roundtable meeting minutes to the public to ensure transparency.
	The life of the community roundtable was too limited.	Consult the community roundtable throughout the life of the project.
	Community roundtable was not involved in the decision-making process.	Involve stakeholders in the decision-making process to produce decisions that reflect their needs, requirements, goals and vision of the future.

The Moncton Shops Project is more than an environmental project. It reaches beyond clean up of contamination to the integration of community values and needs in the vision of how an abandoned industrial urban property can be developed. In its success, the project will make a major contribution to the economic growth of the community, recognize the property's significant history, and increase environmental awareness in the community at large and provide greater levels of enjoyment for the community. It will be a model for New Brunswick and Canada of sustainable development of Brownfields, providing enduring environmental, social and economic benefits for the community.

Canada currently has over 2,900 brownfield sites, of which an estimated 1,000 are high-risk sites, and it is quite possible that many have been left uncounted. These abandoned and contaminated lands must be remediated, and if this costs more than building on Greenfields', ways must be found to support such redevelopment. Since, the redevelopment of Brownfield sites provides economic, social, and environmental benefits and the cost of inaction is enormous. To ensure a sustainable Brownfields Redevelopment project, there is one concept that must be addressed: What is ultimately sustainable is the achievement of the goals and visions of the stakeholders in the surrounding community.

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APPENDIX A

Estimated Number of Brownfield Sites

APPENDIX A
ESTIMATED NUMBER OF BROWNFIELD SITES

Province	Data Source	Raw Data	Comment	Selected Number
British Columbia	Vancouver municipal files	400	Broad range from minor to major	100
	BC Provincial Environment Ministry	District files BC Env.	No aggregate number pro rata from the Vancouver data	100
Alberta	No provincial data	n/a	Sites identified with oil/gas industry, service stations and wood preservers. Many of these fall outside definition in this report, therefore estimate made pro rata of population in moderately industrialized province.	50
Sask.	Contaminated Sites List (Provincial)	36	Landfills, refineries, herbicide plants, transformer facilities, oil re-fineries, scrap metal dealers, DND sites (radar). Only a fraction of these will meet definition, particularly the urbanality.	20
Manitoba	Provincial response identified a number.	50	Range from service stations to former industrial sites.	25
Ontario	Province wide survey of coal gas plants and other similar industries.	90	The majority are in urban centres although some are small centres.	50
	Data base on operating and closed landfills.	1400 open 2400 closed	Many in at least semi-rural settings although urban growth has surrounded former (closed) landfills.	1000
	Large municipality experience.	~ 3% of all Industrial sites	Collection of files approaching statistically significant size.	450
	District offices of provincial env. Ministry has accessible files but no compilation known.	n/a	There will be overlap in the counting of these sites	Total 1500
Quebec	Montreal municipal files	200	Estimate based on discriminating use of terminology.	300
	Rest of Quebec – provincial files	1400	"Potentially" contaminated sites. Allowance should be made for rural settings.	700
NB	Files collected in district office of Env. Ministry.	n/a	No basis for estimate, use population pro rata estimates.	40
PEI	Provincial files almost exclusively service stations.	n/a	Few of the causative agents operative.	0
NS	Same as NB			40
NF	Same as NB			40
TOTAL				**2900**

Source: M.M. Dillon Limited, GlobalRisk Management Corporation, and Tecsult. *The Financial Services Sector and Brownfields Redevelopment*. (Ottawa, Ontario: Canada Mortgage and Housing Corporation, 1996), pp. 2-5.

APPENDIX B

Industries Identified as Potential Sources of Contamination

APPENDIX B
INDUSTRIES IDENTIFIED AS POTENTIAL SOURCES OF CONTAMINATION

Industry	Specifics
Leather and Allied Products	-Tanneries
Primary Textile Industries	
Textile Products Industries	-Carpet, Mat and Rug Industry
Clothing Industries	-Hat and Cap Industry
Paper and Allied Products	-Pulp and Paper Industries
Printing, Publishing and Allied Industries	
Primary Metal Industries	-Iron Foundries -Brass Foundries -White Metal Alloys
Fabricated Metal Products	-Boiler Making -Stamped, Pressed and Coated Meal Products -Wire and Wire Products
Transportation Equipment and Industries	-Railway, Rolling Stock Industry
Electrical and Electronic Products Industries	-Battery Industry
Non-metallic Mineral Products Industries	-Carbide Manufacturing
Refined Petroleum and Coal Products Industries	-Manufactured Gas Works -Tar Distillation
Asphalt/Tar Paving Industries	
Chemical and Chemical Products Industries	-Paint and Varnish Industry -Cleaning Compounds -Printing Ink Industry
Other Manufacturing Industries	-Processing and Production of Commercial Isotope Products
Railway Workshop and Roadhouses	
Large Cleaning and Dyeing Works	

Source: Bordt, M., and Fritzche, J. *Improving Site-Specific Data on the Environmental Condition of Land*. (Ottawa, Ontario:Statistics Canada, 1996), p. 11.

APPENDIX C

Phase I Checklist

APPENDIX C
PHASE I CHECKLIST

Item		Yes	No	Comments
1.	Has the site ever been used in the past or is it currently used for industrial or manufacturing purposes?			
2.	Has the site (or an adjacent one) ever been used in the past or is it currently used as: -a gas station, motor repair facility, vehicle sales facility? -commercial printing facility, dry cleaners, photo developing laboratory? -junkyard, landfill, or waste treatment, storage, disposal or recycling facility?			
3.	Were any of the following ever stored on site, or are they currently on site: -discarded automotive or industrial batteries, paints, pesticides or other chemicals? -industrial drums or sacks of chemicals?			
4.	Is there any evidence of: -landfill materials brought from off-site? -liquid waste facilities on site such as pits, ponds or lagoons? -significantly stained soils or "distressed" vegetation at the property?			
5.	Are there presently or have there ever been any underground or aboveground storage tanks at the property?			
6.	Are there stains in buildings or on the property?			
7.	Does the property have a private well? Was it ever contaminated?			
8.	Does the property have an on-site septic or sewage pre-treatment facility?			
9.	Does the owner or current occupant of the property know of, or have records of any: -government action regarding violations of environmental laws or regulations on the site? -existence of petroleum products or hazardous contaminants on the site? -prior site assessments that indicated contamination present or recommended further assessment of the property? -lawsuits or administrative actions involving actual or threatened releases of hazardous contaminants on the site?			
10.	Is there any reason to suspect, or is there evidence of: -hazardous or petroleum products, tires, automobile batteries or other waste having been buried or burned on site? -transformers, capacitors or hydraulic equipment on site showing signs of leaking? -transformers, capacitors or hydraulic equipment on site for which records indicate they may contain PCBs?			
11.	Is there any evidence of asbestos present on the property - or any records of asbestos removal or abatement in the past?			

Source: The E.P. Systems Group, Inc. *Financing Small-Scale Urban Redevelopment Projects: A Sourcebook for Borrowers Reusing Environmentally Suspect Sites*. (Louisville, Kentucky: 1997), p. 20. URL: http://www.smartgrowth.org/library/finsbk.html

APPENDIX D

Risk Assessment

APPENDIX D

RISK ASSESSMENT

Risk assessment is an important tool to evaluate and predict the severity of existing and potential future impacts from contaminants on site. Although risk assessments are unique to the site for which they are prepared, every risk assessment will provide the following information (BC MELP, 1997):

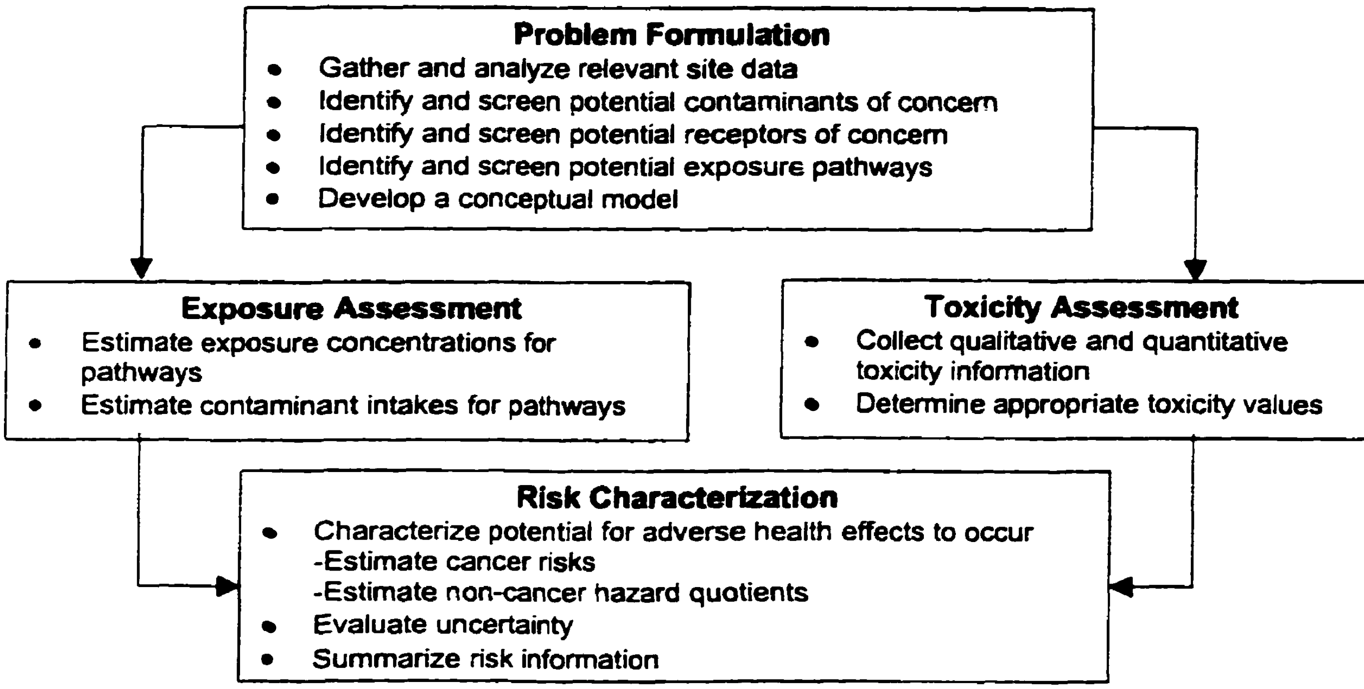
- Documentation of the contaminants location and the extent of any contamination occurring on and off site;
- Estimation of the size and likelihood of risks and hazards to human and non-human receptors on and off site; and
- Documentation and evaluation of the effectiveness of proposed contamination management.

The fundamental goal of a risk assessment is to estimate levels of risk to human and environmental health. It is important to stress that the mere presence of a contaminant at a site does not necessarily constitute a risk. In order for a risk to exist, the following three basic conditions must be met (BC MELP, 1997):

- Contaminants must be present;
- These contaminants must have the potential to cause toxic or other adverse biological effects – that is, contaminants must be hazardous; and
- Pathways by which humans, animals or plants (receptors) may be exposed to contaminants must exist.

A human health risk assessment is performed through the following stages (see Figure 3):

Stage 1 - Problem Formulation
Stage 2 - Exposure Assessment
Stage 3 - Toxicity Assessment
Stage 4 - Risk Characterization



Source: CANTOX Inc. 1997. *CKES 121 Toxicology Course.* CANTOX Inc. Toronto, ON.

Figure 1. Human Health Risk Assessment

STAGE 1: PROBLEM FORMULATION

The problem formulation phase of the risk assessment involves screening three main components: contaminants, pathways and receptors. The screening is based on the preliminary characterization of the site information, with the objective of forming a conceptual model. The problem formulation proceeds with the following steps (CANTOX, 1997):

Step 1: Preliminary Considerations/Site Characterization

- Clearly define why the risk assessment is required
- Identify all the stakeholder(s) involved
- Determine the time and budget constraints
- Provide a history of site activities, including a chronology of land use, building materials
- Identify any neighbouring land uses (parkland/residential)
- Characterize the contaminated soil within the site
- Collect physical/chemical data regarding contaminated media (e.g., soil porosity, permeability, and moisture content)

Step 2: Screening the Contaminants

It is impractical, costly and time consuming to assess all contaminants identified in the Phase II study. These contaminants need to be screened and selected (CANTOX, 1997).

- Identify contaminants that exist at the site
- Apply a screening method to contaminants identified on site such as: quantitative screening method, identifying contaminants of public concern and toxicity, comparing contaminant concentrations with regulatory standards.
- Use assumptions and conclusions derived from receptor and pathway screening.

Step 3: Screening the Receptors

It is not feasible to evaluate every person who could potentially be exposed to contaminants from the site. The assessment must focus on human receptors who have the greatest (CANTOX, 1997):

- Potential exposure to contaminants on site
- Sensitivity to contaminants (e.g., children)
- Public concern

Site characterization (e.g. land use) will help define the receptor selection. For example, if the site characterization step of an assessment indicates industrial land use then only adult workers would be of concern – since children would not normally be spending time at an industrial setting.

Categorize the receptors by the following (CANTOX, 1997):

- Age
    - Infant (0 to <6 months of age)
    - Preschool child (6 months to < 5 years)
    - Child (5 to < 12 years)
    - Adolescent (12 to <20 years)
    - Adult (20 to 70 years)
    - Senior (> 70 years)

- Gender
    - Male
    - Female

- Sensitive Receptor groups
    - Pregnant women
    - Very young or old individuals
    - Individuals with health problems
    - Receptors with excess exposure

Step 4: Pathway Screening

This step involves identifying human exposure pathways. An exposure pathway analysis links the site characterization, receptor and contaminant screening results to determine the significant pathway(s) of human exposure (USEPA, 1989). For example, if non-volatile metals are the only contamination at a particular site, then the vapour inhalation pathway would not be of concern.

Table 1 lists the exposure pathways based on contaminated media (CANTOX, 1997).

Table 1. Contaminated Media Exposure Pathways

Exposure Pathways	Media
Ingestion	-water -food, breast milk, vegetation -dust -surface soil
Inhalation	-air (indoors and outdoors) -dust/soil
Dermal Contact	-water (showering, swimming, washing hands) -dust/soil

Conceptual Model

The conceptual model is critical to the risk assessment process as it determines the receptors, contaminants and pathways of concern, which ultimately drives the risk estimate. Since only a few receptors, contaminants and pathways are chosen, this model serves to focus the assessment and streamline the process.

STAGE 2: EXPOSURE ASSESSMENT

Exposure is defined as the contact of an organism (humans in this study) with a contaminant. The magnitude of exposure is estimated using the amount of contaminant available at the exchange boundaries (i.e., the lungs, gut, skin) during a specified time period. Exposure assessment is the estimation of the magnitude, frequency, duration, and route of exposure of a contaminant in order to estimate the daily intake by a receptor (USEPA, 1989). The exposure assessment proceeds with the following steps:

Step 1: Characterization of the Contaminant

Types of information about a particular contaminant may include (CANTOX, 1997):

- Physical/chemical data
  - Molecular weight
  - Chemical solubility
  - Vapour pressure
  - Henry's law constant
  - K_{ow}

- Path specific bioavailabilities

Step 2: Characterization of the Receptor

Specific receptor parameters that must be characterized include:

- Physical characteristics (CANTOX, 1997)
  - Body weight (kg)
  - Breathing rate (m^3/day)
  - Exposed dermal surface area (m^2)
  - Incidental soil consumption rate (g/day)

- Behavioural characteristics (USEPA, 1989)
  - Time spent on/off site
  - Amount of time spent indoors/outdoors
  - Determine how activities change with seasons

Step 3: Exposure Analysis

This step involves calculating the estimated daily exposure by receptors to contaminants of concern through ingestion of soil, inhalation of soil and dermal contact with soil (CANTOX, 1997).

Ingestion of soil

$$\text{Intake}_{\text{ingestion}} = [CS * IR * OB * EF * ED] / (AT * BW)$$

Table 2 describes the parameters used in the equation for ingestion of soil.

Table 2. Parameters for Ingestion of Soil

Variable	Definition	Unit	Explanation/Source
Intake $_{\text{ingestion}}$	Daily average intake via soil ingestion	mg/kg bw/day	
CS	Concentration in soil or sediment – contaminant specific	mg/kg	contaminant specific
IR	Ingestion rate	g/day	Receptor specific (physical characteristics)
OB	Oral bioavailability	unitless	1 is the maximum value used; equivalent to 100% bioavailable
EF	Exposure frequency – number of days per year on site	days/year	Receptor specific (behavioural characteristics)
ED	Exposure duration – number of years on site	years	Receptor specific (behavioural characteristics)
AT	Averaging time for effect	days	For carcinogens: AT=365days/yr * 70 years (lifetime) For non-carcinogens: AT=365days * ED
BW	Body weight	kg	Receptor specific (physical characteristics)

Inhalation of soil

$$\text{Intake}_{\text{inhalation}} = [CS * IR * EF * ED * (VF^{-1} + PEP^{-1})] / (AT * BW)$$

Table 3 describes the parameters used in the equation for inhalation of soil.

Table 3. Parameters for Inhalation of Soil

Variable	Definition	Unit	Explanation/Source
$\text{Intake}_{\text{inhalation}}$	Daily average intake via soil inhalation	mg/kg bw/day	
CS	Concentration in soil or sediment – contaminant specific	mg/kg	contaminant specific
IR	Inhalation rate	m^3/day	Receptor specific (physical characteristics)
EF	Exposure frequency – number of days per year on site	days/year	Receptor specific (behavioural characteristics)
ED	Exposure duration – number of years on site	years	Receptor specific (behavioural characteristics)
VF	Volatilization Factor	m^3/kg	contaminant specific
PEP	Particulate emission factor	4.28 x 10 ^9 m3/kg	EPA 1991c
AT	Averaging time – days in a year	days	For carcinogens: AT=365days/yr * 70 years (lifetime) For non-carcinogens: AT=365days * ED
BW	Body weight	kg	Receptor specific (physical characteristics)

Dermal contact with soil

$$\text{Intake}_{\text{Dermal}} = (CS * SA * AF * ABS * EF * ED) / (AT * BW)$$

Table 4 describes the parameters used in the equation for dermal contact with soil.

Table 4. Parameters for Dermal Contact with Soil

Variable	Definition	Unit	Explanation/Source
Intake $_{Dermal}$	Daily average intake via dermal contact	mg/kg bw/day	
CS	Concentration in soil or sediment – contaminant specific	mg/kg	contaminant specific
SA	Available surface area	cm^2	Receptor specific (physical characteristics)
AF	Adherence factor	1.0 mg/cm^2	Adherence factor for soil (EPA 1995a)
ABS	Absorption factor	0.001 unitless 0.01 unitless	Equivalent to: 0.1% for inorganics 1.0% for organics (EPA 1992b)
EF	Exposure frequency – number of days per year on site	days/year	Receptor specific (behavioural characteristics)
ED	Exposure duration – number of years on site	years	Receptor specific (behavioural characteristics)
AT	Averaging time – days in a year	days	For carcinogens: AT=365days/yr * 70 years (lifetime) For non-carcinogens: AT=365days * ED
BW	Body weight	kg	Receptor specific (physical characteristics)

Table 5 shows the values for the exposure analysis parameters for each receptor type.

Table 5. Exposure Analysis Parameters

Symbol	Definition	Value	Ref
ED	**Exposure Duration (years)**		
	Residential – all cases	25	4
	Commercial/Industrial	25	1
AT	**Averaging time for carcinogens (years)**		
	All cases	78	6
	Averaging time for non-carcinogens (years)		
	Residential Adult	25	4
	Residential (1-4 years)	4	3
	Residential (5-11 years)	6	3
	Commercial/Industrial	25	2
BW	**Body Weight (kg)**		
	Residential Adult	70.7	3
	Residential (1-4 years)	16.5	3
	Residential (5-11 years)	33	3
	Residential (12-19 years)	57	7
	Commercial/Industrial	70.7	2
EF	**Exposure Frequency (days/year)**		
	Residential – all cases	365	1
	Commercial/Industrial	250	1
IR	**Ingestion Rate (g/day)**		
	Residential Adult	20	5
	Residential (1-4 years)	200	2
	Residential (5-11 years)	200	2
	Residential (12-19 years)	20	7
	Commercial/Industrial	20	5
IR	**Inhalation Rate (m^3/day)**		
	Residential Adult	23	7
	Residential (1-4 years)	5	7
	Residential (5-11 years)	12	7
	Residential (12-19 years)	21	7
	Commercial/Industrial	23	7
SA	**Skin surface area – dermal (m^2)**		
	Residential Adult	0.43	7
	Residential (1-4 years)	0.28	7
	Residential (5-11 years)	0.41	7
	Residential (12-19 years)	0.43	7
	Commercial/Industrial	0.43	7

Source: Atlantic PIRI (Partnership in RBCA Implementation). 1999. *Atlantic RBCA Reference Documentation for Petroleum Impacted Sites Version 1.0.*, 1999:Appendix 6, p. 2.

Step 4: Summarize Exposure Concentrations for each Pathway

Summarize the exposure concentrations derived for each pathway.

STAGE 3: TOXICITY ASSESSMENT

The objective of the toxicity assessment is to:

- Identify the potential toxicological effects associated with the contaminant(s) of concern; and
- Provide an estimate of the maximum recommended daily exposure for a contaminant (exposure limit – RfD and TDI).

Toxicity assessment for contaminants found at contaminated sites is generally accomplished in two steps: toxicity classification and dose-response analysis.

Step 1: Toxicity Classification

This step involves gathering evidence from a variety of sources regarding the potential for a contaminant to cause adverse health effects (e.g., cancer, birth defect) in humans. This classification explains why there is a human health concern about a given contaminant.

Identify any health effect(s) associated with exposure to the contaminant(s) by researching the following (CANTOX, 1997):

- Controlled epidemiology studies
  Well-conducted epidemiologic studies that show a positive association between a contaminant and a disease are accepted as the most convincing evidence about human risk.

- Case reports

- Animal toxicological studies
  The principal animal studies will be drawn from experiments conducted most often on rats, mice, rabbits, guinea pigs, hamsters, dogs or monkeys.

- *In vitro* studies
  In vitro tests are presently being conducted to minimize the need for live animal testing.

Step 2: Gather Toxicity Information for Chemicals being Evaluated

Toxicity assessments for many contaminants have been performed and made available for use by various agencies. The following sources may provide information regarding the toxic effects that occur following exposure to a contaminant (NSEIA, 1999):

- Health Canada reports
- CCME Documents
- IRIS – Integrated Risk Information Systems (IRIS)

- HEAST – Health Effects Assessment Summary Tables
- ATSDR – Agency for Toxic Substances and Disease Registry

Step 3: Classify the contaminant(s) as a carcinogen or a non-carcinogen

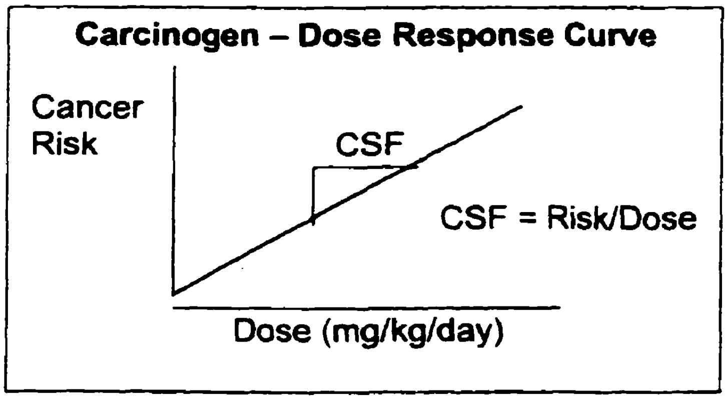
Step 4: Dose-Response Analysis for Carcinogenic (non-threshold) Contaminants

The dose-response assessment defines the quantitative relationship between the magnitude of dose and the adverse health effect. From this quantitative dose-response relationship, the toxicity value or cancer slope factor (CSF) for carcinogenic contaminants can be derived (CANTOX, 1997). The toxicity value (or CSF) will be used in the risk characterization step to estimate the likelihood of carcinogenic effects occurring in humans.

Generating a Cancer Slope Factor (CSF)

It is assumed that every dose of a carcinogen, regardless of the magnitude, can potentially cause a cancer risk. Therefore, the risk of developing cancer is linearly related to the exposure dose (see Figure 4) (USEPA, 1989). The plotting of this data gives what is known as the cancer slope factor (CSF). The slope factor allows health risks of exposure to carcinogens to be evaluated in terms of probabilities. These probabilities identify the likelihood of a carcinogenic response in an individual who has been exposed to an estimated dose of a particular contaminant.

The cancer slope factor depends upon the administration route to the body. Some chemicals produce tumors through only one administration route and do not show an effect through other routes. Ideally, the cancer risk analysis should have a cancer slope factor for each carcinogen and for each exposure route of concern (USEPA, 1989).



Source: NSEIA (Nova Scotia Environmental Industry Association in partnership with Atlantic PIRI Committee). *Atlantic Canada Risked-Based Corrective Action Training Program – June 1999.* (Dartmouth, Nova Scotia., 1999) Section 2, p. 7.

Figure 2. Carcinogen Dose Response Curve

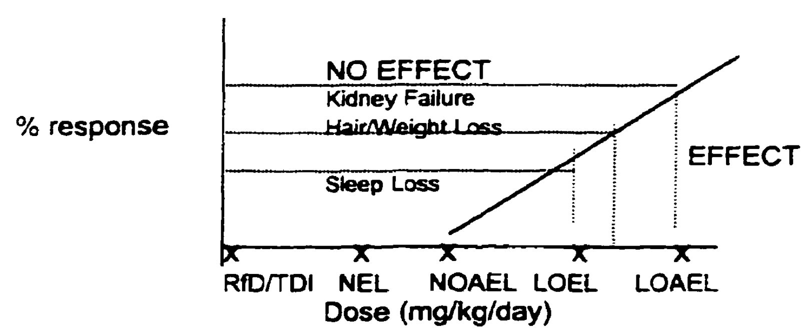
Step 5: Dose Response Analysis for Non-carcinogenic (threshold) Contaminants

The dose-response assessment defines the quantitative relationship between the magnitude of dose and the adverse health effect. From this quantitative dose-response relationship, the reference dose (RfD) for non-carcinogenic contaminants can be derived (USEPA, 1989).

<u>Derivation of the Reference Dose (RfD)</u>

Non-carcinogenic dose-response evaluation assumes that there is some minimum exposure level, or threshold, below which no adverse effects occur because of the defence mechanisms of the human body, or because some contaminants at low doses are known to be beneficial (e.g. zinc) (CLC, 1998). These threshold levels are usually established using animal laboratory studies or epidemiological data. The threshold level [called the TDI (Tolerable Daily Intake) by Health Canada or the RfD (Reference Dose) by the USEPA] is based on identifying the lowest observable adverse effect level (LOAEL) or the no observable adverse effect level (NOAEL) (CLC, 1998).

Non-Carcinogen Dose Response Curve



RfD = Reference Dose
NEL = No effect level
NOAEL = No observable adverse effect level
LOEL = Lowest observed effect level
LOEAL = Lowest observed adverse effect level

Source: NSEIA (Nova Scotia Environmental Industry Association in partnership with Atlantic PIRI Committee). *Atlantic Canada Risked-Based Corrective Action Training Program – June 1999.* (Dartmouth, Nova Scotia., 1999) Section 2, p. 7.

Figure 3. Non-Carcinogen Dose Response Curve

Applying Uncertainty Factors (UF)

If the RfD is based from the NOAEL (or LOAEL), the following are examples of different uncertainty factors (UF) that may be applied (USEPA, 1989):

- A UF of 10 is intended to protect sensitive receptors (e.g., elderly, children).
- A UF of 10 is used when extrapolating from animals to humans.
- A UF of 10 is used when a LOAEL is used instead of a NOAEL.

In addition to the uncertainty factors, a modifying factor (MF) is applied (USEPA, 1989).

- A MF ranging from 0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study. The default value for the MF is 1.

Based on the uncertainty factors and the modifying factor, a RfD is calculated using the following equation (USEPA, 1989:7-7):

$$RfD = NOAEL \text{ or } LOAEL / (UF_1 \times UF_2 \ldots \times MF)$$

Step 6: Summarize Toxicity Information

Summary tables of toxicity values for all chemicals should be prepared. RfDs in the table should be accompanied with uncertainty factors used in their derivation.

STAGE 4: RISK CHARACTERIZATION

Risk characterization is the basis of risk assessment; exposure and toxicity assessments are integrated to quantify the estimated risks associated with the contaminants of potential concern at the site.

Step 1: Calculate risks for individual contaminants

Incorporate exposure and toxicity assessment data to develop a risk estimate for carcinogens or non-carcinogens. The risk estimate that is calculated is the risk of adverse health effects occurring to the theoretical receptor.

Carcinogenic contaminants (non-threshold)

To get an estimate of the lifetime cancer risk, the cancer slope factor is multiplied by the lifetime daily dose of the contaminant. The probability is expressed as R for individual contaminants and pathways (ASTM, 1995:46).

$$RISK = Intake * CSF$$

RISK = Unitless probability of an individual developing cancer
Intake= Lifetime daily average intake averaged over 70 years (mg/kg/day)
CSF = Cancer Slope Factor (mg/kg/day)-1

Noncarcinogenic contaminants (threshold)

The potential of a non-carcinogenic contaminant to cause adverse effects is evaluated using the ratio of the exposure dose to the reference dose. This ratio is defined as the Hazard Quotient (HQ) for individual contaminants and pathways (ASTM, 1995:46).

$$HQ = Intake / RfD$$

HQ = Hazard Quotient
Intake= Daily average intake (averaged over exposure period) (mg/kg/day)
RfD = Reference Dose (mg/kg/day)

Step 2: Calculate Risk for Multiple Pathways

Estimating risk by considering one pathway at a time may significantly underestimate the risks associated with simultaneous exposures to several pathways, therefore risk for multiple pathways must be calculated.

Carcinogenic contaminants (non-threshold)

The cancer risk for multiple pathways is expressed as $Risk_T$ (USEPA, 1989:8-16).

$$Risk_T = \sum Risk_i$$

$Risk_T$ = the total cancer risk, expressed as a unitless probability
$Risk_i$ = the risk estimate for the i^{th} contaminant

Noncarcinogenic contaminants (threshold)

To assess the overall potential for noncarcinogenic effects posed by more than one pathway, a hazard index (HI) approach has been developed. However, it is important to calculate the hazard index separately for chronic, subchronic, and shorter-term exposure periods (USEPA, 1989:8-17).

$$HI = \sum HQ_i$$

HI = chronic, subchronic or shorter term hazard Index
HQ_i = the hazard quotient for the i^{th} contaminant

Step 3: Calculate Risk for Multiple Contaminants

Estimating risk by considering one chemical at a time may significantly underestimate the risks associated with simultaneous exposures to several contaminants, therefore risk for multiple contaminants must be calculated.

Carcinogenic contaminants (non-threshold)

The cancer risk for multiple contaminants is expressed as $Risk_T$ (USEPA, 1989:8-12).

$$Risk_T = \sum Risk_i$$

$Risk_T$ = the total cancer risk, expressed as a unitless probability
$Risk_i$ = the risk estimate for the i^{th} contaminant

Noncarcinogenic contaminants (threshold)

To assess the overall potential for noncarcinogenic effects posed by more than one chemical, a hazard index (HI) approach has been developed. However, it is important to calculate the hazard index separately for chronic, subchronic, and shorter-term exposure periods (USEPA, 1989:8-13).

$$HI \quad = \sum HQ_i$$

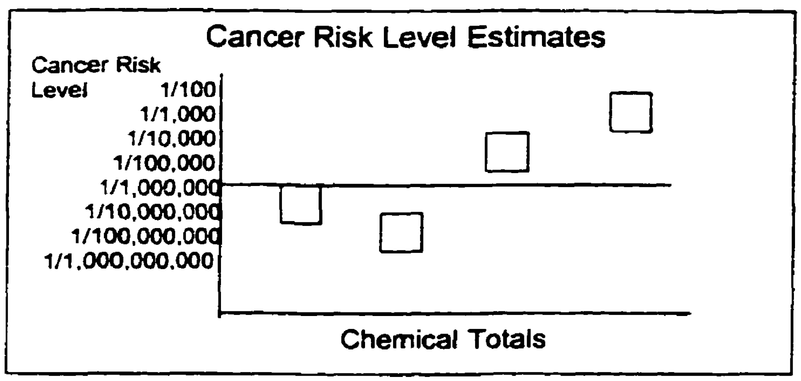
HI = chronic, subchronic or shorter term hazard Index
HQ_i = the hazard quotient for the i^{th} contaminant

Step 4: Interpretation of Risk Estimates

Carcinogenic contaminants (non-threshold)

R/R_T<< acceptable level of risk	- acceptable risk
R/R_T>> acceptable level of risk	- unacceptable risk
R/R_T~ 1	- requires careful consideration

Acceptable levels of risk for humans may be 1:10,000 (10^-5) or 1:1,000,000 (10^-6), depending on whether it is a single or multiple pathway and/or a single or multiple contaminant. A site that has a total cancer risk of less than 10^-5 is generally not considered to pose a significant risk to human health or to require remediation (CANTOX, 1997).



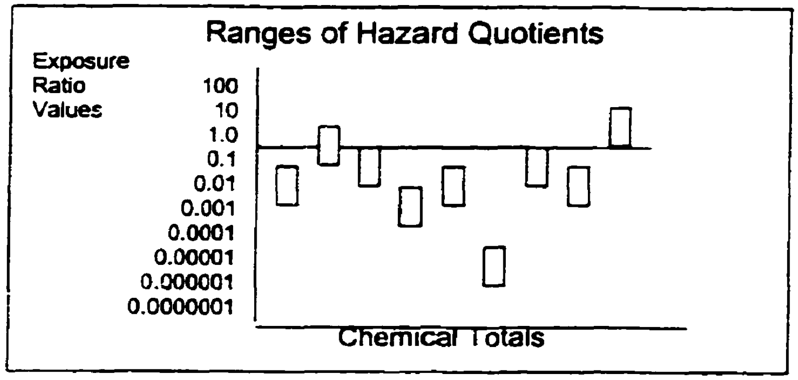
Source: CANTOX Inc. 1997. *CKES 121 Toxicology Course*. CANTOX Inc. Toronto, ON.

Figure 4. Cancer Risk Level Estimates

Non-carcinogenic contaminants (threshold)

HQ/HI<<1	- low or insignificant risk
HQ/HI>>1	- unacceptable risk
HQ/HI ~1	- requires careful consideration

A hazard quotient greater than 1.0 indicates that the exposure levels are capable of producing non-carcinogenic effects (CANTOX, 1997).



Source: CANTOX Inc. 1997. *CKES 121 Toxicology Course.* CANTOX Inc. Toronto, ON.

Figure 5. Ranges of Hazard Quotients

Step 5: Identify Uncertainty Factors

It is important to fully specify the assumptions and uncertainties inherent in the risk assessment to keep the risk estimates in proper perspective and to identify areas where additional data may improve the basis for selection of a remedial alternative. Uncertainty related to the following should be identified (USEPA, 1989):

- Chemicals – reason for exclusion of certain chemicals in the risk assessment
- Exposure pathway – reason why pathway was selected or not selected for evaluation
- Receptor – reason for selection and all assumptions regarding body weight, ingestion rate, etc.
- Derivation of toxicity values (human or animal data, duration of study)
- The potential for synergistic interactions with other contaminants affecting the same individuals
- Calculation of lifetime cancer risks on the basis of less-than-lifetime exposures

Step 6: Develop Site Specific Target Levels

When a contaminant risk is found, an iterative process is used to find an acceptable level or a Site Specific Target Level (SSTL) for which the contaminant can be reduced to. Site specific target levels are the levels to which a site should be cleaned so that there are no observable carcinogenic or non-carcinogenic risks (NSEIA, 1999, section 3, 5).

The SSTLs developed for carcinogenic risks are based on carcinogens exceeding an incremental risk of approximately 10^-5 (NSEIA, 1999). For non-carcinogenic risks, a hazard quotient value of <1 is assumed to be free of risk (NSEIA, 1999).

The site specific target levels can be calculated for both carcinogens and non-carcinogens (NSEIA, 1999):

<u>Carcinogenic contaminants (non-threshold)</u>

$$SSTL = TR / (CSF*EXP)$$

SSTL = Site specific target level
TR = Target risk [assume 1:100,000 (10^-5) or 1:1,000,000 (10^-6)]
CSF = Cancer slope factor for contaminant of concern
EXP = Exposure rate
= (EF * ED * CR) / (BW * AT)
where,
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CR = Contact rate (e.g., ingestion rate, inhalation rate)
BW = Body weight (kg)
AT = Averaging time (days)

<u>Non-carcinogenic contaminants (threshold)</u>

$$SSTL = (THQ*TDI) / EXP$$

SSTL = Site specific target level
THQ = Target hazard quotient (assume <1)
TDI = Tolerable daily intake for contaminant of concern
EXP = Exposure rate
= (EF * ED * CR) / (BW * AT)
where,
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CR = Contact rate (e.g., ingestion rate, inhalation rate)
BW = Body weight (kg)
AT = Averaging time (days)

Note the above focused on developing human health protection soil quality standards for exposure to contaminated soil. However, there are other factors, such as groundwater used for drinking water and environmental protection, that must be taken into consideration when calculating soil quality.

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APPENDIX E

Public Involvement Activities

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PUBLIC INVOLVEMENT ACTIVITIES

PUBLIC CONSULTATION

Public Information

The simplest form of communication with the public is to keep them informed about ongoing decision-making. Information can be made available to the public through advertising, news releases, newsletters/pamphlets, public displays and technical papers. To ensure that the public receives relevant information, mailing lists are both important databases and essential communication tools. The better the mailing list, the better the public outreach and delivery of information (USEPA, 1996).

<u>Steps to a Successful Mailing List</u> (USEPA, 1996)

Step 1: *Solicit names, addresses, and phone numbers of individuals to be included*

- ✓ Telephone numbers are useful to have so that you can contact these individuals for community interviews and to aid you when you update your list.
- ✓ Individuals to include in your mailing list:
  - ❑ All nearby residents and owners of land adjacent to the site
  - ❑ Representatives of organizations with a potential interest (e.g., commerce and business groups, environmental and community organizations, educational organizations, universities, local development and planning boards)
  - ❑ Any individual who attends an open house, public meeting, workshop, or informal meeting related to the site, or who calls the toll-free telephone hotline regarding the site
  - ❑ Media representatives
  - ❑ Municipal, provincial and federal governments

Step 2: *Input information into a computer system*

Step 3: *Send a fact sheet to the preliminary mailing list*

- ✓ Inform the preliminary list individuals of the current and upcoming activities.
- ✓ Ask whether they wish to receive additional information about the site.
- ✓ Ask for accurate addresses and phone numbers of other people who might be interested in the project.

Step 4: *Update your mailing list at least annually*

- ✓ Mailing lists can be updated by telephoning each individual on the list, and by using local telephone and city directories as references.

Public Information Feedback

Public information feedback techniques are used to obtain information from the public. Focus group sessions are important and necessary for gaining detailed understanding of people's concerns and values. A focus group, a meeting of invited participants, is designed to gauge the probable response of the community or the larger public to a proposed action or initiative. Surveys are designed to solicit specific types of feedback from a targeted audience, such as the effectiveness of public participation activities, or what could be done to improve distributed materials. Surveys may be oral or written; used in person or by mail; and distributed either to specific segments of the community or to representative samples (USEPA, 1996).

Steps to a Successful Focus Group (USEPA, 1996)

Step 1: *Determine whether or not a focus group can help the process*

- ✓ Will it be a more effective means of gauging public opinion?

Step 2: *Select your focus groups*

- ✓ Contact other stakeholders and community leaders to get input on who to include in your focus groups.

Step 3: *Use the information in forming a public participation plan*

- ✓ Focus groups provide a quick means of feedback from a representative group and can be a good supplementary activity, especially if such group discussions will make some members of the public feel more comfortable.

Steps to a Successful Survey (USEPA, 1996)

Step 1: *Specify the information that you need to gather*

- ✓ Construct specific questions to include in the survey
  - ❑ For written surveys, consider multiple choice or "check one box" - formats that people are more likely to answer.
  - ❑ Ensure that oral questions are not too long or confusing.

Step 2: *Design the survey*

- ✓ For written surveys, you should leave plenty of room for people to write.
- ✓ Always include the name and number of a contact person.

Step 3: Distribute the surveys and questionnaires

- ✓ Distribute written surveys in person or via mail.
  - ❑ If the survey is mailed, consider including pre-stamped, pre-addressed envelopes.
  - ❑ Consider a "blanket" distribution to all homes and businesses within a certain distance of the site.
- ✓ For telephone surveys, you will have to decide whom to call and whether you will address the survey to a random sample, a representative sample, or a targeted segment of the community.

Open Houses

An open house is a relatively informal event designed to allow people to drop in and obtain information at their convenience. It consists of a display presentation, complemented by handout materials and presence of experts who meet with and answer people's questions one-on-one. It is held in a convenient location within the community, and usually lasts for several hours during the day and/or evening. An open house can help meet the following objectives (MOEE, 1989):

- Provide information through visual aids such as maps, charts, graphs, diagrams or pictures.
- Provides an opportunity to speak to people individually to understand their concerns

<u>Steps to a Successful Open House</u> (MOEE, 1989:handbook)

Step 1: *Understand the objectives and develop an agenda*

✓ Develop a workplan to meet the objectives.

Step 2: *Schedule the Place and Time*

✓ Select a location (typical locations include schools, community centres, public libraries, conference centres, and hotel facilities).

Step 3: *Advertise*

✓ Once the open house has been scheduled, develop an advertising campaign. Use posters, personal invitations by mail or telephone, community newsletters, bulletin boards, newspapers, televisions or radio.

Step 4: *Develop the Display and Supporting Materials*

✓ Consider the information that is to be communicated, and how it might be displayed. The displays should:

- ❑ Have an overview and reflect the most important points
- ❑ Be attractive yet simple
- ❑ Have script that is large and easy to read
- ❑ Have display boards that are a reasonable height from the floor
- ❑ Have charts, graphs, diagrams, maps or pictures to clarify the message
- ❑ Include an outline of the next steps in the planning process, and public involvement process

Step 5: *Set-up*

✓ A pleasant and relaxed atmosphere will encourage people to take their time looking at the display and to ask questions.

Public Meetings

A public meeting is a forum that provides the developer the opportunity to make a formal presentation to the public and which, in turn, provides the public with an opportunity to respond, directly and immediately, with questions and comments. A public meeting can help meet the following objectives (MOEE, 1989):

- Provide information to a large group of people.
- Give voice to people's concerns about the issues
- Keep large numbers of people informed of the next steps and final decisions regarding the issue.

Steps to a Successful Public Meeting (MOEE, 1989:handbook)

Step 1: *Understand the objectives.*

- ✓ Develop a workplan to meet the objectives.
- ✓ Identify the topics that need to be covered.
- ✓ Identify those people who will need to be invited as presenters.
- ✓ Develop an agenda that includes the following elements of a meeting:
  - ❑ Welcome speech
  - ❑ Introductions (of people at the head table who will make presentations or answer questions)
  - ❑ Purpose of Meeting (including how it relates to the ongoing public consultation program, as well as an overview of the meeting's agenda)
  - ❑ Presentations
  - ❑ Question-and-Answer Session
  - ❑ Summary of meeting

Step 2: *Schedule and Advertise the Meeting*

- ✓ Select location of meeting (location must be convenient and accessible)
- ✓ Advertise the meeting at least two weeks in advance, and follow up with a second advertisement the day before the meeting.

Step 3: Set Up

- ✓ On the day of the meeting, arrive at least an hour before the start to ensure everything and everyone is ready
- ✓ Important set-up questions include:
  - ❑ Do you have signs at the building entrance or by the elevators to guide people to the meeting room?
  - ❑ Are there enough chairs available?
  - ❑ Is the head table set up properly?
  - ❑ Is there a sign-in table by the door?
  - ❑ Are there sufficient copies of the agenda available?
  - ❑ Are display materials and handouts available?
  - ❑ Are the microphones and projectors working?
  - ❑ Are your comment sheets ready?

Workshops

A workshop is a structured forum where individuals work together on a common problem or task. It is usually limited to a small number of participants. It is a specialized consultation activity used to support or build upon other activities, such as public meetings and open houses. While it is not a forum for making decisions, a workshop can provide insights for consensus that you can apply in future activities. A workshop can help meet the following objectives (MOEE, 1989):

- Discuss the issues, viewpoints and solutions
- Build consensus for action
- Encourage creativity

<u>Steps to a Successful Workshop</u> (MOEE, 1989:handbook)

Step 1: *Understand the Objectives and Develop a Workplan*

- ✓ Develop a workplan to meet the objectives.

Step 2: *Work with a Facilitator*

- ✓ The facilitator's role is to be a catalyst for generating ideas, the specific tasks during the workshop include:
  - ❑ Outlining the agenda and proposed "ground rules"
  - ❑ Bringing out the concerns and ideas of all participants
  - ❑ Clarifying and restating ideas
  - ❑ Articulating options and recommendations

Step 3: *Schedule the Time and Location*

- ✓ Typically, a workshop runs the entire day. The location may be a conference centre, community centre, public library or hotel meeting room.

Step 4: *Invite the Participants and Prepare Materials*

- ✓ It is important to have the right mix of perspectives and experiences to generate good discussion and to provide ideas and insightful comments.
- ✓ Each prospective participant must be contacted informally well before the workshop. The participants should be informed of the purpose of the workshop, the approach that will be taken, and what is expected of them.
- ✓ Once participants have agreed to participate, a letter of invitation must be sent.
- ✓ Prepare resource materials such as, slides, overheads, flip charts, displays, etc.

Toll-Free Telephone Lines

A toll-free line can be a cost-effective means of keeping in touch with a large number of people on a relatively complex or long-term problem. Telephone lines should also be open to receive general opinions and concerns (USEPA, 1996).

Steps to a Successful Toll-free Telephone Line (USEPA, 1996)

Step 1: *Assign someone to handle the calls*

- ✓ If someone is not available throughout the day, install an answering machine directing people to leave their name, number, and brief statement of concern, and informing them that someone will return their call promptly.
- ✓ If a voice mail system is available, provide information on commonly requested information such as meeting dates and locations.
- ✓ Check the answering machine for messages at least once a day.

Step 2: *Announce the telephone number*

- ✓ Announce the number in news releases to local newspapers, radio stations, and television stations, and in fact sheets, publications, and public notices.

Step 3: *Keep a record of each question*

- ✓ Record each question, when it was received, from whom, and how and when it was answered.
- ✓ All questions and inquiries should be responded to promptly (within 24 hours) if an answer cannot be given immediately.
- ✓ Be diligent in following up requests for information and tracking down accurate, direct responses.

Site Tour

A site tour would involve inviting members of the public to tour the site in order to obtain first-hand information and orientation. Tours may be conducted during the remedial phase of corrective action. A tour of the physical site provides participants with a chance to "see" the problem for themselves. Handout materials may be provided with more detailed background data or information (USEPA, 1996).

<u>Steps to a Successful Site Tour</u> (USEPA, 1996)

Step 1: *Plan the tour ahead of time.*
- ✓ Determine tour routes
- ✓ Ensure that the tour complies with the safety plan for the site

Step 2: *Develop a list of individuals that might be interested in participating*
- ✓ Individual citizens or nearby residents who have expressed concern
- ✓ Representatives of public interest or environmental groups that have expressed interest in the site
- ✓ Interested local officials and regulators
- ✓ Representatives of local citizen or service groups
- ✓ Representatives of local newspapers, TV, and radio stations

Step 3: *Determine the maximum number that can be taken*
- ✓ Keep the group small so that questions may be asked
- ✓ Schedule additional tours as needed

Step 4: *Anticipate questions.*
- ✓ Have someone available to answer technical questions in non-technical terms.

Public Committee

A public committee allows individual members of the public to play a strong advisory role in a formal manner to address a problem. The committee members meet regularly to discuss the issues, provide input and advice throughout the duration of the project. They serve as the vehicle for conveying the publics concerns. As well, they are important for distributing information, developing possible solutions, building consensus, and proposing new directions (MOEE, 1994).

Identifying members for the public committee is one of the key steps to this activity. It is important to select and identify those members that are directly or indirectly affected, positively or negatively, by a project, and who can contribute to or hinder its success.

Steps to a Successful Public Committee (MOEE, 1994)

Step 1: *Understand the Objective and Develop Terms of Reference*

- ✓ The first major task will be to develop terms of reference for the committee. The following questions must be considered:
  - ❑ What is the problem? Is it a visible or recognized problem in the community?
  - ❑ What do you want the committee to do?
  - ❑ How is the membership to be selected?
  - ❑ What are the roles and responsibilities of the committee members?
  - ❑ Is the organization to have a member on the committee?
  - ❑ What resources are to be provided to the committee?
  - ❑ What will be the basic operating rules for the committee?

Step 2: *Inform the Public of the Opportunity*

- ✓ Identify who should participate.
- ✓ Inform the people about the proposed establishment of the committee and opportunity it presents for involvement.

Step 3: *Select Committee Members*

It is crucial to select committee members which ensure that the group is representative of all the interests. The following questions may help identify stakeholders:

- ✓ Who will be affected by the negative environmental and social impacts of the project, both on- and off-site?
- ✓ Who will benefit from the project other than the project sponsor and investors?
- ✓ Who will be responsible for implementing measures designed to avoid, mitigate, or compensate for the project's negative impacts?

- ✓ Whose cooperation, expertise, or influence would be helpful to the success of the project?
- ✓ Who are the most vulnerable, least visible, and voiceless for whom special consultation efforts may have to be made?
- ✓ Who supports or opposes the changes that the project will bring?
- ✓ Whose opposition could be detrimental to the success of the project?

Step 4: *Manage the Committee's Work*

Managing a public committee is like running a workshop, with resource materials distributed in advance. It should have a formal agenda and be advertised much like a public meeting. The committee's first meeting should address the following:

- ✓ Defining the objectives and tasks of the committee;
- ✓ Setting the ground rules, such as:
  - ❑ Are there attendance requirements to remain a member in good standing?
  - ❑ How will consensus be determined?
  - ❑ How will the committee's meeting be publicized?

Consensus

Consensus building is a powerful and effective decision-making and dispute resolution tool that proceeds through four stages.

Stage 1: Assessment

This stage involves discussing the process with the participants. The primary objective is to enable potential participants to make an informed decision on whether to participate in a consensus process or whether to proceed using a consensus process. The following questions should be asked before deciding to proceed with the consensus process (NRTEE, 1993):

- ✓ Is there a reason to participate in a consensus process?
- ✓ Can the subject matter be discussed at this time?
- ✓ Can meaningful deadlines be established for reaching agreements?
- ✓ What are the negative consequences of failing to agree?

Stage 2: Designing the process

The participants must design the process, which is usually embodied in a set of written ground rules formally agreed to by all participants. "Borrowing" a process more than likely will end up in disaster: the most effective process is one that has been created by and for those who will be using it. Some initial steps that should be developed include (NRTEE, 1993):

- ✓ Establishing clear objectives and ground rules
- ✓ Defining what will constitute a consensus for reaching an agreement
- ✓ Structuring how the process will work
- ✓ Identifying the participants' responsibilities
- ✓ Agreeing on a schedule of milestones and deadlines
- ✓ Determining what will happen if consensus is not achieved

Stage 3: Running the process

The search for agreement begins with the commitment to understand, respect, and address one another's concerns and interests. The goal is to reach a joint definition of the issues and, together, to design solutions that work. The best agreements are characterized by innovative solutions and such solutions are possible only where all participants bring to the table their interests, their expertise, and their rights. The participants should focus on building consensus by (NRTEE, 1993):

- ✓ Discussing issues/Focussing on the issues rather than personalities
- ✓ Genuinely listening to one another's perspectives on these issues
- ✓ Recording agreement as they are reached

Stage 4: Implementing and monitoring agreements

The implementation process should provide mechanisms for dealing with new information and unforeseen problems and for resolving future disputes. Several key features need to be considered (NRTEE, 1993):

- ✓ Who is responsible for what
- ✓ Timetable and funding for agreements reached
- ✓ Who will be responsible for monitoring, review, and, if necessary, renegotiating parts of the agreement

REFERENCES

MOEE (Ministry of Environment and Energy). 1989. *Public Consultation: A Resource Kit for Ministry Staff.* Toronto: Environment Ontario.

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USEPA (United States Environmental Protection Agency). 1996. *RCRA Public Participation Manual.* Office of Solid Waste, Washington, D.C. URL: http://www.epa.gov/epaoswer/hazwaste/permit/pubpart/manual.htm

APPENDIX F

Critique of CLC's Activities in PDU-1

PHASE I

Key Elements of Assessment based on PHASE I - ASTM E1527	CLC's Efforts / Activities (PDU-1)	Evaluation*	Comment(s)
CONTRACTORS			
Employ only environmental professional to conduct the ESA since the professional judgement of an environmental professional is vital to conducting a Phase I ESA.	In 1994, Jacques Whitford Environmental Ltd. was contracted to summarize all the earlier environmental reports (CLC, 1998:8).	Poor	A traditional Phase I ESA was not performed.
USE OF PRIOR INFORMATION			
Use a prior environmental site assessment if the property has not changed materially since the prior environmental site assessment was conducted.	34 environmental reports were conducted between 1986 -1996 (CLC, 1998:8).	Poor	Earlier studies were types of Phase II ESA's, therefore they did not indicate a problem with respect to the presence of building and infrastructure remnants.
Investigate current site conditions prior to using previous ESA assessments to ensure the property has not changed materially since the prior environmental site assessment was conducted.	No Activities	N/A	N/A
FOUR COMPONENTS OF PHASE 1 ESA			
Records Review Review records to help identify recognized environmental conditions in connection with the property.	The 34 environmental reports conducted between 1986-1996 prior to CLC's acquisition of the property were reviewed (CLC, 1998:8).	Good	Current CLC approach is adequate.
Historical Use Information: Develop a history of the previous uses of the property and surrounding area, in order to help identify the likelihood of past uses having led to recognized environmental conditions in connection with the property. Standard historical sources: Aerial photographs, Fire insurance maps, Property tax files, Recorded land title records, Zoning/ land use records	A historical review was conducted to identify the activities that occurred on the property between the early 1900's and the late 1980's and their bearing on the environmental state of the Property (CLC, 1998:PDU1-6). Aerial photographs were obtained.	Good	Current CLC approach is adequate.
Conduct Site visits	Site visits were conducted.	Good	Current CLC approach is adequate.
Conduct Interviews	Interviews were conducted with former CN staff that operated and maintained the property.	Good	Current CLC approach is adequate.
DOCUMENTATION			
Document each source that was used, even if a source revealed no findings. Sources shall be sufficiently documented.	Much of the historical activities on the site was uncovered through interviews and information gathered in June-September 1997. This was not adequately documented and is a deficiency in the OCL reports (MacKnight, 2000)	Poor	All sources should be sufficiently documented to facilitate reconstruction of the research.

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

Phase II

Key Elements of Assessment based on PHASE II - ASTM E1903-97	CLC's Efforts / Activities (PDU 1)	Evaluation *	Comment(s)
CONTRACTORS			
Employ only qualified contractors with appropriate certifications and licenses.	Jacques Whitford Environmental Ltd. (JWEL) conducted a Phase II ESA in 1994 (CLC, 1998:8).	Good	Current CLC approach is adequate
Review previously prepared ESAs, other environmental studies, reports, or permits.	JWEL summarized 34 site characterization studies that were conducted between 1987-1996 (CLC, 1998:8).	Poor	JWEL did not identify the problem of remnant buildings or infrastructure.
PRE-SITE CHACTERIZATION			
Excavate and stockpile all debris and remnants.	All remnants, mostly concrete in PDU's 1,2 and 3 were removed and stockpiled before the PDU site characterization was undertaken. Some asphalt was also excavated and stockpiled. Any remnant rails or ties had been mostly removed in 1995 by contractors for CN Rail (MacKnight, 2000).	Good	Current CLC approach is adequate
Survey the site	Recognizing that buried metal, buried infrastructure and conduits and other buried debris could interfere with the standard soil sampling, Northeast Exploration Services Ltd. were contracted (Jan-May/97) to complete electromagnetic surveys to detect buried metal and conductive soil on the property (CLC, 1998:12).	Good	Current CLC approach is adequate
SITE CHARACTERIZATION			
Collect physical/chemical data regarding contaminated media (e.g., soil porosity, permeability, and moisture content).	During July –Sept.1997, GEMTEC Ltd. was contracted to conduct the sampling of PDU-1 in support of the Phase II ESA report being prepared. As the standard requirements of Canada Lands includes providing a property buyer with detailed environmental site assessment and general geotechnical characterization of a property, a geotechnical investigation to determine the subsurface soil/ groundwater conditions and to provide a foundation design criteria for proposed building and pavement structures was carried out (CLC, 1998:Appendix D).	Good	Current CLC approach is adequate

*Excellent - over and above requirement(s)   Good - Adequately meets requirement(s)   Poor - Requires more effort/activities to meet requirement(s)

SAMPLING			
Develop a sampling program that identifies: (i) collection of potentially contaminated media (ii) locations and depths	To establish a statistically-based sampling grid providing 95% confidence of the reported values, a series of test trenches were excavated throughout the Property in June 1997, with 2 trenches located within PDU-1. Each trench was 30 m long and excavated to ~5m below grade (i.e., well into the underlying native Moncton Clay and therefore below the zone of anthropogenic alteration/contamination). Soil samples were collected at 0.5m intervals by depth and length, as well as samples from "odd" zones or layers not otherwise sampled. All samples were chemically analyzed for 10 test metals and the results statistically assessed by a statistical analysis company. The latter assessment determined the density of sampling locations within each PDU (CLC, 1998:PDU-1 A-11).	Excellent	A site specific grid system and sampling methodology was developed that ensured a 95% confidence interval was consistently obtained for each trace metal sampled. The system and methodology were developed by interpreting a very detailed preliminary assessment and contracting a company specializing in statistical analysis to determine the sample size using statistical mathematical modeling.
Develop a sampling program that identifies: (i) collection of potentially contaminated media (ii) locations and depths	September – December 1997 - Assessment -From the data gathered in the preliminary assessment, statistics indicated that a plus or minus 20% upper 95% confidence interval could be achieved by using a grid size of 30mx30m to collect at least 200 soil samples. -Samples were taken at each 0.5m of depth, beginning with and including the surface -Approximately 11 samples were taken/test pit (CLC, 1998:PDU-1 A-12)		
Implement QA/QC measures for sampling - written field sampling protocol, - decontamination procedures, - instrument calibration, - preparation and analysis of trip blanks, - equipment blanks, - duplicate samples, - holding times for sample analysis	QA/QC Program -With every fifth sample taken, two additional bottles of soil were taken as field replicates to analyze for trace metals -With every third sample site, a second bottle of soil was taken for subsequent trace organic analysis -Each soil sample was placed in a clean, new, 0.5L glass Mason jar to about 75% and the jar was labeled -Soils were handled using a clean, Teflon-coated spoon -Spoon was cleaned after every sample by washing in clean water and wiping dry -Samples for metals were stored in their bottles at room temp. -Samples for trace organic analysis were frozen until analysis (CLC, 1998:PDU-1 A-13)	Good	Current CLC approach is adequate
Document sampling locations to allow the sampling event to be reproduced later.	All sampling sites were positioned by Key Surveys (Moncton, NB) and the positioning data entered into the ArcView geographical information system (GIS) database with a Northing and Easting identifier (CLC, 1998:PDU-1 A-11).	Excellent	Accurate and concise record keeping of sampling locations and concentrations of contaminants was performed.

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Accompany each shipment of samples to the analytical laboratory with a completed chain of custody record.	June-September 1997 Samples delivered to the Laboratoire de recherche pour l'industrie et l'environnement/Universite de Moncton (LEIL/UDM) were accompanied with "Chain of Custody" lists that matched the received samples. If everything was in order, the receiving technician signed the "Chain of Custody" lists and photocopied them. The client received the original and LEIL/UDM retained a copy. (CLC, 1998:PDU A3-1)	Good	Current CLC approach is adequate
	September-December 1997 Samples delivered to Philip Analytical Services were accompanied with "Chain of Custody" lists. (CLC, 1998:PDU A3-1)	Good	Current CLC approach is adequate
LABORATORY ANALYSIS			
Select analytical method	LEIL/UdM analyzed the following analytes using an ICP-AES: arsenic, barium, boron, cadmium, chromium, copper, nickel, lead, tin, zinc. The method of analysis was USEPA Waste Method 3050A, with determinations made using an ICP/AES.	Poor	Identification of all contaminants in the soil was not performed. The LEIL/UdM) used an ICP/AES unit with a restricted element set and identified only 10 out of 22 inorganics. Another laboratory should have been selected.
Contract an analytical laboratory that has an established QA/QC program sufficient to allow assessment of the precision and accuracy of the data it generates	A rigorous QA/QC program, including field and laboratory replicates, laboratory blanks and reference materials was established with LEIL/UdM. (CLC, 1998:PDU A3-1).	Good	Current CLC approach is adequate
	CLC records do not indicate that that NBRPC (New Brunswick Research and Productivity Council) in Fredricton used for trace organic contaminant analysis has a QA/QC program.	Good	Current CLC approach is adequate
	Philip has established a QA/QC program (CLC, 1998:PDU A3).	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s)   Good - Adequately meets requirement(s)   Poor - Requires more effort/activities to meet requirement(s)

Contract an analytical laboratory that is certified/licensed	The laboratory LEIL/UDM used from June-September 1997 was not a certified laboratory. However, selection was based on economics. According to Loren Spieran, (Feb. 7/00), "the services of LEIL/UDM, an uncertified laboratory was contracted for the soil analysis based of cost ($10/sample) compared to Philip Analytical Services ($50/sample.)"	Poor	The LEIL/UdM was not certified. Environment Canada recommends using a lab certified by CAEAL.
	NBRPC is a certified laboratory.	Good	Current CLC approach is adequate
	CLC records indicate that Philip Analytical Services Corp used from September-December 1997 is certified (CLC, 1998:Section 9).	Good	Current CLC approach is adequate
EVALUATION OF DATA			
<u>Verification of Assumptions</u> Verify that the samples are collected of the appropriate media (soil, groundwater) and at the right locations and depth (where the highest concentrations of contaminants should be)	In 1994, the JWEL study was based on one sampling test pit of 60m x 60m grid block and samples were taken to depths between 0.3 to 6m. 1-2 samples from each test pit were taken and analysis was performed on samples that were most likely to be contaminated based on a visual inspection. This format was not adequate for making decisions on site rehabilitation requirements. This soil characterization survey was used as the basis for more detailed characterization studies (CLC, 1998:PDU-1 A-11).	Good	Current CLC approach is adequate
<u>Verification of Data</u> Question the analytical results based on the QA/QC procedures.	According to Loren Spieran (Feb 10/00), OCL Services verified the analytical results.	Good	Current CLC approach is adequate
<u>Interpretation of Results</u> Evaluate the data to determine if other sources of contamination or more highly contaminated media may exist at the site but were not assessed.	According to Loren Spieran (Feb 10/00), OCL Services interpreted the analytical results.	Good	Current CLC approach is adequate

DETERMINE FUTURE LAND USE

Key Elements of Assessment	CLC's Efforts / Activities (PDU 1)	Evaluation*	Comment(s)
Determine future land use for the property: agricultural, residential, parkland, commercial, industrial	At the May 29th, 1997 "Agenda for a Sustainable City" conference, presented by the University de Moncton and the City of Moncton, it was determined that the property would be a mix of residential, commercial, and recreational land use.	Good	Current CLC approach is adequate

COMPARE RESULTS TO BACKGROUND

Key Elements of Assessment based on PHASE II - ASTM E1903-97	CLC's Efforts / Activities (PDU 1)	Evaluation*	Comment(s)
Interpret the data to determine if chemicals detected are naturally occurring or are present as a result of human activity. e.g. lead occurs naturally in soils and waters, at a range of concentrations. Mere detection of lead does not necessarily reflect lead release. The lead level detected must exceed the naturally occurring lead level in the vicinity to conclude this.	A series of 95 sites were identified throughout the Greater Moncton area and sampled with analysis for trace metals. (CLC, 1998:13)	Excellent	Analyzed 95 sites to obtain an accurate representation of the background levels in the Moncton Area.
	The trace metals sample results were interpreted and compared to background levels to identify whether high levels of metals were attributed to natural occurrence in native soils and/or as a result of CN operations and activities (CLC, 1998:13).	Good	Current CLC approach is adequate

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PROJECT VISION/GOALS

Key Elements of Assessment	CLC's Efforts / Activities (PDU 1)	Evaluation *	Comment(s)
Adequately characterize the environmental concerns.	Between Nov/96 and May/97 the Environmental Management Advisory (EMA) team developed a sustainable development strategy for development of the Moncton Properties: • Removal of any serious environmental hazards • Rehabilitation of the property so that sale of the land for development can occur, with due regard to the principles of sustainable development • If necessary, participation in the development of the property, to ensure that future activities proceed with due attention to proper environmental management practices, consistent with the principles of sustainable development; and • Provide positive input into the community to improve the overall economic well being of the greater Moncton region. (CLC, 1998:4)	Good	Current CLC approach is adequate
Overcome the social stigma attached to the property	Phase I objectives: • Introduce CLC to the community • Communicate the objective to reintegrate the site into the community • Identify the level of community interest in future development • Explore public perceptions of environmental conditions and potential of the site • Develop and obtain feedback on a proposed strategy for the environmental remediation and future land uses. (CLC, 1998a:3)	Excellent	CLC took on a pro-active approach, in understanding its stakeholders needs.
	Phase II objectives • Provide accurate, clear and timely information to the community in a variety of forms • Obtain public input on issues of concern • Generate options that reflect community values and needs • Provide answers to the public • Document the project • Assure that CLC becomes aware of community wants and needs (CLC, 1998b:2)	Excellent	CLC took on a pro-active, open and transparent approach in dealing with its stakeholders.

* Excellent - over and above requirement(s)   Good - Adequately meets requirement(s)   Poor - Requires more effort/activities to meet requirement(s)

REMEDIATION OPTIONS

Key Elements of Assessment	CLC's Efforts / Activities (PDU-1)	Evaluation*	Comment(s)
Clean up to Background standards.	The average concentration of substances of concern on the property was compared to background concentrations. Any substance of concern measured above background is considered to be a contaminant. Cleaning up to background standards was not considered an option.	N/A	N/A
Assess remediation options.	Five remediation options were considered (CLC, 1998:59): 1. No remedial action and no sale -zones of high concentrations of metals -medium environmental risk -medium health risk 2. No remedial action: sell as is -zones of high concentrations of metals exceeding residential use criteria -medium environmental risk -medium health risk 3. Mix/process soils before sale -requires very thorough mixing of upper 1m -requires high degree of verification testing -overall average concentration greater than Risk-Based Screening Level Criteria (CCME guidelines) -medium-low environmental risk -medium-low health risk 4. Before sale must meet Risk Based Screening Level Criteria -requires removal of identified soils -requires thorough mixing of upper 1 m -overall concentration meets Risk Based Screening Level Criteria (marginally higher than the CCME guidelines) -requires verification testing -low environmental risk -low health risk 5. Before sale, remove all contaminated materials to –1 or –1.5 depth and dispose off site -all concentrations will meet Risk Based Screening Level Criteria (CCME) -requires verification testing -minimal environmental risk -minimal health risk	Excellent	A good range of remediation options was considered. Human health and environmental risks were assessed for each option, justifying the reason for selection.

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RISK BASED APPROACH

Key Elements	CLC's Efforts / Activities (PDU-1)	Evaluation*	Comment(s)
TIER 1			
Use a look up table containing soil guidelines to determine whether the site conditions satisfy the criteria for a quick regulatory closure or warrant a more site-specific evaluation.	Any substance of concern measured above background is considered to be a contaminant. The average concentrations of these contaminants were then compared to the 1997 /CCME recommended soil quality guidelines. For all organic contaminants (except petroleum contaminants) the 1997 CCME residential property use guidelines were used. For petroleum contaminants, the NBDOE criteria for residential quality of soils were chosen for the cleanup criteria (CLC, 1998:PDU-1 A-15).	Good	Current CLC approach is adequate
TIER 2			
Modify the equation used to calculate Tier 1 criteria using more site-specific parameters.	The human health criterion for lead in soil was increased from 260 to 910 mg/kg based on the fact that the intended land use permits children far less exposure to the soil than envisaged under the 1997 CCME Commercial category (CLC, 1999:A-4). (1997 CCME calculation was based on a child that was on site full time. In fact, the site-specific behavioural characteristic of the child is to be on site 3.5 times less than that calculated by the CCME.)	Excellent	A Tier 2 was performed for lead making the cleanup more cost effective.
TIER 3			
Do not restrict the RBCA process to Tier I evaluation, analyze Tier 2 and Tier 3 options.	Decision-making level criteria were established for trace metals using a Tier 3 approach. Any soils that exceeded the decision-making level criteria were removed to ensure that the remaining soils approached the Risk Based Screening Level Criteria (1997 CCME guideline). The soils were divided into two categories: (i) contamination is so high that soils are best managed by removal (soil that exceeded the decision-making criteria) (ii) soils that are contaminated but can be managed on site so no danger will occur (CLC, 1998:A-15)	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

RISK ASSESSMENT #1

Key Elements	CLC's Efforts / Activities (PDU-1)	Evaluation*	Comment(s)
STAGE 1: PROBLEM FORMULATION			
Screening the Contaminants			
Identify contaminants that exist at the site.	arsenic, barium, boron, cadmium, chromium, copper, lead, nickel, tin, zinc, sulphur, cyanide, PCB, PAH, TPH, tetrachloroethylene	Poor	Identification of all contaminants in the soil was not performed. The LEIL/UdM used an ICP/AES unit with a restricted element set and identified only 10 out of 22 inorganics.
Apply a screening method to the contaminants identified.	The contaminants that were selected were arsenic, cadmium, chromium (III and VI), copper, nickel, lead and zinc. No screening method was applied.	Poor	The selection of the contaminants was not based on reasonable criteria.
Receptor Screening			
Focus the assessment on human receptors who have the greatest: -Potential exposure -Sensitivity to contaminants (e.g., children) -Public concern	Exposure is estimated as a certain amount of a contaminant per kilogram of body weight. Since children weigh less than adults, their exposure will be greater even if they eat the same amount of the contaminant. (CLC, 1998:A19).	Good	Current CLC approach is adequate
Characterize the receptors according to age, gender, sensitive receptor groups	• Children (ages 7 months-4years) • Children (ages 5-11years) Gender was not specified	Poor	The rationale for the selection of the two age categories was not defined and the gender was not defined. The most sensitive receptor was not considered (female preschooler).

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Pathway Screening			
Identify human exposure pathways: -ingestion -inhalation -dermal contact	It is anticipated that people of different ages will come into contact with soil. In general, young children will have the highest exposure to contaminants in soil because they will be expected to play in it, may crawl on the ground, and more frequently put objects and their fingers in their mouths. When playing, they can get the soil on their skin as well as consume of the soil. While children eat more soil than adults, adults can also be expected to consume some soil each day as an incidental aspect of their daily activities. Both children and adults may breathe dust or vapours containing chemical substances. There are two sources of soil: outdoor earth and house dust. House dust is largely composed of tracked-outdoor earth, therefore contaminants from outside soil can be tracked into the house. Exposure to inhalation was not estimated because it is not a significant route of exposure, except under circumstances where there are dust bowl conditions or where people are actively working on excavating dusty soils. Exposure on the skin was not estimated because the skin is an effective barrier to penetration for most of the contaminants on the property. (CLC, 1998:A-19)	Good	Current CLC approach is adequate
Conceptual Model			
Develop a conceptual model that determines the receptor(s), contaminant(s) and pathway(s).	<u>Scenario #1</u> Receptor – child (ages 7 months – 4 years) Pathway – ingestion of soil and house dust Contaminant –arsenic, cadmium, chromium(III/VI), copper, nickel, lead, zinc <u>Scenario #2</u> Receptor – child (ages 7months – 4 years) Pathway – ingestion of house dust Contaminant – arsenic, cadmium, chromium (III/VI), copper, nickel, lead, zinc <u>Scenario #3</u> Receptor – child (age 5-11 years) Pathway – ingestion of soil and house dust Contaminant - arsenic, cadmium, chromium (III/VI), copper, nickel, lead, zinc <u>Scenario #4</u> Receptor – child (ages 5-11 years) Pathway – ingestion of house dust Contaminant - arsenic, cadmium, chromium (III/VI), copper, nickel, lead, zinc (CLC, 1998:A-20)	Good	Current CLC approach is adequate
	Remediation options 2, 3, and 4 contained calculations for each scenario. Option #2 – No remedial action Option #3 – Mix/process soils before sale Option #4 – Remove contaminated soils so that the overall average concentration meets the Risk Based Screening Criteria.	Good	Current CLC approach is adequate

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STAGE 2: EXPOSURE ASSESSMENT			
Characterization of the Contaminant			
Identify information about the contaminants: -Physical/chemical data -Path specific bioavailabilities	- Key physical/chemical data about each contaminant was identified. - Path specific bioavailablities – for a child, it was assumed that 100% absorption of the contaminant	Good	Current CLC approach is adequate
Characterization of the Receptor			
Characterize specific receptor parameters: -Physical characteristics -Behavioural characteristics	<u>Child (ages 7 months – 4 years)</u> • Physical Characteristics -body weight = 13 kg -ingestion rate = 80 mg/day = 0.08kg/day <u>Child (ages 5 – 11 years)</u> • Physical Characteristics -body weight = 27 kg -inhalation rate = 20 mg/day = 0.02 kg/day (CLC, 1998:A-20)	Good	Current CLC approach is adequate
	• Behavioural characteristics When the ground is not frozen, children are outdoors more, it is assumed that 50% of the ingestion rate would be soil and 50% would be house dust. It was assumed that the ground would be frozen for 213 days of they year and 152 days of the year. It was also assumed that the concentration of the contaminant in house dust would be two times higher than the concentration in the soil. (CLC, 1998:A-20)	Good	Current CLC approach is adequate
Exposure Analysis			
Calculate the estimated daily exposure for each pathway by receptors to contaminants of concern.	The estimated daily exposure to a child by ingestion was calculated for each scenario for each contaminant. The following were the assumptions: <u>Child (ages 7 months –4 year)</u> • summer months – 152 days, ingestion rate of soil = 40 mg/day, ingestion of house dust = 40 mg/day • winter months – 213 days, ingestion rate of soil = 8 mg/day, ingestion of house dust = 72 mg/day <u>Child (ages 5 –11 years)</u> • summer months – 152 days, ingestion rate of soil = 10 mg/day, ingestion of house dust = 10 mg/day • winter months – 213 days, ingestion rate of soil = 2 mg/day, ingestion of house dust = 18 mg/day	Good	Current CLC approach is adequate
Summarize the exposure concentrations for each pathway.	No activity (only exposure pathway considered was ingestion)	N/A	N/A

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STAGE 3: TOXICITY ASSESSMENT			
Toxicity Classification			
Identify by research the health effect(s) associated with exposure to the contaminant(s): -Controlled epidemiology studies -Case reports -Animal toxicological studies -*In vitro* studies	Toxicity evaluations for trace metals most prominently occurring on the Moncton Properties was performed by researching various studies.	Good	Current CLC approach is adequate
Gather Toxicity Information for Chemicals being Evaluated			
Gather toxicity information for the contaminants from the following: -Health Canada reports -CCME Documents -IRIS -HEAST -ATSDR	The chemical contaminants toxicity information was obtained from various sources (CLC, 1998:A-32): • Arsenic – IRIS • Cadmium – Health Canada • Chromium – IRIS • Copper – Environment Canada • Lead – Health Canada • Nickel – IRIS • Zinc – IRIS	Good	Current CLC approach is adequate
Classify the contaminant(s) as a carcinogen or a non-carcinogen	Carcinogen through ingestion – arsenic Non-carcinogen through ingestion – cadmium, chromium, copper, lead, nickel, zinc	Good	Current CLC approach is adequate
Dose-Response Analysis for Carcinogenic Contaminants			
Derive the toxicity value or cancer slope factor (CSF) for carcinogenic contaminants.	Arsenic is considered a carcinogen under the oral route exposure. But the available reference dose (RfD) is used because the scenario refers to a child exposed only during a short period.	Good	Current CLC approach is adequate
Dose Response Analysis for Non-carcinogenic Contaminants			
Establish the threshold levels (RfD or TDI) using: -animal laboratory studies or epidemiological data -identifying the LOAEL or NOAEL	Reference Doses (ug/kg/day) that were used in the risk characterization calculations for ingestion of trace metals (CLC, 1998:A32): • Arsenic – 0.30 (based on Taiwan case study) • Cadmium – 0.81 (assuming bw = 70 kg) • Chromium III – 1000 and Chromium VI – 5.0 (based on rat study) • Copper – 100 mg/kg in soil (assuming child 3-10 yrs) • Lead – 3.5 (assuming child 2 years) • Nickel – 20 (based on rat study) • Zinc – 300 (based on a study on women)	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s)   Good - Adequately meets requirement(s)   Poor - Requires more effort/activities to meet requirement(s)

Apply Uncertainty Factors (UF) to the RfD that were based on a NOAEL or LOAEL	Uncertainty factors were applied to calculated RfD.	Good	Current CLC approach is adequate
Summarize Toxicity Information			
STAGE 4: RISK CHARACTERIZATION			
Calculate risks for individual contaminants			
Estimate lifetime cancer risk, Risk = Intake * CSF	No calculations	N/A	N/A
Estimate potential of non-carcinogen to cause adverse effects, HQ = Intake / RfD	For each contaminant and every scenario the total yearly calculated dose (or intake) was divided by the total yearly reference dose and was expressed as a percentage (CLC, 1998:23).	Good	Current CLC approach is adequate
Calculate Risk for Multiple Pathways			
Estimate cancer risk for multiple pathways, $Risk_T = \sum Risk_i$	No calculations	N/A	N/A
Estimate potential for non-carcinogenic effects posed by more than one pathway, $HI = \sum HQ_i$	No calculations (exposure through ingestion was the only pathway considered)	N/A	N/A
Calculate Risk for Multiple Contaminants			
Estimate cancer risk for multiple contaminants, $Risk_T = \sum Risk_i$	No calculations	N/A	N/A
Estimate potential for non-carcinogenic effects posed by more than one chemical, $HI = \sum HQ_i$	No calculations	Poor	The synergistic effects of more than one chemical on human health were not considered
Interpretation of Risk Estimates			
Carcinogenic contaminants R/R_T<< acceptable level of risk R/R_T>> unacceptable R/R_T~ 1 - requires consideration	No calculations	N/A	N/A
Non-carcinogenic contaminants HQ/HI<<1 – low risk HQ/HI>>1 - unacceptable risk HQ/HI ~1 - requires consideration	This comparison determines whether the concentration of the contaminant in the soil requires further management. ~10%, there is little need for management. ~100%, a re-evaluation of the scenarios might be requested and appropriate management options explored. >100%, more immediate or a larger management intervention to limit exposure is required. (CLC, 1998:A-24)	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

Non-carcinogenic contaminants HQ/HI<<1 – low risk HQ/HI>>1 - unacceptable risk **HQ/HI ~1 - requires consideration**	Option #2 – arsenic and lead were >100% for a child exposed to house dust and ingestion of soil (CLC, 1998:61) Option #3 - arsenic and lead were >100% for a child exposed to house dust and ingestion of soil (CLC, 1998:64) Option #4 - arsenic was >100% for a child exposed to house dust and ingestion of soil (CLC, 1998:67)		Good	Based on the data for each option, option #4 was selected as the remediation approach.
Identify Uncertainty Factors				
Identify uncertainty related to the following: -Chemicals -Exposure pathway -Receptor -Derivation of toxicity values (human or animal data, duration of study) -The potential for synergistic interactions with other contaminants affecting the same individuals	Each critical component of the risk assessment was evaluated according to the amount and quality of data and knowledge available to support the analysis. High = new data are unlikely to alter the calculated risk Medium = more research would clarify the calculation of risk but not dramatically change the level Low – much more basic research is needed and could dramatically alter the calculated risk, either up or down * Based on what is reasonable and conservative (CLC, 1998:70)		Excellent	This is an excellent method to assess the quality of the risk assessment.
	1. Chemicals included in risk assessment represent the most important for risk characterization of the property	H		
	2. Level so metal contaminants in soil are adequately characterized.	H		
	3. Exposure scenarios are accurate	*		
	4. Human parameters used in exposure and dose equations represent actual conditions on the site.	M		
	5. Toxicity Evaluations			
	Arsenic	M		
	Cadmium	H		
	Chromium	L		
	Copper	M		
	Lead	H		
	Nickel	M		
	Tin	L		
	Zinc	M		
	6. Risk Characterization	M		
Develop Site Specific Target Levels				
Develop SSTLs for carcinogenic risks based on carcinogens exceeding an incremental risk of approximately 10^-5.	No calculations		N/A	N/A
Develop SSTLs for non-carcinogenic risks based on a hazard quotient value of <1.	No calculations		N/A	N/A

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

RISK ASSESSMENT #2

Key Elements of Assessment	CLC's Efforts / Activities (PDU-1)	Evaluation *	Comment(s)
STAGE 1: PROBLEM FORMULATION			
Screening the Contaminants			
Identify contaminants that exist at the site.	arsenic, barium, boron, cadmium, chromium, copper, lead, nickel, tin, zinc, sulphur, cyanide, PCB, PAH, TPH, tetrachloroethylene	Poor	Identification of all contaminants in the soil was not performed. The LEIL/UdM used an ICP/AES unit with a restricted element set and identified only 10 out of 22 inorganics.
Identify a screening method to the contaminants.	The contaminants that were selected were arsenic, cadmium, copper, nickel, lead and zinc. No screening method was applied.	Poor	The selection of the contaminants was not based on reasonable criteria.
Receptor Screening			
Focus the assessment on human receptors who have the greatest: -Potential exposure -Sensitivity to contaminants -Public concern	It has been estimated that between 15 and 30% of children display a behaviour known as pica in which 1,000 mg or more of soil may be deliberately eaten (CLC, 1998:A-28).	Excellent	The screening of receptors was appropriate and well defined.
	Adult construction workers could be exposed during site excavation. (CLC, 1998A-28).	Good	Current CLC approach is adequate
Characterize the receptors according to age, gender, sensitive receptor groups	• Adult workers • Pica child (ages 7 months-4years) -Gender was not specified	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

Pathway Screening			
Identify human exposure pathways: -ingestion -inhalation -dermal contact	Two routes of exposure – inhalation and ingestion, were considered. Inhalation was included because workers could be expected to be exposed during site excavation. Ingestion was considered for the possibility that a small child (ages 7 months to 4 years) might consume a large amount of soil from the property. Either the child can consume soil that was not covered on the site or the child consumed soil that was accidentally brought into the home on shoes and clothing and became house dust. (CLC, 1998:A-28)	Good	Current CLC approach is adequate
Conceptual Model			
Develop a conceptual model that determined the receptor(s), contaminant(s) and pathway(s).	<u>Scenario #1</u> Receptor - Pica Child Exposure – ingestion Contaminants – arsenic, cadmium, copper, nickel, lead, zinc <u>Scenario #2</u> Receptor – Adult worker Exposure – inhalation Contaminants - arsenic, cadmium, copper, nickel, lead, zinc	Good	Current CLC approach is adequate
STAGE 2: EXPOSURE ASSESSMENT			
Characterization of the Contaminant			
Identify information about the contaminants: -Physical/chemical data -Path specific bioavailabilities	Key physical/chemical data about each contaminant was identified.	Good	Current CLC approach is adequate
	Path specific bioavailabilities • Child - it was assumed that 100% absorption of the contaminant • Adult - particulate concentration in the air is assumed to be 100ug/m^3. Of this, 75% is assumed to be respirable and 90% is assumed to be retained. (CLC, 1998:28)	Good	Current CLC approach is adequate
Characterization of the Receptor			
Characterize specific receptor parameters: -Physical characteristics -Behavioural characteristics	<u>Pica Child (ages 7 months – 4 years)</u> • Physical Characteristics (body weight = 13 kg, ingestion rate = 80 mg/day = 0.08kg/day) • Behavioural Characteristics (days = 365, ingestion rate = 1,000 mg/year)	Good	Current CLC approach is adequate
	<u>Adult worker</u> • Physical Characteristics (body weight = 70 kg, breathing rate = 23 m^3/day = 0.98 m^3/hr) • Behavioural characteristics (hours worked per day = 8, days worked per week = 5, weeks worked per year = 50)	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s)   Good - Adequately meets requirement(s)   Poor - Requires more effort/activities to meet requirement(s)

Exposure Analysis			
Calculate the estimated daily exposure for each pathway by receptors to contaminants of concern.	• Estimated daily exposure for ingestion by pica children to contaminants of concern was calculated. • Estimated daily exposure for inhalation by adult workers to contaminants of concern was calculated.	Good	Current CLC approach is adequate
Summarize the exposure concentrations for each pathway.	No activity (only one pathway was calculated for each receptor).	N/A	N/A
STAGE 3: TOXICITY ASSESSMENT			
Toxicity Classification			
Identify by research the health effect(s) associated with exposure to the contaminant(s): -Controlled epidemiology studies -Case reports -Animal toxicological studies -*In vitro* studies	Toxicity evaluations for trace metals most prominently occurring on the Moncton Properties was performed by researching various studies.	Good	Current CLC approach is adequate
Gather Toxicity Information for Chemicals being Evaluated			
Gather toxicity information for the contaminants from the following: -Health Canada reports -CCME Documents -IRIS -HEAST -ATSDR	The chemical contaminants toxicity information was obtained from various sources (CLC, 1998:A-32): • Arsenic – IRIS • Cadmium – IRIS • Copper – American Conference of Governmental Industrial Hygienists • Lead – American Conference of Governmental Industrial Hygienists • Nickel – IRIS • Zinc – American Conference of Governmental Industrial Hygienists	Good	Current CLC approach is adequate
Classify the contaminant(s) as a carcinogen or a non-carcinogen	• Carcinogen – arsenic, cadmium and nickel through inhalation. • Non-carcinogen – lead, copper, and zinc through inhalation.	Good	Current CLC approach is adequate
Dose-Response Analysis for Carcinogenic Contaminants			
Derive the toxicity value or cancer slope factor (CSF) for carcinogenic contaminants.	Reference Doses (ug/kg/day) that were used in the risk characterization calculations for inhalation of trace metals (CLC, 1998:A32): • Arsenic – 2.0x10^-5 mg/m^3 (1 in 10,000 risk, bw = 60 kg, breathing rate = 20m^3 air/day) • Cadmium – 0.06 ug/m^3 (1 in 10,000 risk, air concentration = 0.0006 ug/m^3) • Nickel – 4.0x10^-4 ug/m^3 (1 in 10,000 risk)	Good	Current CLC approach is adequate

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Dose Response Analysis for Non-carcinogenic Contaminants			
Establish the threshold levels (RfD or TDI) using: -animal laboratory studies or epidemiological data; -identifying the LOAEL or NOAEL	Threshold limit values (mg/m^3) that were used in the risk characterization calculations for inhalation of trace metals (CLC, 1998:A32): • Copper – 0.2 mg/m^3 (copper fumes) and 1.0 mg/m^3 (dusts) • Lead – 0.15mg/m^3 (dust and fumes) • Zinc – 1 (zinc chloride fumes), 5 (zinc oxide fumes), and 10 (zinc oxide dust)	Good	Current CLC approach is adequate
Apply Uncertainty Factors (UF) to the RfD that were based on a NOAEL or LOAEL	Uncertainty factors were applied to calculated RfD.	Good	Current CLC approach is adequate
Summarize Toxicity Information			
STAGE 4: RISK CHARACTERIZATION			
Calculate risks for individual contaminants			
Estimate lifetime cancer risk, Risk = Intake * CSF	No calculations	N/A	N/A
Estimate potential of non-carcinogen to cause adverse effects, HQ = Intake/RfD	No calculations	N/A	N/A
Calculate Risk for Multiple Pathways			
Estimate cancer risk for multiple pathways, $Risk_T = \sum Risk_i$	No calculations	N/A	N/A
Estimate potential for non-carcinogenic effects posed by more than one pathway, $HI = \sum HQ_i$	No calculations	N/A	N/A
Calculate Risk for Multiple Contaminants			
Estimate cancer risk for multiple contaminants, $Risk_T = \sum Risk_i$	No calculations	Poor	The synergistic effects of more than one chemical on human health were not considered.
Estimate potential for non-carcinogenic effects posed by more than one chemical, $HI = \sum HQ_i$	No calculations	Poor	The synergistic effects of more than one chemical on human health were not considered.

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

Interpretation of Risk Estimates			
Carcinogenic contaminants R/R_T<< acceptable level of risk R/R_T>> unacceptable R/R_T~ 1 - requires consideration	No calculations	N/A	N/A
Non-carcinogenic contaminants HQ/HI<<1 – low risk HQ/HI>>1 - unacceptable risk HQ/HI ~1 - requires consideration	No calculations	N/A	N/A
Identify Uncertainty Factors			
Uncertainty related to the following was identified -Chemicals -Exposure pathway -Receptor -Derivation of toxicity values (human or animal data, duration of study) -The potential for synergistic interactions with other contaminants affecting the same individuals	No calculations	Poor	Uncertainty should be identified and summarized to assess the quality of the risk assessment.
Develop Site Specific Target Levels			
Develop SSTLs for carcinogenic risks based on carcinogens exceeding an incremental risk of approximately 10^-5	The risk level used was 1 in 10,000 (CLC, 1998: A-27) Arsenic = 260 mg/kg Cadmium = 760 mg/kg Nickel = 5000 mg/kg	Good	Current CLC approach is adequate
Develop SSTLs for non-carcinogenic risks based on a hazard quotient value of <1.	Lead = 3500 mg/kg Copper = 9000 mg/kg Zinc = 4000 mg/kg	Good	Current CLC approach is adequate
RISK MANAGEMENT			
Evaluate options for engineering controls.	Options for engineering controls were evaluated.	Good	Current CLC approach is adequate
Evaluate options for institutional controls.	Property covenants will be established to ensure future owners/operators maintain good stewardship of the properties (CLC, 1998:32).	Excellent	Property covenants are available for future reference.
Maintain engineering controls.	No maintenance of engineering controls.	N/A	N/A
Continue monitoring or remedial action at sites that achieved SSTL (site specific target levels)	No continued monitoring.	N/A	N/A

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

CONFIRMATORY SAMPLING

Key Elements of Assessment	CLC's Efforts / Activities (PDU 1)	Evaluation *	Comment(s)
Conduct confirmatory sampling	With the completion of the remedial actions, a detailed clearance survey was undertaken and served as the basis of "state of property" reports for future buyers and the general public (CLC, 1998:30).	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s)　Good - Adequately meets requirement(s)　Poor - Requires more effort/activities to meet requirement(s)

PUBLIC INVOLVEMENT

Key Elements of Assessment	CLC's Efforts / Activities	Evaluation*	Comment(s)
PUBLIC CONSULTATION			
Involve the stakeholders as Early as Possible			
Prepare a Public Involvement Plan	The communication activities that occurred between 1996-1997 were summarized in the Phase I report dated January 1998. A Phase II public consultation and information plan was developed in January 1998.	Poor	Although a plan was developed it was not made available to the public for input/ comments.
Identify Stakeholders	Three broad groups of stakeholders were identified for this project: Principal, Community and general interest stakeholders. (CLC, 1998:2)	Good	Current CLC approach is adequate
Provide information to the public to ensure meaningful, active public involvement beginning at the earliest practicable time (USEPA, 1979:3).	Consultation for this project started June 1996 – well before site characterization and environmental remediation work began on the property in mid-1997. (CLC, 1998a:1)	Excellent	Public consultation activities began at the projects inception.
Develop and maintain a list of persons/ organizations who have expressed an interest in or who may be affected by the project (USEPA, 1979:3).	Developed a list of person and organizations that attended the open house or conducted the site tour.	Good	Current CLC approach is adequate
	The list was not maintained or updated and did not contain telephone numbers that would aid in updating the list.	Poor	Interested stakeholders were not tracked over time.
Understand the Community/Information Feedback			
Conduct community surveys	A telephone survey was conducted to determine the general awareness and concerns about the CN Shop land to provide CLC with input on how to proceed (CLC, 1998b, 28).	Good	Current CLC approach is adequate
Conduct focus groups	Two focus group sessions were held to assess the level of awareness and understanding surrounding, the CN Shops land, to determine perceptions of the project, and to discuss future initiatives (CLC, 1998b:29).	Good	Current CLC approach is adequate
Inform and Educate the Stakeholders			

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Provide information to the stakeholders.	<u>Moncton Shops Project Video</u> A 15 minute video, 'From Brownfields to Greenfields', showed interviews, historical photos and footage of site assessment work. The video was distributed free of charge upon request (CLC, 1998b:8). People contacted: 200-500	Good	Current CLC approach is adequate
	<u>Print Materials</u> included: On Track newsletter – a 4-page newsletter, produced every 2-3 months. It was distributed to a mailing list of decision makers and people who requested copies, and was delivered as non-addressed mail to households/businesses in areas adjacent to the property (CLC, 1998b:24). On Track update – one page monthly update of progress on the project. It was distributed to the media and mailing list. Moncton Shops Project fact sheets – full colour sheets that gave fast visual access to details about a specific aspect of the project. They were developed as required and distributed to mailing list (CLC, 1998b:24) People Contacted: 5,850	Good	Current CLC approach is adequate
	<u>Web Site</u> Web site was designed to make information available to visitors with varying levels of interest. <u>Www.clc.ca/monton</u> (CLC, 1998b:30)	Excellent	Information was easily accessible and always available.
	<u>Telephone Number & email</u> Provided telephone access and email address to receive input and provide answers. The number and address were included in print materials, advertising and web page (CLC, 1998b:13). People contacted: 18	Good	Current CLC approach is adequate
	<u>Media Relations</u> Regular advertising in local papers and on local radio stations maintained a good level of awareness of the project (CLC, 1998b:18). People contacted: 96	Good	Current CLC approach is adequate
Provide central collections of reports, studies, plans and other documents (USEPA, 1979:3).	CLC did not make documents fully accessible to the public. Copies of eight PDU Environmental Action Plan reports were placed in the Library of Universite de Moncton but were only available to members of the community roundtable and were withdrawn once the roundtable finished its work, in May 1998.	Poor	Allowing accessibility to documents ensures transparency.

* Excellent - over and above requirement(s)   Good - Adequately meets requirement(s)   Poor - Requires more effort/activities to meet requirement(s)

Interact with the stakeholders	Public Presentations Presentations were both formal and informal, and involved individuals, groups and public meetings. The main themes were sustainability and risk assessment (CLC, 1998b:29). People contacted:>250	Good	Current CLC approach is adequate
	Open house 4 open house events were held. Interactive displays, videos, copies of weekly site manager's reports, aerial and ground photographs, take home fact sheets and newsletters were displayed and provided (CLC, 1998b:19). People contacted: 287 Nov 25/97 – 100 (25 students) Feb 11/98 – 32 Feb 23/98 – 47 (25 students) March 19/98 – 17 July 29/98 – 91 (80 press invitees)	Good	Current CLC approach is adequate
	Workshops Six workshops were held to address sustainable development (3), project identity (2) and surface water contamination (1). Purpose was to explore certain project objectives and to exchange information and data. (CLC, 1998b:31). People contacted: 89	Good	Current CLC approach is adequate
	Liaison with community groups Members of project team had meetings with 12 community groups. These meetings involved the sharing of information, discussion of options, and input and feedback on the project progress. The groups included people from various areas. (CLC, 1998b:16). People contacted: 394	Good	Current CLC approach is adequate
	Site Tour Seven advertised tours and numerous tours for groups were held so that people could get a feel for the size of the site and see the remediation activities. Tours were usually conducted in a full size bus or a 15 person van for small groups (CLC, 1998b:26). People Contacted: 165	Good	Current CLC approach is adequate
Translate Scientific and Technical Information			
Translate complex technical jargon to enable the general public to understand the common phases of the site assessment and remediation process.	Assistance and additional needed information was provided to members of the roundtable to increase their understanding of the science and concept of risk.	Good	Current CLC approach is adequate
Translate complex technical jargon to enable the general public to understand the common phases of the site assessment and remediation process.	Six workshops were held to address sustainable development (3), project identity (2) and surface water contamination (1) (CLC, 1998b:31).	Good	Current CLC approach is adequate.
	Fact sheets were written in a language that could be understood by the general public.	Good	Current CLC approach is adequate

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

PUBLIC PARTICIPATION			
Involve the stakeholders			
Form a Public Advisory Group (USEPA, 1979:5)	A key part of CLC's public consultation had been the work of the Community Roundtable. The Community Roundtable consisted of 10 local citizens – business people, academics, students and environmentalists (CLC, 1998b:10).	Excellent	Public input was sought through a public community roundtable.
All segments of the public must have an opportunity to participate in the advisory group (USEPA, 1979:5).	To ensure that their issues and concerns were heard and addressed, vocal critics of the project and residents adjacent to the site were actively recruited to be members of the Community Roundtable (CLC, 1998b:10).	Poor	Membership on the community roundtable was not available to the general public.
Provide the advisory group with information (USEPA, 1979:6).	Assistance and additional needed information was provided to members of the roundtable to increase their understanding of the science and concept of risk.	Good	Current CLC approach is adequate
Advisory group meetings shall be announced well in advance and shall be open to the public (USEPA, 979:6)	Community roundtable meetings were not open to the public.	Poor	Creates a closed process.
The advisory groups should remain aware of community attitudes and responses to issues. The advisory groups may conduct public participation activities to solicit outside advice (USEPA, 1979:6).	The community roundtable sponsored three town hall meetings to remain aware of the community attitudes to issues such as environmental remediation and risk assessment. (CLC, 1998b:10)	Excellent	The general public's advice was solicited by the roundtable members to allow better decisions to be made, that incorporated community values.
	Independent of CLC, the community roundtable set a phone line with voicemail, an email address and a web site to provide links for people to obtain more information and to provide input to the group (CLC, 1998b:10).	Good	Current CLC approach is adequate
Any minutes of advisory groups meetings and recommendations shall be made available to the public (USEPA, 1979:6).	Minutes of the community roundtable meetings were not made available to the public.	Poor	Distribution of community roundtable meeting minutes ensures transparency.

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

The advisory group may adopt its own rules (USEPA, 199:6).	The community roundtable chose to adopt a consensus decision-making model (CLC, 1998b:10).	Excellent	The consensus approach provided people a fair and equal opportunity to input.
Incorporate community concerns into the decision-making process			
Allow public to participate in the project decision-making process.	The community roundtable developed 11 recommendations for issues which members felt were not adequately addressed and CLC addressed each of the recommendations (CLC, 1998b:8). However, the community roundtable was not involved in the decision-making process.	Poor	Involving stakeholders in the decision-making process, will produce decisions that reflect the stakeholders needs, requirements, goals, and vision of its future.
Consult the advisory group throughout the project. (USEPA, 1979:6).	The community roundtable met once a week, from January to May 1998 to review the risk assessment and management strategy for remediation (CLC, 1998b:10). Following this, 80% of the roundtable met in June 1999 to discuss implementation of the remediation of PDU's 1 and 2 and to assess the plans for PDU's 8 and 9.	Poor	The life of the community roundtable was too limited.

* Excellent - over and above requirement(s) Good - Adequately meets requirement(s) Poor - Requires more effort/activities to meet requirement(s)

APPENDIX G

Public Perception Survey – Moncton Shops Project

APPENDIX G

1.0 Public Perception Survey - Moncton Shops Project

Canada Lands Company's (CLC) public awareness activities had reached over 5,500 people (CLC, 1998b). It had provided high quality, comprehensive information, access to data, opportunities to provide input and to receive feedback, and had engaged members of all community stakeholder groups.

The purpose of this research was to assess the effectiveness of Canada Lands Company's public involvement program. A survey was conducted to a number of Moncton residents (Appendix G- Section 2.0). The objectives of the survey was to:

- Test the success of CLC's public involvement work - communicating scientific data, and information.
- Measure people's awareness to potential risks associated with the Moncton Shops Land.
- Determine the most effective method of communication.

The same survey was also conducted to a number of individuals obtained from CLC's mailing list and to members of the community roundtable. The objective was to:

- Determine the relationship between the amount of information received by individuals to the level of comfort with the cleanup.

1.1 Survey Methodology

The target population was the Moncton area residents. A random sample of individuals was selected from the telephone directory. Interviews were also conducted with two other groups: individuals on the CLC mailing list and members of the community roundtable. Each of these groups received various amounts of information, thus their level of understanding and knowledge of the issues is assumed to be different. Table 1, shows the sample size for each group surveyed.

There were 59 names and addresses on CLC's mailing list. These individuals had access to interpretative displays, videos, copies of the weekly site manager's reports, a collection of aerial and ground level photographs, take-home fact sheets and newsletters. They were also given an opportunity to meet and talk to the Project Team members.

10 local citizens were selected by CLC to be members on the community roundtable. This group met once a week, to review how environmental problems on the site were being evaluated and to discuss how they would be cleaned up. They had access to all the reports, direct contact with the Project Team, and explored and assessed all options. Overall, this group had an opportunity to gain the most information regarding the cleanup.

Table 1: Sample Size for Each Group Surveyed

Group Surveyed	Population Size	Sample Size
Random sample	Approx. 70,000	50
Mailing List	59	22
Community Roundtable	10	7

The random sample was taken from the telephone directory using the systematic approach. The following is the procedure that was followed to implement a systematic sample (Frey, 1989):

1. Size of the telephone directory list and sample size was determined.
2. Desired sample size was divided into the population size to determine the sampling interval (k).
3. A random start was selected.
4. Proceeded through the list, selecting every k^{th} listing from the random start.
5. If a non-residential listing was selected, the listing was eliminated, however the interval count continued from the listing.

The CLC mailing list contained only the name and address of the individual. Since, there were no phone numbers an attempt was made to trace the individual using the telephone directory and/or Directory Assistance. Of the 59 individuals on the list, only 31 phone numbers were found and 22 individuals were contacted.
CLC was only able to provide eight telephone numbers of the community roundtable members. However, only 7 members were willing to participate.

1.2 Data Collection

The data was collected November 20th - 24th, 1999. For individuals who refused to participate, no follow up calls were made. For cases in which the timing of the call was inconvenient, an appointment was arranged to call back at a more convenient time. For cases in which there was no one home, three callbacks were made.

1.3 Results

The following is a summary of each groups results, see Appendix G- Section 3.0 for more detail.

<u>Random Telephone Survey Results</u>

Of the 50 respondents, 84% were aware of the CN Shops, however only 45% had heard of Canada Lands Company.

Of the possible things the public could do on this property, most were comfortable with working on the site (80%), using the recreational area (75%) and taking children to the park there (57%). However, only 44% were comfortable with living in the residential area.

Approximately 30% of the respondents felt that the community was not given an adequate opportunity to express their concerns, or that their concerns were not adequately addressed.

The survey probed to discover where people received their information and it determined that most of the information was received from the media (79%).

Mailing List Survey Results

Of the possible things the public could do on this property, 100% were comfortable with working on the site, using the recreational area, taking children to the park there, and 86% were comfortable with living in the residential area.

Only 5% felt that the community was not given an adequate opportunity to express their concerns and that the community concerns were not heard or considered in the site cleanup discussions.

60% of the respondents felt that the most effective method of receiving information was attending an open house and 23% felt it was touring the site.

9% felt that the technical terms were not explained in a language that could easily be understood.

Roundtable Members Survey Results

Of the possible things the public could do on this property, most were comfortable with working on the site (86%), using the recreational area (71%), taking children to the park there (71%), and with living in the residential area (71%).

100% felt that the community was given an adequate opportunity to express their concerns, but only 86% felt that the community concerns were adequately addressed. Approximately 30% feel that community concerns about the cleanup were not either heard or considered in the site cleanup discussions.

100% of respondents felt that the most effective method of receiving information was being a member of the roundtable.
100% felt that the technical terms were explained in a language that could easily be understood.

1.4 Survey Analysis

One of the objectives to this research was to determine the relationship between the amount of information received by a respondent to their level of comfort. The analysis determined whether high public involvement reduces public's perception of risk.

The survey results of the question "How comfortable are you with living in the residential area?" are tabulated and shown in Table 2.

Table 2: Observed Expected Counts

		Level of Public Involvement			Totals
		Roundtable Members	Mailing List	Random Sample	
Comfort Level	Comfortable	5	19	18	42
	Uncomfortable	1	3	23	27
Totals		6	22	41	69

Table 2's data cannot be analyzed using the chi-square test because the expected counts are too small in the "roundtable members" (McClave, 1991).

Therefore, the hypothesis of independence will only be tested for respondents on the mailing list and those randomly selected from the telephone directory.

H_o = The level of comfort and the level of public involvement are independent.
H_a = The level of comfort and the level of public involvement are dependent.

Assuming that the null hypothesis (H_o) is true, the estimated expected cell frequencies (E) can be calculated using the formula (McClave, 1991:615):

$$E(n_{11}) = \frac{r_1 c_1}{n}$$

Table 3: Observed and Estimated (in Parentheses) Expected Counts (X^2)

		Mailing List	Random Sample	Totals
Comfort Level	Comfortable	19 (12.920)	18 (24.079)	37
	Uncomfortable	3 (9.079)	23 (16.920)	26
Totals		22	41	63

The test statistic (X^2) is used to compare the observed and estimated expected counts in each cell of the contingency table (McClave, 1991:615).

$$\text{Test Statistic} = \quad X^2 \quad = \Sigma \frac{[nij\ E(nij)]^2}{E(nij)}$$

$$X^2 \quad = \frac{[n_{11}-E(n_{11})]^2}{E(n_{11})} + \frac{[n_{12}-E(n_{12})]^2}{E(n_{12})} + \ldots + \frac{[n_{23}-E(n_{23})]^2}{E(n_{23})}$$

The calculated value of the test statistic is

$$X^2 \quad = 2.861 + 4.070 + 1.535 + 2.185$$

$$= 10.651$$

Since the null hypothesis is being tested in a two-way contingency table, the appropriate degrees of freedom are (r-1)(c-1), where r is the number of rows and c is the number of columns in the table. The degree of freedom for X^2 is 1. Then, for $\propto$ = .05, the hypothesis of independence is rejected when (McClave, 1991)

$$X^2 > X^2{}_{0.5} = 3.84146$$

Since the computed $X^2 = 10.651$ exceeds the value 3.84146, the null hypothesis is rejected and it is safe to conclude that the level of comfort and the level of public involvement are dependent events. The more information a respondent received (e.g. attending open houses, touring the site, viewing the Brownfields video), the more comfortable they were with living in the residential area.

2.0 1999 TELEPHONE SURVEY - MONCTON SHOPS PROJECT

TELEPHONE # ______________________

Good evening, my name is Michelle. Tonight I am conducting a short survey to find out what people think about important issues in Moncton. The survey will only take five minutes and your responses will be treated confidentially.

REFUSED THANK AND TERMINATE

1. (a) What single environmental issue would you consider to be the most important one in the Moncton area?

DO NOT READ AND CODE ONLY ONE

	Question (a)	Question (b)	
Old city dump	1	1	
Causeway/gates at river	2	2	
Clear cutting	3	3	
Lack of recycling/composting	4	4	
Water quality in general	5	5	
Air quality in general	6	6	
CN Shops/ Canada Lands	7	7	Go to Q3
New landfill	8	8	
Not sure/Don't know	9	9	
Other (specify) ______________________			

(b) What other environmental issues are you aware of in this area?

PROBE AND RECORD ALL MENTIONS ABOVE

2. (a) Are you familiar with the area in Moncton known as the CN Shops? It is the area between Vaughn Harvey Blvd., St. George and Collishaw.

Yes	1
No	2

(b) What do you know about this area?

PROBE AND BE AS SPECIFIC AS POSSIBLE

____

____

3. For the past few years, there has been an initiative underway to cleanup and redevelop the CN Shops land.

(a) Before the cleanup, what did you know or had heard about the environmental conditions at the site?

(b) The site has now been cleaned-up and is ready to be developed. What do you know or have heard about the environmental conditions at the site now?

DO NOT READ. PROBE FOR AS MANY AS POSSIBLE.
IF PEOPLE ARE GENERALLY TALKING ABOUT CONTAMINATOIN, PROBE FOR WHAT TYPES OF CONTAMINATION

	Question (a)	Question (b)
Fuel/gasoline	1	1
PCBs	2	2
Dangerous materials	3	3
Metals/heavy metals	4	4
Cleaning materials/dry-cleaning	5	5
Garbage	6	6
Explosives	7	7
Hydrocarbon (gas & oil)	8	8
Not sure/Don't know	9	9
All cleaned up		10
Other (specify)	________	________

4. I am going to read a list of possible developments that might be feasible for a property of this size and location and would like you to tell me how comfortable you are with each one. The choices are very comfortable, somewhat comfortable, somewhat uncomfortable or very uncomfortable and the possible developments are:

	Very Comfortable	Somewhat Comfortable	Uncomfortable	Very Uncomfortable	Don't Know
(a) Park area	1	2	3	4	9
(b) Residential	1	2	3	4	9
(c) Recreational	1	2	3	4	9
(d) Business	1	2	3	4	9
(e) Combination	1	2	3	4	9

5. Once again, I am going to read a list, this time of things people might do on this property and would like you to tell me how comfortable you are with each one. The choices are very comfortable, somewhat comfortable, somewhat uncomfortable or very uncomfortable. How comfortable would you feel with:

	Very Comfortable	Somewhat Comfortable	Uncomfortable	Very Uncomfortable	Don't Know
(a) Working on the site	1	2	3	4	9
(b) Using recreation area	1	2	3	4	9
(c) Taking children park	1	2	3	4	9
(d) Living residential area	1	2	3	4	9

6. (a) Have you heard of Canada Lands Company?

Yes	1
No	2

(b) What have you heard?

Responsible for development of CN Shops	1
Responsible for development of various land	2
Has held public meetings	3
Studied site for contamination	4
Federal government/Crown corporation	5

7. (a) From what you know, or have heard, do you strongly approve, somewhat approve, somewhat disapprove or strongly disapprove of the work being done?

Strongly approve	1	
Somewhat approve	2	
Somewhat disapprove	3	Go to Q 7(b)
Strongly disapprove	4	Go to Q 7(b)
DO NOT READ don't know	9	

(b) (if disapprove) Why do you say you disapprove of the job being done by Canada Lands Company?

DO NOT READ - CODE AS MANY AS MENTIONED

Land should have been developed a long time ago/taking too long	1
Don't know long-term effects of contamination	2
Don't trust government/company	3
Want to know more	4
Other (specify) ______________________________	

8. (a) Do you feel that the community was given an adequate opportunity to express their ideas and concerns about the clean up to Canada Lands?

Yes	1
No	2
Not sure/Don't know	9

(b) Do you feel that the community concerns that were expressed about the cleanup were adequately addressed?

Yes	1
No	2
Not sure/Don't know	9

(c) Do you think that there are community concerns about the cleanup that were not either heard or considered in the site cleanup discussions?

Yes	1
No	2
Not sure/Don't know	9

9. (a) From what sources did you receive information about the CN Shops Land?

(b) What method(s) was the most effective? DO NOT READ

		Question (a)	Question (b)
1.	Brownfield video	1	1
2.	Telephone number	2	2
3.	Email address	3	3
4.	Meetings/presentation community groups	4	4
5.	Open houses	5	5
6.	Print materials (On Track)	6	6
7.	Media (newspapers)	7	7
8.	Property tours	8	8
9.	Public presentations	9	9
10.	Web page	10	10
11.	Workshops	11	11
12.	Drove by	12	--
13.	Word-of-mouth	13	--
14.	Community Round Table	14	14
15.	Radio	15	--

10. Was the scientific information and the technical terms explained in a language that could be easily understood?

Yes	1
No	2
Not sure/Don't know	9

****

And now, so we can compare the answers from different people, I would like to ask a few final questions about you and your household. Again, please be assured that your responses will be kept entirely confidential

11. In what age category may I place you? READ

18-24	1
25-34	2
35-44	3
45-54	4
55-64	5
65 OR OVER	6
DO NOT READ Refused	9

12. What is the highest level of education you have had an opportunity to obtain? DO NOT READ

Elementary (grade 1-11)	1
Completed high school	2
Community college, vocational or trade school	3
Some university	4
Completed university	5
Post graduate	6
No formal schooling	7
DO NOT READ Refused	9

13. Which of the following categories best represents you total household income? READ

under $20,000	1
$20,000 - $29,999	2
$30,000 - $39,999	3
$40,000 - $49,999	4
$50,000 - $59,999	5
$60,000 OR OVER	6
DO NOT READ Refused	9

14. What is your mother tongue?

English	1
French	2
Other (specify)________________________	

15. Did any member of your immediate family or a close relative ever work at the CN Shops site?

Yes	1
No	2
Not sure/Don't know	9

16. Did any member of your immediate family or a close relative work on the cleanup of the CN Shops site?

Yes	1
No	2
Not sure/Don't know	9

17. NOTE GENDER. DO NOT ASK

Male	1
Female	2

This concludes my study and I thank you for your participation

3.0 TELEPHONE SURVEY RESULTS

RANDOM TELEPHONE LIST SURVEY RESULTS

Q2a: Are you familiar with the area in Moncton known as the CN Shops?

	N	%
Total	50	100.00
Yes	42	84.00
No	8	16.00

Q3b: For the past few years, there has been an initiative underway to cleanup and redevelop the CN Shops land. The site has now been cleaned-up and is ready to be developed. What do you know or have heard about the environmental conditions at the site now?

	N	%
Total	42	100.00
All cleaned up	18	42.87
Not all cleaned up	18	42.87
Don't know	6	14.28

Q4a: Please tell me how comfortable you are with the following list of possible developments that might be feasible for a property of this size and location: Park area?

	N	%
Total	42	100.00
Very Comfortable	16	38.09
Somewhat Comfortable	17	40.48
Somewhat Uncomfortable	7	16.67
Very Uncomfortable	1	2.38
Don't know	1	2.38

Q4b: Housing/residential?

	N	%
Total	42	100.00
Very Comfortable	6	14.29
Somewhat Comfortable	18	42.86
Somewhat Uncomfortable	10	23.81
Very Uncomfortable	7	16.66
Don't know	1	2.38

Q4c: Recreational/golf?

	N	%
Total	42	100.00
Very Comfortable	15	35.71
Somewhat Comfortable	18	42.86
Somewhat Uncomfortable	6	14.29
Very Uncomfortable	2	4.76
Don't know	1	2.38

RANDOM TELEPHONE LIST SURVEY RESULTS (continued)

Q4d: Business area?

	N	%
Total	42	100.00
Very Comfortable	7	16.67
Somewhat Comfortable	25	59.52
Somewhat Uncomfortable	7	16.67
Very Uncomfortable	2	4.76
Don't know	1	2.38

Q4e: Combination of all?

	N	%
Total	42	100.00
Very Comfortable	7	16.67
Somewhat Comfortable	25	59.52
Somewhat Uncomfortable	8	19.05
Very Uncomfortable	1	2.38
Don't know	1	2.38

Q5a: Please tell me how comfortable you are with the following list of things you might do on this property: Working on the site?

	N	%
Total	42	100.00
Very Comfortable	8	19.05
Somewhat Comfortable	25	59.52
Somewhat Uncomfortable	3	7.14
Very Uncomfortable	5	11.90
Don't know	1	2.38

Q5b: Please tell me how comfortable you are with the following list of things you might do on this property: Using the recreational area?

	N	%
Total	42	100.00
Very Comfortable	6	14.29
Somewhat Comfortable	25	59.52
Somewhat Uncomfortable	4	9.52
Very Uncomfortable	6	14.29
Don't know	1	2.38

Q5c: Please tell me how comfortable you are with the following list of things you might do on this property: Taking children to the park there?

	N	%
Total	42	100.00
Very Comfortable	7	16.66
Somewhat Comfortable	17	40.48
Somewhat Uncomfortable	6	14.29
Very Uncomfortable	11	26.19
Don't know	1	2.38

RANDOM TELEPHONE LIST SURVEY RESULTS (continued)

Q5d: Please tell me how comfortable you are with the following list of things you might do on this property: Living in the residential area?

	N	%
Total	42	100.00
Very Comfortable	4	9.52
Somewhat Comfortable	14	33.33
Somewhat Uncomfortable	10	23.81
Very Uncomfortable	13	30.95
Don't know	1	2.38

Q6: Have you heard of Canada Lands Company?

	N	%
Total	42	100.00
Yes	19	45.24
No	23	54.76

Q7a: From what you know, or have heard, do you strongly approve, somewhat approve, somewhat disapprove or strongly disapprove of the work being done?

	N	%
Total	42	100.00
Strongly Approve	30	71.43
Somewhat Approve	4	9.52
Somewhat Disapprove	5	11.90
Strongly Disapprove	0	0
Don't know	3	7.14

Q7b: Why do you say you disapprove of the job being done by Canada Lands Company?

	N	%
Total	5	100.00
Don't know long term effects	4	80.00
Want to know more	1	20.00

Q8a: Do you feel that the community was given an adequate opportunity to express their ideas and concerns about the clean up to Canada Lands?

	N	%
Total	42	100.00
Yes	14	33.33
No	15	35.71
Don't know	13	30.95

Q8b: Do you feel that the community concerns that were expressed about the cleanup were adequately addressed?

	N	%
Total	42	100.00
Yes	12	28.57
No	13	30.95
Don't know	17	40.48

RANDOM TELEPHONE LIST SURVEY RESULTS (continued)

Q8c: Do you think that there are community concerns about the cleanup that were not either heard or considered in the site cleanup discussions?

	N	%
Total	42	100.00
Yes	10	23.81
No	12	28.57
Don't know	20	47.62

Q9b: What method was the most effective for receiving information about the CN Shops Land?

	N	%
Total	42	100.00
Open House	3	7.14
Media (newspaper)	30	71.43
Site Tour	2	4.76
Radio	3	7.14
n/a	4	9.52

Q11: In what age category may I place you?

	N	%
Total	42	100.00
18-24	2	4.76
25-34	11	26.19
35-44	8	19.05
45-54	7	16.67
55-64	8	19.05
65 or over	6	14.28
Refused to answer	0	0

Q12: What is the highest level of education you have had an opportunity to obtain?

	N	%
Total	42	100.00
Elementary (grade 1-11)	4	9.52
Completed high school	11	26.19
Community college, trade	12	28.57
Some university	3	7.14
Completed university	11	26.19
Post graduate	1	2.38
No formal schooling	0	0

Q13: Which of the following categories best represents you total household income?

	N	%
Total	42	100.00
Under $20,000	5	11.90
$20,000 - $29,000	3	7.14
$30,000 - $39,999	7	16.67
$40,000 - $49,999	7	16.67
$50,000 - $59,999	3	7.14
$60,000 OR OVER	3	7.14
Refused to answer	14	33.33

RANDOM TELEPHONE LIST SURVEY RESULTS (continued)

Q14: What is your mother tongue?

	N	%
Total	42	100.00
English	34	80.95
French	8	19.05

Q15: Did any member of your immediate family or a close relative ever work at the CN Shops site?

	N	%
Total	42	100.00
Yes	20	47.62
No	22	52.38

Q16: Did any member of your immediate family or a close relative work on the cleanup of the CN Shops site?

	N	%
Total	42	100.00
Yes	3	7.14
No	39	92.86

Q17: Gender?

	N	%
Total	42	100.00
Male	15	35.71
Female	27	64.29

MAILING LIST SURVEY RESULTS

Q3b: For the past few years, there has been an initiative underway to cleanup and redevelop the CN Shops land. The site has now been cleaned-up and is ready to be developed. What do you know or have heard about the environmental conditions at the site now?

	N	%
Total	22	100.00
All cleaned up	15	68.18
Not all cleaned up	4	18.18
Don't know	3	13.63

Q4a: Please tell me how comfortable you are with the following list of possible developments that might be feasible for a property of this size and location: Park area?

	N	%
Total	22	100.00
Very Comfortable	9	40.90
Somewhat Comfortable	11	50.00
Somewhat Uncomfortable	0	0
Very Uncomfortable	2	9.09
Don't know	0	0

Q4b: Housing/residential?

	N	%
Total	22	100.00
Very Comfortable	7	31.82
Somewhat Comfortable	11	50.00
Somewhat Uncomfortable	1	4.55
Very Uncomfortable	3	13.64
Don't know	0	0

Q4c: Recreational/golf?

	N	%
Total	22	100.00
Very Comfortable	8	36.36
Somewhat Comfortable	10	45.45
Somewhat Uncomfortable	2	9.09
Very Uncomfortable	2	9.09
Don't know	0	0

Q4d: Business area?

	N	%
Total	22	100.00
Very Comfortable	14	63.63
Somewhat Comfortable	8	36.36
Somewhat Uncomfortable	0	0
Very Uncomfortable	0	0
Don't know	0	0

MAILING LIST SURVEY RESULTS (continued)

Q4e: Combination of all

	N	%
Total	22	100.00
Very Comfortable	7	31.81
Somewhat Comfortable	13	59.10
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	4.54
Don't know	1	4.54

Q5a: Please tell me how comfortable you are with the following list of things you might do on this property: Working on the site?

	N	%
Total	22	100.00
Very Comfortable	12	54.54
Somewhat Comfortable	10	45.45
Somewhat Uncomfortable	0	0
Very Uncomfortable	0	0
Don't know	0	0

Q5b: Using the recreational area?

	N	%
Total	22	100.00
Very Comfortable	12	54.54
Somewhat Comfortable	10	45.45
Somewhat Uncomfortable	0	0
Very Uncomfortable	0	0
Don't know	0	0

Q5c: Taking children to the park there?

	N	%
Total	22	100.00
Very Comfortable	12	54.54
Somewhat Comfortable	10	45.45
Somewhat Uncomfortable	0	0
Very Uncomfortable	0	0
Don't know	0	0

Q5d: Living in the residential area?

	N	%
Total	22	100.00
Very Comfortable	10	45.45
Somewhat Comfortable	9	40.91
Somewhat Uncomfortable	2	9.10
Very Uncomfortable	1	4.54
Don't know	0	0

MAILING LIST SURVEY RESULTS (continued)

Q7a: From what you know, or have heard, do you strongly approve, somewhat approve, somewhat disapprove or strongly disapprove of the work being done?

	N	%
Total	22	100.00
Strongly Approve	19	86.36
Somewhat Approve	3	13.64
Somewhat Disapprove	0	0
Strongly Disapprove	0	0
Don't know	0	0

Q8a: Do you feel that the community was given an adequate opportunity to express their ideas and concerns about the clean up to Canada Lands?

	N	%
Total	22	100.00
Yes	9	40.90
No	1	4.54
Don't know	3	13.64

Q8b: Do you feel that the community concerns that were expressed about the cleanup were adequately addressed?

	N	%
Total	22	100.00
Yes	16	72.72
No	1	4.54
Don't know	5	22.72

Q8c: Do you think that there are community concerns about the cleanup that were not either heard or considered in the site cleanup discussions?

	N	%
Total	22	100.00
Yes	1	4.54
No	14	63.63
Don't know	7	31.81

Q9b: What method was the most effective for receiving information about the CN Shops Land?

	N	%
Total	22	100.00
Open House	13	59.09
Property Tour	5	22.72
Media (newspaper)	2	9.10
Print Materials	1	4.54
Web Page	1	4.54

MAILING LIST SURVEY RESULTS (continued)

Q10: Was the scientific information and the technical terms explained in a language that could be easily understood?

	N	%
Total	22	100.00
Yes	17	77.27
No	2	9.10
Don't know	3	13.64

Q11: In what age category may I place you?

	N	%
Total	22	100.00
18-24	4	18.18
25-34	0	0
35-44	5	22.72
45-54	3	13.64
55-64	4	18.18
65 or over	6	27.27
Refused to answer	0	0

Q12: What is the highest level of education you have had an opportunity to obtain?

	N	%
Total	22	100.00
Elementary (grade 1-11)	3	13.64
Completed high school	2	9.09
Community college, trade	8	36.36
Some university	0	0
Completed university	7	31.82
Post graduate	2	9.09
No formal schooling	0	0

Q13: Which of the following categories best represents you total household income?

	N	%
Total	22	100.00
Under $20,000	4	18.18
$20,000 - $29,000	1	4.54
$30,000 - $39,999	2	9.09
$40,000 - $49,999	0	0
$50,000 - $59,999	3	13.64
$60,000 OR OVER	5	22.72
Refused to answer	7	31.82

Q14: What is your mother tongue?

	N	%
Total	22	100.00
English	18	81.81
French	4	18.18

MAILING LIST SURVEY RESULTS (continued)

Q15: Did any member of your immediate family or a close relative ever work at the CN Shops site?

	N	%
Total	22	100.00
Yes	8	36.36
No	14	63.64

Q16: Did any member of your immediate family or a close relative work on the cleanup of the CN Shops site?

	N	%
Total	22	100.00
Yes	3	13.64
No	19	86.36

Q17: Gender?

	N	%
Total	22	100.00
Male	17	77.27
Female	5	22.73

ROUND TABLE MEMBERS SURVEY RESULTS

Q3b: For the past few years, there has been an initiative underway to cleanup and redevelop the CN Shops land. The site has now been cleaned-up and is ready to be developed, what do you know or have heard about the environmental conditions at the site now?

	N	%
Total	7	100.00
All cleaned up	5	71.43
Not all cleaned up	2	28.57

Q4a: Please tell me how comfortable you are with the following list of possible developments that might be feasible for a property of this size and location: Park area?

	N	%
Total	7	100.00
Very Comfortable	5	71.43
Somewhat Comfortable	0	0
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	14.29
Don't know	1	14.29

Q4b: Housing/residential?

	N	%
Total	7	100.00
Very Comfortable	5	71.43
Somewhat Comfortable	1	14.29
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	14.29
Don't know	0	0

Q4c: Recreational/golf?

	N	%
Total	7	100.00
Very Comfortable	5	71.43
Somewhat Comfortable	0	0
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	14.29
Don't know	1	14.29

Q4d: Business area?

	N	%
Total	7	100.00
Very Comfortable	6	85.71
Somewhat Comfortable	1	14.29
Somewhat Uncomfortable	0	0
Very Uncomfortable	0	0
Don't know	0	0

ROUND TABLE MEMBERS SURVEY RESULTS (continued)

Q4e: Combination of all?

	N	%
Total	7	100.00
Very Comfortable	4	57.14
Somewhat Comfortable	1	14.29
Somewhat Uncomfortable	1	14.29
Very Uncomfortable	0	0
Don't know	1	14.29

Q5a: Please tell me how comfortable you are with the following list of things you might do on this property: Working on the site?

	N	%
Total	7	100.00
Very Comfortable	6	85.71
Somewhat Comfortable	0	0
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	14.29
Don't know	0	0

Q5b: Using the recreational area?

	N	%
Total	7	100.00
Very Comfortable	5	71.43
Somewhat Comfortable	0	0
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	14.29
Don't know	1	14.29

Q5c: Taking children to the park there?

	N	%
Total	7	100.00
Very Comfortable	5	71.43
Somewhat Comfortable	0	0
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	14.29
Don't know	1	14.29

Q5d: Living in the residential area?

	N	%
Total	7	100.00
Very Comfortable	4	57.14
Somewhat Comfortable	1	14.29
Somewhat Uncomfortable	0	0
Very Uncomfortable	1	14.29
Don't know	1	14.29

Q8a: Do you feel that the community was given an adequate opportunity to express their ideas and concerns about the clean up to Canada Lands?

	N	%
Total	7	100.00
Yes	7	100.00
No	0	0
Don't know	0	0

Q8b: Do you feel that the community concerns that were expressed about the cleanup were adequately addressed?

	N	%
Total	7	100.00
Yes	6	85.72
No	1	14.28
Don't know	0	0

Q8c: Do you think that there are community concerns about the cleanup that were not either heard or considered in the site cleanup discussions?

	N	%
Total	7	100.00
Yes	2	28.57
No	5	71.43
Don't know	0	0

Q10: Was the scientific information and the technical terms explained in a language that could be easily understood?

	N	%
Total	7	100.00
Yes	7	100.00
No	0	0
Don't know	0	0

Q11: In what age category may I place you?

	N	%
Total	7	100.00
18-24	1	14.29
25-34	1	14.29
35-44	2	28.57
45-54	2	28.57
55-64	0	0
65 or over	1	14.29
Refused to answer	0	0

Q12: What is the highest level of education you have had an opportunity to obtain?

	N	%
Total	7	100.00
Elementary (grade 1-11)	0	0
Completed high school	2	28.57
Community college, trade	2	28.57
Some university	0	0
Completed university	1	14.29
Post graduate	2	28.57
No formal schooling	0	0

Q13: Which of the following categories best represents you total household income?

	N	%
Total	7	100.00
Under $20,000	0	0
$20,000 - $29,000	0	0
$30,000 - $39,999	0	0
$40,000 - $49,999	0	0
$50,000 - $59,999	0	0
$60,000 OR OVER	2	28.57
Refused to answer	5	71.43

Q14: What is your mother tongue?

	N	%
Total	7	100.00
English	5	71.43
French	2	28.57

Q15: Did any member of your immediate family or a close relative ever work at the CN Shops site?

	N	%
Total	7	100.00
Yes	4	57.14
No	3	42.86

Q16: Did any member of your immediate family or a close relative work on the cleanup of the CN Shops site?

	N	%
Total	7	100.00
Yes	2	28.57
No	5	71.43

Q17: Gender?

	N	%
Total	7	100.00
Male	5	71.43
Female	2	28.57

APPENDIX H

List of Acronyms

ACRONYMS

ASTM	American Standard for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BC MELP	British Columbia Ministry of Environment, Lands and Parks
CAEAL	Canadian Association for Environmental Analytical Laboratories
CCME	Canadian Council of Ministers of the Environment
CLC	Canada Lands Company
CN	Canadian National
CSA	Canadian Standards Association
CSF	Cancer Slope Factor
EPA	Environmental Protection Agency
ESA	Environmental Site Assessment
GIS	Geographic Information Systems
GPS	Geographic Positioning System
HI	Hazard Index
HQ	Hazard Quotient
HEAST	Health Effects Assessment Summary Tables
IRIS	Integrated Risk Information Systems
JWEL	Jacques Whitford Environmental Limited
LEIL/UDM	Laboratoire de recherche pour l'industrie et l'environnement/ Universite de Moncton
LOEL	Lowest Observed Effect Level
LOEAL	Lowest Observed Adverse Effect Level
MF	Modifying Factor
MOEE	Ministry of the Environment and Energy
NEL	No Effect Level
NGO	Non-governmental organization
NBRPC	New Brunswick Research and Productivity Council
NOAEL	No Observable Adverse Effect Level
NRTEE	National Roundtable on the Environment and the Economy
NSEIA	Nova Scotia Environmental Industry Association
PDU	Property Development Unit
QA/QC	Quality Assurance/Quality Control
RBCA	Risk Based Corrective Action
RBSL	Risk Based Screening Level
RfD	Reference Dose
SSTL	Site Specific Target Level
TDI	Tolerable Daily Intake
THQ	Target Hazard Quotient
TR	Target Risk
UF	Uncertainty Factors
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank

APPENDIX I

Glossary of Terms

GLOSSARY OF TERMS

Absorption factor	The percent or fraction of a contaminant with an organism that becomes absorbed into the receptor.
Acceptable Risk	A risk level that is considered by society or regulatory agencies as tolerable.
Anthropogenic	Of human origin.
Arbitration	A process with an "arbitrator" acting in the capacity of a judge. Disputing interests present their arguments and evidence and the arbitrator "rules," making a decision on behalf of the parties. The parties will be bound legislative mandate or contractual agreement to accept and adopt the decision of the arbitrator.
ASTM	American Society for Testing and Materials, responsible for many of the standard methods used in industry.
Background level	The normal ambient environmental concentration levels of a contaminant.
Bioavailability	The proportion of substances that enters the systemic circulation following exposure (crosses absorption barriers).
Brownfields	Brownfields sites are abandoned, idled, or underutilized industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination.
Brownfields Site	A Brownfields site is a property, or portion thereof, that has actual or perceived contamination and an active potential for redevelopment or reuse.
Cancer	A disease characterized by malignant, uncontrolled invasive growth of body tissue cells.
Carcinogen	A chemical or substance capable of producing cancer in living organisms.
Carcinogenic	Tending to produce cancer in living organisms.
Certificate of Compliance (COC)	A certificate given by a government agency (typically a Ministry of Environment) that verifies that a site has been remediated or managed to meet the requirements of the agency.
Chronic	Having a persistent, recurring or long-term nature.

Clean-up	Actions taken to deal with a release or threat of release of a hazardous substance that could affect humans and/or the environment. The term "cleanup" is sometimes used interchangeably with the terms remedial action, removal action, or corrective action.
Contamination	Contact with an admixture of an unnatural agent, with the implication that the amount is measurable. The deposition of unwanted material on the surfaces of structures, areas, objects, or people. It may also be airborne, external, or internal (inside components or people).
Dermal exposure	Exposure of an organism or receptor through skin absorption.
Dose	The amount of a contaminant taken in by potential receptors on exposure; it is a measure of the amount of contaminant received by the receptor, as a result of exposure, expressed as an amount of exposure (mg) per unit body weight of the receptor (kg) (mg/kg).
Dose-response analysis health	The process of characterizing the relationship between the dose of a chemical administered or received and the incidence of an adverse effect in exposed populations.
Environment	Water, air, land, and all plants and man and other animals living therein, and the interrelationships which exist among them.
Environmental Justice	Environmental justice asserts the fair treatment of people in the development of environmental laws, regulations, and policies; irrespective of race, culture or socioeconomic status.
Environmental Site Assessment (ESA)	The process of determining whether there is contamination present at A site, the source and extent of that contamination, and the potential pathways of exposure to the public and the environment.
Epidemiology	The study of the distribution and dynamics of diseases and injuries in human populations. Specifically, the investigation of the possible causes of a disease and its transmission.
Exposure	Contact of an organism with a contaminant. Exposure is quantified as the amount of contaminant available at the exchange boundaries of the organism (e.g. skin, lungs, gut) and available for absorption.
Exposure Assessment	The determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration and route of exposure.
Exposure Limit	The maximum recommended daily exposure to a chemical (ADI, RfD, RsD, TDI).
Exposure Pathway	The course a chemical takes from a source to an exposed population or organism; it describes a unique mechanism by which an individual or population is exposed to chemicals originating from a site.

Facilitation	Refers to the task of managing discussions in a joint session. A facilitator may be used in any number of situations where parties of diverse interests or experience are in discussion, ranging from scientific seminars, to management meetings, to public consultation sessions.
Grab Sample	A single sample collected at a particular time and place that represents the composition of the water only at that time and place.
Greenfields	Clean, never-contaminated development lands, often located on the periphery of urban areas.
Hazard	The inherent adverse effect that a chemical poses.
Hazard Index (HI)	Potential noncarcinogenic (systemic) effects are characterized by comparing projected intakes of chemicals to toxicity values (i.e., reference doses). The numerical risk or hazard quotient estimates that results is a ratio. The ratio of the intake over the reference dose (hazard index) is compared to unity (1.0). If the quotient is less than 1, then the systemic effects are assumed not to be of concern; if the hazard quotient is greater than 1, then the systemic effects are assumed to be of concern. The hazard index is the sum of hazard quotients.
Hazard Quotient (HQ)	The ratio of a single substance exposure level over a specified time period (e.g. subchronic) to a reference dose for that substance derived from a similar exposure period.
Henry's Law Constant	Water/air partition coefficient provides a measure of the distribution of a chemical between water and air at equilibrium.
Human Health Risk	The likelihood (or probability) that a given exposure or a series of exposures to a hazardous contaminant will cause adverse health impacts on individual receptors experiencing the exposures.
Ingestion	An exposure type whereby contaminants enter the body through the mouth and into the gastrointestinal system.
Inhalation	The intake of a contaminant by receptors through the respiratory tract system.
Intake	The amount of material inhaled, ingested, or dermally absorbed during a specified time period. It is a measure of exposure, expressed in mg/kg/day.
Integrated Risk Information System (IRIS)	An EPA data base containing verified RfDs and slope factors and up-to-date health risk and EPA regulatory information for numerous chemicals.
K_{ow}	Octanol/water partition coefficient provides a measure of the extent of chemical partitioning between water and octanol at equilibrium.

Lowest-Observed-Adverse-Effect-Level (LOAEL)	In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.
Monitoring	Measurement of concentrations of chemicals in environmental media or in issues of humans and other biological/organisms over time.
No-Observed-Adverse-Effect Level (NOAEL)	In dose-response experiments, an exposure level at which there are not statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered to be adverse, nor precursors to specific adverse effects. In an experiment with more than one NOAEL, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL to mean the highest exposure level without adverse effect.
Orphan Site	A contaminated site where the landowner will not or cannot pay for clean-up, or where the land owner cannot be located.
Pathway	Any specific route by which a potential receptor or individual may be exposed to an environmental hazard, such as the release of a chemical material.
Phase I	An ASTM Phase I is an initial environmental investigation that is limited to a historical records search to determine ownership of a site and to identify the kinds of chemical processes that were carried out at the site. A Phase I may include a site visit, but does not involve any environmental sampling.
Phase II	An ASTM Phase II is an investigation that includes tests performed at the site in order to confirm the location and identity of environmental hazards and recommend clean up alternatives.
Phase III	A Phase III includes the comprehensive characterization, evaluation, and removal of contaminated materials from a site, and their legal disposal.
Probability	The likelihood of an event occurring.
RBCA	Risk-Based Corrective Action is a streamlined approach, defined by the ASTM, in which exposure and risk assessment practices are integrated with traditional components of the corrective action process to ensure that appropriate and cost-effective remedies are selected, and that limited resources are properly allocated.
Receptor	Refers to members of a potentially exposed population, e.g., persons or organisms that are potentially exposed to concentrations of a particular chemical compound.

Reference dose (RfD)	Maximum amount of a chemical that the human body can absorb without experiencing chronic health effects; it is expressed in mg/kg body weight/day. It is the estimate of lifetime daily exposure of a non-carcinogenic substance for the general human population which appears to be without an appreciable risk of deleterious effects; used interchangeably with acceptable daily dose and Tolerable Daily Intake (TDI).
Remediation	Process of managing contaminants to the degree necessary to accommodate a specified land use.
Risk	Probability or likelihood of an adverse consequence from a hazard, or the potential for the realization of undesirable adverse consequences from impending events.
Risk Assessment	The process of identifying and documenting actual and perceived risks to human health or the environment, to allow further evaluation and appropriate responses.
Risk Characterization	This last step in the risk assessment process characterizes the potential for adverse health effects and evaluates the uncertainty involved.
Risk Estimate	A description of the probability that organisms exposed to a specific dose of a chemical or other pollutant will develop an adverse response (e.g., cancer).
Risk Management	The steps and processes taken to reduce, or eliminate the risk that has been revealed by a risk assessment. It is an activity concerned with decisions about whether an assessed risk is sufficiently high to present a public health concern and about the appropriate means for controlling the risks judged to be significant.
Risk Perception	The magnitude of the risk as an individual or society perceives it.
Slope Factor	A plausible upper-bound probability estimate of a response per unit intake of a chemical over a lifetime. It is used to estimate an upper bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.
Stakeholders	Stakeholders are persons or groups who are affected by or can affect the outcome of a project. These can include affected communities, local organizations, and NGOs and government authorities. Stakeholders can also include politicians, commercial and industrial enterprises, labor unions, academics, religious groups, national social and environmental public sector agencies, and the media.
Subchronic	Of intermediate duration, usually used to describe studies or levels of exposure between 5 and 90 days.

Sustainability	The ongoing process of achieving development or redevelopment that does not undermine its physical or social systems of support.
Sustainable Development	A process of change in which the resources consumed (both social and ecological) are not depleted to the extent that they cannot be replicated. The concept also emphasizes that the creation of wealth within the community considers the well-being of both the human and natural environments, and is focused on the more complex processes of development rather than on simple growth or accumulation.
Sustainable Brownfields	A project defined as one in which redevelopment and growth are maintained over the long-term and occur within the limits the environment so that the current needs of citizens are met without compromising the ability of future generations to meet their needs.
Synergistic	Joint effects of two or more agents, such as drugs that increase each other's effectiveness when taken together.
Threshold	The lowest dose or exposure of a chemical at which a specified measurable effect is observed and below which such effect is not observed.
Tolerable Daily Intake (TDI)	The maximum amount of a chemical that the human body can absorb without experiencing chronic health effects; it is expressed in mg/kg body weight/day. It is the estimate of lifetime daily exposure of a non-carcinogenic substance for the general human population that appears to be without an appreciable risk of deleterious effects used interchangeably with acceptable daily dose and Reference Dose (RfD).
Toxicity	The harmful effects produced by a chemical substance. It is the quality or degree of being poisonous or harmful to human or ecological receptors.
Toxicity Assessment	Evaluation of the toxicity of a chemical based on available human and animal data. It is the characterization of the toxicological properties and effects of a chemical substance, with special emphasis on the establishment of dose-response characteristics.
Trace Metals	Metals normally found in trace amounts due to their insolubility or to their relative lack of abundance in the crust of the earth.
Uncertainty Factor (UF)	Refers to a factor that is used to provide a margin of error when extrapolating form experimental animals to estimate human health risks.
Underground Storage Tank	A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals.

Urban Sprawl	The decentralization of the urban core through the unlimited outward extension of development beyond the urban fringe where development is cheaper. It results in the consumption of resources and land in excess of what is necessary.
Workshop	A structured forum where people are invited to work together in a group (or groups) on a common problem or task.