Environmental Monitoring & Reporting

Course Workbook

FIRST NATIONS LAND MANAGEMENT RESOURCE CENTRE

Training, Mentorship & Professional Development

Last updated: 2017

Environmental Monitoring & Reporting

https://labrc.com/public/courselet/EnvironmentalMonitoringandReporting/presentation_html5.html

Welcome

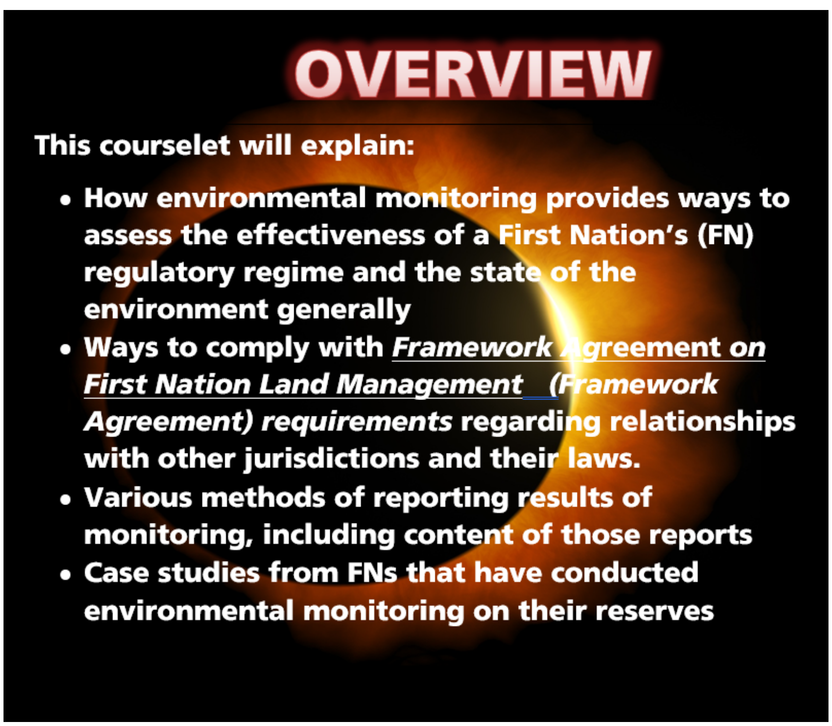
Welcome to the Environmental Monitoring and Environmental Reporting courselet.

This courselet:

- Defines environmental monitoring and what it does
- Its purpose and what it assesses
- Identifies who does environmental monitoring
- Defines environmental monitoring reporting

The material provided in this courselet is current to date of courselet. Thank you to the environmental experts to the Lands Advisory Board (LAB), for aiding in the development of this courselet. https://labrc.com/

Overview



Big Picture

Introduction

Environmental monitoring and reporting represent a range of activities for verifying compliance with environmental laws and policies on reserves and for presenting environmental information to community members and others. General lessons learned in environmental monitoring and reporting may also be applicable to other programs and operations that require control and assessment such as financial management, social programs or contract and service agreement administration.

Land Code

A FN's laws and policies established under its Land Code (LC) http://labrc.com/wp-content/uploads/2015/02/s14-land_code_summary.pdf will only be successful depending on their effective application to situations on the ground. Environmental monitoring is one of the activities a FN can use to effectively administer or monitor these laws, policies and verify compliance on First Nation Lands.

Monitoring

Environmental monitoring involves systematic longer-term observation to identify and measure changes in the environment.

Formal monitoring can be carried out by a FN or by a private entity as authorized and directed by a First Nation.

Reporting

Environmental reporting describes the process of making environmental information available to FNs' members, leadership and others. All are important functions in maintaining community health and environmental quality.

Administration

A Lands Governance Director (LGD) will be responsible for administering or conducting monitoring activities that are essential to all aspects of this effectiveness.

Terminology and Difference between Inspection and Monitoring

Introduction

The terms "environmental inspection" and "environmental monitoring" are often confused, used interchangeably or used differently by different agencies. Similarly, "Environmental Inspector" and "Environmental Monitor" are at times applied differently in different jurisdictions.

Environmental Inspection

The easiest way to explain environmental inspection https://labrc.com/public/courselet/Environmental_Inspection_and_Reporting/player.html is that it takes place at a given point in time. For the purpose of LC administration generally, Environmental Inspection is defined as:

- Inspections are formal examinations carried out by someone in an official capacity at a specific time and place to observe whether some activity or development meets required standards. Inspections are a critical component of enforcing environmental legislation and protecting environmental health in matters as diverse as food safety, water quality, air quality, pest management, sanitation, noise control and injury prevention.

Environmental Monitoring

Environmental monitoring is used to detect changes in environmental conditions of specific issues or the broad state of the environment. Environmental monitoring is a long-term activity requiring measurement of a consistent set of criteria over long periods

What is Environmental Monitoring?

Introduction

Environmental Monitoring is an important function in maintaining community health and environmental quality.

Therefore, environmental monitoring involves systematic longer-term observation to identify and measure changes in the environment.

What is the definition of Environmental monitoring?

For the purpose of this courselet and LC administration generally, the following term will be used to define Environmental Monitoring:

Environment Canada defines "environmental monitoring" as follows:

"Environmental monitoring involves collecting and analyzing information on the state of the environment in order to identify changes and trends over time. An integral part of scientific research, it is also a means of verifying whether policies and programs are having the desired results and activities are in compliance with legislation."

What does it do?

Environmental monitoring tracks changes in the environment, such as climate and weather conditions, air quality, wildlife populations and water levels.

Environmental monitors may collect samples of air, water, soil and tissue for analysis to determine the degree and possible causes of change, or may observe and analyze other evidence of change.

Picture: Fish Sampling using electrofishing technique
Source; Government of Canada www.pc.gc.ca

What does it Assess?

Environmental monitoring provides ways to:

- Determine the condition of the physical environment (air, soil, water) and biota (plants, fish, mammals, birds)
- Assess the effectiveness of a FN's environmental regulations and programs
- Create a basis for identifying the impacts of proposed development, establishing appropriate land uses, and supporting applications for habitat improvement or remediation of contaminated sites

Who does the Environmental Monitoring?

Formal monitoring, as authorized and directed by a FN, can be carried out by staff of the FN, another government body, or a private entity. If an environmental monitoring program is carried out by private entities such as businesses and industrial operations, monitoring requirements are usually included in the transactional documents that enable the activity to take place on First Nation Land. Where the monitoring is done by a private entity, formal reporting requirements are normally included so that the applicable authorities are informed in a systematic and binding way.

Purpose of Environmental Monitoring

Introduction

Environmental monitoring is a long-term activity requiring measurement of a consistent set of criteria over long periods including information to determine whether a change is due to human activity, natural variation or a combination of both.

Environmental monitoring can provide factual information to assess threats to environmental quality and to design and evaluate remedial action programs.

Purpose

The purpose of environmental monitoring is to identify and assess longer term trends in environmental conditions as a means of informing decision-makers about conditions that may require changes in a FN's policies or in personal, business, or institutional behavior.

Monitoring the state of the environment also enables a FN to:

- Assess whether its environmental objectives are being met
- Determine whether its environmental management programs are effective
- Detect changes in environmental conditions before a crisis occurs so that action can be taken to avert larger problems in the future.

Monitoring Components

Environmental monitoring programs can be designed to study trends in the condition of specific parameters such as aquatic and terrestrial ecosystems or air quality on reserves.

The following environmental components are often included in monitoring programs:

- Aquatic species and habitat
- Wildlife species and habitat
- Soil condition
- Tree cover and forest health
- Native plant species
- Water quality
- Air quality
- Progress of contaminated site remediation.

Monitoring Human Activity

Human activities that affect the environment also are commonly monitored, including:

- Land use change (e.g. area of land devoted to housing and development)
- Area of impervious surface that affects runoff and hydrology
- Population growth
- Transportation modes (e.g. vehicles, pedestrians, transit, cycling) and traffic volumes

- Housing type (e.g. detached or attached)

Collecting information on human activities allows results to be analytically linked to monitored changes in environment.

Compliance with First Nation Law

Environmental monitoring can play an important part in ensuring that FNs' laws are in compliance with clause 24.5 of the Framework Agreement, https://labrc.com/wp-content/uploads/2014/03/Framework-Agreement-Amendment-5-edited.pdf%20 which provides that in certain essential areas of environmental protection (EP), FNs "environmental protection standards and punishments will have at least the same effect as those in the laws of the province in which the First Nation is situated."

Harmonization under the Framework Agreement (19)

Monitoring programs can help determine whether a FN's environmental management program is effectively harmonized with federal and provincial environmental management as required by clause 23.5 of the Framework Agreement. https://labrc.com/wp-content/uploads/2014/03/Framework-Agrmt-Exec-Summary-June-2013.pdfEnvironmental inspections that are to be carried out in any land management regime are intended to ensure that services provided to the community and the activities of businesses, developers and members are safe and are following all applicable standards and laws, including environmental laws enacted under a Land Code or bylaws passed by a Council under the *Indian Act*.

Environmental Monitoring Case Studies

Introduction

Knowledge of species and habitats that are sensitive to disturbance will help LGDs guide decisions, that include land development on reserves and the creation of environmental laws that pertain to wildlife protection.
Therefore, we provide you the following example, which outlines:

- How two FNs have developed an environmental monitoring program
- How FN communities can partner with other organizations to research and identify ecologically sensitive wildlife species

Case Study 1

Case Study 1 involves the Sandy Bay FN, and Swan Lake FN.
In 2009, the two Manitoba communities partnered with the Centre for Indigenous Environmental Resources (CIER) to conduct monitoring surveys of species-at-risk on their lands.
CIER assisted the Swan Lake FN and Sandy Bay FN collect information about species at risk on their lands. This project helped the communities to support the recovery of species at risk and fill in the knowledge gap about species at risk on FN lands in Manitoba.

In the longer term, the information collected will help to guide species at risk recovery planning and the communities to undertake stewardship activities to help protect these and other wildlife on their lands (CIER, 2010). Click on: CIER Environmental Monitoring Online Survey Results for more information on environmental monitoring https://labrc.com/wp-content/uploads/2017/05/CIER-environmental_monitoring_online_survey_results.pdf

Example #1: Sandy Bay First Nation communities surveying Species at Risk

Sandy Bay First Nation

CIER and Sandy Bay First Nation community researchers gathered data for three bird species at risk:

- Least Bittern, a threatened marsh bird. The Least Bittern is a threatened bird that nests in wetlands with dense emergent vegetation interspersed with areas of open water. This type of habitat occurs throughout the Interlake region of Manitoba.
- Red-headed Woodpecker, a threatened woodland bird.
- Yellow Rail, a bird of special concern living in wet meadows.

No Species at Risk birds were detected during surveys. Suitable habitat was present and information was gathered on this habitat. Communication and outreach activities included:

- Sharing species at risk information with First Nation leadership and community members
- Educational activities for youth
- Distribution of pamphlets and posters about local species at risk and habitat for participating and surrounding First Nations.

Swan Lake First Nation

Swan Lake First Nation is located in the Carberry sandhills, an area filled with pockets of mixed prairie and stabilized sand dunes that offer an ideal refuge to Manitoba's only lizard, the Prairie Skink, as well as vulnerable snake populations, including the Western Hognose Snake.

Community researchers at Swan Lake First Nation conducted walking surveys for the Prairie Skink. During the course of the summer, community researchers found 36 Prairie Skinks; 12 of which were immature. CIER also spent a day with children at a local youth camp teaching them about the species that live under their feet, and even looking for Prairie Skinks from one of the actual survey sites. The Swan Lake First Nation plans to continue surveying for Prairie Skinks and protecting their habitat.

Case Study 2

Case study 2 explains how the Poplar FN in Manitoba conducted a peatland monitoring project to increase their understanding of the implications of climate change and the role an intact boreal forest can play in maintaining carbon stocks and avoiding the release of carbon that could contribute to climate change.
More information on this project is available by clicking on the following: PDK Projects July 2007 report: Putting Manitoba Peatlands on the Map https://labrc.com/wp-content/uploads/2017/05/poplarriverpeatsamplingjuly2007.pdf

Case Study 2: Poplar River First Nation peatland monitoring project

In 2007, the Poplar River First Nation partnered with a research scientist to start a peatland monitoring project. The long-term goal of the peatland monitoring project is to establish several boreal forest/peatland monitoring and research sites in order to:

- Obtain information about carbon storage in peatlands
  - Carbon accumulation rates for various classes of peatlands
  - Baseline moisture levels
  - Carbon inventory data for climate change impacts monitoring
- Explore, document aboveground and belowground biodiversity
- Study fire and other natural disturbances in the boreal forest
- Apply traditional knowledge in study design, site selection and integrate with western scientific approach
- Apply innovative field technologies
- Train members of Poplar River First Nation in data collection and environmental monitoring methods and techniques to facilitate an ongoing monitoring program

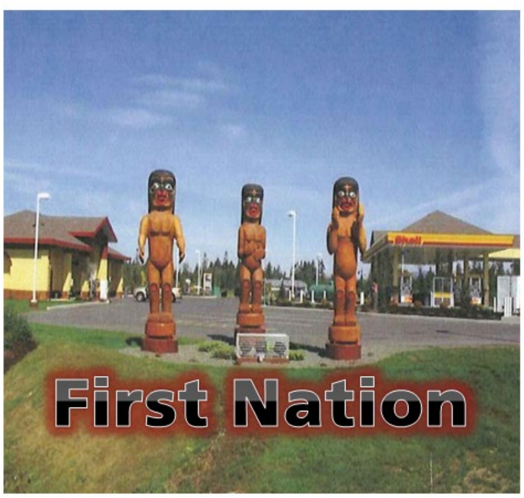
The first phase of the peatlands project took place in July 2007. Four project team members arrived in Poplar River to meet with the four community members of the project team. The five-day field trip included preliminary site visits to identify sampling sites and initiate belowground sampling of representative types of peatlands in the area.

Scientists and Elders collaboratively determined potential sampling sites to be visited during the field trip, based on knowledge of the land and the desired variation in types of peatlands for sampling. Community members were involved in all aspects of the field research, sharing knowledge of the land, and assisting with peat sampling and data recording.

Conduct of Environmental Monitoring

Introduction

Environmental monitoring is typically conducted for a governing authority or private entity by individuals with research expertise or skills similar to those of Environmental Inspectors. https://labrc.com/wp-content/uploads/2017/03/skillsenvironmentalcomplianceinspector.pdf



First Nation

Designing a monitoring program could engage a FN’s staff, Council and membership. An LGD could design and conduct a monitoring program if the LGD has appropriate experience and education and can devote adequate time to the study.

Experts

Environmental monitoring may need to be done by professionals with specific education and professional experience in fields such as environmental science, biology, and contaminated sites. Even if experts are retained, the LGD should oversee the work.

Full State of the Environment (SOE) reporting often requires additional expertise in socio-economics and environmental planning because the reports examine how environmental conditions affect communities and make recommendations for individual actions and changes to environmental policy.

Qualified environmental contractors can be identified by contacting local government agencies, other FNs, and professional organizations or by issuing a Request for Proposals to conduct the work.

Environmental Indicators

Introduction

A FN needs to know what is happening in its environment. Because the environment is very complex, environmental indicators are selected to simplify and explain conditions and trends.

Environmental indicators help a government see if its environmental objectives are being met and to communicate to its membership and decision makers the state of the environment.

Environmental Indicators

Environmental indicators are parameters or “proxies” that describe the status of the environment or components of the environment, or human and other influences on the environment. When compared over time, these Indicators tell us about changes in the environmental or social parameter being assessed. These changes can indicate positive change, negative change or static situations and when examined together with a broad range of indicators, can provide a State of the Environment report that shows the “big picture”.

Effective Characteristics

The British Columbia Ministry of Environment http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/reporting/environmental-reporting-bc has provided the following list of characteristics for effective environmental indicators:

- Scientifically credible and accepted by experts in the field
- Representative of key issues and broader impacts or effects
- Responsive to changes within a useful reporting time scale
- Useful for prediction
- Relevant to needs of FNs to make meaningful decisions
- Compatible with other indicators to present an overall picture
- Readily communicable, interesting, clear and easy to understand

Interpret Information

For selected indicators, the information collected should be interpreted in ways that explain:

Conditions: What is the current state of the environment on the reserve?
Trends: How has the environment changed over recent years? Are conditions deteriorating or improving?
Causes: What are some of the pressures on the environment? How have these pressures changed over time?
Comparisons: How do conditions on the reserve compare with accepted standards or with circumstances in other places?

Well Managed Environmental Monitoring System

Introduction

Environmental monitoring programs provide a longer-term view of what is happening in the environment. Federal researchers have found that well managed monitoring programs share similar traits that represent good practices for designing and putting in place a

monitoring system. Click on link for Canada's Study on Environmental Monitoring
https://labrc.com/wp-content/uploads/2017/05/studyofenvironmentalmonitoring.pdf

Before implementing a specific monitoring system, it is critical to have a coordinated and strategic vision of:

- What needs to be monitored
- How the various parts of a monitoring program will fit together
- How the information will be reported
- How the monitoring results will be used

Design

The design specifies the objectives of the monitoring program, what will be monitored, how the data will be used, what indicators will be prepared, and how stakeholders will be involved. The geographic and temporal details will be determined by the design—for example, frequency, timing, location, and density of monitoring stations.

Implementation

The parties responsible for each aspect of the monitoring program will be identified and will receive the necessary training. The methods and sampling strategies will be tested and documented. Contingency plans will be established to allow effective responses to potential problems.

Data collection

Procedures and practices to obtain the data will be established and applied. The samples and data records will be documented and archived.

<u>Quality control</u>

The methods will be consistently applied, following specified guidelines and standards. Other quality controls will be in place to maintain the integrity of the data sets.

<u>Data Synthesis/Analysis</u>

The data will be converted into summaries, such as maps or graphs. Data that support the indicators will be analyzed and used to compare results to those for other times and locations, using statistically sound methods.

<u>Internal/Eternal Reporting</u>

Internal

The results will be communicated to staff and leaders in the organizations responsible for monitoring. The data will be reported internally with a description of their properties, assumptions, and limitations.

External reporting and communication

Monitoring results need to be reported in ways that communicate findings effectively to external audiences (community members, the public, other governments, and regulatory agencies). Specialized users should have access to detailed monitoring results.

System Audit/Review

Audits or evaluations of the monitoring program should be conducted to assess whether it is achieving its objectives, and to identify opportunities for improvements.

Environmental Monitoring Reporting

Picture - Circle

Introduction

Environmental monitoring reporting describes the process of making environmental information available to FNs' members, leadership and others.

Environmental monitoring reports may focus on specific issues or may be broader SOE reports. Therefore, we will take a look at three different environmental monitoring reports:

- Specific Issue Report
- State of Sustainability Report
- State of the Environment Report

Reporting

In this course, “environmental reporting” refers to documents that present the results of monitoring activities.

Environmental reporting to decision makers and the community:

- Helps to determine the effectiveness of plan and policy implementation
- Supports plan and policy amendments and improvements
- Supports due diligence associated with environmental governance

Environmental Monitoring Report

A monitoring report describes conditions and trends in the environment based on the parameters being monitored. For example, a monitoring report might describe the overall state of the environment or more specific trends in a particular plant or wildlife population. Environmental monitoring reports are usually technical in nature, containing scientific data that is analyzed and reported in statistical and graphical form. The detail and the length of the report depend on the purpose of the environmental monitoring program. Some reports may just be an update on findings from a field season or they can be annual reports highlighting key findings.

Creation of the Report

Environmental monitoring reports are usually completed by the individuals hired to complete the environmental monitoring field studies or data collection.

Specific Issue Reports

Specific issue environmental monitoring reports provide detailed information on a particular monitoring program that is specific to a particular environmental issue such as:

- Air or water quality
- Fish or wildlife habitat or populations
- Specific geographic areas, such as sites being subjected to restoration through re-vegetation, stream bank stabilization or habitat enhancement
- Community health or similar matters related to environmental conditions.

Specific issue reports can vary in format but usually contain the following key information:

- Assessment of past activities and issues that have led to the monitoring study
- Goals and objectives for the monitoring program
- Description of the indicators being monitored
- Methods
- Results and analysis
- Discussion of findings
- Recommendations

Click on link for examples of Specific Issue Reports:

- Maternal and Infant Health https://labrc.com/wp-content/uploads/2017/05/maternalandinfanthealthexample.pdf
- Lake Simcoe Watershed https://labrc.com/wp-content/uploads/2017/05/lakesimcoewatershedexample2013.pdf

State of Sustainability Report

In recent years, some jurisdictions have begun preparing State of Sustainability reports that examine a suite of environmental, social, and economic indicators of progress towards sustainability. A conceptual framework for monitoring community sustainability example https://labrc.com/wp-content/uploads/2017/05/communitysustainabilityexample.pdf

State of Sustainability Report

In recent years, some jurisdictions have begun preparing State of Sustainability reports that examine a suite of environmental, social, and economic indicators of progress towards sustainability. A conceptual framework for monitoring community sustainability example https://labrc.com/wp-content/uploads/2017/05/communitysustainabilityexample.pdf

Introduction

The goal of SOE reporting is to provide the basis for informed decision making.

What is a SOE Report?

A SOE report makes scientific environmental information that is collected through long-term environmental monitoring accessible to broad audiences.

What Topics Does It Cover?

SOE reports typically cover several key topics, including:

- Explanation of why and how indicators were selected
- Comprehensive analysis of environmental conditions and trends of the indicators
- Identification of "stressors" and problems that cause change in the indicators (e.g., motor vehicle emissions affecting air quality)
- Comparison of monitored indicator values with accepted standards of environmental quality
- Recommended actions that can be taken to improve identified environmental conditions and trends.

What about State of Environment Indicators?

A SOE report that aids a FN community and its Council to evaluate its environmental situation might include environmental indicators such as:

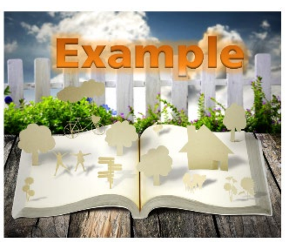
- Settlement patterns (design and location of housing)
- Use of infrastructure
- Terrestrial habitat
- Aquatic habitat, including wetlands and waterbodies
- Pollutants in marine or freshwater foreshore environment
- Greenhouse gas emissions
- Smoke that affects visibility and human health
- Toxic contamination
- Drinking water quality

Reporting SOE Results

The ability to affect policy and public behaviour depends on explaining results and recommendations in a clear manner.

Therefore, SOE reports usually contain easily-understood summaries with detailed technical information contained in appendices.

Example of SOE Reports



A FN's SOE report may be modest in size and scope. Ideas for how to design an SOE report may be gained by reviewing others' documents.

Examples of provincial or territorial SOE Reports can be found here:

- Yukon Government
- British Columbia Government

http://www.env.gov.yk.ca/publications-maps/stateenvironment.php http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/reporting/environmental-reporting-bc

Federal SOE Indicators are described here:

https://www.ec.gc.ca/indicateurs-indicators/

Examples of municipal SOE reports are here:

- Calgary
- Saskatoon

http://www.calgary.ca/UEP/ESM/Pages/State-of-the-Environment/State-of-the-Environment-Report.aspx

https://www.saskatoon.ca/community-culture-heritage/environment/our-environment

Summary

Introduction

An environmental management regime has little value unless it can be implemented, enforced and evaluated. This course provides an overview of the environmental monitoring and environmental reporting activities that are fundamental to meeting a FN's obligations for assuring a high standard of EP and management under its LC.

Purpose of Monitoring

The purpose of environmental monitoring is to identify and assess trends in environmental conditions.

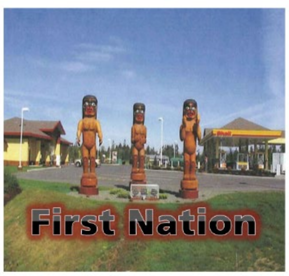
Why is it necessary?

Environmental monitoring is necessary to determine compliance with the requirements of the *Framework Agreement* to ensure that the effects of standards and punishments in essential areas of environmental management are the same as those of the province, and that environmental management regimes are harmonized with federal and applicable provincial regimes. Reports of monitoring programs can support better decisions by Council and staff, and can help justify applications for environmental or infrastructure funding.

Who Carries out the Monitoring?

Monitoring can be carried out by the FN or by an entity that is authorized to use First Nation land and resources, in which case the obligation to monitor and report is usually prescribed as part of the lease, permit or other transaction documentation.

The courselet illustrates the broad range of basic skills and knowledge required for the conduct of monitoring activities.



Lands Governance Director

LGD will need to be aware of ways that other governments address the costs and liabilities of regulatory enforcement, including results-based management, administrative penalties and "contractual compliance" measures that are negotiated into development contracts and agreements. Monitoring can aid the LGD in making better land management decisions and in developing effective FN programs.

ACRONYM LIST

CIER	-	Centre for Indigenous Environmental Resources
EP	-	Environmental Protection
FN	-	First Nation
FRAMEWORK AGREEMENT	*-*	*Framework Agreement on First Nation Land Management*
LAB	-	Lands Advisory Board
LC	-	Land Code
LGD	-	Land Governance Director
SOE	-	State of the Environment

GLOSSARY OF TERMS

CONTAMINATION

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

DUE DILIGENCE

Under a Land Code the First Nation has the authority to make decisions on their land and resources. In order for a First Nation to make informed decisions they must understand the implications of the project, permit etc. regarding lands and resources by becoming fully informed of their legal obligations, liabilities and responsibilities before making a final decision on whether or not to approve it.

First Nations, as part of carrying out due diligence will also:

> (1) Make reasonable inquiries to confirm the facts on which the approval decision is to be based (e.g. that leases are valid or that an environmental site assessment is satisfactory)
> (2) Assure itself of the ability of the other party (i.e. Canada) to carry out its responsibilities under the *Framework Agreement* and Individual Agreement, all for the purpose of evaluating the risks to the First Nation.

ENVIRONMENTAL INSPECTION

Environmental inspection is a formal examination carried out by someone in an official capacity at a specific time and place to observe whether some activity or development meets required standards.

ENVIRONMENTAL MONITORING

Environmental monitoring involves systematic longer term observation to identify and measure changes in the environment in order to identify changes and trends over time. As an integral part of scientific research, it is also a means of verifying whether policies and programs are having the desired results and activities are in compliance with legislation.

ENVIRONMENTAL PROTECTION

Environmental protection is defined as the efforts made to identify, remediate and prevent contamination of soil, water and air, and to reduce attendant risks to environmental and human health and safety. The adverse effects of exposure to contaminants may result from direct or indirect contamination of soils, water, and air from hazardous materials and uncontrolled exposure to those contaminants.

ENVIRONMENTAL REPORTING

Environmental reporting describes the process of making environmental information available to First Nations' members, leadership and others. All are important functions in maintaining community health and environmental quality.

FIRST NATION LAND

"First Nation land", in respect of a First Nation, means all or part of a reserve that the First Nation describes in its land code.

FRAMEWORK AGREEMENT ON FIRST NATION LAND MANAGEMENT

The *Framework Agreement on First Nation Land Management* is a government-to-government agreement. The Framework Agreement is an initiative for First Nations to opt out of the land management sections of the *Indian Act* and take over responsibility for the management and control of their reserve lands and resources. The Framework Agreement sets out the principal components of this new land management process.

The *Framework Agreement* provides First Nations with the option to manage their reserve lands under their own Land Codes. Until a First Nation community develops and approves a Land Code to take control of its reserve lands and resources, federal administration of their reserve lands continues under the Indian Act. The Framework Agreement is not a treaty and does not affect treaty rights or other constitutional rights of the First Nations.

LAND CODE

A Land Code will be the basic land law of the First Nation and will replace the land management provisions of the Indian Act. The Land Code will be drafted by the First Nation and will make provision for the following matters: identifying the reserve lands to be managed by the First Nation (called "First Nation land"), the general rules and procedures for the use and occupation of these lands by First Nation members and others, financial accountability for revenues from the lands (except oil and gas revenues, which continue under federal law), the making and publishing of First Nation land laws, the conflict of interest rules, a community process to develop rules and procedures applicable to land on the breakdown of a marriage, a dispute resolution process, procedures by which the First Nation can grant interests in land or acquire lands for community purposes, the delegation of land management responsibilities, and the procedure for amending the Land Code.

LANDS ADVISORY BOARD

Under Sections 38, 39, and 40 of the *Framework Agreement*, the First Nations have established a First Nation Land Advisory Board (LAB) to provide:

- Developmental First Nations political, technical, legal, advisory and financial support
- Operational First Nations assistance in implementing the *Framework Agreement* and their own land management regimes.

The LAB is composed of Chiefs regionally elected from the Operational First Nations.

Some of the LAB's functions include*:*

- Establishing a resource centre
- Providing strategic direction to the Resource Centre
- Proposing to the Minister such amendments to the *Framework Agreement* and the federal legislation, as it considers necessary or advisable in consultation with First Nations
- Negotiating a funding method with the Minister, and performing such other functions or services for a First Nation as are agreed to between the LAB and the First Nation.

The LAB established a resource centre to carry out many of its technical functions and this body is the Lands Advisory Board Resource Centre (LABRC).

LIABILITY

Liability: obligations arising from past transactions or events, the settlement of which may result in the transfer or use of assets, or the provision of services or other economic benefits in the future.

OPERATIONAL

When referring to the *Framework Agreement* "operational" means a First Nation which has ratified its Land Code and the Land Code is in **force**.

REMEDIATION

Remediation is defined by Environment Canada as the improvement of a contaminated site to prevent, minimize or mitigate damage to human health or the environment. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to receptors of concern. Remediation may involve clean-up of contaminants, or “risk management” that limits exposure to contaminants that are not or cannot be removed.

RESERVE

The *Constitution Act of 1867 Section 91 (24)* - "Indians and lands reserved for Indians":

- Creates a distinction between Indian reserve lands and other lands in Canada
- Provides that Indians and reserve lands are a federal responsibility
- Gives the federal government exclusive jurisdiction over reserve lands
- Provides that only Parliament can legislate with regard to the use of reserve lands

The basic legal framework underlying reserves is:

- The underlying legal title to reserves belongs to the federal Crown
- How the reserve was created (e.g. before or after Confederation in 1867)
- Pursuant to section 2 of the *Indian Act*, reserves are set aside by the Crown in Right of Canada for the use and benefit of a First Nation

The *Framework Agreement* (see Section 4) clarifies that reserve lands under a Land Code will continue to be reserves within the meaning of the *Indian Act* and that any reserve, title to which is vested in Canada, and managed by a First Nation under a Land Code, will continue to be vested in Canada for the use and benefit of the respective First Nation for which it was set apart.

CIER On-line Survey
Environmental Monitoring Survey Results

Table of Contents

1.0 Introduction 2

2.0 Survey Results 2

2.1 Background Information on Respondents ...2

2.2 Survey Results ...6

2.3 Summary ...12

1.0 INTRODUCTION

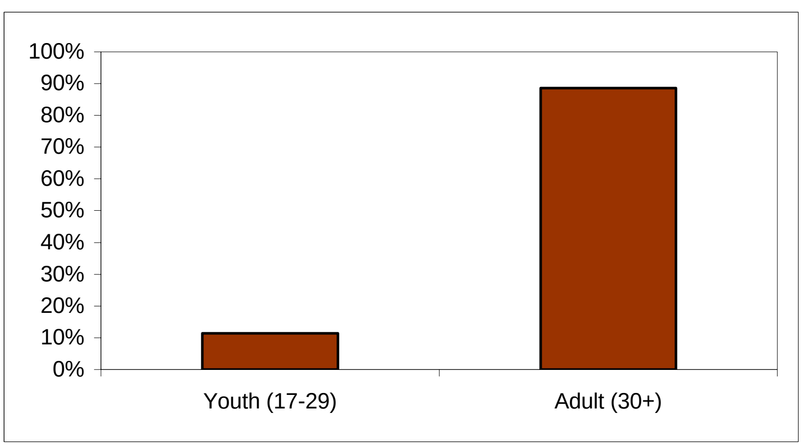
The purpose of the online survey was to identify priorities, needs and barriers to community-based environmental monitoring in Aboriginal communities. This data will help CIER refine the monitoring tools developed in the Environmental Monitoring Project and will guide Year Three planning activities in future years. The survey consisted of six questions focused on respondent background information and six targeted questions focused on environmental monitoring. CIER solicited the majority of information from First Nation members or those familiar with First Nations communities, however, some Inuit and Metis participants included their input.

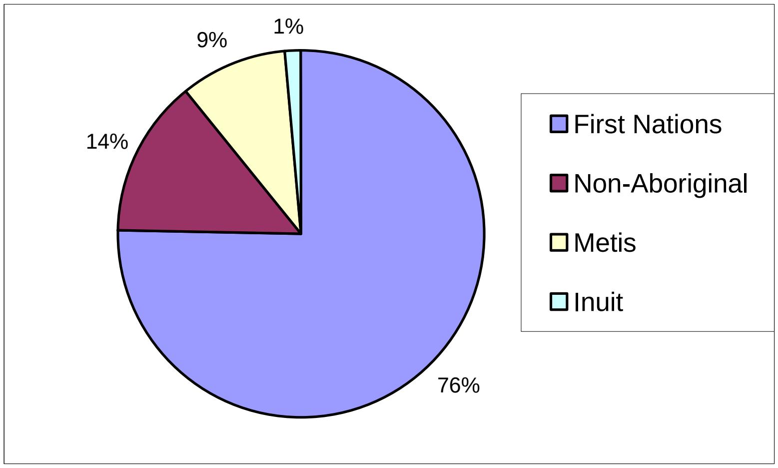
2.0 SURVEY RESULTS

2.1 BACKGROUND INFORMATION ON RESPONDENTS

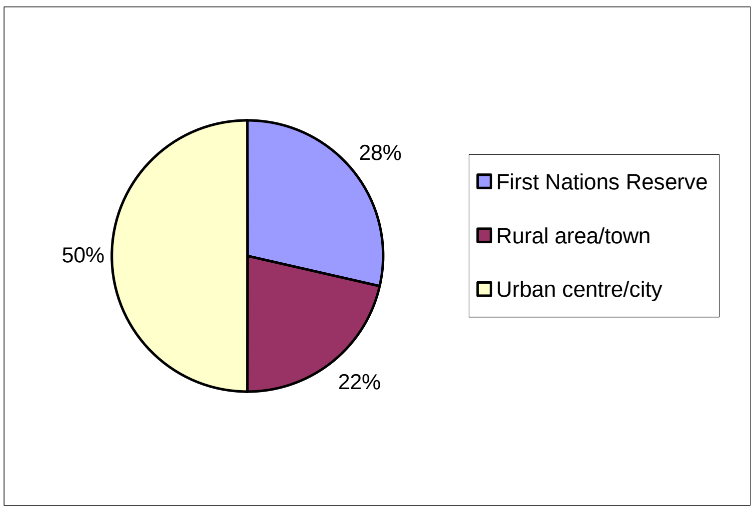
A total of 93 people responded to the online survey on environmental monitoring from 93 people. While CIER directed the survey towards First Nations, there was small input from Inuit (1%) and Metis (9%) individuals. The majority of respondents were: First Nations, over 30 years of age, either in manager or supervisor roles, administrative/clerical or professionals, and worked for Aboriginal communities or governments. The graphs on the following two pages outline the demographics of the individuals who responded.

1) Age and ethnic background:

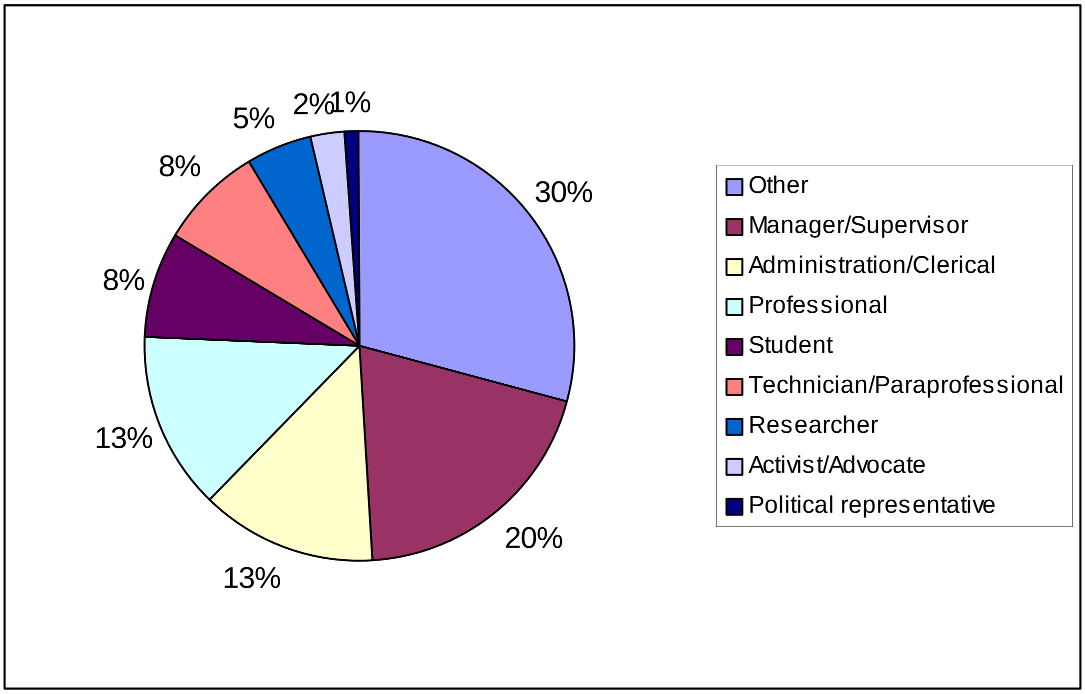




2) Primary place of residence:



3) Type of work:



The following list summarizes all answers offered by survey participants under the answer 'other':

Coordinator (8)

- Research Coordinator
- Land Management Resource Coordinator
- AHRDA Employment & Training Coordinator
- Educator & Program Coordinator
- Marketing / Training Coordinator
- Employment coordinator
- Environment Coordinator

Outreach (5)

- Counsellor
- Social worker
- Outreach Worker
- Support worker for homeless women

Education (6)

- Instructor
- Cultural education
- Educational consultant
- Aboriginal education consultant

Liaison (2)

- Aboriginal Liaison Worker
- FN Program Liaison Officer

Officer (2)

- Chief Executive Officer
- Membership, Lands & Estates Officer

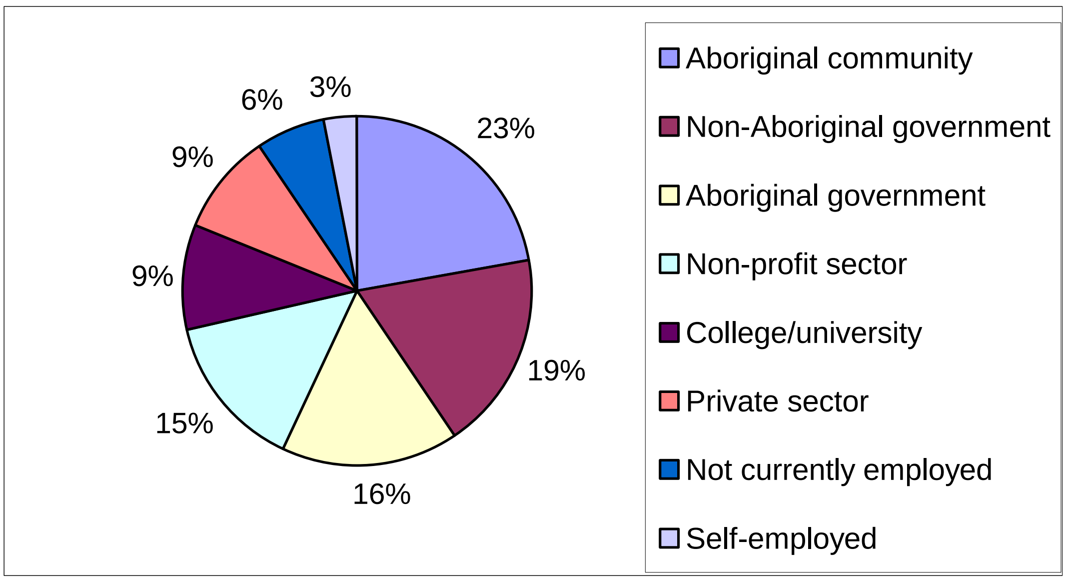
Additional:

Contractor

- Road builder
- Manufacturing
- Oil sands

- Human Services Worker
- Aboriginal Resource Worker
- Training and Employment assistance
- Student services
- Hunter/Trapper
- Daycare
- Economic development
- Museum Programmer
- Server, housekeeper

4) Organization currently working for:

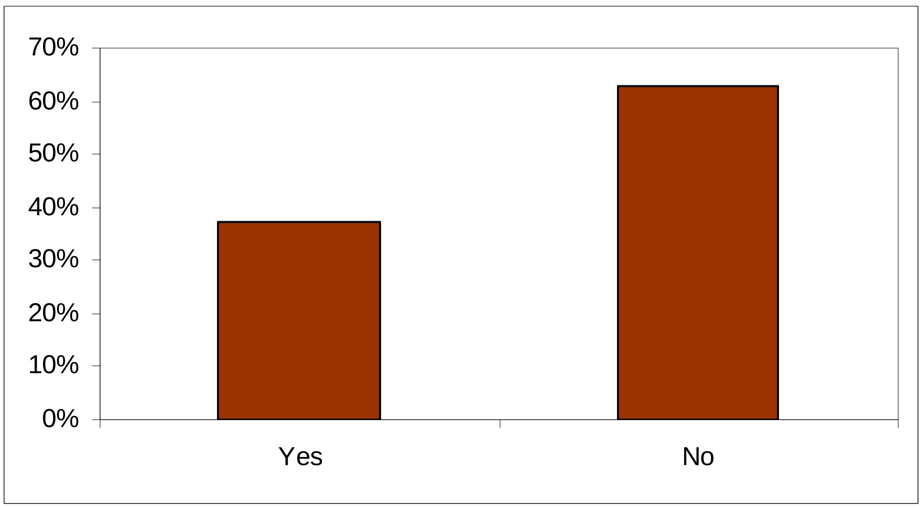


2.2 SURVEY RESULTS

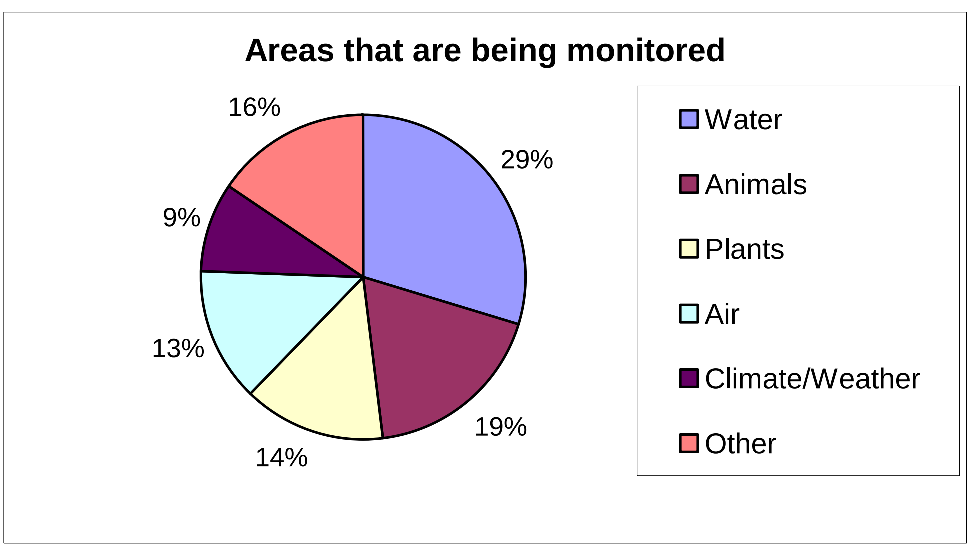
This section outlines the questions provided in the online survey and a summary of the responses.

1) Is your First Nation currently involved in community-based monitoring?

Thirty seven percent of respondents said their community (or communities they have worked with) is currently involved in community-based monitoring.



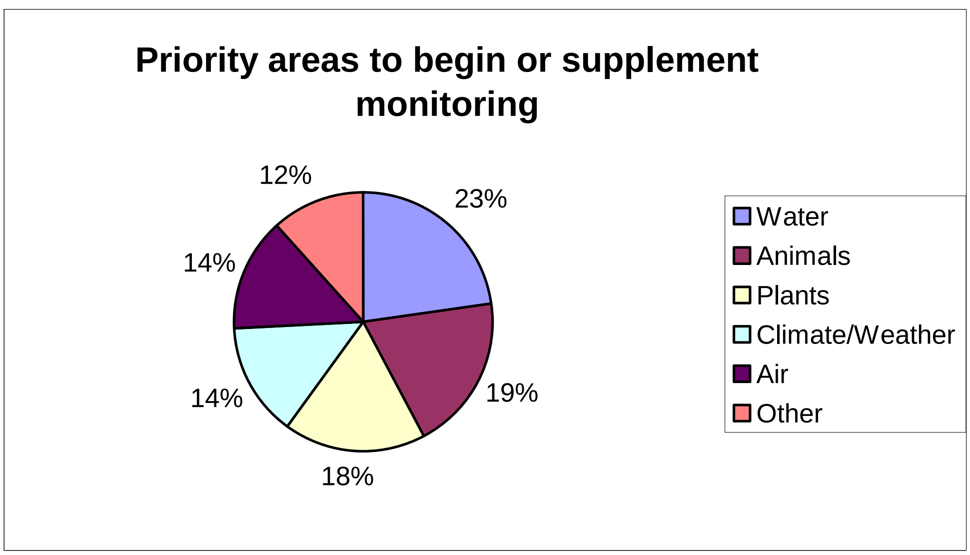
2) What is being monitored?



The following list summarizes all answers offered by survey participants under the answer 'other':

- Resource development
- Hydro development
- Forestry
- Mining
- Soils
- Education
- Archaeology
- Land use
- Law enforcement
- Traditional rights
- Waste disposal

3) What would your community like to monitor on your lands and waters (to add to existing monitoring efforts or to begin monitoring)? (e.g. water levels? Berry production? Elk populations?)



The following list summarizes all answers offered by survey participants under the answer 'other'.

- Contaminants/pollution (6) (Hazardous spills, Soil contamination/cleanup, Cumulative impacts, Acid rain, Power line contaminants)

- Human health (3) (Blood testing, Epidemiological testing)
- Impact of natural resource harvesting industry in traditional territories (3) (Mining, Hydro)
- Sensitive/ protected areas (2)
- Waste management (2) (Garbage disposal, Landfills)
- Land erosion,
- Infrastructures,
- Land use planning,
- GIS for traditional hunters/gatherers/trappers,
- Recycling programs.

4) Does your community have any concerns about your lands and waters? What are they?

All ninety-three respondents described concerns they had about their lands and waters. The majority of comments related to concerns about industry or contaminants, animals and plants and water.

Industry/Contaminants (10)

- Industry along the Great Lakes.
- Oil and Gas development
- Hydro development
- Placer mining, other mining,
- Nuclear waste
- Forestry
- Fish farming
- Farming
- Pesticide use, chemicals in our water and land
- Pollution from oil sands development

Animals and Plants / Traditional Foods (7)

- Species at risk
- Traditional medicines and food plants
- Fishing and fish habitat
- Sustainability of marine foods.
- Contaminants and health of traditional foods

- Pollution affecting wildlife and human health (cancer)
- Impacts of open pit mining on wildlife, water and fish.

Water (5)

- Water, water levels, water tables, water contamination, drinking water, well water, flooding
- Drinking water in relation to Great Lakes water levels; adequate wastewater treatment; solid waste management
- Deteriorating well water quality, less and less water in sloughs and lakes
- Water levels
- Red River diversion project in North Dakota, USA

Aboriginal rights/cultural practises (3)

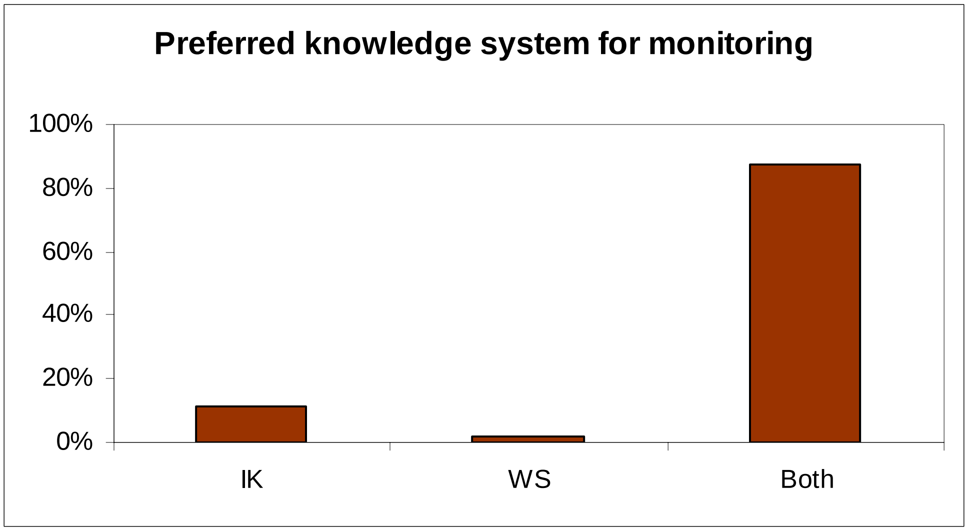
- Recreational versus traditional uses of the land and water.
- Treaty rights
- Loss of way of life

Other concerns:

- Non-renewable resources
- Access to natural resources;
- Climate change
- Waste disposal
- Air quality
- Erosion
- Land use
- Ice quantity and quality
- Tourism and garbage

5) What type of knowledge is your community using or would you like to use to monitor the environment? (Indigenous Knowledge (IK) or Traditional Knowledge from the community; Western Science (WS) methods, or Combination of both.

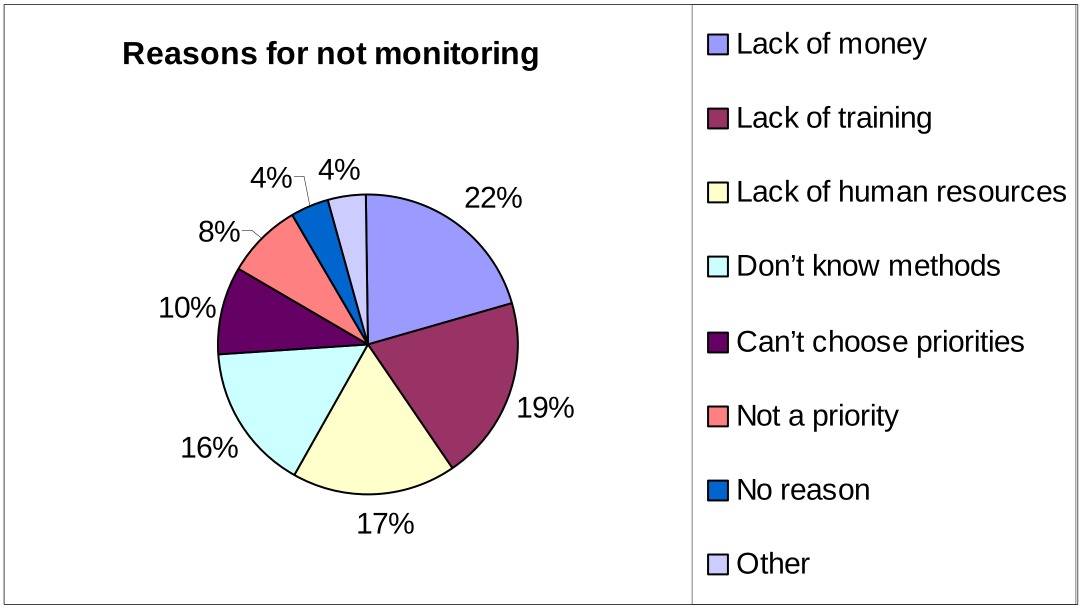
Eighty-seven percent of respondents said that they preferred that both Indigenous Knowledge and Western Science methods were used to monitor the environment. The majority of respondents that selected only one knowledge system chose Indigenous Knowledge.



All answers provided by survey participants under the answer 'other' related to the importance of traditional knowledge.

- Listen to what our older people are saying about how the area (land, water, air) is changing
- Have our elders input incorporated to findings
- Help from other traditional people, communities
- Should bring in elders from each province to talk about the environment, set up terms of reference, natural law proposed guidelines in control and management of our world, traditional cultural concepts of dealing with world issue
- We need both but the scientific methods validate all other methods to the white world.

6) Are there any reasons your First Nation is not doing community-based monitoring?
The reasons selected most often by respondents for not monitoring were a lack of money, lack of training, lack of human resources and lack of knowledge of appropriate methods.



The following list summarizes all answers offered by survey participants under the answer 'other':

- Political Barriers (6)
    - Lack of government concern
    - Lack of federal and provincial support
    - Political interference
    - Political laziness
    - No public forums or consultation by the leadership
    - No leadership support
- All of the above
- Lack of communication
- Social and economical barriers.

7) Why does your community want to do community-based monitoring?

Reason for Monitoring	**Percent**
To have community-controlled information when dealing with industry/ government	76.3%
To protect important areas on traditional territory	73.1%
To be alerted to potential negative changes in the environment	68.8%
To get environmental baseline information	52.7%

Other	28.0%

The following list summarizes all answers offered by survey participants under the answer ‘other’:

- Protect land for future generations (2)
- Maintain the health and safety of community members
- Keep the land and water healthy
- To educate grassroots people,
- All of the above,
- Concern with harvesting of game animals and fish,
- To become more involved in external initiatives,

2.3 SUMMARY

The majority of 93 respondents from the online survey were First Nations adults who work in Aboriginal communities, or for non-profits or governments. Only thirty-seven percent of respondent’s communities were involved in monitoring; the majority of monitoring work focused on water and animals. The priority areas selected by respondents (either to begin monitoring or add to existing monitoring activities) were water, animals, and plants. All the respondents described concerns they had about their lands and water. The topic listed most often were the impacts of industry, such as oil and gas development, and contaminants. Other commonly raised concerns concerned animals and plants (e.g. species at risk) and water (e.g. water levels and deteriorating water quality). The majority (87%) of respondents preferred the use of both Indigenous Knowledge and Western Science methods for monitoring, but heavily emphasized the importance of Indigenous Knowledge in their comments. The most common reasons for not monitoring selected by respondents were lack of money, training, human resources and knowledge of methods. The two reasons for community-based monitoring selected most by respondents were to have community controlled information when dealing with industry/government and to protect important areas on traditional territory. In their comments respondents also described the need to keep the land healthy and protect it for future generations.

A Conceptual Framework for Monitoring Municipal and Community Sustainability in Canada

Prepared for:

Environment Canada

Prepared by:

Mark Anielski
Mark Winfield
Pembina Institute

JUNE 17, 2002

Pembina Institute
for Appropriate Development

Pembina Institute for Appropriate Development

Box 7558, Drayton Valley, AB T7A 1S7 Canada 124 O'Connor Street, Suite 505, Ottawa, ON K1P 5M9
Phone: (780) 542-6272 Fax: (780) 542-6464 Phone: (613) 235-6288 Fax: (613) 235-8118

June 17, 2002

A Conceptual Framework for Monitoring Community/Municipal Sustainability

We are pleased to submit our report, which develops a conceptual framework for measuring, monitoring, and reporting community economic, social, and environmental sustainability and quality of life in Canada. Our framework uses the conventional three pillars of sustainable development (economic/environmental/societal), with a narrow focus on environmental quality and a natural capital component, to provide guidance to Environment Canada on how it may assist Canadian communities to better monitor and report on the environmental conditions that contribute to their quality of life.

In our examination of existing conceptual community sustainability indicators, we were overwhelmed by the number and diversity of reporting efforts across Canada at the national, provincial, and local levels. While a diversity of indicators and reporting systems may be a strength, reflecting the unique needs of each community for indicators, it also presents a significant challenge for common or standardized definitions of sustainability, sustainability indicator framework, database development, data gathering protocol, and reporting protocols. Indeed, many of the challenges to the development of urban sustainability indicators as identified by Virginia Maclaren's (1996) seminal work remain unresolved to this day. Our analysis attempts to build on Maclaren's analysis and recommendations, taking Maclaren's ideas for a conceptual community sustainability measurement and indicator framework to a new level of practicality. There is considerably more work to be done before a common community sustainability measurement framework emerges.

We are particularly encouraged by the efforts of the Federation of Canadian Municipalities to develop a suite of environmental indicators to complement their existing quality-of-life indicators and reporting system. This multi-municipal process of developing a common set of core environmental and quality-of-life indicators could lead to a common "sustainability" measurement framework.

We are also encouraged by other efforts at the national level, particularly the National Round Table on the Environment and the Economy's Sustainable Development Indicators initiative; Environment Canada's environmental indicators initiatives; the Statistics Canada resource and environmental accounting initiative and their new "Cities Trends" indicators initiative; and Natural Resource Canada's National Atlas (Quality of Life Mapping) project. These national indicator and reporting efforts will provide important context for a community- and municipal-scale sustainability measurement and reporting system.

Our study focused on the following key issues:

1) An examination of Canada's environmental and natural capital sustainability information system and database, from the perspective of existing municipal/community sustainability and environmental reporting;
2) Identification of potential or desirable sustainability indicators for which data may not already exist; and
3) A critical analysis (strengths, weaknesses, opportunities and threats) of the feasibility of developing a Canadian community environmental quality and sustainability accounting and reporting system.

While we were conducting this study, it became apparent that despite more than 10 years of indicator development, the emergence of a commonly accepted national framework for community/municipal sustainability indicators and reporting systems is still a good distance from becoming a reality. We believe what is required is a commitment to a process that engages all levels of government, in consultation with measurement experts and citizens, to develop a prototype CSSI sustainability measurement and reporting framework. Such a framework must be dynamic, adjusting for changing issues and values in society and data availability, and flexible enough to provide a national reportage while at the same time allowing customized reporting at the local level in response to local measurement and reporting needs.

We believe Environment Canada can and must play a critical role in the development of community sustainability indicators by providing baseline national environmental community-based data and guidance in data collection and reporting protocols, in support of efforts like the Federation of Canadian Municipalities' (FCM) quality-of-life reporting system.

Sincerely,

For commentary please contact Mark Anielski:
e-mail: marka@pembina.org
Tel: 780-491-0696
Mail: 9847 — 90 Avenue, Edmonton, AB, Canada, T6E 2T2

Table of Contents

Table of Contents 4
List of Figures 5
List of Tables 6
1. Executive Summary 7
2. Background 12
    2.1 Purpose of Project 12
    2.2 Why a Framework for Measuring Community Sustainability and Environmental Quality? 13
    2.3 Defining Sustainable Communities 14
    2.4 Community Capital 15
3. Review of Potential Frameworks 17
    3.1 Hart's Guide to Sustainable Community Indicators 20
    3.2 IISD's Dashboard of Sustainability 22
    3.3 Maclaren's Urban Sustainability Indicator Matrix 24
    3.4 FCM Quality of Life Reporting System: Environmental Indicators 28
    3.5 National Round Table on the Environment and the Economy, Environment and Sustainable Development Indicator Initiative 32
    3.6 Statistics Canada's Trends in Cities Project 37
    3.7 Statistics Canada's Human Activity and the Environment Report 41
    3.8 The Canadian Policy Research Networks Quality of Life Indicators 41
    3.9 National Atlas and Quality–of-life Mapping System 45
    3.10 Community Sustainability Pressure–state–response Analytic Framework 45
    3.11 Pollution Watch Canada's Pollution Scorecard 47
    3.12 The Alberta GPI Sustainable Well-Being Accounting System 48
    3.13 Edmonton Capital Region "Indicators of Success" 56
    3.14 GPI Atlantic's Community Sustainability Indicators 60
    3.15 UBC's Sustainable Development Institute's Georgia Basin (QUEST) Model 61
    3.16 Fraser Basin Sustainability Indicators 61
4. Community/Municipal Indicator Initiatives 65
    Vancouver's State of the Environment Report (1997) 67
    Sustainable Calgary's State of the City 2001 Report and Green Map Calgary 67
    City of Calgary's State of the Environment Report (1998) 68
    City of Edmonton's State of the Environment Environmental Indicators 68
    Edmonton LIFE (Local Indicators for Excellence) (1998) 69
    City of Regina's State of the Environment Report (1994) 69
    Toronto *Vital Signs* (2002) 70
    Hamilton Vision 2020 Sustainability Indicators 70
5. A Conceptual Community Sustainability and Environmental Monitoring Framework 71
    Data Gaps 78
References 82
Appendix A 85
Municipal Quality of Life Indicators and State of the Environment Reports 85
A1. Hart's Sustainable Community Indicators 86
A2. Maclaren's Canadian Municipal/Regional State of the Environment Report Indicators 91
A3. Summary of Canadian and U.S. Municipal, Regional, and State Quality of Life and Sustainability Indicators 103
A4. Federation of Canadian Municipalities Original List of Proposed Environmental Indicators for Canadian Municipalities 112
A5. City of Vancouver Environmental Trends and Indicators (1997) 115

A6. Sustainable Calgary: State of Our City Report (2001) 118
A7. City of Calgary State of the Environment Report Indicators 120
A8. City of Edmonton State of the Environment Report Environmental Indicators 122
A9. Edmonton LIFE (Local Indicators for Excellence) Quality of Life Indicators, 1998 124
A10. City of Regina State of the Environment Report, 1994 126
A11. Hamilton Sustainability Indicators 129

List of Figures

Figure 1: Conceptual Community Sustainability Measurement Framework 10
Figure 2: Community Capital Framework 21
Figure 3: Hart's Topic Areas for Categorizing Sustainability Indicators 21
Figure 4: The Dashboard of Sustainability and Canada's Dashboard Prototype 23
Figure 5: Maclaren's Typology for Sustainability Indicators Development 25
Figure 6: Maclaren's Urban Sustainability Evaluation Matrix 26
Figure 7: NRTEE Proposed National Capital Indicator Framework 33
Figure 8: National Round Table on the Environment and the Economy: Preliminary Environment and Sustainable Development Indicators List 35
Figure 9: CPRN's Quality of Life Indicators Framework 42
Figure 10: Sustainability Report Community Sustainability Framework 46
Figure 11: Genuine Progress Indicator (GPI) Sustainable Well-Being Measurement Framework 49
Figure 12: Integration of Alberta GPI Environmental Accounts to Measure Ecosystem Integrity 50
Figure 13: Alberta GPI Environmental Sustainability Index Compared with GDP Growth, 1961 to 1999 54
Figure 14: Alberta GPI "Balance Sheet" Showing Condition of 51 Indicators of Economic, Social, Human Health, and Environmental Well-Being. 55
Figure 15: Alberta Capital Region (Edmonton) Indicators of Success Framework 57
Figure 16: Alberta Capital Region Quality of Life Indicators Set 58
Figure 17: Capital Region's Triple E Operational Indicators 59
Figure 18: Fraser Basin Sustainability Indicators 62
Figure 19: Community Capital Accounting and Measurement Framework 72
Figure 20: Community Capital Accounting and Measurement Framework Based on Statistics Canada National Capital Framework 73
Figure 21: Sustainability Indicators Classification System 74
Figure 22: Conceptual Community Environmental Sustainability Monitoring Structure 75
Figure 23: Prototype Community Environmental Sustainability Indicator Accounting System 76
Figure 24: Environmental Data Gap Analysis 79
Figure 25: Hart's Sustainable Community Indicators List 86
Figure 26: Virgina Maclaren's Survey of Canadian Municipal/Regional Economic, Social, and Environmental Indicators Reported in State of Environment or Other Reports 92
Figure 27: Canadian and U.S. Community Economic, Social, and Environmental Indicators Comparative Grid 103
Figure 28: City of Vancouver Environmental Trends and Indicators (April 1997) 115
Figure 29: Sustainable Calgary Sustainability Indicators (2001) 118
Figure 30: City of Calgary's State of the Environment Report Indicators 120
Figure 31: Edmonton's State of the Environment Environmental Indicators 122
Figure 32: Edmonton LIFE Quality of Life Indicators 124
Figure 33: Regina's State of the Environment Report, Environmental Indicators, 1994 126
Figure 34: City of Hamilton Sustainability Indicators, 2001 129

List of Tables

Table 1: Sustainability and Quality-of-life Indicator Frameworks 18
Table 2: StatsCan Trends in Cities Project Indicator Framework 39
Table 3: Alberta GPI Natural Resource and Environmental Accounts 51
Table 4: Maclaren's Inventory of Municipal and Community State of the Environment Reports ... 65
Table 5: Federation of Canadian Municipalities Original Preliminary Long List of Proposed Environmental Indicators for Canadian Municipalities 112

1. Executive Summary

The primary goal of this project was to examine the opportunities for developing a Canadian community sustainability measurement and reporting framework that would provide meaningful portraits of community-level environmental quality and sustainability of natural, social, and produced capital. To achieve this goal we examined a variety of conceptual and actual sustainability and environmental reporting systems at the national, provincial/regional, and community/municipal level; critically assessed their strengths and weaknesses; and developed a conceptual framework for community sustainability measurement.

The first part of our report examines the emerging sustainability, environmental, and quality-of-life indicator and reporting systems. We examined a few of these efforts, including national efforts such as the Federation of Canadian Municipalities (FCM), the National Round Table on the Environment and the Economy (NRTEE), Statistics Canada, Environment Canada, and the Canadian Policy Research Networks Quality of Life indicators. We examined regional sustainability measurement efforts such as the Alberta Genuine Progress Indicators (GPI) Sustainability Accounting System, the GPI Atlantic's work on a sustainability "genuine progress index" for the province of Nova Scotia and for the communities of Glace Bay and Kings County, and the Fraser Basin Sustainability Indicator. Finally, we examined a number of municipal/community sustainability and state of the environment reporting initiatives. By examining the overlaps and common features of national, regional, and local sustainability indicator and reporting systems, we can begin to make out a potential conceptual framework for national community sustainability measurement and reporting.

Of the conceptual sustainability measurement and reporting frameworks we examined, we were particularly impressed with Virginia Maclaren's (1996) urban sustainability indicator evaluation framework/matrix and the International Institute for Sustainable Development's (IISD) Dashboard of Sustainability. The most important contribution to developing such a national CSSI system is Virginia Maclaren's (1996) *Developing Indicators of Urban Sustainability: A Focus on the Canadian Experience.* Maclaren's seminal work for Environment Canada and the Canada Mortgage and Housing Corporation still provides one of the most comprehensive analyses of urban sustainability indicators. We feel her extensive research of urban sustainability indicators, her posited framework for urban sustainability measurement, and her ongoing inventory of municipal environment indicators and reporting provides a solid foundation upon which to build the desired conceptual sustainability measurement and reporting framework. IISD's Dashboard of Sustainability provides another conceptually attractive sustainability reporting framework, though it has had limited applications.

Of the national community-based indicator initiatives, the most promising of all is the Federation of Canadian Municipalities' (FCM) Quality of Life Reporting System. The FCM is truly national in scope, representing 18 major Canadian municipalities or metropolitan regions. As part of this national quality-of-life reporting initiative, the FCM is currently in the process of developing a suite of key environmental indicators drawn from a long list of potential indicators. We believe this indicator effort could well lead to the emergence of a "sustainability" indicator and reporting system for Canadian municipalities and communities, with the support of federal and provincial governments working in concert with municipal governments in supporting data inventory, data-gathering protocols, and analysis.

We believe the emerging Environment and Sustainable Development Indicators (ESDI) being developed by the NRTEE will provide another important framework for sustainability measurement and reporting. However, while they are important for national sustainability reporting, we are not convinced these ESDI will provide specific relevance to the unique spatial reporting needs of municipalities and communities. This is because the ESDI will be, for the most part, national in scale. Yet there is potential for the integration or nesting or alignment of the national ESDI with a suite of core Canadian Community Sustainability Indicators (CCSI) in a comprehensive national-provincial-local environment and sustainable development measurement and reporting system.

We are also encouraged by Statistics Canada's new Cities Indicator project, which should result in eco-zone, spatial "mapping" of environmental quality and sustainability at the drainage basin (sub-basin and sub-sub-basin) level. This spatial mapping of quality of life and sustainability using existing Statistics Canada databases and Environment Canada and other federal government data sets should provide meaningful portraits of sustainability of the ecosystem scale in which municipalities are located. A similar spatial sustainability-mapping project is Peter Morton's National Atlas of Quality of Life Mapping, a project of Natural Resources Canada. Morton's reporting efforts are on a more refined Census Division scale, which presents considerable reporting limitations.

The qualitative research into quality-of-life indicators of Canadian communities being conducted by the Canadian Policy Research Networks (CPRN) is another encouraging example of drawing on citizen input through dialogue in developing subjective or perceptual measures of sustainability and quality of life.

We also reflect on our own experience and success in developing the prototype Genuine Progress Indicators (GPI) Sustainable Well-Being Accounting system applied to Alberta. This unique sustainability accounting system combines quantitative, qualitative, and monetary measures of economic, social, health, and environmental capital well-being in an integrated measurement framework using such traditional accounting tools as a balance sheet, income statement, ledgers/accounts, and performance-reporting protocols. The GPI Sustainability Accounting system shares common features with IISD's Dashboard of Sustainability, in both measurement framework and reporting instruments. The GPI Alberta accounts provide an important glimpse of what is possible with a robust sustainability and quality-of-life measurement and reporting system.

Finally, our research examined and compared a number of existing municipal or community sustainability and quality-of-life indicator initiatives. This inventory and comparison of indicator suites provides important guidance to developing a common CSSI framework, in support of the FCM efforts. Our analysis, while preliminary, points to a common set of CSSI, identifies data sources at the municipal scale, and points to indicator and data gaps for completing a national CSSI system. Some of this important inventory and cross-examination is being done by Dr. Virginia Maclaren at the University of Toronto and should be sustained.

Our research showed a vast variety of independent, community-based "state of the environment," "quality of life," and "sustainability" reporting efforts. Over the past 10 years, most major municipalities, several regional governments, and many other communities have been active in developing such reports, either as part of a municipal governance structure or as grassroots or multi-stakeholder community indicator initiatives (e.g., Sustainable Calgary). We recommend that Environment Canada, along with other federal and provincial agencies, maintain an ongoing inventory and assessment of these community-based environmental indicator and reporting efforts by establishing an ongoing relationship with these communities, in cooperation with provincial government ministries or agencies.

Our analysis shows a wealth and variety of municipal and community environmental indicators and data, each with its respective strengths and weaknesses. Some municipalities are stronger in terms of environmental reporting and sustainability and quality of life reporting. We are particularly impressed with the City of Vancouver, City of Calgary, City of Regina, and City of Hamilton's *Vision 2020* environmental and sustainability reporting systems, as well as the emerging City of Edmonton's state-of-the-environment reporting system.

This analysis also shows the lack of a cohesive and common measurement, data-collection protocols, and reporting framework. It is clear that there is no common "game plan" for a standard approach to community sustainability reporting and information gathering, though the FCM environmental indicator initiative does provide hope for such a future outcome. The challenge will be in organizing the disparate initiatives and data sets that are currently in a state of random disarray, scattered across the country with no consistent protocols for information gathering or reporting. Most of these challenges are beyond the scope of this study. At best we were able to identify some of the overlaps in municipal ESDIs, identify data sources, and identify gaps in both indicators and data (though this last was more challenging and required considerably more effort).

What is apparent from our analysis is the need for coordination of database development, reporting protocols, and measurement frameworks across the country, particularly closer coordination by federal departments. While considerable progress has been made in coordinating provincial-federal environmental measurement and reporting through bodies such as the NRTEE, at the CCME (Canadian Council of Environment Ministers) and CCFM (Canadian Council of Forestry Ministers) there is considerably more room for economies of scale for data gathering and reporting coordination. There is a need for a robust and enabling Canadian community-based CSSI information and data-gathering system that coordinates the efforts of the FCM, Statistics Canada, Environment Canada, NRCAN, and other federal and provincial government agencies. This recommendation is consistent with recommendations of the Task Force on a Canadian Information System for the Environment (CISE).[1]

Our preliminary research and analysis, and the important "state of the environment" reporting benchmark research by Dr. Virginia Maclaren (University of Toronto),[2] shows there is already a wealth of community-level environmental quality and sustainability information, though reporting is inconsistent across the country. This is encouraging, however, as it demonstrates the fragmented and random nature of environmental quality information and reporting systems, and the need for a national community-based environmental information system. Some of theleading environmental and sustainability reporting efforts have occurred or are taking place in Vancouver, Calgary, Edmonton, Toronto, and Hamilton. Maclaren's superb inventory shows the depth and scope of community-based environmental indicators. We recommend Maclaren's inventory as the basis for constructing a national community sustainability and environmental indicator data set in support of FCM's individual community reporting and other national sustainability reporting efforts. We have attempted to begin the construction of such a database in the form of an Excel spreadsheet that inventories environmental indicator domains, subdomains, and individual indicators by municipality, region, or community. We recommend that

---

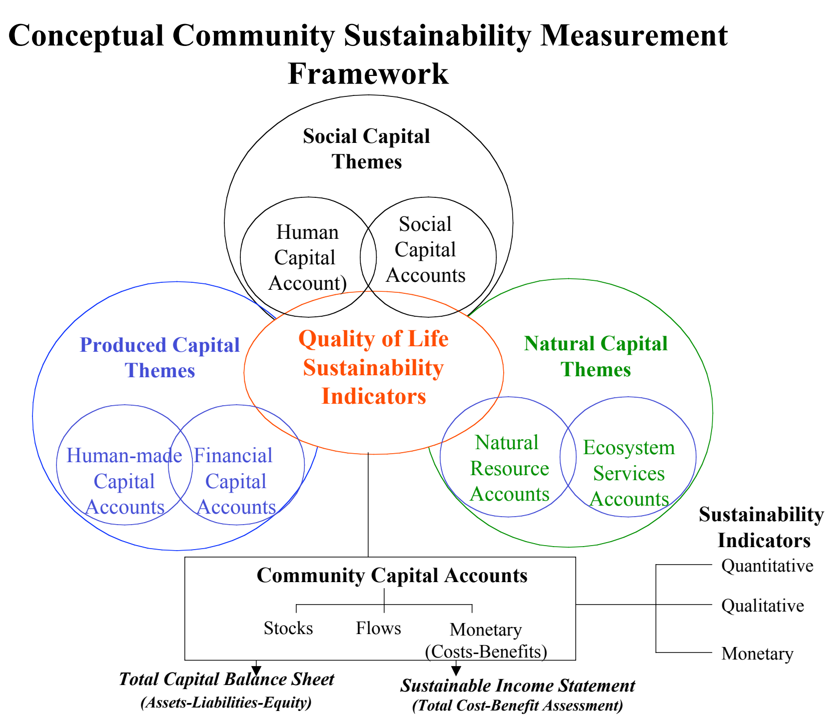
[1] *Informing Environmental Decisions: First Steps Toward a Canadian Information System for the Environment.* The interim report of the Task Force on a Canadian Information System for the Environment to the Minister of the Environment. Minister of Public Works and Government Services, May 2001.
[2] http://www.geog.utoronto.ca/CommunityReporting/SOEsummaries.htm

Environment Canada, in cooperation with other federal agencies, attempt to maintain an ongoing national database that allows for benchmarking of communities.

Our analysis confirms that there are serious challenges to standardizing data collection, reporting, and dissemination, which would be the basis of a national CISE for communities. There is a need for a coordinated effort, possibly through the FCM and in cooperation with Environment Canada and Statistics Canada, to conduct a thorough and forensic assessment of the existing municipal-scale environmental information. Our initial efforts in this project suggest that this is a major undertaking and we have only begun to scratch the surface. As Environment Canada and others know, there are serious data gaps in such areas as groundwater quality monitoring, surface water monitoring (including the Great Lakes), biodiversity measurement and monitoring, and climate change, as well as in more complex areas, such as the impacts of our consumer behaviour on ecosystem integrity and productivity (e.g., measures like the Ecological Footprint may hold some future promise with methodological improvements). Good examples of what is possible in terms of relevant information dissemination include the Pollution Watch website (www.scoredcard.org/pollutionwatch), which allows citizens to profile the pollution "footprint" using point source emissions on the quality of the air, water, and land in the ecosystems in which they live. Such web-based information and reporting systems, we believe, are the desired future for a national, community-based CISE.

We conclude our paper with a conceptual Community Sustainability Measurement Framework (Figure 1).

Figure 1: Conceptual Community Sustainability Measurement Framework



We believe this framework combines the strengths of the "capital" approach to national accounting being advocated by Statistics Canada and would be particularly relevant to community "capital" accounting and reporting as a tool for measuring sustainability and quality of life at the community level.

We echo Maclaren's (1996) own conclusions that much work remains to be done in order to achieve the desired outcome of a common measurement framework. What is required is a national commitment to a dynamic system of continuous development and improvement, as well as a balance between the desire for a CCSI framework with a core set of sustainability indicators and the need for a community-specific CCSI in accordance with the community's unique sustainability and quality-of-life vision and goals and societal values. An optimum CSSI framework would include a set of core (perhaps 10) indicators across several key domains (e.g., land use, air, water, appropriated carrying capacity (ecological footprint), etc.). These indicators may be further stratified according to whether they represent a condition, state, or response (C-S-R). A core set of Canadian CSSIs would make benchmarking and comparison of best sustainability conditions/performance possible. This core set of CSSIs would be supplemented by a second tier of supplemental, supporting indicators.

We feel a prudent approach for Environment Canada and other federal agencies involved in developing national environmental and sustainability indicators is to build upon the important and ongoing inventory work by Virgina Maclaren at the University of Toronto. Dr. Maclaren has assembled the most extensive inventory to date of state of the environment reporting at the community level, providing a comprehensive database[3] for historical and current environmental information. Her work suggests that a plethora of environmental quality information already exists. The challenge is in following the audit trail to the hundreds of data sources that were used to populate these community environmental indicators, which was beyond the scope of this limited project.

We believe Environment Canada can and must play a key role in creating an enabling community-specific and ecosystem-relevant environmental information system (e.g., the emerging EMAN ecosystem profiling system for 30 Canadian communities) in support of the FCM quality of life reporting system. This should include Canadian municipal and community data gathering and reporting standards or protocols, development of new community sustainability measurement tools (e.g., ecological carrying capacity analysis (ecological footprint analysis), material-energy flow analysis and budgeting tools, groundwater budgeting tools, and carbon budgeting tools). Common monitoring, accounting, and reporting standards are required. Some of these issues have already been identified in the *Informing Environmental Decisions* report of the Task Force on a CISE but lack the necessary political and fiscal enabling support.

[3] http://www.geog.utoronto.ca/CommunityReporting/SOEhome.htm

2. Background

2.1 Purpose of Project

Pembina Institute for Appropriate Development was asked to examine the potential conceptual framework for measuring and reporting community-based environmental quality and sustainability indicators. The purpose of such a framework would be to assist municipalities and communities in planning and monitoring environmental quality, as part of a more comprehensive sustainability, quality of life, or performance measurement system for municipal-community governance.

The goal of this project was to identify a potential conceptual measurement and reporting framework for environmental quality and sustainability measurement that might provide guidance to Environment Canada in assisting communities and municipalities in filling data and information gaps and to help in the development of a national, community-based environmental information system. Such a measurement and reporting system would provide citizens and community decision makers with meaningful portraits of community-level environmental quality and sustainability of natural capital assets.

The project entailed an examination of current community-scale (i.e., municipalities and communities) environmental, sustainability, and quality-of-life indicators, databases, and reporting "architectures," "infrastructure," and "systems" that are emerging out of the collective efforts of the Canadian Federation of Municipalities, the National Round Table on the Environment and the Economy, Environment Canada, Statistics Canada, Industry Canada, Natural Resources Canada, and individual municipalities or community state-of-the-environment and/or sustainability reporting initiatives.

The recent report by the Task Force on a Canadian Information System for the Environment (CISE), titled *Informing Environmental Decisions: First Steps Toward a Canadian Information System for the Environment*, was released in May 2001. The report made several recommendations for the development of a CISE "moving towards a 'place-based' approach, with boundaries that make environmental sense, such as those for ecosystem or watershed." The report recognized the inadequacy of a national state-of-the-environment reporting system relevant at both the scale of "place" or community and the scale of an ecosystem or watershed. Citizens lack information that would allow them to assess the current state of their environment and the way it impacts upon their quality of life. Nor is there a way of comparing relative environmental quality of life across the nation. A number of environmental information data gaps, in terms of monitoring and surveillance programs, were already identified in Annex C of the Task Force report. These include the media or domains of air, climate, water, biodiversity, human and environmental health, natural resources (including wildlife, fish/marine, land, forests, minerals, and metals), and eco-efficiency. These gaps are significant at various scales, including municipalities and smaller communities, and represent the research and information agenda for the future.

The desired outcome for this project is to help begin the process of developing a comprehensive environmental information system that is relevant at the community or municipal scale but is also an integral part of a national environmental information system. We hope we have contributed to this effort in a meaningful way.

2.2 Why a Framework for Measuring Community Sustainability and Environmental Quality?

There are a number of reasons for, and benefits of, developing a framework for measuring and reporting on community sustainability and environmental quality. Overall, there is a growing interest in quality-of-life and sustainable development measurement and indicators. Canadian citizens and decision makers are looking for information and policy analysis and decision-making tools that can guide them in measuring the conditions of the quality of life in their communities, relative to other Canadian communities, and thus to guide decision making to improve the various dimensions of quality of life: economic, social, and environmental.

The need for indicators of sustainable development is best summed up in Meadows' (1998) reference:

> Indicators of sustainable development need to be developed to provide solid bases for decision making at all levels, and to contribute to the self-regulating sustainability of integrated environment and development systems.
>
> — Chapter 40.4 of Agenda 21, from the United Nations Earth Summit in Rio, 1992

Meadows points to two fundamental questions that such sustainability indicators help us to address, particularly at the local or community level:

a. How can we provide sufficiency, security, and good lives to all people?
b. How can we live within the rules and boundaries of the biophysical environment?

Meadows (1998: p.12) would define sustainability as "good lives for all people living in harmony with nature." How do we measure genuine progress towards this vision of sustainability? This is the purpose of a sustainability accounting and reporting system or a quality-of-life measurement system.

A framework for measuring and monitoring quality of life and sustainability at the community level is important for determining whether the quality of life is improving or declining over time, with an eye on the well-being of our current and future generations. There is a growing recognition that traditional financial and economic performance measurement systems and a traditional focus on economic growth alone are inadequate. New tools for measuring quality of life and the sustainability of economic, social, and environmental well-being are required. Quality of life is about the balance and interconnectedness of these multi-determinants of quality of life. Until only recently, citizens and decision makers have lacked a compass to guide their sustainable "development" journey.

There are many benefits to developing an analytic framework and tools for measuring and monitoring community quality of life and sustainability, including the following.

- They provide a deeper and critical understanding of how economic, social, health, and environmental factors interconnect in defining quality of life.
- They provide a focal point for discussion by citizens and decision makers about quality-of-life and sustainability issues by measuring the current conditions, trends, and comparative analyses of quality of life and sustainability.

- They provide the tools (using indicators) to account for the conditions of economic, social, and environmental well-being in communities, thus creating a more informed policy decision-making process.
- Traditional indicators of community well-being measure changes in one part of the community as if they were independent of the other parts; sustainability indicators take a more integrated view of the world that shows the linkages and multidimensional nature of a community's economy, environment, and society (Hart, 1999).
- They allow for an alignment of citizen quality-of-life values with indicators of progress in relation to those values.
- They provide a practical decision-making tool that allows decision makers to track trends in the conditions of quality of life, and thus provide knowledge about the linkages and sustainability of economic, social, and environmental conditions.
- They allow decision makers to understand the complex interconnections that contribute to quality of life and thus provide some guidance as to where and when to intervene in the system, through policies, to improve living conditions in a sustainable community.
- They provide an educational tool that can be used by teachers, citizens, businesses, community organizations, and public decision makers by providing a diagnosis of the community's overall well-being.
- They provide citizens and decision makers with a better compass for understanding the relative strengths (assets) and weaknesses (liabilities) of local endowments of human, social, natural, produced, and other intangible assets, in relationship with economic endowments.
- The indicators of quality of life and sustainability that emerge from the measurement system would provide decision-makers with the information they need to develop strategies and business plans to move communities in the direction of sustainability and to improve quality of life.
- They provide a full cost/benefit monetary accounting of the various parameters of quality of life and sustainability as part of a more robust financial and economic policy decision-making process.

The ultimate utility is to provide practical tools for measurement, reporting, and analysis of quality of life to achieve a sustainable local community whereby local needs are met in a way that can be continued in the future. Sustainability and quality-of-life indicators must be more than environmental indicators; they must be about time and/or thresholds (Meadows, 1998). Of course a sustainable community means many things to the different people and stakeholders who live there.

2.3 Defining Sustainable Communities

The Brundtland Commission (1987) defined sustainable development as "Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." For individuals and households living in a "community," increasingly in urban settings or municipalities, this would suggest living in a manner or lifestyle that improves the quality of life (i.e., increasing human and social capital) for all generations and all age, sex, and socio-economic classes (i.e., the inter- and intra-generational equity goal of sustainable development) while living within the means of nature or the environment to provide a flow of "natural capital" resources and to provide ecosystem services for the assimilation of our wastes. Sustainability at the community level may be best defined in terms of ensuring our "ecological footprint" (i.e., our demands on material, energy, and resources from the natural environment) does not exceed the natural carrying capacity of the natural environment in which we live. Sustainable development is as closely related to quality of life as it is to living within the means of nature. We have found that there is no particular importance in splitting hairs between sustainability and quality-of-life indicators; in part they are one and the same.

In her *Guide to Sustainable Community Indicators*, Hart (1999) provides a useful definition of sustainable development with respect to communities:

> A **sustainable community** is a community that improves and enhances its natural, social, and economic capital in ways that allow current and future inhabitants of the community to have healthy, productive and happy lives.

She breaks down the meaning of the definition as follows:

- **Sustain** means to continue without lessening, to nourish and allow to flourish;
- **Develop** means to improve or bring to a more advanced state; and
- **Community** is a group of people who live and interact in a specific geographic area.

Maclaren (1996: p. 1), in defining “urban sustainability,” distinguishes between “sustainable urban growth” and “sustainable urban development.” “Sustainable urban growth” implies a continuous physical or quantitative expansion of an urban area and the economy supporting it, whereas “sustainable urban development” is a qualitative concept that emphasizes “improvement,” “progress,” or “positive change.” As Hart (1999) notes, sustainability is not about maintaining the status quo or reaching perfection, nor is it about sustained “growth”; sustainability has to do with the story of human “development” and is thus a journey or process of continuous balancing and rebalancing of economic, social, and environmental priorities that make life worthwhile and contribute to the conditions of well-being.

2.4 Community Capital

“**Capital**” is a useful term to employ in considering and measuring the condition of well-being in a society. Capital is synonymous with **wealth,** an Old English term that means literally “the condition of well-being”: condition (*th*) plus well-being (*weal*). We have traditionally known capital or wealth to mean financial or physical assets (e.g., land, equipment, or other valuables), but according to the original definition of the word, we can widen our lens to consider wealth more comprehensively to include human, social, natural, and produced capital. The “condition” of this capital can be measured quantitatively in terms of physical stocks (e.g., the stock of trees in a forest, oil in the ground, or people in a community) and in terms of flows (e.g., the rate of timber harvesting, oil extraction, or population growth (births and deaths)). Many proxies or indicators of the condition of human, social, natural, and produced capital exist that can serve as “signposts” of physical and qualitative condition. Wealth can also be measured monetarily, in terms of the monetary proxies (e.g., market values or market costs) of human activities. Finally, wealth can be measure qualitatively through measures of individual perceptions of well-being (e.g., self-rated health).

The essence of sustainable development is to make choices today that do not compromise the condition of these capital “endowments” or assets and their ability to provide for a quality of life for current and future generations. That is, it is important to measure and understand the conditions of total capital well-being to ensure sustainability. A measurement and monitoring system is thus imperative to understand our societal “performance” as stewards of our living capital (human, social, natural), while building vibrant and flourishing economies of built capital assets that contribute to quality of life. Such a total capital measurement and monitoring system is an important tool for decision makers in a community to ensure the community is on a sustainable course in its quality-of-life journey.

This “capital” approach is consistent with the emerging national environment and sustainable development indicators being developed by the National Round Table on the Environment and the Economy (see Smith, Simard, and Sharpe, 2001). Smith, Simard, and Sharpe (2001: p. 2) note that “the essence of sustainability is that we wish economic production to continue for the benefit of the future…. To do this, we need to maintain the means of production — or capital — intact over time.”

According to these authors, capital can be measured in terms of stocks and flows. **Stocks** describe the state of the system at a particular time (e.g., the amount of arable land, oil reserves, water in an acquirer, greenhouse gases in the atmosphere, or free time) (Meadows, 1998). Stocks are indicators of the state of a system and its response time. With stocks, size and expected “lifetime” (e.g., years of oil reserves remaining) can give useful indicators of the response rates of the system. **Flows** are measures of the pressures that change the overall state of the capital — that is, the inputs or outputs (measured per time unit) that increase or decrease stocks. Flows may be leading indicators of change over time. Assessing rate of change in flows in the context of changes in the stock of capital can provide advance warning of an emerging imbalance (i.e., liability) in the condition of the well-being of that capital endowment or asset. This stock-flow orientation is consistent with the pressure-state orientation that the United Nations, the OECD, and other indicator systems have used.

Anielski (2001) developed a total capital sustainable well-being measurement framework for measuring the sustainable development of economies, titled the Genuine Progress Indicators (GPI) Sustainable Well-Being Accounts. His framework uses a series of interconnected human, social, natural, and produced capital accounts that contain quantitative, qualitative, and monetized values data, which can then be used to derive “indicators” or proxies for sustainability or proxies of the condition of the well-being of these capital endowments. The GPI sustainability accounting and reporting framework was first developed for the Yukon (Anielski et al., 2000) and then applied to Alberta (Anielski et al., 2001). The GPI framework is described in greater detail later in this report.

Hart (1999) provides another useful framework for identifying the domains or parameters for a conceptual community capital accounting framework. She has identified three broad categories and subsets (subaccounts) in the following orientation (see Figure 2, “Community Capital Framework”):

- Built and financial capital
    - manufactured goods
    - equipment
    - buildings
    - roads
    - water supply systems
    - jobs
    - information resources
    - credit and debt
- Human and social capital
    - people
    - skills
    - education

  - health
  - ability to cooperate and work together (social cohesion)
- Natural capital
  - natural resources (renewable and non-renewable)
  - ecosystem services
  - life-enhancing quality of nature (intrinsic value)

This framework is a useful visualization of how various forms of capital may interconnect and relate to each other in defining overall well-being and sustainability. The Hart framework for community capital is also consistent with the Alberta Genuine Progress Indicator (GPI) Sustainable Well-Being Accounting System (Anielski, 2001).

3. Review of Potential Frameworks

Our research examined a number of conceptual and existing sustainability, quality-of-life, and environmental measurement, indicator, and reporting frameworks or initiatives as the basis of positing a conceptual, community-based environmental quality and sustainability accounting and reporting system. The number and diversity of the national, regional, and community initiatives across Canada are impressive yet overwhelming. We have undoubtedly only managed to do justice to a few of these indicator and measurement efforts and have provided what we believe is a good summary of the "best practices" or "best-in-class" at measuring sustainability at the community and municipal scale. The diversity and unique characteristics of each initiative provide hope that a conceptual unifying sustainability measurement framework may emerge in Canada through progressive testing and continuous improvement of these individual initiatives by sharing and comparing the strengths and weaknesses of each one.

There is no "holy grail" of community sustainability measurement systems. If anything, the measurement tools often reflect the explicit cultural needs of the community they are intended to serve. Because these will vary across communities, it would be shortsighted to argue that all communities in Canada should use a common framework. Yet we find common measurement themes (e.g., domains of issues) with different choices of indicators to measure the condition of well-being in the community. These reflect in part the unique societal characteristics of each community. After all, indicators of quality of life and sustainability should be relevant to a community's needs and values.

Table 1 provides a summary of some of the sustainability and quality-of-life indicator and measurement frameworks we examined, which we believe could be used to develop a unifying conceptual community sustainability measurement framework. Clearly, this list reflects our own selection bias and should not be considered to be comprehensive nor the definitive list of potential options. New frameworks are emerging on a regular basis. We believe each one of the initiatives we identified has unique strengths that could be used in constructing a conceptual Canadian (national) community sustainability or quality-of-life measurement system. Following the list, we examine a subset of these initiatives in more detail, identifying their strengths and weaknesses; our analysis does not consider the whole list in the interest of space.

Table 1: Sustainability and Quality-of-life Indicator Frameworks

Indicator Framework or Initiative	Description	Strengths	Weaknesses
3.1 Hart's Guide to Sustainable Community Indicators	Enabling guidelines for community ESDI reporting.	Comprehensive list of potential CSSI from an analysis of a wide selection of North American sustainability reporting initiatives.	Does not provide database for comparison of reporting results.
3.2 IISD's Dashboard of Sustainability	Conceptual sustainability accounting and reporting framework for national, provincial, municipal, and government sustainability reporting.	Excellent conceptual framework (dashboard) for reporting sustainability performance using concepts of capital, assets, liabilities, and equity; conditions, stress, and pressure indicators.	No tangible applications at national, provincial, or municipal level.
3.3 Maclaren's Urban Sustainability Indicator Matrix Maclaren's Municipal State of Environment Reporting Inventory	A prototype urban sustainability indicator matrix of 16 core sustainability indicators classified according to sustainability themes/domains, sustainability goals, indicator selection criteria, and condition-stress-response criteria. An inventory of state of the environment reporting efforts at the municipal scale in Canada.	Provides a good framework, checklist, and decision rules for choosing, stratifying, and organizing community sustainability indicators. A comprehensive inventory of historical municipal/community state of the environment reports and a complete listing of indicators used for reporting.	Limited to only 16 core indicators. Does not break down indicators according to domains. Needs to be updated and better organized. No raw data or data sources are identified.
3.4 Federation of Canadian Municipalities Quality of Life Reporting System	National set of municipal quality-of-life indicators across economic, social, health, and environmental domains.	National in scope, covering 18 municipalities. Includes other economic, social, and health indicators related to sustainability.	Limited to only a few (8-10) indicators for the environment.
3.5 National Round Table on the Environment and the Economy, Environment and Sustainable Development Indicator Initiative	A set of national sustainability and environmental indicators using a "capital" approach to measurement.	Provides a portrait of sustainability at the national level.	Lacks the resolution of sustainability measurement at the municipal or community level.
3.6 Statistics Canada's Trends in Cities	A new interdepartmental initiative to develop metropolitan, drainage basin-based indicators and a reporting system of socio-economic and environmental conditions.	Sustainability reporting at an eco-zone (drainage basin) scale. Uses existing data sets from federal government sources.	May be constrained to report on.

3.7 Statistics Canada's Human Activity and the Environment Report	Comprehensive national state of the environment report.	Comprehensive in its scope of reporting on key issues related to the environment.	Not a sustainable development report and lacks enough resolution for municipal environmental profiles.
3.8 The Canadian Policy Research Networks Quality of Life Indicators	A values-based, citizen-engagement approach to defining quality-of-life indicators; forthcoming in April 2002.	Uses citizen input from 40 community dialogues to identify key value themes and quality-of-life indicators.	Does not provide detailed survey results for each community consulted. Many citizen-suggested indicators lack quantitative or qualitative data. Environmental indicators are limited to only four or five indicators, with the environment as only one of nine quality-of-life themes.
3.9 National Atlas and Quality of Life Mapping System	A spatial mapping of quality-of-life profiles, including environmental issues, at the Census Division level.	Sustainability and quality-of-life mapping down to the Census Division level of resolution.	Data constraints limit meaningful portraits of quality of life on a larger spatial scale. Environment indicators are thus far limited to pollution issues only.
3.10 The Sustainability Report's (York University) Community Measurement Pressure–state–response Framework	A framework for assessing sustainability by organizing indicators according to a pressure-state model.	Useful framework for visualizing the interrelationships between various environmental indicators in defining sustainability.	No data is provided, simply a framework.
3.11 Pollution Watch Canada's Pollution Scorecard	A web-based instrument that allows users to develop pollution profiles for their communities down to the postal-code scale based on Environment Canada's National Pollution Release Inventory (NPRI).	A meaningful web-based tool for citizens to generate reports of emissions by industry impacting their immediate neighbourhood, given the postal code search engine. A good example of using point source pollution statistics and allowing citizens to spatially assess the pressure on their spatial, "place-relevant" community.	Limited to point source pollution release and transfer information only.
3.12 Pembina Institute's Genuine Progress Indicators (GPI) Sustainable Well-being Accounting System	A sustainability measurement and reporting system that accounts for the physical, qualitative, and monetary conditions of 51 human, social, natural, and produced capital well-being indicators in an integrated accounting framework.	Comprehensive in its scope of economic, social, human health, and environmental parameters that are used to measure sustainability. Uses a traditional accounting framework to derive a total capital balance sheet and a net sustainable income statement.	Has only been applied at the provincial scale.
3.13 Alberta Capital (Edmonton) Region's Indicators of Success	An economic, social, environmental performance measurement and	Provides a practical municipal/regional performance measurement	Applied to the Edmonton Capital region only.

	management system for metropolitan governance.	tool that connects citizen values, with quality-of-life/sustainability indicators and a system of managing the fiscal efficiency and effectiveness of municipal services and infrastructure.	
3.14 Nova Scotia Genuine Progress Index (GPI) and Community GPI Profiles for Glace Bay and Kings County	The 20 GPI accounts for Nova Scotia include several environmental components. The GPI community projects in Glace Bay and Kings County are developing a customized sustainability measurement system at a community level.	Rigorous analytic and methodological development for each of the 20 GPI accounts.	Too early to comment on the pros and cons of developing a community-based GPI accounting system. Community GPI accounts are developed by replicating costly StatsCan survey and inventory protocols.
3.15 University of British Columbia's Sustainable Development Research Institute's QUEST[4]	A user-friendly computer modelling and spatial mapping tool/software for examining future prospects and implications to the sustainability of the Fraser Basin and the larger Georgia Basin watershed.	Allows decision-makers and citizens to visualize "what if" scenarios of economic development and sustainability impacts. This sustainability measurement and future scenario analysis tool examines the interrelationship of prime systems of the biosphere, the economy, and human society.	Has not yet been fully tested and applied.
3.16 Fraser Basin's Sustainability Indicators	The framework to measure the sustainability and quality of life for the Fraser Basin watershed of British Columbia, which includes the City of Vancouver.	Watershed or drainage basin-scale sustainability measurement and reporting. Intuitively attractive and meaningful mix of sustainability indicators. Multi-stakeholder approach to determining the indicator set.	Unique to Fraser Basin and stakeholders only.

We now examine in greater detail the nature of these measurement and monitoring frameworks or tools, and identify their strengths and weaknesses in terms of contributing to a national community sustainability measurement and monitoring system.

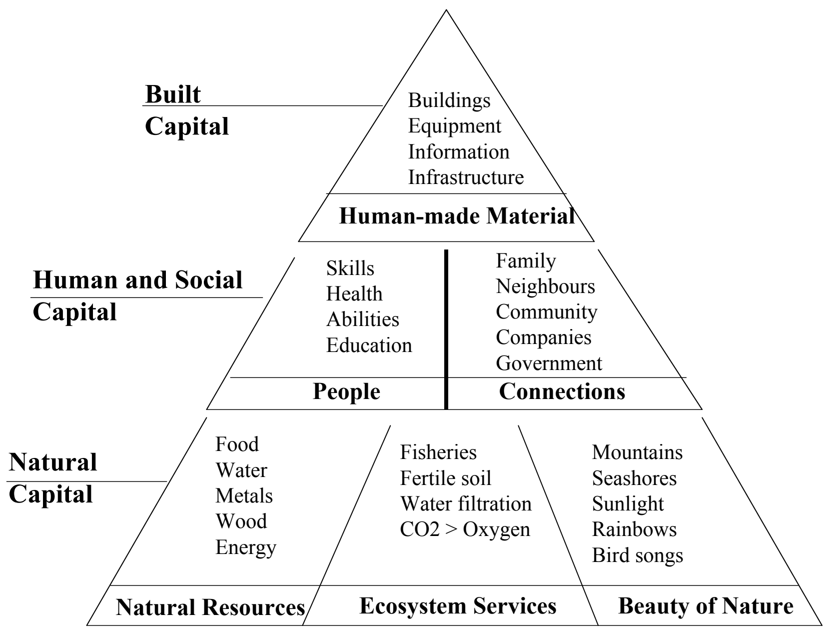
3.1 Hart's Guide to Sustainable Community Indicators

Maureen Hart, a quality of life and sustainability measurement consultant in the United States, recently developed a *Guide to Sustainable Community Indicators* (1999), which provides some practical guidelines, in the manner of a "how-to" handbook, for ways communities can measure

[4] http://www.geog.ubc.ca/research/robinson2.html

their economic, social, and environmental sustainability, explicitly as it relates to quality of life. Hart, through an examination of existing sustainability and performance measurement frameworks in North America, develops a useful framework for organizing economic, social, and environmental indicators for tracking progress towards sustainability. First, she provides a useful "community capital accounting" framework (see Figure 2) that organizes capital according to "capital domains" and subdomains of built (human-made material); human and social (people and connections); and natural capital (natural resources, ecosystem services, and beauty of nature). There are categories within each of the subdomains (e.g., education in the "people" subdomain and within the "human and social capital" domain).

Figure 2: Community Capital Framework



Source: Hart, Maureen (1999). *Guide to Sustainable Community Indicators*

Hart suggests a framework for organizing sustainability indicators according to the themes of economy, society, and environment (see Figure 3).

Figure 3: Hart's Topic Areas for Categorizing Sustainability Indicators

Economy	Society	Environment
General Business (jobs and income)	Education	Ecosystems
Industry (manufacturing, services, renewable and nonrenewable resource extraction)	Government, Participation, Volunteerism, Cooperation	Population
Energy	Health	Land Use
Transportation	Housing	Resource Use
	Public Safety	
	Recreation/Culture	

Then, based on her assessment of sustainability indicators used in North American communities, she develops a potential list of sustainability indicators for each sustainability topic area (see Figure 25, Appendix A1). Hart's list is comprehensive and instructive, as it contrasts "traditional" performance indicators with sustainability indicators.

***Strengths*:** The key strength of Hart's sustainable community indicators *Guide* is that it provides a common-sense guide to development of meaningful community sustainability and quality-of-life indicators using a "capital" framework. The long list of potential sustainability indicators (contrasting with traditional performance indicators) and useful examples of indicators should also serve as a useful tool for Canadian communities to develop their own sustainability indicators. Innovative indicators like the Ecological Footprint and the Index for Sustainable Economic Welfare (or Genuine Progress Indicator) are also important highlights of this comprehensive indicator survey. Hart's *Guide* is also an excellent resource for networking with other communities.

Weaknesses: The long list of potential indicators provides an almost overwhelming list of choices; however, this is also a strength.

3.2 IISD's Dashboard of Sustainability

The International Institute for Sustainable Development (IISD) has developed a *Dashboard of Sustainability,*[5] a set of 46 aggregate sustainability indicators for economy, environment, and society, portrayed visually utilizing the automotive dashboard panel of dials and sustainability warning indicators to provide a picture of the state of a nation's sustainability journey (see Figure 3). Using a holistic accounting approach, the Dashboard is composed of a series of composite indices (Environmental Quality; Social, Health, and Economic Performance Indices), each made up of several indicators. An overall Sustainable Development Index (SDI), a composite of the total suite of indicators, is also derived. The Dashboard provides the end-user with a meaningful image or portrait of the interrelationships of economy, environment, and society. The Dashboard clearly shows areas of unsustainability using warning lights and colour codes. The data that supports the 46 sustainability indicators that make up the Dashboard can be analyzed statistically for their trends and interrelationships (i.e., correlations) to provide a meaningful analytic tool for decision makers.

Figure 4 shows the layout of the Dashboard and provides a mockup example for Canada. Ideally, Dashboards can be compared across nations or communities once an international data set has been developed for comparative analysis.

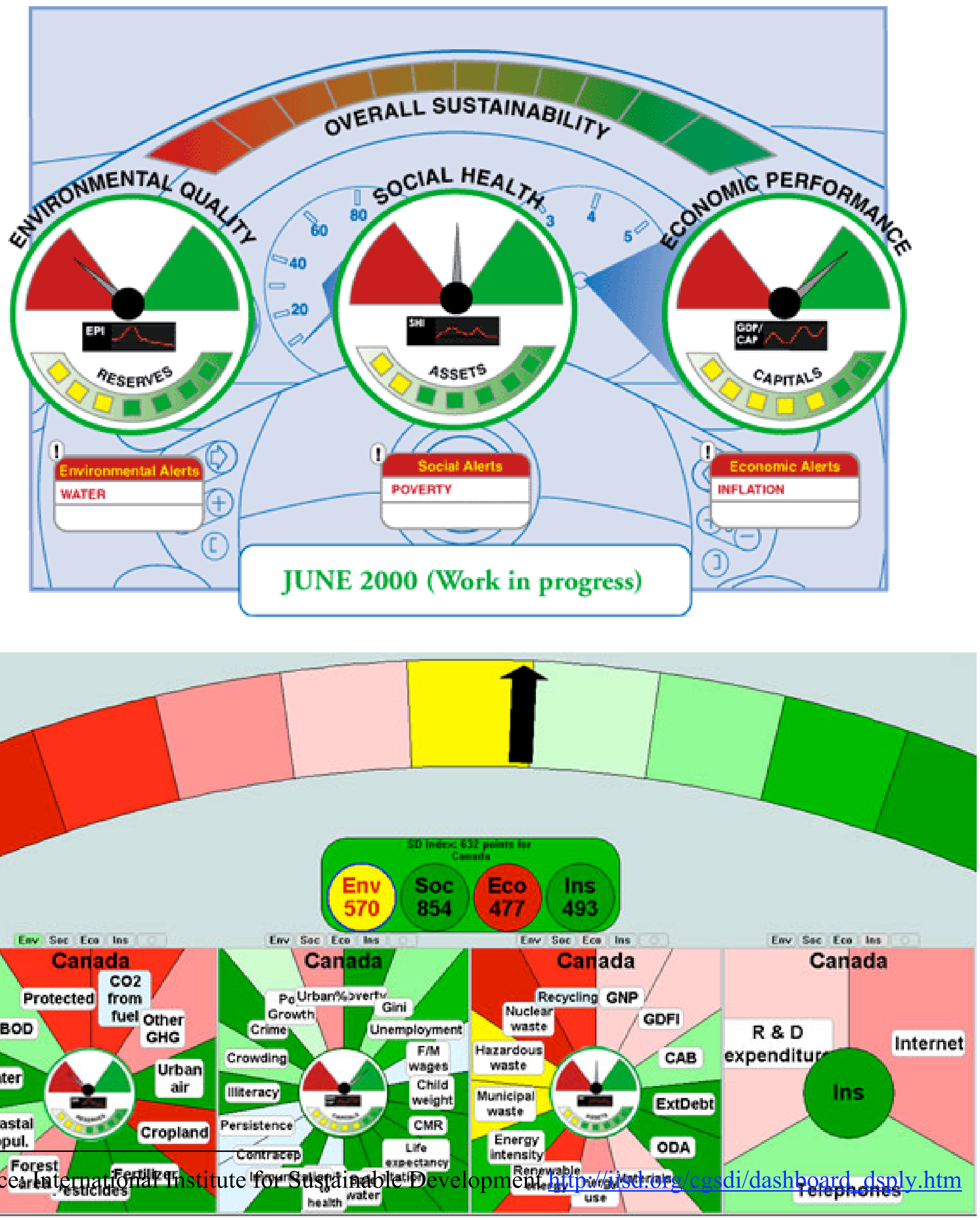
Strengths: The Dashboard is a visually attractive format, showing clearly the state of the primary dimensions of sustainability and providing meaningful quantitative and qualitative information about progress towards (or away from) sustainability for a nation or community. The Dashboard is the ultimate example of the whole systems measurement and reporting required for sustainability accounting and reporting. The Dashboard provides a meaningful tool for presenting

[5] The Dashboard of Sustainability. See http://iisd.org/cgsdi/dashboard.htm

the complexity of sustainability through an effective organization of sustainability indicators and a presentation format for decision makers and citizens.

Weaknesses: The Dashboard is in the early stages of application and construction by IISD researchers (led by Peter Hardi). National Dashboards are being constructed using United Nations and other international agency data sets. It has not yet been tested or applied at the community or municipal level. Like other composite indicator systems, the Dashboard suffers from the challenges of weighting the value placed on individual indicators in the creation of a composite index. The data set required to populate 46 indicators is also a challenge and requires a commitment to database development and ongoing maintenance.

Figure 4: The Dashboard of Sustainability and Canada's Dashboard Prototype[6]



[6] Source: International Institute for Sustainable Development http://iisd.org/cgsdi/dashboard_dsply.htm

3.3 Maclaren's Urban Sustainability Indicator Matrix

Virginia Maclaren's *Developing Indicators of Urban Sustainability: A Focus on the Canadian Experience* (1996) provides one of the most comprehensive and complete treatments of the subject of urban and community sustainability indicators. The study, commissioned by Environment Canada and the Canada Mortgage and Housing Corporation (CMHC), provides important conclusions and a proposed indicators framework that is as relevant in 2002 as it was in 1996.

Maclaren's other important contribution is her inventory of municipal State of the Environment reporting, including a list of indicators used or reported by Canadian municipalities (http://www.geog.utoronto.ca/CommunityReporting/SOEhome.htm). This is an invaluable resource for developing a national sustainability indicator database and moving towards a common sustainability and environmental measurement and reporting system. Her extensive list of economic, social, and environmental indicators appears in Appendix A2 and shows the scope and depth of historical municipal reporting, which bodes well for the development of a common sustainability indicator monitoring and reporting system for Canadian communities. The challenge will be determining the source of data and reconciling disparate measurement methodologies and reporting approaches; this remains the most daunting challenge for implementing a conceptual municipal sustainability measurement framework.

Maclaren's work highlights the most important sustainability indicator and measurement efforts in Canada, some of which are still ongoing. She identifies key methodological, theoretical, and practical questions that remain to be resolved. The following seven questions (Maclaren, 1996: pp. 103-105), which she raises with respect to measuring urban and community sustainability, are still relevant to this inquiry:

1. Is there a common definition of urban sustainability that should be used when developing indicators of urban sustainability?
2. Which indicator framework offers the most promise for developing urban sustainability indicators?
3. Which indicator selection criteria should be used when identifying urban sustainability indicators? Are some selection criteria more important than others? If so, which ones are more important and how should their relative importance be determined?
4. Is it desirable to have a "core" set of urban sustainability indicators that can be used by all municipalities in Canada? If so, how many indicators should be included in this core set and how should they be selected?
5. Who should be involved in identifying and choosing urban sustainability indicators? How does the choice of indicators vary with the target audience and with the proposed application?
6. How can "forward-looking" indicators be constructed?
7. Should attempts be made to develop composite indicators or indices of sustainability?

Maclaren concludes that the key challenge for future research will be developing examples of "good" sustainability indicators while satisfying the needs of a chosen conceptual framework.

Many of these questions are now being dealt with by the Federation of Canadian Municipalities in developing a national set of quality-of-life indicators, which could eventually become a set of sustainability indicators.

Maclaren does offer her own typology (Figure 5) and conceptual sustainability indicators framework (Figure 6) based on her studies. Maclaren's typology (Figure 5) shows five general frameworks that could be used for developing sustainability indicators: *domain-based frameworks* (based on key dimensions of sustainability); *goal-based frameworks* (based on sustainability goals); *sectoral frameworks* (based on the sectoral responsibilities of local governments); an *issues-based framework* (based on popular issues); and *causal frameworks* (the condition/pressure–state–response model used by Environment Canada for state of the environment reporting) (Maclaren, 1996: p. 47). These frameworks can also be combined.

Figure 5: Maclaren's Typology for Sustainability Indicators Development

Domain-Based

- Environment
- Economy
- Society

Goal-Based

- Carrying capacity
- Basic human needs
- Social well-being
- Economic prosperity
- Participation in governance
- …

Sectoral

- Housing
- Welfare
- Recreation
- Transportation
- Environment
- Economic development
- …

Issues-Based

- Urban sprawl
- Solid waste management
- Crime and safety
- Job creation
- Industrial pollution
- …

Causal

Conditions	**Stresses**	**Responses**
– Air quality	– Automobile use	– Public transit policies
– Unemployment	– Inadequate education	– Special training programs
– Human health	– Air quality	– Pollution reduction
– …	– ….	– ….

Maclaren also presents a prototype urban sustainability evaluation framework (Figure 6) showing 16 examples of potential sustainability indicators. The indicators are classified according to domains or combinations of domains, sustainability goals, and sustainability criteria, and according to condition–stress–response indicator type. The sustainability goals (listed below the table) provide a good framework for stratifying indicators. The general selection criteria (listed below the table) provide a useful set of criteria for communities in selecting sustainable development or sustainability indicators. Each indicator is also classified as either a condition (state), stressor (pressure), or response indicator in the CSR (or PSR) framework.

Figure 6: Maclaren's Urban Sustainability Evaluation Matrix

Type of Indicator	Potential Indicator (Examples)	Sustainability Goals	General Selection Criteria	Condition Indicator	Stressor Indicator	Response Indicator
Environment	Exceedances of air quality objectives	1,3,4	F, G, H, I, J, K			
	Primary commuting modes	4,3,5	B, F, H, I, J, K			
	Residential water consumption	1,3,4	F, G, H, I, J, K			
Social	Adult literacy rate	2,8	F, G, H, I, J, K			
	Low birthweight of infants	1,8	F, G, H, I, J, K			
	Crime rate	2,8	F, G, H, I, J, K			
Economic	Employment concentration	6,7	F, G, H, I, J			
	Building permits	6	F, G, H, I, J, K			
	Unemployment rate	2,6,8	F, G, H, I, J, K			
Environmental–Social	Environmental restoration activities	1,3	F, H, J, K			
	Green space	2,5	F, H, J, K			
Environmental–Economic	Defensive expenditures	1,3,6	H			
	Environmental elasticity	1,3,6	H			
Social–Economic	Low-income households	2,8	B, F, G, H, I, J, K			
	Health care expenditures	6,8	F, G, H, I, J, K			
Environmental–Social–Economic	Appropriated carrying capacity (ecological footprint)	1,2,3,4,5	B, F, H, J, K			
Source: Maclaren (1996: 79)						

Table Legend:

Sustainability Goals

1. Inter-generational equity
2. Intra-generational equity
3. Minimal impact on the natural environment
4. Living off the interest of renewable resources

5. Minimal use of non-renewable resources
6. Long-term economic development
7. Diversity
8. Individual well-being

General Selection Criteria

A. Scientifically valid
B. Representative
C. Responsive
D. Relevant to the needs of potential users
E. Based on accurate, available, accessible data that are comparable over time
F. Understandable by potential users
G. Comparable to thresholds or targets
H. Comparable to indicators developed in other jurisdictions
I. Cost-effective to collect and use
J. Unambiguous
K. Attractive to the media

Maclaren proposes a six-step process for developing urban sustainability indicators, which draws from the above typology, sustainability goals, and general selection criteria:

1. Define and conceptualize the nature of urban sustainability indicators and the urban sustainability goals for which indicators are needed.
2. Identify the target audience, the associated purpose for which indicators will be used, and the relative number of indicators needed.
3. Choose an appropriate indicator framework.
4. Define indicator selection criteria.
5. Identify a set of potential indicators and evaluate them against the selection criteria.
6. Choose a final set of indicators and test their effectiveness.

Maclaren notes three important distinguishing characteristics of sustainability indicators from other performance indicators:

1. Since sustainability is a value-laden and context-sensitive concept, broad multi-stakeholder input and a decision-making process are desirable.
2. Sustainability indicators provide the means of integrating two or more economic, environmental, and social aspects of sustainability into a single indicator.
3. Sustainability indicators can deal with distributional issues such as intra-generational equity.

Maclaren's study highlights some of the most important sustainability indicator initiatives, including the City of Seattle's *Sustainable Seattle,* the Vision 2020 sustainability indicators initiative of the Regional Municipality of Hamilton-Wentworth, and the Fraser Basin Councils sustainability indicators initiative.

Strengths: Maclaren's urban sustainability indicators typology and evaluation framework (including sustainability goals, criteria, and examples of indicators by domains) provides a useful tool for the development of Canadian municipal and community sustainability measurement framework. Maclaren's ongoing inventory of state of the environment reporting and indicators, stratified by municipality, provides an important mechanism to identify sources and gaps for key sustainability indicators for the development of a Canadian CSSI system of reporting.

Weaknesses: Maclaren's work could be expanded to include a database associated with her web-based state-of-the-environment (SOE) inventory, identifying actual data and data sources for each of the municipal SOE indicators being reported.

3.4 FCM Quality of Life Reporting System: Environmental Indicators

Until recently there has been a gap in the Federation of Canadian Municipalities (FCM) Quality of Life Reporting System with respect to environmental indicators. An Environmental Indicators Working Group has been established, as part of the FCM Quality of Life Indicators team (representing 18 municipalities),[7] to develop a set of indicators to measure the quality of the environment for inclusion in FCM's Quality of Life Reporting System. This new set of indicators will complement the existing FCM measures for population, community affordability, employment, housing, community stress, health, safety, and community participation.

The Environmental Indicators working group, which consists of municipal or regional government representatives from the City of Calgary, the City of Edmonton, the Halton Region, the Peel Region, and the City of Ottawa and an FCM representative, are in the earliest stages of identifying a short list (8–10 indicators) from a longer, 34-indicator prospective list (see list below).

In 1996, the Federation of Canadian Municipalities (FCM) launched a project to monitor the quality of life in Canadian communities. The FCM, in partnership with participating municipalities, developed the Quality of Life Reporting System (QLRS) as a tool to accomplish the following:

- identify and promote awareness of issues affecting quality of life in Canadian communities;
- better target policies and resources aimed at improving quality of life;
- support collaborative efforts to improve quality of life; and
- establish municipal governments as a strong and legitimate partner in public policy debates in Canada.

In terms of placing the environmental indicators within the context of sustainable development, the FCM Environmental Indicators Working Group is working from the following definition:

> A sustainable community preserves or improves quality of life while minimizing its impact on the environment. And it achieves these goals using fiscally and environmentally responsible policies.[8]

The Working Group will develop indicators that are based on the following principles.

---

[7] City of Vancouver, City of Burnaby, City of Calgary, City of Edmonton, City of Regina , City of Saskatoon, City of Winnipeg, City of Windsor, City of London, Regional Municipality of Waterloo, City of Greater Sudbury, City of Toronto, City of Hamilton, Regional Municipality of Halton, Regional Municipality of Peel, Regional Municipality of York, City of Ottawa, Halifax Regional Municipality.
[8] FCM Quality of Life Reporting System, Environmental Indicators Working Group, Terms of Reference and Mandate, Draft January 28, 2002.

- Quality of Life (QOL) Reporting must include environmental considerations along with social and economic ones.
- New indicators will be in line with existing QOL indicators.
- Indicators will be designed to incite action.
- Indicators will be linked to "inputs" and "outcomes" (emissions vs. environmental health).
- A clean and healthy environment is important to the functioning and competitiveness of a city and to the quality of life of its citizens.
- A sustainable community is a smart community. It achieves economic, environmental, and social health by:
    - making the most efficient use of resources;
    - generating the least amount of waste;
    - providing high-quality service to its residents; and
    - living within the carrying capacity of its natural resources — land, water, and air.

The FCM Working Group is using the following indicator selection criteria:

Primary criteria

- Be responsive to intervention.
- Be nationally, regionally, and locally relevant.
- Be understandable to general public and encourage action, education, and awareness.
- Show meaningful differences among communities.
- May be supported by available data.
- Not be limited to areas for which municipal government is responsible.
- Be derived from collection methodology that is scientifically defensible.

Secondary criteria

- Take into account "hot issues."
- Be a mix of quantitative and/or qualitative measures.
- Allow for tracking of short- and long-term trends.
- Have regard for interrelationships with other QOL measures.
- Support principles established by the Technical Team.

Based on conversations with the FCM Environmental Indicators Working Group, a short list of indicators will be selected from a longer, 34-indicator shopping list (see below).

In drawing up this list of potential environmental indicators, Santiago Olmos drew from existing municipal state-of-the-environment reports (see Table 5, Appendix A5). Olmos found in examining municipal SOE reports that they are not produced annually (in some municipalities this is done every three years). The focus of each SOE report varies over time. The data sources often vary and can come from multiple sources, ranging from municipal departments (e.g., public works) to provincial and federal departments (e.g., environment). He also found that the frequency in data collection varies depending not only on the variable(s) under consideration, but also on the agencies involved in data collection. Only a few municipalities report on an annual basis. Finally, some municipalities that do not presently produce state of the environment reports report progress on some quality-of-life or other indicators on a more frequent basis.

There are overlaps in the indicators listed below (i.e., some measure essentially the same thing), and also in the categories that have been used to group the indicators. In some cases an attempt was made to collapse or synthesize indicators that were similar (but worded differently), but that was not always possible or even desirable. Some indicators measure corporate issues, while others measure city-wide or community issues. Not all the indicators listed below are necessarily being monitored, as in some cases the documents reviewed contained only a suggestion to adopt certain indicators. Interviews with municipal officials and planners have revealed that some municipalities are currently expanding or revising the set of indicators that will be reported on in their next state of the environment reports, while other municipalities are in the process of developing and selecting the indicators that will be monitored.

The FCM Environmental Indicators working group has identified the following long list of proposed environmental categories and indicators (the original, even longer list of indicators identified by researcher Santiago Olmos is found in Appendix A5, Table 5).

Energy

1. Community energy consumption by sector: residential, commercial, industrial, transportation, waste, municipal operations, other (GJ)
2. Per capita energy consumption; per capita energy consumption residential
3. Community energy consumption by fuel type: electricity, gasoline, natural gas, propane, biomass, renewables, other
4. Percentage of energy supplied by local sources

Atmosphere

5. Particulate matter emissions (2.5 and 10 microns)
6. Nitrogen oxide, volatile organic compounds, carbon monoxide emissions
7. Number of air quality advisories
8. Greenhouse gas emissions: carbon dioxide (CO_2), methane, and nitrous oxide emissions by sector and per capita

Water

9. Per capita/household consumption of water (for all uses)
10. Surface water quality:
    - fecal and total coliform count
    - dissolved oxygen
    - total dissolved solids
    - metals
    - organic carbon
11. Stormwater quality:
    - total suspended solids
    - chemical oxygen demand
    - total phosphorous
    - total metals
12. Drinking water quality:
    - total number of boil-water orders
    - coliform occurrence ratio
    - annual average turbidity
    - annual average trihalomethane concentrations
13. Total number of groundwater wells: domestic, industrial, other
14. Percentage of residences and industrial customers metred
15. Number of beach closings (in hours or days)
16. Area covered by watershed management plan

Transportation

17. Modal share
18. Travel distances and time by modal share
19. Number of streets with bike lanes (expressed in kilometres)
20. Vehicle occupancy

Housing and Urban Form

21. Redevelopment to total development ratio
22. Residential and non-residential densities
23. Percentage of population both working and living in region
24. Annual consumption of land area for urban development

Natural Areas, Green Space, Land Resources, and Rural Economy

25. Total (or per capita) area of park space
26. Area, extent, and connectedness of greenlands
27. Amount of contaminated polluted soils (in hectares)
28. Amount of land cleared for development (in hectares per year)
29. Amount of pesticide used or reduced
30. Number of trees planted per year or inventory
31. Number, area, and quality of wetlands

Waste

32. Per capita amount of waste generated (residential)
33. Total and per capita amount of waste landfilled
34. Total and per capita material recycled

Strengths: Overall, we believe the FCM environmental indicator initiative is one of the most important potential frameworks for monitoring and reporting on environmental quality and sustainability in Canadian communities. This initiative should receive the full support of federal and provincial government agencies in provided methodological and data support, to populate the indicators with raw data that meet the criteria and rigour of performance measurement systems. This would include support by Statistics Canada; Environment Canada; the NRTEE; provincial environment, natural resource, and sustainable development ministries and agencies; and other federal and provincial agencies. There is clearly an opportunity to work collaboratively across at least three levels of government (federal, provincial, municipal) in developing the FCM environmental quality and sustainability indicators data set with respective structural and political economies of scale. The FCM QOL indicators initiative has the broad support of at least 18 major municipalities or urban/metropolitan regions. Their work is at the formative stage of indicator selection and will enter the next phase of determining data sources that would provide data for all 18 municipal partners. FCM's QOL indicators are entering their third iteration of reporting, and the inclusion of environmental indicators to the already impressive suite of measures of quality of life will strengthen the capacity of the FCM to provide a national, community-based profile of quality of life and sustainability. We would recommend that Environment Canada, Statistics Canada, Natural Resources Canada, and other federal and provincial agencies work in collaboration with the FCM indicators team.

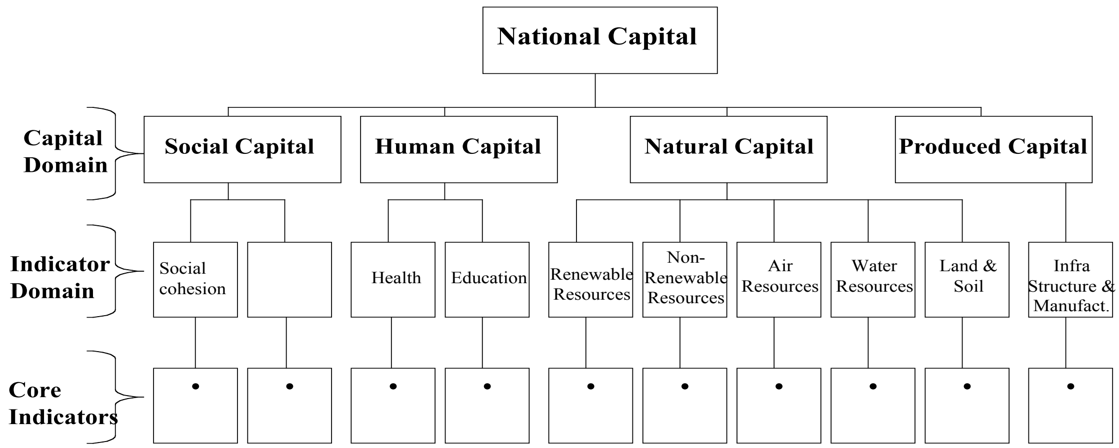
Weaknesses: One of the shortcomings of the FCM quality-of-life indicator system is that it is limited to only a few key indicators for each of the quality-of-life domains or categories being measured. The environmental indicators will likely be short-listed to 8 to 10 indicators out of a longer list of 34 potential measures. Clearly, this would be inadequate for providing a full accounting of environmental quality and sustainability as has been defined even in traditional SOE reporting at the municipal scale (e.g., City of Calgary, City of Vancouver, and City of Regina's SOE reports). That said, the FCM environmental indicators framework might be considered as a macro- or meta-analytic and reporting system, which would be supported by meso- or more micro-indicators within an accounting and reporting structure that would be stratified by domains/categories, subdomains (issues), and indicators. Indicators could be further identified as either pressure (input), state (output), or response (outcome) indicators, consistent with the Sustainability Report's proposed pressure–state–response community sustainability measurement framework. We elaborate on this structure later in our report.

3.5 National Round Table on the Environment and the Economy, Environment and Sustainable Development Indicator Initiative

The National Round Table on the Environment and the Economy is in the final year of a three-year process to develop a national set of environment and sustainable development indicators to enable the informed public and opinion leaders to gain a more complete understanding of national economic and environmental performance (Stratos, 2002). While the indicators being developed are national in scope and do not necessarily provide guidance for community/municipal sustainability measurement, the measurement framework (i.e., a capital accounting framework) and the process of selecting indicators (including examination of important data sources) provide important guidance for a conceptual community sustainability measurement framework.

What is particularly attractive about the NRTEE indicator framework is the structure of the "capital" accounting framework, which considers the four key capital domains: human, social, natural, and produced capital (see Figure 7).

Figure 7: NRTEE Proposed National Capital Indicator Framework



In the “capital” framework, four types of capital are considered:

- *Social Capital:* “The relationships, networks and norms that facilitate collective action,”[9] including both formal and informal institutional arrangements (e.g., social cohesion);

- *Human Capital*: “The knowledge, skills, competencies and other attributes embodied in individuals that facilitate the creation of personal, social and economic well-being”;[10]

- *Natural Capital*: The stock of assets produced by the environment, comprising natural resource stocks (renewable and non-renewable), land, and ecosystems, including the biological diversity they contain and the services they provide; and

- *Produced Capital*: Produced or manufactured goods that provide benefits to their owners over time by helping produce other goods and services. This includes equipment, buildings, machinery, and other infrastructure, as well as manufactured goods used in the production of goods and services.

Within each of these broad capital account “domains,” a subset of subdomains, subaccounts, or “indicator domains” can be identified (see Figure 3). Within these subaccounts, quantitative, qualitative, and monetary data can be organized to provide an accounting of the stocks, flows, and monetary values of different forms of capital. From this data set, a series of core and

---

[9] *The Well-Being of Nations: The Role of Human and Social Capital*. OECD, 2001.
[10] *The Well-Being of Nations: The Role of Human and Social Capital*. OECD, 2001.

supplemental indicators of capital "health" or conditions of the well-being of the nation's capital can be derived.

The NRTEE framework has stratified different types of indicators within their framework as follows:

Capital Stock Indicators: A "state" type of capital indicator, in the pressure–state–response framework.

- *Quantity of capital stocks*: Physical or monetary units (e.g., oil and gas reserves or market value of these reserves).
- *Quality of capital stocks*: The qualitative dimension of a stock (e.g., agricultural soil quality).

Outcomes of Functioning Capital: The service outcomes provided by the capital, a "state" type of indicator.

- *Ecosystem Services*: The observable quality of outcomes of ecosystem services (e.g., water or air quality).
- *Ecosystem Health*: The general state of health of an ecosystem (e.g., ecosystem functionality, integrity, and biodiversity).

Demand for Capital Stocks: These are "pressure" indicators that reflect human activity pressures (e.g., loading, emissions, linear disturbance) on ecosystems and thus human demands for ecosystem services (e.g., waste assimilation).

Through a process of expert "cluster group" discussions, a potential list of indicators was identified (see Figure 8). These indicators were stratified according to domain and stock (quantity, quality), outcomes, and demand indicators.

Figure 8: National Round Table on the Environment and the Economy: Preliminary Environment and Sustainable Development Indicators List

Capital Stock Domain	Indicator	Capital Type of Indicator	Source
Ecosystem health and services	Index of vulnerable, threatened, and endangered species	Ecosystem health	
	Areas protected from industrial activity	Ecosystem health	
	Total area of natural ecosystems without roads	Ecosystem health	
	SO_x and NO_x emissions	Pollutant loading	
	Total greenhouse gas emissions	Pollutant loading	
Water	Measure of water scarcity	**Quantity** of capital stocks	Statistics Canada's Canadian Water Account
	Mercury in fish tissue (measure of water quality and freshwater fish health)	***Quality*** of capital stocks	
	Surface water quality (indicator of provision of clean water for humans and ecosystems)	Outcome of ecosystem services	
	Incidence of water-borne diseases (indicator of clean water for human health)	Outcome of ecosystem services	
	Municipal population served by wastewater treatment (indicator of clean water for human health)	Outcome of ecosystem services	
Air	Air pollutant population exposure (indicator of provision of clean air)	Outcome of ecosystem services	
	Level of acid deposits on ecosystems (indicator of provision of clean air)	Outcome of ecosystem services	
Climate	Average national temperature (indicator of climate stability)	Outcome of ecosystem services	Environment Canada
Agricultural land	Change in stock of agricultural land; crop production on marginal land	**Quantity** of capital stocks	Agriculture Canada and Canada Land Inventory
	Amount of agricultural land converted to urban land	**Quantity** of capital stocks	Canada Land Inventory
	Soil residue cover (avg. number of bare-soil days)	***Quality*** of capital stocks	
	Soil organic carbon	***Quality*** of capital stocks	
	Nutrient balance for nitrogen	***Quality*** of capital stocks	
Fisheries	Percentage of fisheries that are sustainably exploited	**Quantity** of capital stocks	
Forests	Total forest area	**Quantity** of capital stocks	Natural Resources Canada, Canadian Forest Service national forest inventory
	Percentage of wood supply from certified forests	***Quality*** of capital stocks	

Capital Stock Domain	Indicator	Capital Type of Indicator	Source
	(commercial forests)		
	Level of carbon storage in Canada's forests	Outcome of ecosystem services	Canadian Forest Service
Fossil fuels, minerals, and metal resources	Dollar value of non-renewable resources	**Quantity** of capital stocks	
	Combined stocks of all fossil fuels	**Quantity** of capital stocks	
Human capital (education)	Literacy and numeracy	***Quality*** of capital stocks	
	Child education potential	***Quality*** of capital stocks	
Human capital (health)	Health adjusted life expectancy (HALE)	***Quality*** of capital stocks	
Source: National Round Table on the Environment and the Economy, 2002. Environmental and Sustainable Development Indicators Initiative: Steering Committee Synthesis Report. Prepared by Stratos Inc. April 26, 2002.			

From this list, a much shorter list of six to eight indicators will be selected.

While many of these indicators are national in scope and do not necessarily have direct relevance to community or municipal sustainability issues, there are some indicator developments by the NRTEE that could benefit community sustainability indicator development. The potential NRTEE sustainability indicators of particular relevance to communities include:

- *Air Quality Indicators*
    - SO_x/NO_x emissions
    - GHG emissions
    - Human health indicator (related to air quality)
- *Water Indicators*
    - Water scarcity index
    - Daily water use
    - Surface water quality index
    - Incidences of water-borne diseases
    - Mercury in fish tissue
    - Municipal population served by wastewater treatment
- *Land and Soils Indicators*
    - Loss of agricultural land stocks to urban land

While not all of these indicators will be selected in the short list being developed by the NRTEE, this fuller potential list of community-relevant indicators should be considered in the development of a community sustainability measurement system.

Much of the data to populate the NRTEE indicators will likely come from Statistics Canada, Environment Canada, and Natural Resources Canada, in cooperation with provincial agencies of the environment or natural resources. A key Environment Canada–led initiative that could address both the NRTEE and community sustainability indicator data needs is the Canadian Information System on the Environment (CISE). CISE is working towards improving the quantity, quality, and accessibility of information needed for environmental indicators. This should lead to a common methodological approach to information collection and should yield a national environmental data and information system that covers all jurisdictions.

Strengths: The key strength of the NRTEE ESDI initiative is the national capital framework for measuring or accounting for the sustainability of human, social, natural, and produced capital. The framework has both conceptual and practical strengths that could be applied at various scales: national, regional, and local or community. The capital accounts can be continually improved through ongoing collection of data on stocks, flows, and monetary values. The accounts, in principle, would include information for the development of indicators on the quantity and quality of capital stocks, the dimensions of flows, and some monetized values of capital where monetary data is available.

Weaknesses: The ESDI is national in scope and is not intended to report at the local or regional scale, although some of the data that will be used to develop the indicators (e.g., surface water quality index) will likely draw from regional data sets (e.g., regional surface water basins) that could be used for developing community profiles of natural capital sustainability. Secondly, the ESDI focuses primarily on natural capital with only cursory treatment of human and social capital and no treatment of produced capital (i.e., infrastructure and manufactured capital), which is of particular relevance at the community scale. Third, the ESDI will be limited to no more than eight to ten core indicators, of which only a few (e.g., surface water quality and key air pollutant emissions) would be of importance to communities.

3.6 Statistics Canada's Trends in Cities Project

Statistics Canada is in the early developmental stage of a **pilot** project on cities: Trends in Canada's Cities*.* This Cities project would see the development of economic, environmental, and social profiles for Canada's 27 CMAs (Census Metropolitan Areas) with reporting at a drainage-basin spatial scale, using a variety of environmental and sustainability indicators and information (see Table 2). The focus of the Cities project is identifying **all** statistical information (environmental and non-environmental) that can be reported for cities. This project should provide greater clarity on the information and data gaps in Canada's community-scale environmental information system.

The project process will involve several federal departments, leading researchers, and representatives active in the measurement of municipal and community quality of life and sustainability. StatsCan is currently examining a potential client and funder of the project from within the federal system. The expected outcome of the project is the development of an information system that profiles demographic, socio-economic, and environmental conditions at the scale of municipalities or cities across Canada.

The process of developing indicators will take account of work to date in this area, including FCM's Quality of Life Reporting System and the Vital Signs project of the Toronto Community Foundation. The data, analysis, and commentary in the report will be presented under a number of broad themes, and graphs, charts, and maps (to illustrate the spatial aspects of major trends) will be used extensively. Some of the themes that could be included are demographic trends, economic trends, social trends, and environmental trends, focusing on Canada's 27 CMAs.

In our opinion, potential clients might include the Federation of Canadian Municipalities (in the future) as the FCM attempts to populate its own set of environmental quality of life indicators with data. StatsCan is a logical source for data, though one of the challenges will be to make StatsCan "basin"-level measurement relevant and meaningful to the geopolitical boundaries of cities and municipalities. Nevertheless, it will be important for municipalities to consider their geopolitical and socio-economic footprint in the context of the broader ecosystem in terms of water drainage basins or watersheds that they occupy.

At the municipal level of aggregation, data on a number of variables are not as readily available as those at the provincial or national levels of aggregation. This is mostly due to the confidentiality provisions of the *Statistics Act,* which prohibit the release of data that would identify a respondent.

The thrust of StatsCan's environment reporting, with respect to cities and municipalities, is to provide a measurement and reporting system at the eco-zone or drainage basin (watershed) level, using GIS tools. The basin-level measurement allows StatsCan to deal with current data constraints that limit reporting at the lower levels of aggregation due to confidentiality issues. Using drainage basins for analysis is appropriate for measuring environmental sustainability with respect to human-scale socio-economic communities. StatsCan uses census data (from the Census of Population and Census of Agriculture) at the enumeration area (EA) level to report data by environmental geographies.

Table 2 contains a preliminary list of environmental and sustainability domains and indicators that have been identified by StatsCan as potential candidates.[11]

[11] Based on personal communication with Alice Born and John Marshall of Statistics Canada on March 19, 2002.

Table 2: StatsCan Trends in Cities Project Indicator Framework

Domain	Indicators	Potential Data Sources
Air quality	Ambient air quality (Human Activity and Environment report)	Environment Canada
Water quality	Sewage treatment levels (primary, waste, secondary, and tertiary treatments)	Environment Canada: Municipal Use Database (MUD)
	Boil days advisories	
Water use	Domestic water use (litres per capita, per day)	Environment Canada: Municipal Use DB Industrial Water Use
	Total water use (litres per capita, per day)	
Environmental impacts outside of municipalities/cities	Estimated livestock manure by basin and sub-sub-basin (based on livestock data from Census of Agriculture data with a coefficient applied)	Manure report on StatsCan Web site
	Nitrogen, Phosphorous, Coliform, and Fecal Coliform	
	Pesticide sales per ha	
	Fertilizer application rates (tonnes/ha)	Agriculture Census
	Area treated by pesticides and fertilizers	
Urban land and urban land use	Urban land use and consumption of agricultural land by water drainage basin (km^2)	
	Population of urban centres	Statistics Canada Census
Consumption of agricultural land	Consistent with the NRTEE ESDI framework and indicator for conversion of prime agriculture land to urban development, 1971 to 1996	Cities/municipalities actually have more accurate information than StatsCan (identified as a current data gap for StatsCan)
Population density by sub-sub-basin — human activity measure	Population by environmental geography, CMA, etc.	Derive population densities from these data (census)
Transportation	Travel by mode to work by municipality: selected years 1971, 1981,1996, 2001	StatsCan Census
Waste management	Disposal (volume to landfill and incineration)	StatsCan collects data on all significant municipal landfill sites and incinerators across the country from municipalities and private waste management firms. Have challenges with publishing at the municipal level given confidentiality of data, but are now working to aggregate data to a sub-basin level to avoid confidentiality problems.
	Recycling by material type	
	Waste generation by residential and non-residential sources	
	Municipal expenditures on water and sewage treatment	StatsCan Econnections
Household sustainable consumption habits	Drinking water quality and water conservation	StatsCan Household Environment survey; results reported in Human Activity and Environment reports
	Waste management and recycling practices	StatsCan household surveys under development?

Domain	Indicators	Potential Data Sources
	Pesticide and fertilizer use	StatsCan household surveys under development?
	Purchase of “green” products	StatsCan household surveys under development?
	Individual/household participation in environmentally related activities	StatsCan household surveys under development?
	Commuting patterns and relationship to climate change	StatsCan household surveys under development?

In addition to this information, our conversation with StatsCan revealed that the agency also gathers information on community health through the compilation of community health surveys at the public health region level. These may be useful for creating CMA-based profiles of public health, particularly self-rated health. The self-rated health questions relate only indirectly to environmentally related health issues, covering such subjects as: (a) chronic health conditions; (b) participation in the health system; (c) social supports; and (d) questions on stress and smoking. There are no direct questions on how the environment affects health and quality of life.

Discussions with StatsCan reveal that the types of data that may be pursued as part of the Cities initiative may or may not include various environmental data, but would include a number of non-environmental variables (e.g., economic, demographic) in a quality reporting system at the drainage basin, sub-basin, and sub-sub-basin levels. Creating profiles of environmental quality of life at the spatial scale of drainage basins makes good sense, in our opinion, and would complement other municipal- or community-based indicators of quality of life and sustainability. StatsCan has not yet determined what kind of reporting format will be used to disseminate the information.

The Cities project would be draw from several existing databases, including the Census and other StatCan data sources. The project would entail identifying databases and data gaps, including identification of municipal-based information and data sets.

Strengths: The key strength of the StatsCan Cities project is that the accounting framework will attempt to take an ecosystem approach to measurement at a drainage basin or water basin spatial scale. This kind of watershed or drainage basin spatial accounting for sustainability is a refreshing and important step in monitoring and assessing the sustainability of a community (i.e., human populace) in the context of the ecosystem that provides the community with stocks of natural capital and ecosystem services. The StatsCan initiative has the potential of being complementary to the FCM quality-of-life indicators.

Weaknesses: First, the StatsCan Cities is in its early development phase and has not received full funding. Second, it is not clear how robust the underlying data set is to populate and report indicators at the drainage basin scale. Third, developing yet another series of municipal environmental and quality-of-life indicators, albeit at a water basin–relevant scale, may lead to some confusion in the mind of the public vis-à-vis the FCM Quality of Life Indicator reporting initiative.

3.7 Statistics Canada's Human Activity and the Environment Report

Statistics Canada's *Human Activity and the Environment 2000* report has become an important source of information on the connection or impact of human activity on the environment. The report uses a conceptual framework that shows the relationship between (1) Driving Forces (conditions and trends that are shaping the relationship between human activity and the environment (e.g., socio-economic conditions)); (2) Natural Resources (the consumption of natural capital stocks and their uses); (3) Ecosystem and Well-Being (the status of wildlife, air quality, and other ecosystem health conditions); and (4) Responses and Participation (activities, practices, and policies that are minimizing or reducing human impacts on the environment). Much of the information in the 2000 report is reported at the drainage basin and eco-zone scale. Most other reporting is at the provincial/territorial scale or at the national scale. Very little information is reported at the municipal or community scale, with the exception of Environment Canada's Air Quality Index for selected cities. The ecosystem spatial portraits of the human pressures (e.g., population growth), resource consumption, and condition of ecosystems are very useful and unique; however, more effort could be made to produce these portraits with municipalities and communities clearly mapped within eco-zones or drainage basins.

3.8 The Canadian Policy Research Networks Quality of Life Indicators

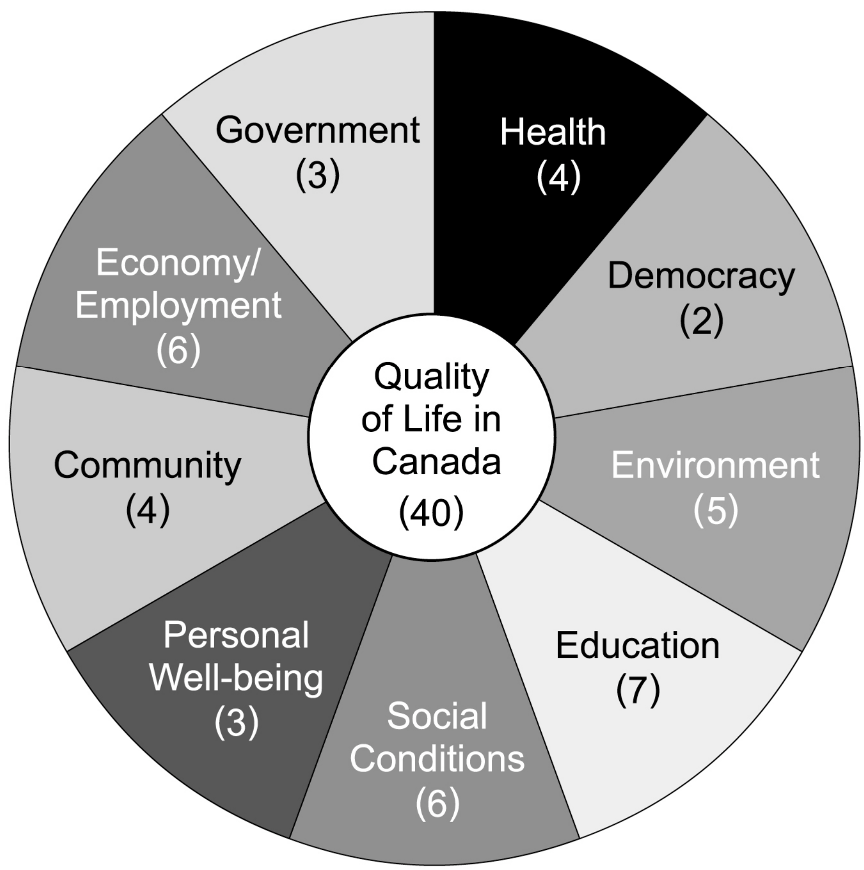
The Canadian Policy Research Networks (CPRN) has been developing a set of quality-of-life indicators based on a series of cross-country dialogues with Canadian citizens in roughly 40 communities. Through a facilitated process, citizens identified key quality of life themes or domains and a list of indicators that would be meaningful to them as measures of the conditions of those themes (see Figure 9).

Figure 9: CPRN's Quality of Life Indicators Framework

Quality of Life Indicators Project (QOLIP)

Prototype Set of National Indicators

CPRN's prototype of national quality of life indicators includes 40 indicators, organized under nine themes. The number of indicators associated with each theme is indicated in brackets.



Adapted from: Calvert-Henderson, *Quality of Life Indicators: A New Tool for Assessing National Trends*, Hazel Henderson, Jon Lickerman and Patricia Flynn (editors), 2000.

The quality-of-life themes are interconnected and overlapping. These elements together form a comprehensive picture of what Canadians consider important to their quality of life. The following is a list of indicators, by quality-of-life theme, that were suggested by citizens through the dialogue process:

I. Democracy (Political/Democratic Participation and Rights) (2 indicators)
1. Exercising democratic rights
2. Tolerance of diversity

II. Health (4 indicators)
3. Quality of health care system
4. Status of physical health
5. Status of mental health
6. Lifestyle

III. Education and learning (7 indicators)
7. Access to a universal primary and secondary education system
8. Access to post-secondary education
9. Participation rates and enrolment
10. Access to lifelong learning
11. Adult literacy rates
12. Child/youth literacy rates
13. Quality of education

IV. Environment (5 indicators)
14. Water (drinking) quality
15. Air quality
16. Waste management
17. Resources devoted to developing renewable energy sources
18. Access to clean, healthy public outdoor spaces

V. Social programs and conditions (6 indicators)
19. Availability and affordability of child care
20. Adequacy of income supports in meeting basic needs
21. Poverty and child poverty rates
22. Living wages
23. Food bank usage
24. Housing affordability

VI. Personal well-being (3 indicators)
25. Personal time stress or control over time
26. Degree of social interaction, intimate connections, and social isolation
27. Sense of personal security

VII. Community (4 indicators)
28. Satisfaction with police, courts, and probation
29. Sense of personal safety and changes in crime rate
30. Level of civic involvement
31. Availability of programs and services

VIII. Economy and employment (6 indicators)
32. Unemployment and labour-force participation rates
33. Percentage of involuntary part-time workers
34. Job security, satisfaction, and working conditions
35. Bankruptcies (personal and business)
36. Income and wealth distribution
37. Consumer debt levels

IX. Government (3 indicators)
38. Level of public trust
39. Accountability and stewardship of public values and funds
40. Public governance

The CPRN approach is unique in that the indicators were developed based on citizen input rather than on the more traditional top-down, expert process. As a result, the indicator domains and the indicators themselves reflect the opinions and intuitive sense by citizens of the issues that are important to them individually in their community.

The **environment theme** ranked fourth as the most important quality-of-life theme (see full list following Figure 8). Citizens identified the following environmental quality indicators as most meaningful: (1) water (drinking) quality; (2) air quality; (3) waste management; (4) resources devoted to developing renewable energy sources; and (5) access to clean, healthy public outdoor spaces. What is unique about the CPRN indicators is that they combine quantitative and qualitative data, in many cases.

CPRN is in the final process of completing and releasing their report *Quality of Life in Canada: A Citizen's Report Card*, which will include quantitative and qualitative indicators of their 40 quality-of-life indicators.

With respect to the environmental indicators, only availability of and access to green space will not be reported on, given the lack of data. For **air quality**, CPRN is combining quantitative and qualitative data — quantitative data from the Index of Quality of Air (IQA) for all of Canada from Environment Canada (reporting fair and poor air quality days), and qualitative data from a recent COMPAS poll (May 2001) asking Canadians about their concerns regarding the air they breathe. The CPRN **water quality** indicator also combines quantitative and qualitative data — quantitative data includes the percentage of Canada's population that is served by municipal wastewater treatment facilities (1993–1998), sourced from Treasury Board of Canada (*Canada's Performance 2001*), and qualitative data from the May 2001 COMPAS poll asking Canadians about their concerns regarding the safety of their drinking water. The **waste management** indicator uses data on the percentage of materials reused, recycled, and discarded in Canada (1988–1996) from Statistics Canada sources, and waste disposed in tonnes per capita (by province, 1994, 1996, and 1998).[12] The **renewable energy sources** indicator uses National Energy Board data on total energy consumption in Canada, which shows the percentage of total domestic demand for primary energy met by renewable fuels (excluding nuclear). As noted, there are to date no data sources for the **availability of green space** indicator.

[12] Statistics Canada, 1999. Waste Management Industry Survey, Business and Government Sectors, 1998. Ottawa: Statistics Canada (Catalogue No. 16F0023XIE); Statistics Canada (Environment Accounts and Statistics Division). 2001. *Human Activity and the Environment 2000*. Ottawa: Statistics Canada (Catalogue No. 11-509-XPE).

Strengths: A key strength is that the indicators that are chosen are likely to resonate with citizens in their communities, given that they reflect, in part, input from citizens themselves. The citizen input in defining key quality-of-life themes and the suggested suite of indicators can be used by decision makers and elected officials to report back to citizens on the conditions of community well-being, knowing their indicators are relevant to local issues.

Weaknesses: The key weakness of this approach is that a citizen-based indicator development process may introduce another kind of indicator selection bias. For example, citizens may be unaware of significant or important threats to well-being that experts may be studying or monitoring. Second, many of the indicators that citizens selected lack supporting data. Third, the CPRN suite of indicators will be national in scope and not customized to individual community values or issues.

3.9 National Atlas and Quality–of-life Mapping System

The National Atlas and Quality of Life Mapping System is a project headed by Peter Morton of Natural Resources Canada. The objective of the National Atlas project is to map quality of life in Canada at a national level, using a QOL geographical model, which is a hybrid of other social science models, as developed and mapped in the Atlas of Saskatchewan.

Strengths: As with the StatsCan Cities project, the National Atlas has tremendous potential to present quality-of-life and sustainability information at a spatially relevant scale. Such a reporting system provides citizens and decision makers with a visual "map" of strengths and weaknesses in quality of life across the country at the census division scale. Such visual mapping of data is highly desirable if combined with transparent linear data accounts.

Weaknesses: The key weakness we observed in discussions with Peter Morton is that limiting the scope of the mapping to a census division scale would artificially constrain the indicators and reporting, given the absence of environmental data at that scale of statistical data gathering. While modelling impacts (e.g., pollution) can be done where detailed data is unavailable at this scale, this is simply a sign of the constraints of attempting to report at such a fine resolution.

3.10 Community Sustainability Pressure–state–response Analytic Framework

Another important model for consideration is the pressure–state–response framework for assessing community sustainability at the national level that has been developed by The Sustainability Report Program (http://www.sustreport.org/home.html), affiliated with the York Centre for Applied Sustainability (YCAS) at York University.[13] The Sustainability Reporting system works from a definition of sustainability that "sees human activities as part of — and dependent upon — the natural world."

The pressure–state–response framework (see Figure 10) is intended to show the connections between human activities and environmental conditions at the community level. The framework,

[13] The Sustainability Report Program is Canada's first independent initiative "to find out how Canadians are doing at living in balance for the long term." The pressure–state–response model emerged out of the United Nations and OECD work in developing sustainability indicator systems and cannot be attributed solely to York University.

which includes suggested indicators, does provide architecture potentially suitable for community sustainability accounting and reporting, in combination with the FCM QOL environmental indicator initiative and other indicator projects. The authors note that the framework is a "work in progress and will continue to expand as new information becomes available."

Figure 10: Sustainability Report Community Sustainability Framework

ENVIRONMENTAL SUSTAINABILITY			SOCIO-ECONOMIC SUSTAINABILITY		
Sust.Signal (Pressure/ Driving Force)	**State**	**Response**	**Sust. Signal (Pressure/ Driving Force)**	**State**	**Response**
Population	Urbanizing Population	Conversion of rural land to urban use	**Employment**	Unemployment Rate	Employment programs
Energy Consumption	Air Quality	Structure of energy supply	**Poverty**	Social Assistance	Social assistance and housing subsidies and programs
	Greenhouse Emissions			Homelessness	
Human Health	Air Quality	Pollution Abatement and Control Expenditures	**Governance**	Access to information	Internet connections Newspaper subscriptions Information campaigns
				Voter turnout in local elections	Public awareness campaigns.
	Hospital Admissions			Public involvement in environmental actions	Direct solicitations
				Donations to charities	
Transport	Vehicle ownership/	Public Transport	**Well-being & Safety**	Accidental deaths	Public safety laws and information campaigns [e.g., seat belts].
	Fuel consumption per capita			Crime	More policing and crime prevention
	Traffic density/ volume	Alternative Modes of Travel		Green space	Public pressure for parks
	Time/ distance travel to work				
Natural Resource Consumption	Water Supply	Water meters	**Social Investment**	Day care spaces	Public pressure and increased government spending for young and old.
	Water Quality	Wastewater treatment		Chronic care (incl. elderly)	
	Waste Generation	Recycling		Education	Changes to education system.
		Expenditures on waste management			
	Land Use	Infill housing		Hospital beds	Attempts to reform medical care system to control budgets and provide care.
		Green space			
		Environmental Protection Expenditures			

Source:
http://www.sustreport.org/home.html

Strengths: The key strength of the YCAS is that it uses a pressure–state–response framework in which to measure environmental and socio-economic sustainability. Such a framework provides a robust set of sustainability signals to decision makers. For example, a significant trend or sudden shift in a "pressure" or "driven force" indicator, or a similar trend or shift in a "state" (or condition) indicator, can signal the need for action. Moreover, the "response" indicators can be used to determine whether policy choices or other actions are making a difference to sustaining or improving environmental or socio-economic conditions.

Weaknesses: The framework does not appear to have been tested, only posited.

3.11 Pollution Watch Canada's Pollution Scorecard

The Pollution Watch Web site (www.pollutionwatch.org) was launched in 2001 by three Canadian environmental non-governmental organizations: the Canadian Institute for Environmental Law and Policy; the Canadian Environmental Law Association; and the Canadian Environmental Defence Fund (now Environmental Defence Canada). The Canadian site is based on the Chemical Scorecard site (www.scorecard.org) developed by the U.S. environmental group Environmental Defense, and launched in 1998.

The Pollution Watch site combines data from Environment Canada's National Pollutant Release Inventory with a geographic information system and a methodology for weighting the toxicity of pollutants. This allows the site to provide a customized analysis of the pollution data on demand. Members of the public, for example, can see how their local community (down to postal code level), municipality (defined by census division), or province ranks relative to other Canadian jurisdictions (by percentile) in terms of total pollutant releases and transfers, releases and transfers in terms of cancer and non-cancer health risks, and air releases of recognized carcinogens, developmental toxicants, and reproductive toxicants. Rankings for each location in terms of the pollutant associated with the greatest human health risk can also be provided, along with rankings of pollution releases sorted by health effect (e.g., kidney toxicants, liver toxicants, and neurotoxicants), and pollution releases and transfers by media and year.

The site includes mapping functions that allow the users to locate and identify facilities reporting pollutant releases or transfers, and to obtain analysis of the performance (by percentile) of these facilities in terms of their reported total pollutant releases and transfers, the cancer and non-cancer health risks associated with their releases, and air releases of carcinogens relative to other facilities in Canada. The Web site also provides an extensive database of information on individual pollutants.

***Strengths*:** The Pollution Watch site illustrates the potential of advanced Web sites to generate customized, community, and location-specific analyses of environmental stresses and conditions on demand, and to compare local conditions and facilities with those in other locations. The toxicity weighting system allows the system to be sensitive to the differences in the toxicity of individual substances, in addition to ranking communities and facilities on the basis of the simple total weight of pollutants released and transferred.

Weaknesses: The Pollution Watch Web site is limited to the data provided through the National Pollutant Release Inventory (NPRI). It therefore only reflects pollutant loadings from point sources, such as industrial facilities that report to the NPRI. It does not include loadings from mobile sources like automobiles or non-point sources like agricultural or urban run-off. The range of pollutants covered by the NPRI is limited, although the inventory has undergone significant expansion in the last two years. It now includes both highly toxic micro-pollutants, such as dioxins and furans, and criteria air pollutants, such as particulate matter, nitrogen oxides, sulphur dioxide, carbon monoxide, and total Volatile Organic Compounds (VOCs). The development of a

Web site with these capacities requires a high-quality data set, gathered and presented in a consistent and usable form.

3.12 The Alberta GPI Sustainable Well-Being Accounting System

In 2001 the Pembina Institute released a prototype sustainability accounting and reporting system: the Genuine Progress Indicators System of Sustainable Well-Being Accounts. The GPI sustainability measurement system was developed for Western Economic Diversification (WED) as a research project on constructing an accounting and measurement framework for assessing the long-term economic, social, and environmental sustainability of a province or nation. In this case the province of Alberta was the subject of the first application of the GPI framework. The framework was developed by Anielski (2001a) based on previous work on the U.S. Genuine Progress Indicator (Anielski, 1999). Anielski has applied a version of the GPI framework at the community level in Edmonton (Anielski, 1999), in the form of a performance measurement and sustainability management system for the governance of the Greater Edmonton (Capital) region.

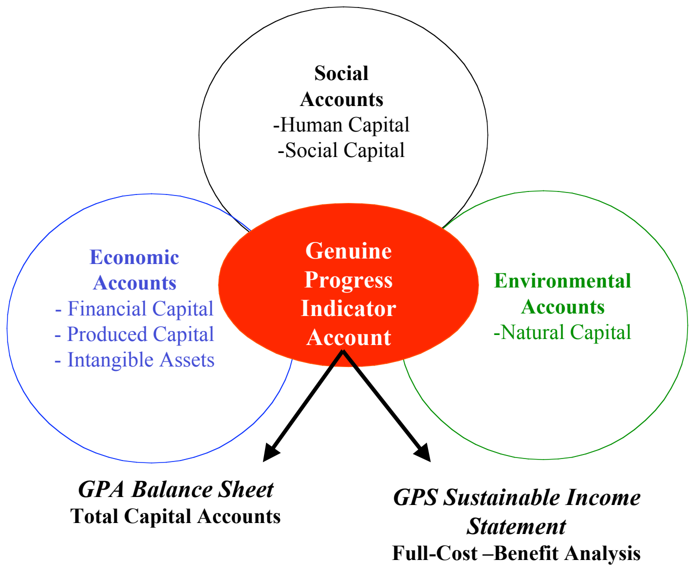
The GPI accounting framework uses the "capital accounting" structure advocated by Statistics Canada in developing the environment and sustainable development indicators for the NRTEE initiative. The GPI accounts are unique in that they attempt to account for both the stock, flow, quantitative, qualitative, and monetary (full-cost accounting) dimensions of human, social, natural, and produced capital endowments and the liabilities of a region or nation.

The GPI accounts are intended to form a seamless integration of human, social, natural, economic, and produced capital components or "accounts" that are the basis for measuring and tracking trends in the condition and long-term sustainability of all capital (i.e., the "weal-th" of a society: *weal* (well-being) and *th* (condition of)).

The GPI accounting framework is based on the traditional financial accounting system of a balance sheet, income statement, and ledgers (accounts) (see Figure 11) as the basis of monitoring overall performance or conditions of a society over time. Accounts are clustered according to economy/society and human health/environment. These account themes are further divided into domains or account categories (e.g., air quality, water quality, and non-renewable resource accounts in the environmental cluster). Each account is composed of a comprehensive data set that reveals a number of potential indicators of the condition of each of the sustainability categories being monitored. The data includes quantitative and qualitative data as well as, where available, full cost or benefit estimates associated with each category.

This makes the GPI framework unique as a performance measurement and management tool for governance at any scale — federal, provincial, community, or corporate. The GPI accounting system can be used to provide a comprehensive assessment of sustainability, quality of life, and other parameters of governance performance of interest to citizens, policy analysts, and the media.

Figure 11: Genuine Progress Indicator (GPI) Sustainable Well-Being Measurement Framework



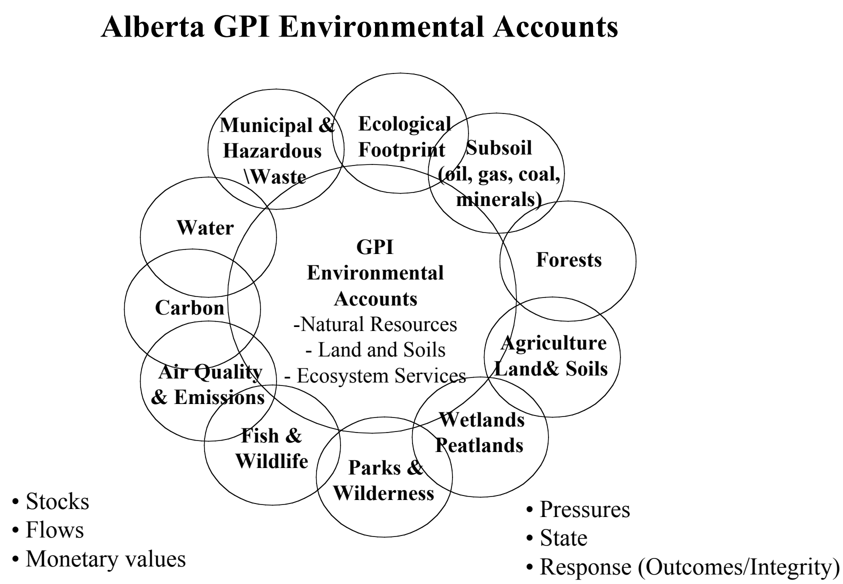
The GPI environment and natural resource accounts were developed using, for the most part, natural capital accounting methods. The natural capital accounts include accounts for:

- forests (timber capital)
- carbon budget (emissions versus sequestration by forests and peatlands)
- non-renewable energy resource (oil, gas, gas byproducts, and coal)
- agricultural land

The Alberta GPI environment accounts (see Figure 12) that track environmental quality and ecosystem integrity include:

- renewable energy resource capacity analysis
- agricultural land and sustainable agriculture practices
- GHG emissions
- air quality
- water quality and volume (flow)
- toxic waste
- municipal landfill waste (and recycling)
- species diversity, effective habitat, and habitat fragmentation
- ecological integrity and ecosystem fragmentation
- ecological footprint analysis

Figure 12: Integration of Alberta GPI Environmental Accounts to Measure Ecosystem Integrity



The Alberta GPI Environmental Accounts are integrated and linked to one another in an information database (see Figure 11) using Excel spreadsheets. These accounts track the stock, flows, and monetary values of each environmental quality and natural capital category, providing important information about the long-term trends in the pressures, state, and response (outcomes or integrity) of the environment or broad ecosystem framework of analysis (provincial in scope, in the case of Alberta GPI accounts). Indeed, the GPI accounts lend themselves to accommodating a pressure–state–response measurement framework.

The GPI environment accounts are generally provincial in scope but do contain some municipal-specific data sets and indicators for air quality and emissions (Wilson and Griffiths, 2001), water quality (Wilson, Griffiths, and Anielski, 2001), municipal and hazardous waste (Wilson, Griffths, and Anielski, 2001), ecological footprint analysis (Wilson, J., 2001), and infrastructure spending (Taylor and Anielski, 2001). Our experience in understanding municipal- or community-based environmental indicator data for Alberta is limited. Still, the GPI measurement and sustainability accounting framework could be easily applied to a municipal accounting scale.

Table 3 provides details of the GPI Alberta environment and natural accounts in terms of domains, categories, indicators, and the monetary values (full costs or benefits) we examined for the period from 1961 to 1999 for Alberta.

Table 3: Alberta GPI Natural Resource and Environmental Accounts

Domain	Sustainability Indicator	Data Sources
Forests	Timber sustainability index (ratio of annual growth to annual of total depletions)	Derived from the Alberta GPI Forest Accounts with data for growth, harvesting, fire, insect, and linear disturbance impacts from Alberta Forest Service statistics, 1961-1999
	Age-class distribution of forests (% of forest remaining that are "old-growth")	Alberta Forest Service
	Carbon sequestration rate of forest ecosystems	Carbon budget developed using estimates of forest sequestration rates by Alberta's tree species and peatlands in relationship to annual GHG emissions
	Employment per $ of forestry GDP	Statistics Canada
	Forestry GDP per cubic meters of trees harvested	Statistics Canada
	Cost of Unsustainable Timber Resource Use (loss in pulp production value)	Derived
	Cost of non-timber forest values due to change in productive forest	Derived
Agriculture	Agriculture Sustainability Index, a composite of the following parameters:	Composite index
	a) Crop yields	Information from Don Hansen, Alberta Agriculture, Food and Rural Development, Statistics and Data Development Division
	b) Soil erosion	Inherent risk of wind erosion of bare soil on the cultivated land of the prairie provinces (broken down by province) from Human Activity and the Environment 2000 - source given for risk is Wall, GJ et al. "Erosion", in D.F. Acton and L.J. Gregorich (eds.). Human Activity and the Environment 2000 - source given for risk is Wall, GJ et al. "Erosion", in D.F. Acton and L.J. Gregorich (eds.) Agriculture and Agri-Food Canada, Catalogue no. A53-1906/1995E, pp. 61-76. Ottawa.
	c) Salinity	Data from Determination of Historical Changes in Salinity, K. Cannon and D. Wentz, Proceedings of 37th Annual Alberta Soil Science Workshop, Feb. 22-24, 2000 Medicine Hat, Alberta
	d) Pesticide/Herbicide use (expenditure data)	Data for 1971 to 1999 from Statistics Canada Catalogue No. 21-603-UPE and Catalogue No. 93-358-X; Census Data, Statistics Canada, Historical Overview of Canadian Agriculture
	e) Irrigation	Alberta Agriculture, Food and Rural Development, Irrigation Branch, Lethbridge Alberta
	f) Farm debt	Statistics Canada CANSIM v383139 from table 002-0008
	Cost of erosion on bare soil on cultivated land	The replacement costs and damage costs are from, Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M. Crist, S., Shpirtz, L., Fitton, L., Saffouri, R., and Blair, R. 1995. "Environmental and Economic Costs ofSoil Erosion and Conservation Benefits". Science. 267: 1117-1123.
	Cost of reduction in yields due to salinity on dryland and irrigated cropland	Dervied based on estimated loss in yields and applied to average crop prices

Nonrenewable resources (oil, natural gas, gas byproducts and coal)	Conventional crude oil reserve life·	Derived using stock and flow data from Canadian Association of Petroleum Producers, Statistical Handbook (various issues) and Statistics Canada data base for subsoil assets from Environment Accounts and Statistics Division
	Natural gas reserve life·	Derived using stock and flow data from Canadian Association of Petroleum Producers, Statistical Handbook (various issues) and Statistics Canada data base for subsoil assets from Environment Accounts and Statistics Division
	Synthetic/Bitumen crude oil (from oilsands) reserve life·	Derived using stock and flow data from Canadian Association of Petroleum Producers, Statistical Handbook (various issues) and Statistics Canada data base for subsoil assets from Environment Accounts and Statistics Division
	Coal reserve life (sub bituminous, bituminous)	Econnections, Statistics Canada data base for subsoil assets from Environment Accounts and Statistics Division
	Depreciation costs (economic rent value) of depletion of oil, gas and coal reserves (inventories)	Statistics Canada, Econnections, Environment Accounts and Statistics Division
Energy use intensity	Energy use (GJ) per GDP and per capita·	Primary Energy Demand data from Statistics Canada CANSIM - Matrix 7996 AND 7997 (1978 to 1999)
	GHG emissions per GDP	Derived from StatsCan CANSIM Primary Energy Supply And Demand ANN NRCDA - Matrix 2481
Carbon budget	Ratio of carbon dioxide emissions (all sources) to annual sequestration by forests, peatlands and agricultural soils.	Derived from Statistics Canada and Canadian Forest Service statistics and found in Alberta GPI carbon, forest, peatland and agriculture soil accounts
	Estimated global environmental and health liability cost of carbon emissions.	Based on a study by Suzuki Foundation that estimated total cost, including health costs and climate change damage at Cdn$38.00/tonne of carbon emission.
Ecosystem integrity	Forest fragmentation index (% of forest ecosystems that have a given degree of linear disturbance and industrial development)·	Modelled using actual linear disturbance data from Alberta Forest Service starting from an estimate of forest fragmentation of Alberta's forests developed from spatial imaging by Global Forest Watch (World Resources Insitute) "Canada's Forests at a Cross Roads"
	Percentage of land and water, which has been designated as parks, wilderness, “special places” or other designation.	Alberta Environment
Biodiversity (fish and wildlife)	Population levels of fish and wildlife species·	Alberta Enviromental Protection
	Endangered species list	Alberta Enviromental Protection
Wetlands	Area of wetlands remaining of original (pre-settlement) area	Alberta Enviromental Protection
	Cost of loss of wetlands and peatlands	Estimated based on Costanza et.al. estimates of value of wetland services
Peatland	Area of peatland	Alberta Environment
	Peatland volume harvested (historical)	Alberta Environment
	Carbon content of peatland	Derived by Pembina researchers based on carbon content in peatland applied to area of peatland.

Water quality	Water quality composite index including:	
	a) pulp effluent	Alberta Environment
	b) percent of municipal population with tertiary sewage treatment	Alberta Environment; Statistics Canada
	c) Giardia and Cryptosporidium casesd)	Alberta Environment
	d) long-term monitoring of dissolved oxygen, nitrogen, phosphorous and fecal coliforms along five major Alberta rivers.)	Alberta Environment
	Environmental cost of human wastewater pollution (based on municipal water treatment expenditures)	Statistics Canada, Environment Accounts and Statistics Division; Public Institutions Division
Air quality and emissions	Percentage of increased risk of death for Edmonton and Calgary attributed to city-specific	Data from Burnett, R.T. Catmak, S., and Brook, J.R. 1998. The effect of urban ambient air pollution mix on daily mortality rates in 11 Canadian cities. Canadian Journal of Public Health. 89: 152-156
	Change in air pollution concentrations of carbon monoxide, nitrogen dioxide, sulphur dioxide, and ozone	Clean Air Strategy for Alberta (1991). Report to the Ministers. Edmonton, Alberta; Slubik, Dave (1996). Emissions Inventories of Sulphur Dioxide, Nitrogen Oxides and Ammonia in Alberta 1963 to 1995: A Review. Edmonton, Alberta; Environment Canada (1997). Various data series. and personal conversations with Tim Goth (Edmonton office); Alberta Energy and Utilities Board (EUB).
	Cost of air pollution	Estimated
	Cost of GHG (damage of climate change)	Estimated
Toxic (hazardous waste)	Volume of toxic releases and storage·	Environnment Canada, National Pollution Release Inventory; Alberta Hazardous Waste Inventory, Robert Huang, Alberta Environment; A Summary of the 1998 and 1999 Annual Oilfield Waste Disposition Reports, EUB General Bulletin GB 2000-19.
	Volume of toxic (hazardous) waste eliminated	Alberta Environment
	Non- market cost of toxic waste liabilities	Estimated based on Repetto et al. 1992 Green Fees: How a tax shift can work for the env. and the economy
Landfill waste	Volume of waste to landfills·	Alberta Environment
	Percentage of landfill waste recycled	Alberta Environment
	Non-market cost of municipal waste landfills	Derived
Ecological Footprint	Ecological footprint per capita (the amount of land, water and other resources required to meet the current consumption patterns of Albertans, also broken down by income group and major cities).	Derived using Wackernagel and Rees' Ecological Footprint Analysis methodology and using StatsCan personal consumption expenditure data.

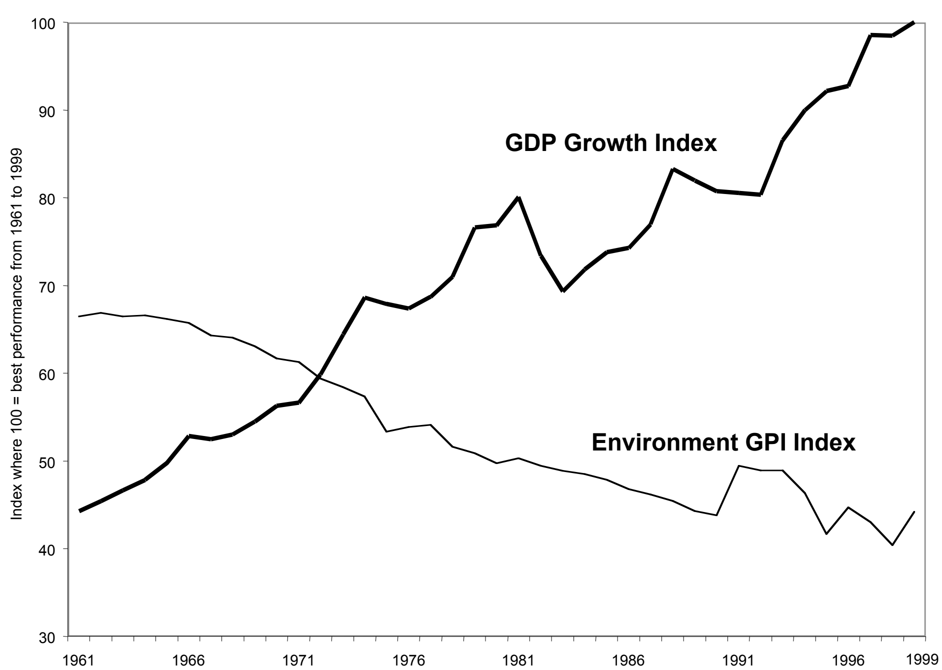
Note: Italicized figures represent monetary values for natural capital depreciation or service values (opportunity cost) estimates

Each one of the GPI environmental indicators was developed from longitudinal quantitative and qualitative data derived from various sources, including Alberta Environment, Alberta Sustainable Renewable Resources, Alberta Energy, and Alberta Agriculture, Food, and Rural Development. In principle, all indicators of sustainability of natural capital draw directly from the raw data contained in the GPI environmental accounts which come from primarily provincial government data sources. The GPI environmental accounts are provincial in scale; however, municipal indicators were developed for Edmonton and Calgary in the case of ecological footprint analysis (Wilson, 2001), surface (river) water quality by major river system (Wilson and Griffiths, 2001), and air quality (Wilson and Griffiths, 2001).

A key feature and strength of the GPI sustainable well-being accounting system is the use of an indexing system that converts raw data to a normalized index (normalizes the data), allowing comparison across otherwise incomparable indicators and aggregation of indicators into composite indices. For example, an index of economic growth (based on GDP figures) can be contrasted with an index for air quality or ecological footprint.

An example of a composite index (Figure 13) compares the GDP growth index with a composite environmental indicators index composed of 17 environmental indicators from the GPI accounts.

Figure 13: Alberta GPI Environmental Sustainability Index Compared with GDP Growth, 1961 to 1999



Source: The Alberta GPI Accounts 1961 to 1999

The GPI Environmental Sustainability Index is a composite of the 17 indicators of natural resource sustainability and environmental quality listed in Table 2. Combining these indicators into a composite index requires assumptions about weighting, which must be based on some notion of the relative importance of each indicator to measuring quality of the environment and must ultimately be in relationship to the values of a community or society. We have only begun to develop alternative weighting systems that are being built on the work of the CPRN in their Quality of Life Indicators project, involving soliciting values from Canadians. These values could then be used as a basis to create meaningful composite environmental or quality-of-life indices relevant to each community's unique value set.

Another creative way of presenting the "condition" statement of the well-being of a society is to present an integrated picture of well-being by comparing the scores of all 50 indicators simultaneously (see Figure 14).

Figure 14: Alberta GPI "Balance Sheet" Showing Condition of 51 Indicators of Economic, Social, Human Health, and Environmental Well-Being.

Figure 14 illustrates a composite GPI Indicator Account portrait — a kind of holistic balance sheet — for the year 1999. This GPI Sustainability Circle is a visual image of the condition of each of the 50 indicators relative to either a benchmark year or another best-performance benchmark. Those GPI indicators that reflect an optimal state of well-being would score a perfect 100 points; thus their performance would be plotted at the outer edge of the Sustainability Circle. Indicators with a less than perfect score would be plotted along an axis from 1 (worst performance, near the centre of the circle) to 100. A perfect GPI Sustainability Circle would be completely filled to the outer edges of the circle. This approach to showing visually the condition of all wealth or well-being in a society is a powerful tool for communicating a number of complex issues.

The use of composite indices was adopted in cases, such as sustainable agriculture practices, where we recognized that measuring sustainability is complex without any single proxy that all stakeholder parties would accept or find meaningful. The principles we adopted were:

1. Provide a full and transparent account of all dimensions or conditions of the natural capital being accounted for; and
2. Derive reasonable proxies or indicators of sustainability that best reflect the principles of sustainable development.

Strengths: The main strength of the Alberta GPI Sustainable Well-Being Accounting system is that it uses a common-sense total capital accounting framework of ledgers (accounts), balance sheet, and income statement to measure and report on economic, social, and environmental sustainability. The sustainability accounts are effectively subdomains of the three sustainability domains: economy, society, and environment. They contain detailed quantitative, qualitative, and monetary (full cost–benefit) data that can be readily organized into meaningful indicators. The GPI system of accounts provides a useful tool for decision making that can be used for planning and budgeting purposes. The GPI income statement provides a full cost accounting of economic development policies by accounting for regrettable or defensive social and environmental costs. The presentation of sustainability indicators in the "GPI star" diagrams provides a unique visual portrait of a community's "well-being balance sheet," contrasting the conditions of economic, social, health, and environmental parameters of well-being. In addition, indicators can be easily contrasted and compared to show trends and analyze correlations of relationships.

Weaknesses: The GPI framework has been applied only at the provincial scale and has not yet been tested at the municipal or community scale. However, the GPI framework is applicable at any scale — municipal, community, or corporate — with some modifications of indicators and accounting methods.

3.13 Edmonton Capital Region "Indicators of Success"

Anielski (2000) helped develop a quality-of-life performance measurement and reporting framework for the Alberta Capital Region (Edmonton Metropolitan area) that could be considered as a framework (see Figure 15) and tool for sustainability accounting. Anielski's proposed quality-of-life and sustainability measurement framework was developed by first examining a number of North American community and municipal quality-of-life measurement initiatives (see Figure 27, Appendix A3) and then drawing upon three expert cluster groups (using three themes: economy, society, and environment) to create a short list of the Capital Region's "Indicators of Success." These indicators and the performance measurement and management framework provide citizens and decision makers with a comprehensive picture of economic, social, health, and environmental conditions for the Edmonton Capital Region. The following diagram (Figure 15) represents the recommended framework for the Capital Region's quality of life and indicators of success framework, using three tiers of measures:

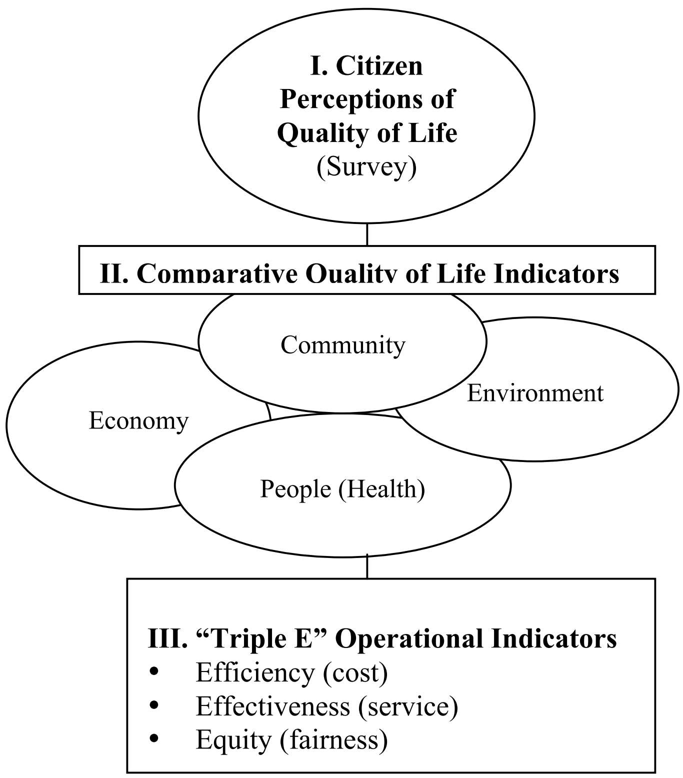
- citizen-rated quality-of-life measures (based on citizen surveys of quality of life);
- comparative quality-of-life indicators (based on FCM, Edmonton LIFE (Local Indicators for Excellence), and Edmonton Social Health Index (ESHI) as the starting point for the basis for indicators); and
- triple E (efficiency, effectiveness, and equity) indicators of municipal service delivery.

The indicators contained in the three tiers of this framework provide a kind of "triple bottom line" for the Capital Region: (1) perceived quality of life; (2) comparative quality-of-life indicators; and (3) efficiency, effectiveness, and equity of services and programs. These three tiers of indicators provide a robust information base from which to manage growth, economic development, social responsibilities, and environmental management. Balancing citizen perceptions with quantitative indicators of quality of life provides a powerful basis for more effective management of the Region. Many indicator projects lack this balance between perception and quantitative reality.

Augmenting these two pillars are the Triple E indicators, which provide managers and municipal decision makers with information on the cost efficiencies and effectiveness (from the perspective of citizens) of municipal and regional services. Comparing cost and service effectiveness data across municipalities in the Region also helps to identify differences and inequities. Identification of these gaps will allow all municipal governments in the Region to achieve more cohesive, cost-efficient, and effective management of the collective assets of the Region that contribute to the Capital Region's strengths. The following diagram outlines the three tiers of indicators:

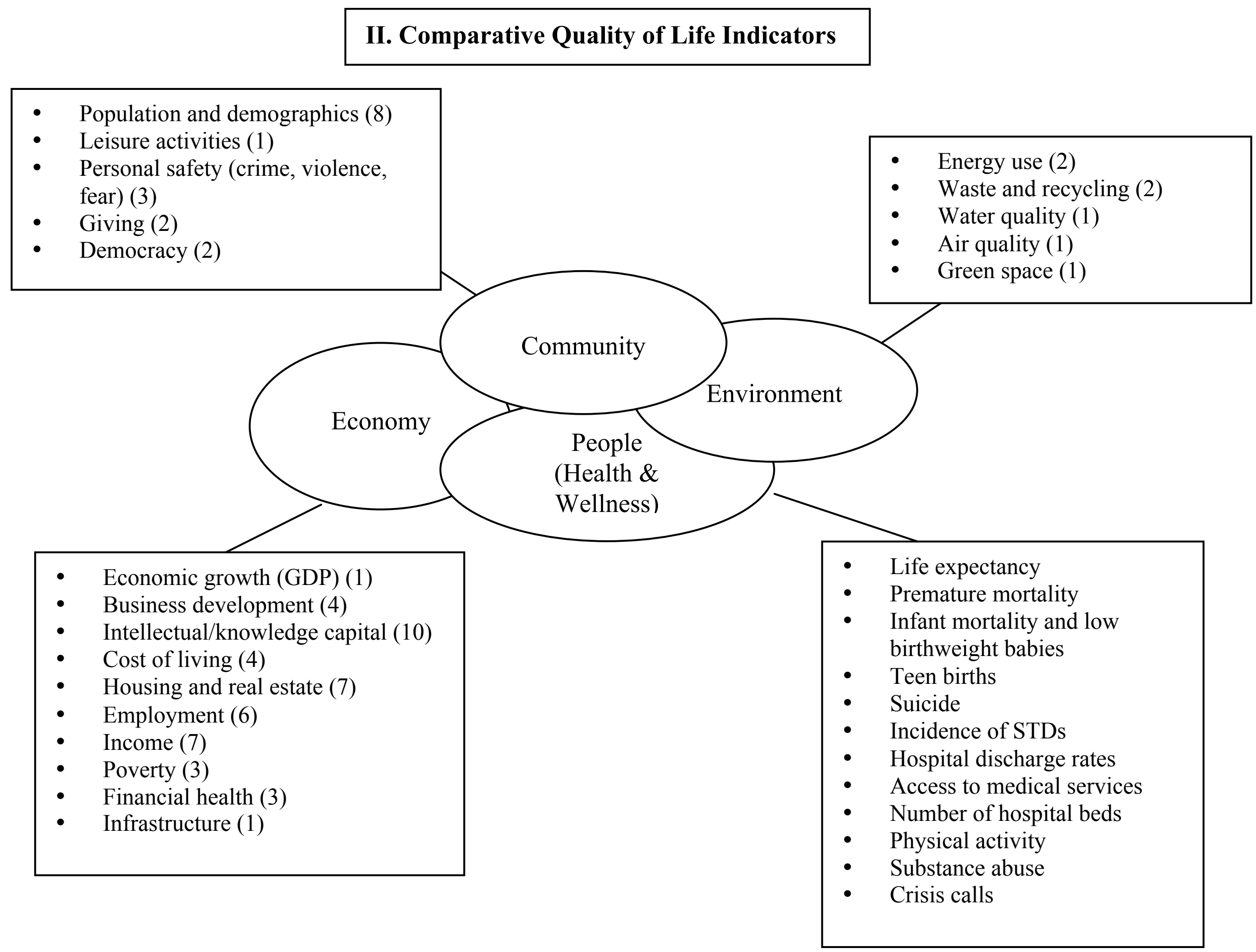
Figure 15: Alberta Capital Region (Edmonton) Indicators of Success Framework

Capital Region Indicators of Success Framework



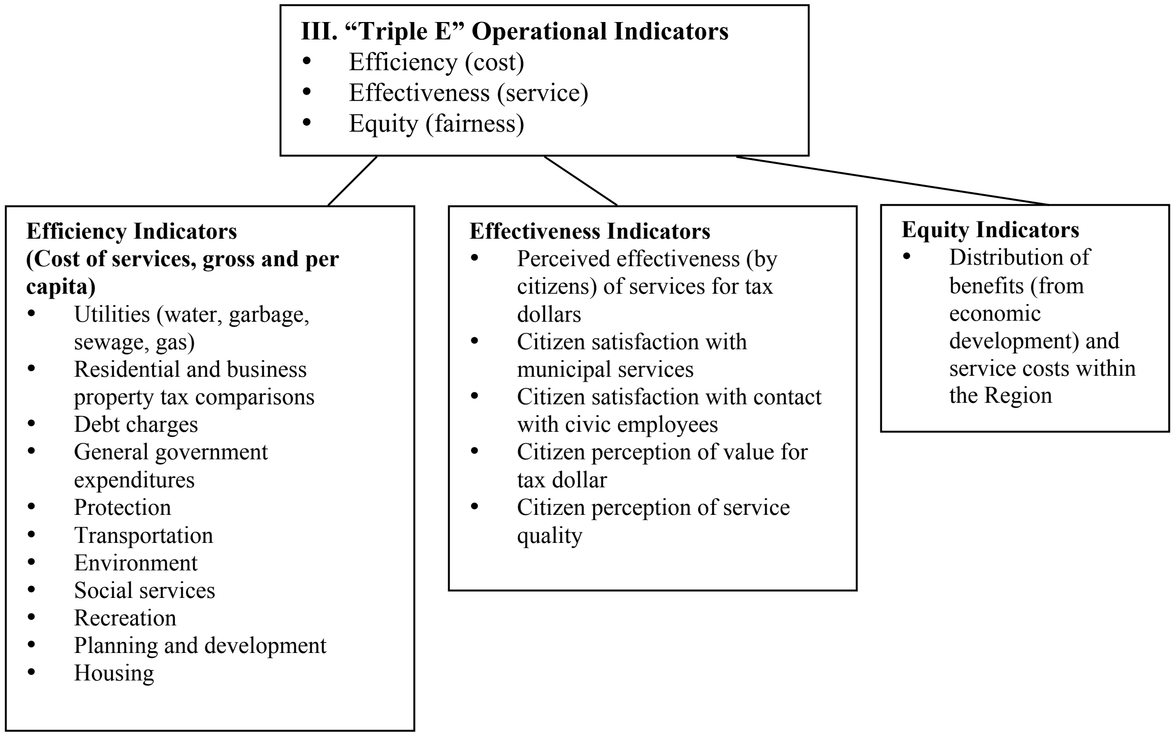
The indicators (see Figure 16) were chosen from various sources: FCM's Quality of Life indicators, Edmonton LIFE, the Edmonton Social Planning Council's ESHI, and other North American community sustainability and quality-of-life benchmarks. A measurement framework of quality-of-life indicators uses four quality-of-life themes: economy, community (society), people (health), and environment. The framework provides the basis for comparing the Alberta Capital Region with 15 other Canadian municipalities or municipal regions.

Figure 16: Alberta Capital Region Quality of Life Indicators Set



The performance measurement system is completed by a practical *Triple E (efficiency, effectiveness, equity)* form of full-cost accounting of the Region's operations using a set of indicators to measure and compare operational (programs, services) cost efficiency and service effectiveness at the regional and possibly municipal level. This framework is illustrated in the diagram below (Figure 17). Cost-efficiency indicators account for the total per capita costs and costs per dollar unit output of municipal services, comparing the Capital Region with other Canadian municipalities. In addition, the efficient use of limited resources (financial, human capital, materials) should be part of the efficiency indicator set. Each municipality may wish to track efficiency indicators using the criteria identified for comparison with other municipalities in the Capital Region; however, the focus should be on the cost competitiveness and service effectiveness of the Capital Region as a whole. Effectiveness measures account for taxpayers' perceived value of services and program delivery for tax dollars, as well as the effective use of limited resources. Equity measures examine the distribution of the benefits from economic development within the Region and the distribution of related municipal service costs. Tracking the trends in service costs within the Region would help to identify any growing disparities between have and have-not municipalities.

Figure 17: Capital Region's Triple E Operational Indicators



These Triple E indicators would facilitate the strategic positioning of the Region in Canada, building on the collective strengths of the 21 municipalities that make up the Capital Region. Understanding the current state of cost efficiency and service effectiveness, along with an understanding of equity (disparity) within the Region, will provide important information upon which decision makers can position the Region for comparative advantage in Canada.

The framework has not yet been adopted by the Capital Region's governance structure, which has been hindered by political challenges. Data sources were identified to construct the measurement system. It was felt that operating and capital cost data to complete the Triple E accounting would be available from municipal budget documents. Cost data would be compared or benchmarked for various service and program expenditure categories. Thus the cost efficiency of service delivery could be compared on the basis of each individual municipal government and in terms of the Region as an integrated system of services and programs. This comparison would reveal inequities in expenditures within the Region and would provide a basis for comparing citizen perceptions of value for tax dollars and quality of municipal services.

Strengths: While not explicitly defined as a sustainability measurement and reporting system, the Indicators of Success framework does come close to providing a comprehensive and practical tool for monitoring, measuring, and reporting on the state of the Edmonton Capital Region in the same dimension (domains) of sustainable development. Moreover, the framework has the added feature of full cost accounting, which helps decision makers better manage the efficiency and effectiveness of services in the Region, in line with quality of life and sustainability objectives. The measurement system would rely, in part, on the FCM quality-of-life indicator set to provide meaningful, comparable benchmarks of performance.

Weaknesses: Because of political complications, the measurement and reporting framework has not yet been adopted by the regional governance structure.

3.14 GPI Atlantic's Community Sustainability Indicators

GPI Atlantic, a non-profit organization based in Halifax, Nova Scotia, has been actively developing a set of sustainable development indicators for Nova Scotia and is working towards a Genuine Progress Index for the province. This project is similar to the Alberta GPI project in that it examines a series of well-being accounts that track sustainable development. However, GPI Atlantic does not use the accounting framework adopted by Pembina Institute researchers for the Alberta GPI accounts. Furthermore, GPI Atlantic's work is focused on only 20 accounts. The GPI Atlantic initiative was originally intended to replicate the U.S. GPI developed by Redefining Progress, providing a full cost accounting of the regrettable environmental, social, and economic costs associated with economic growth.

GPI Atlantic has also been actively developing Community GPIs for Kings County and Glace Bay, Nova Scotia (http://www.gpiatlantic.org/community.shtml). The Community GPI is a pioneering effort to build a new measure of community well-being, also known as the Genuine Progress Index (GPI). This pilot initiative is unique in that it has engaged citizens in the community to research and develop the GPI data set. The Kings County Citizens for Community Well-Being has undertaken the task of surveying Kings County residents to gather data for this pilot project. Following consultation with survey and socio-economic data collection experts from Statistics Canada and academia, survey methods have been designed and tested in both communities, and more than 20 residents of Glace Bay and Kings County are now hard at work gathering the necessary data for Canada's first Genuine Progress Index. The indicators are intended to replicate, in part, the Nova Scotia GPI framework, with some exceptions.

The Community GPI indicator categories include:

- Employment/unemployment
    - underemployment
    - labour market activity
    - job characteristics
    - work schedule and income
    - job security
    - work reduction
- Household well-being
- Volunteerism
- Health
- Peace and security
- Environment (ecological footprint)

The environmental indicators are almost all in the ecological footprint (EF) calculations that account for energy use, transportation, recycling and waste, and food consumption. Survey questions regarding water quality in the Glace Bay GPI are also used. The Kings County GPI survey includes agriculture-related questions plus an inquiry into sustainable agriculture practices in Kings County.

Strengths: One of the key strengths of the Community GPI project is the engagement of citizens at the local level in developing sustainability indicators using the rigour of Statistics Canada survey methods to gather information. The process of engaging citizens in survey development and application provides a tangible net benefit; both citizens and local decision makers can understand sustainability from an applied perspective. This project should provide an important prototype benchmark for future community-based sustainability measurement and reporting efforts in other Canadian communities, particularly where there are insufficient statistical data from traditional data sources (e.g., Statistics Canada).

Weaknesses: The key weakness of the Community GPI project is the onerous nature of developing and administering surveys akin to Statistics Canada's Census and socio-economic profile surveys. Also, it is not clear how robust the environmental indicators will be, although the development of ecological footprint estimates at the community level is an important undertaking.

3.15 UBC's Sustainable Development Institute's Georgia Basin (QUEST) Model

The Georgia Basin (QUEST) model developed by the University of British Columbia's Sustainable Development Institute is a good example of spatial mapping of quality-of-life and sustainability indicators on a drainage basin or watershed scale. The QUEST initiative goes beyond the traditional approach of monitoring environmental quality from a quantitative measurement perspective by combining dialogue with citizens about their perceptions of environmental quality, priorities, and issues with spatial portraits of the condition of the environment, economy, and society on the scale of ecosystems or watersheds (e.g., Fraser and Georgia basins). The QUEST framework and modelling tools allow users and citizens to examine a virtual database and construct "what if" sustainability scenarios. This allows for breaking through the barrier of the challenge to the interface between inputs and outputs, so it is user-friendly.

Strengths: We believe the QUEST model and framework represent an important benchmark for spatial portrayal of environmental quality indicators that are spatially relevant and place-relevant, and yet allow for the scenario analyses that are important to urban and community planning.

***Weaknesses*:** We are uncertain as to the current status of the QUEST model and how readily available it might be as a tool for a spatial analysis of sustainability on a regional, water-basin, or other geographic scale.

3.16 Fraser Basin Sustainability Indicators

The Fraser Basin Council (Vancouver, B.C.) is in the process of developing a set of 40 sustainability indicators to help monitor progress towards sustainability in the Fraser River Basin geographic area. The Fraser Basin Council (2000) defines sustainability in its *Charter for Sustainability* as "social well-being supported by a vibrant economy and sustained by a healthy environment." The Fraser Basin sustainability indicators were developed through a multi-stakeholder consultative or dialogue process among the many partners in the Fraser Basin Council. Workshops and on-line surveys were used to solicit citizen feedback on the indicators. The sustainability indicators include a good mix of economic, social, and environmental indicators (see Figure 18).

Figure 18: Fraser Basin Sustainability Indicators

Number	Indicator	What It Measures	Data Source
1	Waste Diverted from Landfills	The amount of waste per capita going to landfill now, subtracted from the amount of waste per capita in 1980 — before waste reduction, reuse, and recycling programs were introduced.	Ministry of Environment, Lands and Parks (collects data on waste going to landfills)
2	Water Consumption	How much domestic water is used per person each year in the Basin.	Environment Canada, Municipal Water Use Database (data available on litres of water used per person on a daily basis; data refer to water used in municipal systems and can be sorted by municipality, water source (surface or groundwater), and end use, not including information on private wells; data collected every three years)
3	Adoption of Regional Growth Strategy		Ministry of Municipal Affairs
4	Newspaper Circulation Rates		B.C. Media Guide, B.C. Government Policy and Communications Office
5	Internet Access		Statistics Canada Labour Force Survey
6	Level of Education Attained		B.C. Ministry of Education; Statistics Canada
7	Water Quality Index	The frequency and degree to which water quality objectives are achieved in water bodies where human activities have a high potential of negatively affecting water quality.	B.C. Ministry of Environment, Lands and Parks, Water Quality Index (reports on results from freshwater monitoring stations through the province, using rankings of excellent, good, fair, borderline, or poor)
8	Status of Fraser River Sockeye	Run size and spawning escapements of Fraser River Sockeye.	Pacific Salmon Commission (data collected annually of total run size and escapements of Fraser River Sockeye Salmon (since 1946))
9	Salmonid Stocks at Risk	The percentage of salmonid stocks that are extinct, at moderate to high risk of extinction, or of special concern.	T.L. Stanley et. al., 1996 Status of Anadramous Salmon and Trout in B.C. and Yukon, Fisheries, V21, No. 10 (not clear whether this data will be monitored in the future)
10	Number of Species at Risk	The percentage of known species that are threatened or endangered.	B.C. Ministry of Environment, Lands and Parks, Conservation Data Centre (data updated annually; information can be provided on a regional basis)
11	Toxic Contaminants in Wildlife	The amount of persistent organochlorides (POCs) in Great Blue Heron eggs.	Environment Canada; Canadian Wildlife Service; B.C. Ministry of Environment, Lands and Parks (analyzed and raw data available via MELP Web site; data collected annually from the Great Heron rookery near UBC since 1977)
12	Age and Species Composition of Forests	Percentage and extent of area, by forest type and age class, relative to historical condition and total forest area.	Provincial Timber Inventory (contains data gathered from aerial photos on dominant tree species; may not be updated regularly to reflect fires, insect outbreaks, and timber harvesting)
13	Sustainable Farm	Area of farmland serviced by	Statistics Canada, Census Agriculture

	Practices	integrated pest management (IPM) consultants and the area of farmland where soil and water conservation are practiced.	1991-1996: Soil and Water Conservation Practices (data collected every 5 years); B.C. Ministry of Environment, Lands and Parks, Pollution Prevention and Pesticide Management Branch (data has not been updated since 1995)
14	Access to Parks	The area of parkland available for public recreation for every 1000 people; provides a measure of access to and availability of parkland for recreation.	B.C. Ministry of Municipal Affairs; Statistics Canada
15	Park Use	Number of park user days by type of use.	B.C. Ministry of Environment, Lands and Parks; Ministry of Forests (recreation sites)
16	Contaminated Mine Sites	Number of mine sites in the Basin listed on the contaminated site registry as suspected or remediated sites (as defined by the Contaminated Site Act).	B.C. Ministry of Environment, Lands and Parks; Ministry of Energy, Mines, and Petroleum Resources
17	Non-Compliance in Mining Sector	The number of mines that do not meet environmental standards and appear on the non-compliance list.	B.C. Ministry of Environment, Lands and Parks, Pollution Prevention Department; B.C. Ministry of Energy, Mines, and Petroleum Resources
18	Alternative and Total Energy Consumption	Total per capita energy consumption and total alternative energy consumption (including wind, solar, micro-hydro, tidal, and wave energy; excludes large hydroelectric).	Statistics Canada: Energy Statistics Handbook (updated monthly); the Canadian Socio-Economic Information Database (updated on an ongoing basis)
19	Fine Particulate Levels (PM10)	The number of 24-hour periods when fine particulate matter (less than 10 microns in size, PM10) measurement exceeds maximum acceptable levels.	B.C. Ministry of Environment, Lands and Parks, Air Resources Branch (data available annually; analyzed and raw data available via MELP Web site; location of data collection station will determine if data represents the Fraser Basin)
20	Greenhouse Gas Emissions	Total greenhouse gas emissions reflect our ability to reduce activities that produce greenhouse gas.	Estimates of greenhouse gas emissions are available from: B.C. Ministry of Environment, Lands and Parks; Environment Canada; and B.C. Ministry of Finance
21	Low-Income Families/Households	Percentage of families in the Basin below the low-income cut-off (LICO).	Statistics Canada, Canadian Census
22	Crime Rates	Rate of crime (by type) for regions within the Basin.	Police Services Division, B.C. Ministry of the Attorney General
23	Morbidity Rates	Number and percentage of Basin residents who suffer from serious disease, by type of disease.	B.C. Ministry of Health
24	Mortality Rates	Age and natural causes of death, and life expectancy for residents within the Basin.	Statistics Canada, National Population Health; B.C. Vital Statistics Agency
25	Volunteerism Rates	Number and percentage of Basin residents who are members of voluntary or community organizations.	Statistics Canada (special Basin tabulation)
26	Charitable Donations	Number of Basin residents contributing to charitable organizations (by type of charity) and the amount they donate.	Statistics Canada (provincial data)

27	Aboriginal Employment Rates	Rate of employment among Aboriginal men and women of different ages (living on or off reserve).	Statistics Canada
28	Population in Growth Concentration Areas	The number of people living within and outside Growth Concentration Areas (GCAs) where GCAs are designated in the Basin.	Census data customized to GCA
29	Employment in Growth Concentration Areas	The number of jobs located within and outside Growth Concentration Areas (GCAs) where GCAs are designated in the Basin.	Census data customized to GCA
30	Public Transit Ridership	The number of transit trips per person per year.	B.C. Transit (ridership data are available by Regional District on an annual basis)
31	Vehicle Ownership	The number of vehicles owned per household.	ICBC
32	Investment in Public Assets	The total amount of investment in public assets compared to GDP.	B.C. Ministry of Finance and Corporate Relations; Ministry of Municipal Affairs
33	Economic Diversity Index	The number of industries driving local economies.	B.C. Ministry of Finance and Corporate Relations (information available for a number of communities in the Basin)
34	Jobs by Sector	The number of jobs within different sectors.	Statistics Canada
35	Interim Agreements with First Nations	Number and type of interim agreements made with First Nations and the provincial government.	B.C. Ministry of Aboriginal Affairs
36	First Nations in the BCTC Process	Number of First Nations involved in the B.C. Treaty Consultation Process.	B.C. Treaty Commission
37	Voter Turnout Rates	Percentage of registered voters casting ballots (in municipal, provincial, and/or federal elections).	Elections B.C.; Elections Canada; Municipal Government data
38	Elected Officials' Reflection of Population	The extent to which our elected officials reflect the ethnic, age, and gender make-up of the population.	To be determined
39	Access to Information Reviews	The number of reviews carried out by the Office of the Information and Privacy Commissioner.	B.C. Office of the Information and Privacy Commissioner
40	Complaints to the Ombudsman	Number of complaints to the Ombudsman and the manner in which they were addressed.	B.C. Office of the Ombudsman
Source: Fraser Basin Council (2000).			

Strengths**:** The strength of the Fraser Basin Council sustainability indicators is both in the process of stakeholder involvement used to select the indicators and in their intuitive appeal. The indicators capture a broad range of economic, social, and environmental determinants of well-being and quality of life, and are relevant and unique to the Fraser Basin. The indicators will be reported in a manner that demonstrates why they are important to citizens, thus telling the sustainability story in plain language. It is also clear that many of the environmental indicators have data sources primarily from the B.C. Ministry of the Environment, as well as some from Environment Canada and Statistics Canada.

***Weaknesses*:** One of the weaknesses of the Fraser Basin sustainability indicators is that they are not organized according to a conceptual sustainability measurement and reporting framework; rather, the indicators are mostly stand-alone, independent measures. Organizing the indicators according to sustainability domains or themes (e.g., economy, environment, society/health) might help. Also, the indicators are not integrated; there is no sense of how individual indicators relate to each other in providing a sustainability portrait of the region.

4. Community/Municipal Indicator Initiatives

In addition to the review of the sustainability measurement framework, we examined a number of municipal state-of-the-environment (SOE), quality of life, and sustainability indicator reports or initiatives that are worth noting as benchmark studies. This analysis was useful to show the scope of environmental and sustainability indicators being used or reported by communities and to help Environment Canada identify data sources and information gaps.

The most comprehensive and useful inventory of municipal environmental and sustainability indicators has been conducted by Virginia Maclaren, who surveyed a number of municipalities' or regions' SOE reports (see Table 4 and Figure 26, Appendix A2). Maclaren's indicator inventory shows the considerable scope (over 460 environmental and energy indicators identified) and range of sustainability indicators that have been reported by Canadian municipalities over the past 10 years. Maclaren's work provides a good starting point for Environment Canada to identify environmental indicator data sources and data gaps with a vision of working towards a Canadian Information System for the Environment (CISE) of relevance to Canadian municipalities and communities.

Table 4: Maclaren's Inventory of Municipal and Community State of the Environment Reports

BRITISH COLUMBIA:
- City of Burnaby State of the Environment Report 1993
- Capitol Regional District Report on the Environment 1997-1998
- Biophysical Sustainability Indicators for the Cowichan Valley Regional District 1998 *View Full Report*
- City of Kamloops State of the Environment Report 1994
- City of Kelowna State of the Environment Report 1998 *View Full Report*; City of Kelowna State of the Environment Preliminary Data Report 1995
- Progress Nanaimo 1998
- City of Richmond State of the Environment Report 1998
- City of Vancouver State of the Environment Report 1997 and 1995 http://www.city.vancouver.bc.ca/commsvcs/pandl/ENVIRO/envirotr.htm

ALBERTA:
- City of Calgary State of the Environment Report 1998

SASKATCHEWAN:
- City of Regina State of the Environment Report 1996 Air & Water; City of Regina State of the Environment Report 1994
- Saskatchewan State of the Environment Report http://www.serm.gov.sk.ca/publications.htm

MANITOBA:
- City of Winnipeg, Quality of Life Indicators **http://iisd.ca/pdf/wpg.qoli.pdf**

ONTARIO:
- Brant County State of the Environment Report 1997
- State of the Environment Report for the City of Burlington 1998
- Durham Region State of the Environment Poster Map 1996

- Haliburton, Kawartha & Pineridge Health Unit State of the Environment Report 1997
- Region of Hamilton Wentworth State of the Environment Update 1994; Region of Hamilton Wentworth State of the Environment Report 1990
- Kingston, Frontenac & Lennox Addington State of the Environment Report 1994
- Middlesex-London Health Unit State of the Environment Reports: Recreational Water Quality, April 1995; Air Quality, 1997; PCBs, November 1995
- District Municipality of Muskoka State of the Lakes Report 1996
- City of Ottawa Land & Water Report 1993
- Region of Ottawa Carleton State of the Environment Report 1991
- Ottawa Carleton State of the Environment Report 1997: An Environmental Health Perspective
- Peel Region State of the Environment Water Report 1996; Peel Region State of the Environment Atmosphere Report 1995
- Region of Sudbury State of the Environment Report 1994
- Metropolitan Toronto State of the Environment Report 1995; City of Toronto State of the Environment Report 1994; City of Toronto State of the Environment Report 1988
- Region of Waterloo State of the Environment Report 1991
- Wellington-Dufferin-Guelph Health Unit: State of the Environment Report 1998
- York Region State of the Environment Report 2000

QUEBEC:

- Ville de Becancour Bilan de la situation environnemental 1993
- Region de Mauricie Bois Francs Bilan de Sante et Environnement 1994
- Communaute Urbaine de Montreal Air Quality Report 1997

We have reconstructed Maclaren's original list (Appendix A2) to show the potential for a comprehensive community/municipal environmental reporting system for Canada. We have also identified benchmark municipal state-of-the-environment and quality-of-life reporting initiatives (see following section and Appendices A5–A11) to help identify existing data. We hope this will provide Environment Canada with a useful tool for identifying and prioritizing environmental information needs in working towards a CISE that supports community/municipal quality-of-life reporting. Unfortunately, Maclaren's inventory does not provide a list of data sources for each indicator inventoried to guide Environment Canada, yet her extensive list alone suggests the wealth of data that is available and being reported. Maclaren's work is an excellent resource that needs to be sustained and possibly expanded as a basis of constructing a comprehensive Canadian community environmental and sustainable development indicator database.

What became apparent during our inventory and analysis was the variety and scope of environmental information available at the community level, whether from municipal, provincial, or federal government sources. Many community indicator initiatives lack a conceptual framework or model for measuring sustainability or quality of life. There are many challenges, particularly in standardizing methodologies, reporting, and data collection across such a diverse set of initiatives. While Maclaren's inventory shows the depth and breadth of environmental indicator reporting, it also reveals the discontinuity and uncoordinated nature of these reporting efforts. Each community is essentially developing its own unique set of indicators, drawing mostly from local government sources, augmented with provincial government data sources from ministries of the environment. In some cases, environmental data is sourced from Environment Canada, Statistics Canada, and other national data sets. What Maclaren's inventory shows is the potential for a common sustainability and environmental indicators database, with considerable work required in standardizing data gathering and reporting methododologies to ensure meaningful comparisons and benchmarking across communities.

We are confident that a common reporting system will emerge as several national indicator initiatives take shape, namely the FCM Quality of Life Reporting System, StatsCan's Cities project, the NRTEE ESDI initiative, NRCAN's National Atlas and Quality of Life Mapping project, and Environment Canada's CISE. It will be imperative to ensure that economies of scale and synergies are found across these various initiatives. Our analysis, combined with Maclaren's, points to the desire for a nationally coordinated process of gathering community-level data based on a common inventory strategy. As for who and how this should be coordinated, that is beyond the scope of this paper.

From Maclaren's list and other sources, we examined the following benchmark municipal or community SOE reports to assess the scope of their quality-of-life, sustainability, and environmental indicators reporting. There were no particular criteria for selecting these reports or initiatives, save that they had been identified by Maclaren and by the Sustainability Report Web site (www.sustreport.org). We conducted this additional analysis to illustrate the varied and yet common suite of indicators (and measurement domains) being reported. Our analysis also helped identify indicator gaps and data gaps, identified by the communities themselves. This analysis was useful as it revealed the current depth and capacity of municipalities to report on a broad number of environmental quality and sustainability issues, even if such reporting efforts are not yet standardized within a common measurement and reporting framework. Our inventory and assessment are certainly only the first steps in a longer-term initiative to move towards a common sustainability measurement and reporting system on a municipal, provincial, and national scale. What is encouraging is that many of the environmental indicators currently reported by these municipalities are consistent with the environmental indicators being considered by the FCM Quality of Life reporting initiative.

Vancouver's State of the Environment Report (1997)

The City of Vancouver has developed a comprehensive SOE reporting system including roughly 70 environmental indicators (see Appendix A5). The Vancouver SOE draws on a wealth of data from the following sources: the Greater Vancouver Regional District (GVRD), the City of Vancouver, the B.C. provincial government (e.g., B.C. State of the Environment Report), B.C. Hydro and B.C. Gas, Environment Canada's State of the Environment Reporting Program (and Canada's National Report Climate Change), and Statistics Canada (e.g., Census, time-use surveys). No data or indicator data gaps are identified. The Vancouver SOE report is one of the most comprehensive we examined and shows the possible scope of environmental quality reporting.

Sustainable Calgary's State of the City 2001 Report and Green Map Calgary[14]

Sustainable Calgary is a grassroots, voluntary initiative of 11 core groups in Calgary inspired by and modeled upon the Sustainable Seattle initiative. Their State of the City Report provides a common-sense account of the sustainability of the City of Calgary using 36 community sustainability indicators clustered according to the sustainability themes or domains of community, economy, education, natural environment, resource use, and wellness (health) (see Appendix A6). Their report is one of the best examples of an intuitively attractive format for reporting and tracking sustainability trends. The report uses "sustainability trend" symbols to show whether an indicator is moving towards or away from sustainability. What is unique about

[14] Sustainable Calgary's State of Calgary (2001) (http://www.telusplanet.net/public/sustcalg/home.html) and Green Map Calgary http://www.telusplanet.net/public/sustcalg/greenmap/

the State of the City Report is its use of common-sense indicators like the ecological footprint (as a measure of resource use or consumption), bird counts, food grown locally, and hours required to meet basic needs at minimum wage.

Another innovative initiative of Sustainable Calgary is the Green Map project. Once completed, Green Map will provide a graphical presentation of Calgary's ecologically significant sites and a locational map of Calgary's environmentally friendly and not-so-friendly sites for sustainable living. Using a series of 50 icons, this mapping tool, which is web-based,[15] is useful for education, advocacy, and planning for community groups, governments, and the private sector in moving towards the sustainability objectives envisioned by Sustainable Calgary. The map has unlimited uses, including (but not limited to): a teaching tool in schools, a starting point for environmental discussions, an environmental inventory, a resource guide, and even a catalyst for influencing environmental policies. Green Map should provide an ideal complement to the State of the City sustainability indicators' combined data and spatial mapping in visually attractive graphics.

City of Calgary's State of the Environment Report (1998)

The City of Calgary produces a regular State of the Environment Report prepared by the Environmental Advisory Committee for City Council.[16] The most recent report (1998) contains a total of 32 environmental indicators (see Appendix A7). Some of the indicators are corporate performance measures for the City of Calgary, while others are city-wide quality of the environment indicators. Based on the 1998 report we examined, we could not identify data sources, nor did we discern any data or indicator gaps in Calgary's SOE. We did, however, note that Calgary does not monitor groundwater quality. Since the City of Calgary maintains a potable water supply system from surface water, groundwater quality is not required for domestic consumption and therefore is not assessed in a comprehensive manner. Groundwater is, however, assessed and monitored if a contamination problem is encountered. Calgary's report demonstrates the scope of the environmental information that exists, which would likely be sourced from the City of Calgary, the Alberta government (Alberta Environment, Alberta Energy), and federal government sources.

City of Edmonton's State of the Environment Environmental Indicators

The City of Edmonton's Office of the Environment is in the early stages of developing a State of the Environment Report using a reporting framework that includes 19 environmental topic areas and a number of supporting indicators (see Appendix A8). A list of recommended environmental indicators has been developed. The Office of the Environment is now attempting to populate the suggested indicators with data. Notable indicator and data gaps are as follows:

- sustainable urban form
- indoor air quality
- ozone layer
- hazardous materials
- light pollution
- electric and magnetic fields

---

15 http://www.telusplanet.net/public/sustcalg/greenmap/

16 City of Calgary State of the Environment Report 1998

Edmonton LIFE (Local Indicators for Excellence) (1998)

Edmonton LIFE (Local Indicators for Excellence) is a good example of a multi-stakeholder, collaborative quality-of-life indicator project that is intended to provide regular reporting on the local quality of life in the City of Edmonton. The Edmonton LIFE report contains roughly 43 indicators, divided into the four themes or domains of "healthy" economy, environment, people, and community (see Appendix A9). Most of the environmental indicators are populated with data from the City of Edmonton or Alberta Environment, with the following indicator data gaps:

- sustainable community/urban design
- public awareness/satisfaction with environmental issues/quality

City of Regina's State of the Environment Report (1994)

The City of Regina's State of the Environment report (1994) was developed to provide the public with information on how the City of Regina is protecting and managing the natural and built environment and to help identify sustainable actions for business and individuals. The initiative is led by the Regina Urban Environment Advisory Council (RUEAC), a 10-community member council with a mandate to assist city council with environmental considerations in planning and development. Regina's SOE includes roughly 50 biophysical and socio-economic environment indicators clustered according to the themes or domains of land use, transportation, air, water, waste, and energy. In their 1994 report, we have identified the following indicator or data gaps (where indicators have not yet been developed or data is missing):

- flora and fauna (land use)
- agriculture (land use)
- aggregates (land use)
- general water quality (water)
- water loadings (water)
- contaminant concentrations (water)
- sediment quality (water)
- drinking water quality (water)
- water consumption (water)
- aquatic life (water)
- waste generation (waste)
- disposal to landfills (waste)
- incineration/fuel-derived waste (waste)
- reduction and diversion of waste (waste)
- recycling programs (materials diverted) (waste)
- household hazardous waste (waste)
- snow-related waste (waste)
- general energy consumption (energy)

Toronto *Vital Signs* (2002)[17]

The Greater Toronto Area (GTA) is in the early stages of developing a quality-of-life reporting system. *Vital Signs* is intended to promote discussion, citizen engagement, and change on issues that are important to the quality of life and future vitality of the Greater Toronto Area. The indicator project was developed to identify a number of credible measures in areas where there was broad agreement about their importance. The results will be communicated as widely as possible on an annual basis. The *Vital Signs* environment-related indicators include the following:

- safety of drinking water supply, based on exceedances of organic and inorganic contaminants from Lake Ontario (in the case of private groundwater wells, the GTA will rely on the Ontario Ministry of the Environment's Web site to post incidences or exceedances of standards);
- surface water quality, based on levels of pollutants in excess of Provincial Water Quality Objectives;
- water consumption rates, measuring average per capita municipal water consumption in litres;
- beach closings;
- waste diverted from landfill sites;
- air quality: (1) Air Quality Index (Ontario Ministry of the Environment) and (2) premature deaths and hospital admissions attributed to poor air quality (Toronto Public Health);
- parks: (1) public satisfaction with parks and recreation areas from the annual Quality of Life Survey, and (2) area of park and recreation areas per capita;
- Brownfield development of former industrial sites (area converted to other revitalization uses);
- vehicle kilometres travelled (number of kilometres driven per day and average trip length); and
- transportation modal split (private cars, public transit, cycling, or walking).

We were unable to identify data sources from the most recent *Vital Signs* report, nor were data gaps or indicator gaps identified in the report.

Hamilton Vision 2020 Sustainability Indicators [18]

One of the enduring local or community sustainability projects is Hamilton-Wentworth's regional Vision 2020 initiative. In 1993 the City of Hamilton and the Regional Council (Hamilton–Wentworth) began a process to envision a more sustainable future — Vision 2020. This vision describes the desired outcome in 2020 of an economically vibrant, socially equitable, and environmentally responsible community. Sustainability indicators were identified and the first Sustainability Indicators Report Card was produced in 1995, with subsequent updates to 1999. The purpose of the sustainability indicators is to measure specific aspects of each of the 14 Vision 2020 areas (see Appendix A11). The indicators will serve as signposts on the sustainability trail to Vision 2020. The signposts "do not reflect the full range of factors affecting our quality of life, but instead provide a snapshot of key trends each year. The indicators were created to provide a simple way to keep people informed of the community's progress and

---

[17] Toronto Vital Signs http://www.torontovitalsigns.com/
[18] http://www.vision2020.hamilton-went.on.ca/default.htm

involved in working towards Vision 2020."[19]

The original 29 sustainability indicators (the 1999 report contains 26 indicators) were selected through a process of consultation with over 100 individuals from a variety of organizations and different sectors. The indicators in the 1995, 1996, and 1997 reports were selected because of their significance to the local community and the availability of data. In 1999, consultation with data providers, community organizations, and other government institutions resulted in some changes to the original report. The original 29 indicators were re-categorized into the 14 theme areas with some indicators eliminated, some added, and others reworked to improve them. The indicators will be modified over time as new data becomes available and new issues emerge.

The 1999 Sustainability Indicators report shows trends in all 26 key indicators dating back to 1993 (the baseline year), with data sources (see Appendix A11) and "places to get more information" provided as web links. Most of the environmental data sources are from various City of Hamilton departments, with some data from the Ontario Ministry of the Environment and the Ontario Ministry of Transportation. Federal ministries noted as alternative sources of information include Environment Canada (e.g., freshwater data at http://www.ec.gc.ca/water/ and www.ec.gc.ca/climate/index.thm for air quality data), the Canadian Wildlife Service, and the National Energy Board, as well as other national organizations like Pollution Probe.

5. A Conceptual Community Sustainability and Environmental Monitoring Framework

The overall objective of this project is to posit a conceptual framework for monitoring sustainability and environmental quality at the community and municipal level. Drawing from our extensive review of existing measurement systems, we believe there are sufficient pieces of the sustainability measurement puzzle to create a cohesive, comprehensive, and practical sustainability measurement and monitoring framework for Canadian communities.

Our proposed framework is a conceptual model that attempts to combine the most important attributes of a variety of measurement systems to help guide communities and Environment Canada in selecting and organizing sustainability, quality-of-life, or environmental issues and performance indicators. Our research has found that the main difference between sustainability/quality-of-life measurement frameworks is the means by which the dimensions, domains, or issues are organized, which in turn shapes the choice of indicators. Many of the measurement systems we examined tended to lack a conceptual framework for sustainability measurement.

The first task in developing a framework is to clarify and focus on: (1) what to measure (e.g., themes, domains); (2) what to expect from measurement (outcomes); and (3) what kinds of measurement tools and indicators to use.

We believe combining the conceptual "capital" framework of Statistics Canada (2001) (prepared for the NRTEE ESDI initiative), Maureen Hart's (1999) conceptual "community capital model" (see Figure 2), and the Alberta GPI Sustainable Well-Being Accounting System would provide an appropriate "community capital accounting and measurement framework" to measure both quality of life and sustainability outcomes. Figure 19 shows the overall structure of this

[19] http://www.vision2020.hamilton-went.on.ca/indicators/index.html

community capital framework. Figure 20 shows the same framework with core and supplemental sustainability indicators nested within each capital theme and capital subaccount.

Figure 19: Community Capital Accounting and Measurement Framework

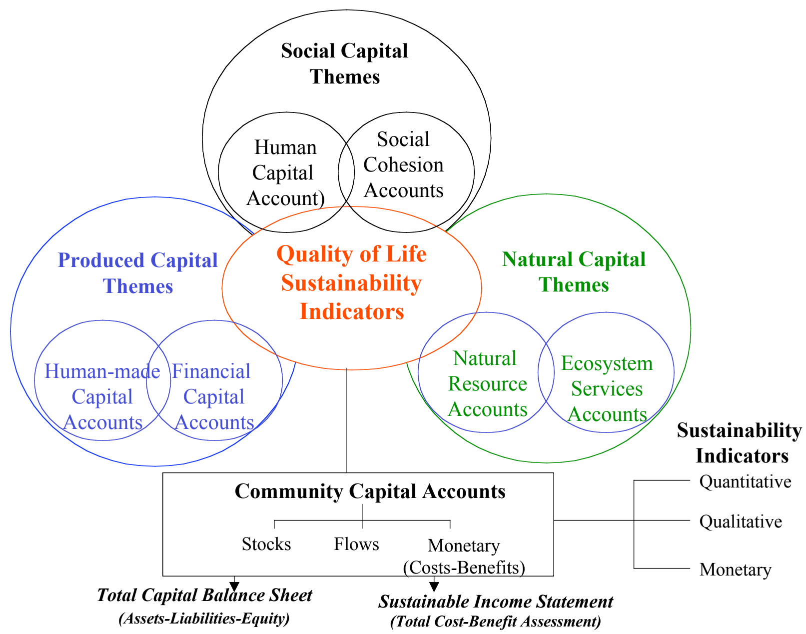
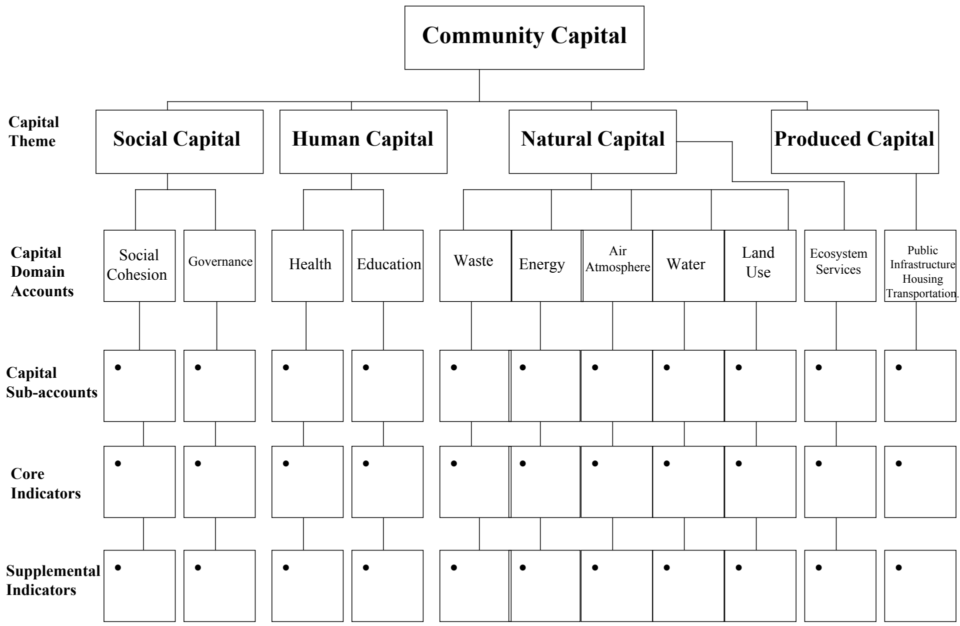


Figure 20: Community Capital Accounting and Measurement Framework Based on Statistics Canada National Capital Framework



Using the capital model, we have defined three primary capital themes (Figure 19) : social capital, natural capital, and produced capital. These three capital theme clusters can be further broken down into subclusters or capital accounts: 1) human capital (people) and social cohesion (connections) within the social capital theme; (2) natural resources and ecosystem services within the natural capital theme; and (3) human-made and financial capital within the produced capital theme.

Within each of the three capital themes is a series of capital domains or accounts, as per Figure 20. We define a **capital domain** as a community capital "account." These accounts, like financial accounting ledgers, could be structured with information on the physical **stock and flow** characteristics (including quantitative and qualitative data) and **monetary** characteristics (i.e., full cost and benefit data) associated with each capital domain. The categorization of information according to stocks and flows may not always lend itself to certain sustainability or quality-of-life issues; nevertheless, this accounting structure does have important organizational characteristics for maintaining information inventories and for understanding the pressure–state–response dimensions of sustainability. The monetary accounts would contain information related to local government expenditures (i.e., defensive expenditures) on environmental and social capital management issues.

The capital domain accounts can be further broken down into **capital subaccounts** or "indicator subdomains," which contain the quantitative, qualitative, and monetary information used to derive **core indicators** of sustainability or sustainable quality of life, along with **supplemental indicators**.

This conceptual community sustainability measurement framework is attractive because it aligns nicely with Statistics Canada's emerging national capital framework being developed as an outcome of the NRTEE ESDI initiative. From our experience with the Alberta GPI accounts, this accounting framework lends itself to comprehensive sustainability measurement and reporting that considers quantitative, qualitative, and monetary dimensions. The framework provides a practical tool for organizing community capital information into accounts from which information can be drawn to derive any number or variety of indicators. Because the framework is an integrated accounting system, the accounts can be used to examine interrelationships between economic, social, and environmental dimensions of sustainability.

Using the information contained in the community capital subaccounts, a number of sustainability or quality-of-life reports can be generated. These may include a "Sustainable Quality of Life Report" that shows the trends in key or core indicators of sustainability that provide a "condition of well-being" portrait of a community. This report could include a **community capital balance sheet** that uses the subaccount information and sustainability indicators that are categorized as community assets (endowments), liabilities, or equity/equality issues. The notion of a community capital balance sheet is similar to the Alberta GPI accounts, which portrayed 51 sustainability indicators as assets, liabilities, or equity issues.

The community **sustainable income statement** could be derived using the monetary data (full costs and benefits accounting) derived from municipal budget documents and other monetary cost estimates associated with human, social, natural, and produced capital management. Social and environmental costs, defined as "defensive expenditures," could be a key tool for sustainability budgeting showing areas of regrettable losses in social, human, or environmental capital in relationship to traditional financial and economic performance measures (e.g., tax revenues or GDP). The creation of a sustainable income statement for communities is a long-term objective that would require considerable effort by local governments and support from federal agencies (e.g., Statistics Canada) to collect the necessary information to conduct such full cost accounting (like the proposed Alberta Capital Region's *Indicators of Success* (Anielski, 2000) framework). Extending this model another step would suggest an indicator classification system according to the type of indicator. Figure 21 shows a potential classification system, in accordance with our proposed community capital framework, by which communities might organize their sustainability indicators. Indicator types include: (1) core or sub-indicators; (2) stock-flow-monetary indicators; (3) asset, liability, or equity indicators (balance sheet); and (4) pressure (condition)–state–response indicators.

Figure 21: Sustainability Indicators Classification System

Capital Theme	Capital Domain Accounts	Capital Sub-accounts	Indicators (description)	Type of Indicator										
						Capital Account Parameter			*Balance Sheet Parameter*			*PSR-parameter*		
				Core Indicator	Sub-Indicator	Stock	Flow	Monetary	Asset	Liability	Equity	Pressure	State	Response
Social Capital	Social Cohesion													
	Governance													
Human Capital	Health													
	Education													
Natural Capital	Waste													
	Energy													
	Air-Atmosphere													
	Water													
	Land Use													
	Ecosystem Services													
Produced Capital	Public Infrastructure													
	Transportation													
	Housing and Urban Form													

We now focus on the natural capital and produced capital subaccount components of the conceptual community capital accounting system. We have identified clusters of subaccounts within each of the natural capital and produced capital themes that would be used to construct environmental indicators of relevance to community sustainability or a quality-of-life measurement and management system (see Figure 22).

Figure 22: Conceptual Community Environmental Sustainability Monitoring Structure

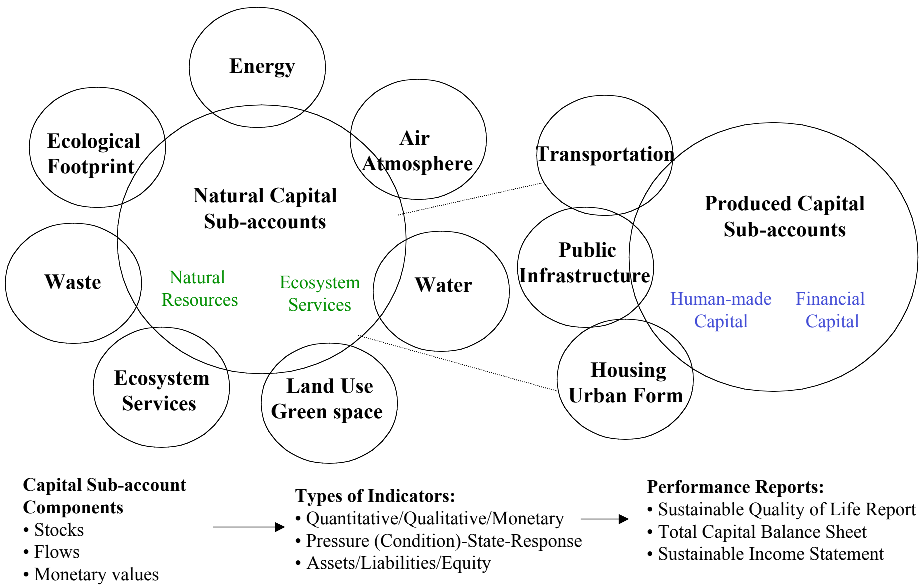


Figure 22 shows each of the major natural capital and produced capital subaccounts that are related to environmental quality issues. The natural capital accounts would include subaccounts for energy, air and atmosphere, water, land use and greenspace, ecosystem services, waste, and ecological footprint. The produced capital accounts would include subaccounts for transportation, public infrastructure, and housing/urban form. The subaccount themes were chosen based on our previous literature review and framework analyses. In particular, the FCM environmental indicator cluster and Maclaren's SOE inventory served as key benchmarks for creating our proposed architecture. As noted, the information contained in each of the subaccounts could be organized according to stocks, flows, and monetary value information. Information could also be organized simply in terms of core and supplemental indicators that could be defined according to various indicator characteristics (i.e., qualitative/quantitative/monetary, pressure–state–response, or asset/liability/equity).

Figure 23 presents a prototype community environmental sustainability indicator accounting system, taking Figure 20, as the model, to a practical level by showing how the natural capital and produced capital subaccounts can be further stratified into sub-subaccounts (e.g., an emissions sub-subaccount in the air/atmosphere subaccount). We also present an example of the use of core indicators for each subaccount that can be supplemented with additional indicators also drawn from information contained in accounts. We used Virginia Maclaren's SOE and sustainability indicators inventory and hierarchy to create the sub-subaccounts. Such a further stratification of the subaccounts may or may not be necessary or desirable, depending on the scope of reporting desired by each community.

Figure 23: Prototype Community Environmental Sustainability Indicator Accounting System

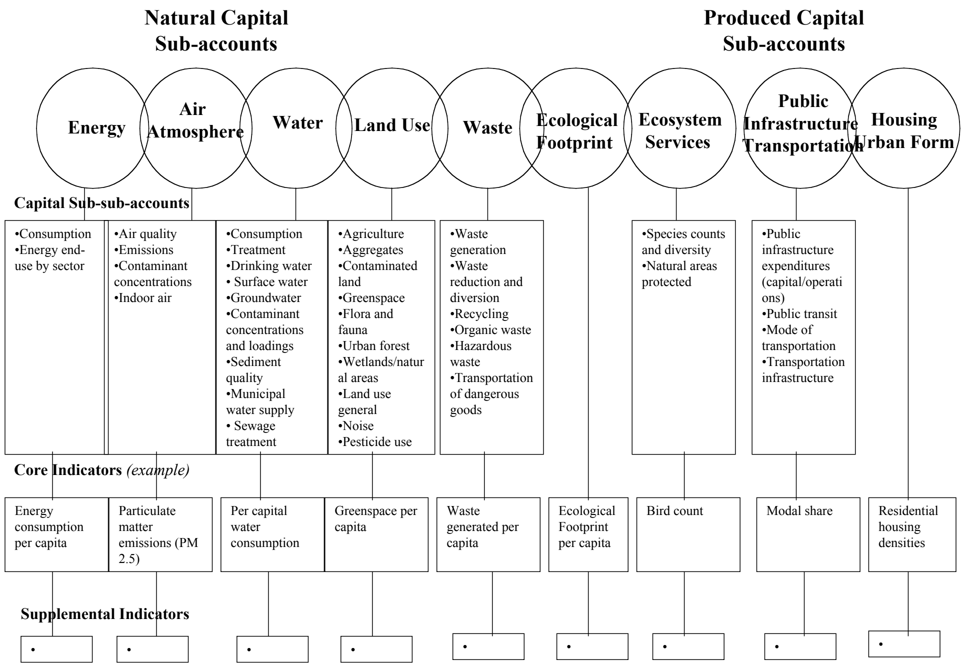


Figure 22 thus represents the suggested community sustainability measurement and accounting framework as it relates specifically to environmental issues and environmental indicators. The stratification of subaccounts and sub-subaccounts aligns with both existing municipal SOE reporting systems and would be consistent with the emerging FCM environmental indicators.

What is unique about our proposed environmental sustainability accounting framework is the use of the ecological footprint (EF) as a measure of sustainable consumption or a sustainable lifestyle. The EF provides a meaningful measure of how much land and resources the average citizen needs in order to meet their material, food, and energy demands for economic well-being. The EF can contrast the area of land required to sustain economic well-being with the ecological carrying capacity of the ecosystem it occupies. The EF also shows how much a community imports in terms of natural capital that is not otherwise available at the local level because of ecological capacity or other constraints. The EF thus stands alone as a subaccount and indicator of sustainability.

Another key potential addition to our conceptual model would be a system that could map the indicator information at various spatial scales of relevance to a community's geographic boundaries as well as in the context of eco-zones, drainage basins, or sub-basins. We did not extend our framework to consider such spatial accounting and mapping. We feel confident that other initiatives, including the StatsCan Cities Trends initiative and NRCAN's Quality of Life Mapping project will tackle this important challenge.

The conceptual framework we have developed has several advantages. First, it provides an open architecture for customization by each community, yet suggests a common framework for a national community sustainability measurement and reporting system. Second, it allows individual communities to define their core suite of sustainability indicators and supplemental indicators in accordance with local issues and community needs.

The accounts provide a wealth of information (data) that could be used by each municipality or community in providing a “place-specific” and “values-relevant” portrait of environmental quality of life and sustainability. A common domain or category set is provided, and the flexibility of indicator selection is left to the purposes and desires of each community. The capital domains we have identified are consistent with many existing measurement frameworks and would be in line with the emerging FCM environmental quality-of-life indicators.

This accounting structure provides meaningful information about the condition of the environment and trends in sustainability practices at the community level. The accounts also provide meaningful information on municipal environment-related expenditures for contrasting environmental infrastructure capital and operating expenditures across Canada. Such investments and operating expenditures might be used as a proxy for the opportunity costs of declining environmental quality and risks to sustainability.

Another key benefit of the proposed framework is that it allows for benchmarking of best practices and best environmental conditions across communities and municipalities. This provides meaningful information to environmental managers and citizens for identifying gaps in environmental stewardship.

With the environmental or sustainability accounts, populating the indicators with raw data could derive indicators. While our research found many disparate data sources and a particular reliance on municipal government and provincial government data sources, we are encouraged by the number of indicator initiatives that are emerging, including the FCM’s Quality of Life indicators, StatsCan Cities Trends project, Environment Canada’s CISE development, and the NRTEE ESDI.

Our research suggests that most communities in Canada could adopt this framework, though considerable work will be required to create common measurement methodological and reporting standards. Many communities could already populate our proposed framework with information to generate the suggested indicators and reports.

While we would seek a framework that is national in scope, the ideal system is one that allows customized environmental profiling at the individual community level. It is thus desirable to build a robust Canadian Community Environmental Information System that facilitates such customized profiles while providing the basis for a national portrait, which is the desired outcome of the FCM quality-of-life indicators system.

On a national scale, we would recommend that Environment Canada, along with other federal government departments (including Statistics Canada), focus their unified data collection and information systems development in support of the emerging Federation of Canadian Municipalities’ environmental indicators framework. The expanding FCM Quality of Life indicators series is an important resource for Canadians to compare and contrast economic, social, health, and environmental quality of life, and thus provides the greatest potential for a sustainability measurement framework. The FCM is also a recognized national body and voice for Canadian communities (currently 18 municipalities and growing), and the current process of developing an environmental indicator set for Canadian communities of municipal governments should, in our opinion, yield a commonly acceptable set of community-level environment indicators. We also recommend that the FCM environmental indicator process (i.e., FCM working group) work closely with Environment Canada and other federal and provincial ministries in supporting, with data collection and information systems, the core set of environmental indicators (i.e., 8–10 key indicators) that will emerge from a longer list of potential indicators under consideration.

We are encouraged by the efforts of Statistics Canada's Trends in Cities initiative and the NRTEE's ESDI initiative. The ESDI results may not lend themselves entirely to the purpose of community environmental indicators; however, the ESDI system should keep community reporting in mind as the project is completed. We are also encouraged by Statistics Canada's Cities project, particularly with the focus on creating spatial portraits of well-being and sustainability at the eco-zone (drainage basin) scale, which allows for the use of otherwise confidential data (the limitations of measuring quality of life at the census district scale). Indeed, spatial "mapping" of environmental quality and sustainability at the drainage basin (sub-basin and sub-sub-basin) scale makes sense from an ecosystem monitoring perspective and would lead to a more informed sense of a community's impact on the ecosystems it occupies.

Data Gaps

From our analysis of various existing municipal and community environmental and sustainability indicator initiatives, and based on Maclaren's SOE reporting inventory, we have identified some environmental data and information gaps. Our gap analysis is by no means exhaustive and needs greater resources to complete the necessary forensic analysis. Nevertheless, our preliminary analysis should provide some guidance to Environment Canada in its desire to support community sustainability measurement and reporting.

To conduct our gap analysis, we used the 34 FCM environmental indicators that are currently being short-listed by an FCM working group. While the FCM core environmental indicators may not be the definitive or comprehensive set of environmental indicators that would meet Environment Canada, provincial, or community government expectations, they will nevertheless serve as a benchmark to compare at least 18 major Canadian communities. Using existing or proposed environmental or sustainability indicators being reported by Vancouver, Calgary, Regina, Toronto, and Hamilton, we attempted to match these indicators against the natural capital domains and list of indicators proposed by the FCM.

Figure 24 shows where data currently exist or are being reported (boxes that are shaded in green) and data gaps (boxes that are not shaded). This is a preliminary analysis, but it does show data gaps in virtually every community capital domain that will need to be filled. It also reveals the differences in the capacity of municipal governments to provide a comprehensive environmental report (e.g., compare Regina's capacity to report with Calgary's or Vancouver's). Data sources for each of the municipalities assessed in this gap analysis were already identified in previous sections of the report. Combining this preliminary analysis with the extensive inventory of SOE report indicators collected by Virginia Maclaren should provide a robust gap analysis.

Figure 24: Environmental Data Gap Analysis

Community Capital Domain	Indicator	FCM Municipalities or Regions					
		Vancouver	Calgary	Edmonton	Regina	Toronto	Hamilton
Energy	1. Community energy consumption by sector: residential, commercial, industrial, transportation, waste, municipal operations, other (GJ)		Yes but not sure of sources				
	2. Per capita energy consumption; per capita energy consumption residential		Consumption is converted to Kwh				
	3. Community energy consumption by fuel type: electricity, gasoline, natural gas, propane, biomass, renewables, other		Reported in the SOE, City of Calgary; do no have renewables and gasoline (but Sustainable Calgary did have this data; barrels of oil equivalent)				
	4. Percentage of energy supplied by local sources		?				
Atmosphere	5. Particulate matter emissions (2.5 and 10 microns)		?				
	6. Nitrogen oxide, volatile organic compounds, carbon monoxide emissions		Index for Quality of Air (IQUA) NPRI and Environment Canada				
	7. Number of air quality advisories		?				
	8. Greenhouse gas emissions: Carbon dioxide (CO2), methane and nitrous oxide emissions by sector and per capita		Not available but being developed through Partners in Climate Change through FCM				
Water	9. Per capita/household consumption of water (for all uses)		City of Calgary				
	10. Surface water quality:		Alberta Government (Environment) data				
	- fecal and total coliform count		Yes				
	- dissolved oxygen		Yes				
	- total dissolved solids		Yes				
	- metals		?				
	- organic carbon		Yes				
	11. Stormwater quality:		Not available				
	- total suspended solids		Not available				
	- chemical oxygen demand		Not available				
	- total phosphorous		Not available				
	- total metals		Not available				
	12. Drinking water quality:		Limited				
	- total number of boil water orders		Not available				
	- coliform occurrence ratio		?				
	- annual average turbidity		?				
	- annual average trihalomethane concentrations		?				
	13. Total number of groundwater wells: domestic, industrial, other		Not available				
	14. Percentage of residences/industrial customers metered		Voluntary metering				
	15. Number of beach closings (in hours/days)		N/A				
	16. Area covered by watershed management plan		NO				
Transportation	17. Modal share		Yes, SOE (City)				
	18. Travel distances and time by modal share		Yes, SOE (City)				
	19. Number of streets with bike lanes (expressed in kilometers)		Not available				
	20. Vehicle occupancy		Yes, SOE (City)				
Housing and Sustainable Urban Form	21. Redevelopment to total development ratio		?				
	22. Residential and non-residential densities		Yes, SOE (City)				
	23. Percentage of population both working and living in region		Yes, SOE (City)				
	24. Annual consumption of land area for urban development		Yes, SOE (City)				
Land Use: Natural Areas, Green Space, Land Resources	25. Total (or per capita) area of park space		Yes, SOE (City)				
	26. Area, extent and connectedness of greenlands		No				
	27. Amount of contaminated polluted soils (in hectares)		? (# of sites?)				
	28. Amount of land cleared for development (in hectares/year)		Yes, SOE (City)				
	29. Amount of pesticides used/reduced		Yes, SOE (City)				
	30. Number of trees planted/year/inventory		Yes, SOE (City)				
	31. Number, area and quality of wetlands		Yes, SOE (City)				
Waste	32. Per capita amount of waste generated (residential)		Yes, SOE (City)				
	33. Total and per capita amount of waste landfilled		Yes, SOE (City)				
	34. Total and per capita material recycled		Yes, SOE (City)				

The following provides a descriptive summary of the key gaps in the emerging FCM indicators.

- **Sustainable Consumption-Based Indicators** (e.g., ecological footprint)
  With the exception of Calgary, no municipality or community has a sustainable consumption-based indicator, such as the ecological footprint, to assess the sustainability of citizen lifestyles. However, the FCM is considering the possibility of an Ecological Footprint Analysis for all 18 municipalities. The Alberta GPI accounts did include an estimate of the ecological footprints for Edmonton and Calgary, as well as for the Province of Alberta. GPI Atlantic has conducted a similar analysis for Nova Scotia.

- **Atmosphere Indicators**
  Lacking are indicators of pollutant loadings (GHGs, Criteria Air Pollutants), air toxics, and hazardous air pollutants from point sources (using NPRI data), and mobile and area sources. Such indicators could be considered in the suite of FCM atmosphere indicators. Point-source pollution data is available through the NPRI database, and Pollution Watch's Pollution Scorecard demonstrates the utility of a Web-based tool for providing spatially relevant portraits of pressures on community air quality from point sources.

- **Groundwater**
  Good groundwater qualitative (e.g., groundwater quality) and quantitative (e.g., groundwater stocks and flow (recharge) rates) information is still a serious gap in Canada's environmental database. The FCM and individual communities will need to address the shortcomings of groundwater quality data and consumption rates (not just measuring the number of wells). Fortunately, as an outcome of Walkerton, the province of Ontario represents one example of an emerging groundwater monitoring and reporting system that provides meaningful signals (indicators) to citizens and decision-makers. There is a need to address loadings from point sources (e.g., industry and sewage treatment plants). This information is partially available from NPRI, although it does not include conventional pollutants like the water analogues of criteria air pollutants (e.g., total suspended solids, biological oxygen demand).

- **Green Space and Natural Areas**
  The lack of a national accounting of the area and availability of green space across Canadian municipalities is a key data gap, as identified by the CPRN Quality of Life indicator initiative. The FCM has also identified the lack of good indicators of ecosystem health of natural areas, particularly of undeveloped areas in municipalities or metropolitan regions. Some indicator of biodiversity and ecosystem health would be helpful. For example, bird counts may serve as a proxy of ecosystem health, as the City of Calgary's annual bird count statistics might reveal. EMAN's "frogwatch" may serve as another benchmark approach for a citizen-based, voluntary approach to collecting ecosystem health indicator data. Coldwater fish populations might be interesting as a proxy indicator of riparian zone health. Hardened shorelines can also be a good indicator.

- **Wastes**
  Good measures of the impacts of waste appear to be a consistent weakness among all indicator sets, including the FCM list. There is a need to include hazardous waste generation and disposal, which may be derived from waste manifests and NPRI.

Industrial discharges to sewers are also an important data gap.

- **Urban environmental infrastructure expenditures**
  "Defensive" environmental capital and operating expenditures (water systems, sewage treatment, parks and recreation, transit expenditures, roads, pathways, etc.) could be a useful indicator or proxy for improving or declining environmental quality. In the Alberta GPI accounts, for example, we considered Edmonton's municipal water treatment expenditures per capita as a potential proxy for the "opportunity cost" of degraded water quality due to human impacts. Tracking and comparing infrastructure spending (both gross and per capita) would be of interest and benefit to all municipal governments in Canada. Such expenditures could also form the "response" category of indicators in a pressure–state–response framework.

References

Anielski, Mark. 2001a. *The Alberta GPI Blueprint: the Genuine Progress Indicator (GPI) Sustainable Well-being Accounting System*. Pembina Institute for Appropriate Development, Edmonton, Alberta. September 2001. Web site: www.pembina.org/green/gpi)

Anielski, Mark. 2001b. *Synopsis Report: Towards Edmonton Community Quality of Life Indicators*. Prepared for the City of Edmonton, Community Services Department by Anielski Management Inc., July 3, 2001. Edmonton.

Anielski, Mark. 2001c. *The Genuine Progress Indicators (GPI) Accounting Project: Charting a Sustainable Future for all Canadians*. Pembina Institute for Appropriate Development. Paper prepared for the National Round Table on the Economy and the Environment. January 2001.

Anielski, Mark. 2000. *Indicators of Success: A Framework for Reporting on the State of the Alberta Capital Region*. Report to the Capital Region Governance Review Committee. September 29, 2000. Edmonton.

Anielski, M. 1999. *The 1998 U.S. Genuine Progress Indicator Methodology Handbook.* Redefining Progress, San Francisco.

Anielski, M., et al. 2001. *Alberta Sustainability Trends 2000: Genuine Progress Indicators Report 1961 to 1999*. April 2001. Pembina Institute for Appropriate Development. Drayton Valley, Alberta.

Anielski, M. and J.Rowe. 1999. The Genuine Progress Indicator — 1998 Update. Redefining Progress, San Francisco. March 1999. Web site: http://www.rprogress.org/pubs/pdf/gpi1998_data.pdf

Anielski, M. and C. Soskolne. 2001. "Genuine Progress Indicator (GPI) Accounting: Relating Ecological Integrity to Human Health and Well-Being." Paper in *Just Ecological Integrity: The Ethics of Maintaining Planetary Life*, ed. Peter Miller and Laura Westra. Lanham, Maryland: Rowman and Littlefield: pp. 83-97.

Anielski, M. and S. Wilson. 2001. *The Alberta GPI Environmental Accounts*. Pembina Institute for Appropriate Development. Paper prepared for the National Round Table on the Economy and the Environment. April 2001.

Anielski, M. and S. Wilson. 2001. *The Alberta GPI Accounts: Forests.* Report # 20. Pembina Institute for Appropriate Development, Edmonton. September 2001.

Anielski, M., B. Campbell, and L.Duguay. 2000. *Yukon Sustainable Progress Indicators: Framework, Indicators and Implementation Approach for Reviewing the Yukon Economic Strategy*. Pembina Institute for Appropriate Development. Prepared for the Yukon Council on the Environment and the Economy, March 2000.

Brundtland, G.H. 1987. *Our Common Future*. Report of the World Commission on Environment and Development. Oxford University Press, London.

Canadian Policy Research Networks. 2002 (forthcoming). *Quality of Life in Canada: A Citizen's Report Card: Background Report*. Draft January 22, 2002. Prepared by Joseph H. Michalski for CPRN.

City of Calgary. 1998. State of the Environment Report. Web site: http://www.gov.calgary.ab.ca/environmental_management/environmental_services/state_environment.html

City of Edmonton. 2001. Edmonton's State of the Environment Report, Workshop Report, Workshop on Environmental Indicators, October 4, 2001. City of Edmonton, Office of the Environment.

City of Hamilton. Vision 2020. Sustainability Indicators. Web site: http://www.vision2020.hamilton-went.on.ca/default.htm

City of Regina. 1994. 1994 State of the Environment Report. Web site: http://www.geog.utoronto.ca/CommunityReporting/PDFfiles/SOEsummaries/Regina94SOE.pdf

City of Winnipeg. Quality of Life Indicators. Web site: http://iisd.ca/pdf/wpg.qoli.pdf

Edmonton Social Planning Council. 1999. *Edmonton LIFE — Local Indicators for Excellence*. Web site: http://www.edmspc.com/publ.htm#edmontonlife

Environment Canada. 2000. *National Pollutant Release Inventory 1998.*

Environment Canada. 1996. *Urban Air Quality*. SOE Bulletin No. 96-1. National Environmental Indicator Series. State of the Environment Directorate. Ottawa. (Cited, in Health Canada. 1997. *Health and Environment*. Health Canada. Cat. H49-112/1997E. Ottawa.)

Environment Canada. 1993. *Air Quality Trends in Canadian Cities*. 1979–1992. Web site: http://www2.ec.gc.ca/pdb/uaqt/aqfact_e.html

Federation of Canadian Municipalities. 2001. *Second Report Quality of Life in Canadian Communities*. The FCM Quality of Life Reporting System. March 2001.

Fraser Basin Council. 2000. *Sustainability Indicators for the Fraser Basin*. Workbook. October 2000. Web site: http://www.fraserbasin.bc.ca/indicators.html

GPI Atlantic: Genuine Progress Index for Atlantic Canada. Various reports, including Glace Bay and Kings County GPI project, can be found on GPI Atlantic. Web site: www.gpiatlantic.org

Hamilton Vision 2020 Sustainability Indicators. Web site: http://www.vision2020.hamilton-went.on.ca/indicators/

Hart, Maureen. 1999. *Guide to Sustainable Community Indicators: Second Edition*. Hart Environmental Data, North Andover, MA.

Informing Environmental Decisions: First Steps Toward a Canadian Information System for the Environment. 2001. The Interim Report of the Task Force on a Canadian Information System for the Environment to the Minister of the Environment. May 2001.

International Institute for Sustainable Development. 2000. *Review Paper on Selected Capital-Based Sustainable Development Indicator Frameworks*. Study prepared by Dr. Peter Hardi for the Steering Committee of the National Round Table on the Environment and the Economy Indicator Initiative.

Maclaren, Virginia. 2002. Local SOE and SOC Reporting in Canada: State of the Environment Reports. Web site: http://www.geog.utoronto.ca/CommunityReporting/SOEhome.htm

Maclaren, Virginia. 1996. *Developing Indicators of Urban Sustainability: A Focus on the Canadian Experience*. Report prepared for the State of Environment Directorate, Environment Canada; Canada Mortgage and Housing Corporation; and Intergovernmental Committee on Urban and Regional Research. ICURR Press, Toronto. January 1996.

Maclaren, Virginia, Monica Campbell, and Wendy Dickinson. 1994. *Municipal State of the Environment Reporting in Canada: Current Status and Future Needs.* Ottawa: State of the Environment Reporting. 1994.

Meadows, Donella. 1998. *Indicators and Information Systems for Sustainable Development*. A Report of the Balaton Group. September 1998. The Sustainability Institute, Hartland Four Corners, VT.

Morton, Peter. 2001. *National Atlas of Canada: Quality of Life Mapping Proposal.* Natural Resources Canada.

National Round Table on the Environment and the Economy. 2002. Environmental and Sustainable Development Indicators Initiative: Steering Committee Synthesis Report. Prepared by Stratos Inc. April 26, 2002.

National Round Table on the Environment and the Economy. 2002. *Draft Final Report: Land and Soils Cluster Group*. Prepared by Delaney and Associates for the NRTEE Environment and Sustainable Development Indicators Initiative. February 13, 2002.

National Round Table on the Environment and the Economy. 2002. *Non-Renewable Resource Indicators for the ESDI Initiative*. Draft final report prepared by Gregg Sheehy, Environmental Consultant for the NRTEE Environment and Sustainable Development Indicators Initiative. February 13, 2002.

National Round Table on the Environment and the Economy. 2002. *Draft Final Report: Air Resources Cluster Group*. Draft report prepared by DSS Management Consultants Inc. for the NRTEE Environment and Sustainable Development Indicators Initiative. March 13, 2002.

National Round Table on the Environment and the Economy. 2002. Draft Final Report: Air Resources Cluster Group. Draft report prepared by DSS Management Consultants Inc. for the NRTEE Environment and Sustainable Development Indicators Initiative. March 13, 2002.

National Round Table on the Environment and the Economy. 2002. *Water Resources Cluster Group Final Report*. Draft report prepared by Gardner Pinfold Consulting Economists Ltd. for the NRTEE Environment and Sustainable Development Indicators Initiative. March 19, 2002.

National Round Table on the Environment and the Economy. 2002. *Final Report for the Human Capital Cluster Group*. Draft report prepared by Weiqiu Yu, Department of Economics, University of New Brunswick, for the NRTEE Environment and Sustainable Development Indicators Initiative. March 1, 2002.

OECD. 2001. *The Well-Being of Nations: The Role of Human and Social Capital*.

Pollution Watch Canada. Pollution Watch Scorecard. Web site: http://www.scorecard.org/pollutionwatch/

Robinson, J.B., D. Biggs, and M. Walsh. "QUEST: Quite Useful Ecosystem Scenario Tool," forthcoming in *Electronic Series on Integrated Assessment Modelling,* ed. J. Rothmans and H. Dowlatabadi. Bilthoven. Netherlands: National Institute for Public Health and the Environment (RIVM).

Smith, Robert, C. Simard, and A. Sharpe. 2001. *A Proposed Approach to Environment and Sustainable Development Indicators Based on Capital*. Prepared for the National Round Table on the Environment and the Economy's Environment and Sustainable Development Indicators Initiative. January 2001.

Statistics Canada. 2001. *Econnections: Linking the Environment and the Economy; Indicators and Detailed Statistics, 2000.* (Cat. No. 16-200-XKE)

Statistics Canada. 1999. Waste Management Industry Survey, Business and Government Sectors, 1998. Ottawa: Statistics Canada. (Cat. No. 16F0023XIE)

Statistics Canada (Environment Accounts and Statistics Division). 2001. *Human Activity and the Environment 2000*. Ottawa: Statistics Canada. (Cat. No. 11-509-XPE).

Stratos Inc. 2002. National Round Table on Environment and Economy, Environment and Sustainable Development Indicators Initiative: Steering Committee Synthesis Report. NRTEE Steering Committee meeting, April 26, 2002. Ottawa, Ontario

Sustainable Calgary. 2001. State of Our City Report. Web site: www.telusplanet/public/sustcalg)

Taylor, M. and M. Anielski. 2001. *The Alberta GPI Accounts: Public and Household Infrastructure.* Report #5. Pembina Institute for Appropriate Development, Edmonton, Alberta. September 2001.

Wilson, J. and M. Anielski. 2001. *The Alberta GPI Accounts: Ecological Footprint.* Report #28. Pembina Institute for Appropriate Development. September 2001. Web site: http://www.pembina.org/green/gpi/

Wilson, S., M. Griffiths, and M. Anielski. 2001a. *The Alberta GPI Accounts: Energy Use, Intensity, Greenhouse Gas Emissions, and Air Quality*. Report #26. Pembina Institute for Appropriate Development. September 2001.

Wilson, S., M. Griffiths, and M. Anielski. 2001b. *The Alberta GPI Accounts: Municipal and Hazardous Waste*. Report #28. Pembina Institute for Appropriate Development. September 2001.

Wilson, S., M. Griffiths, and M. Anielski. 2001c. *The Alberta GPI Accounts: Water Resource and Quality*. Report #24. Pembina Institute for Appropriate Development. September 2001. Web site: http://www.pembina.org/green/gpi/

Appendix A

Municipal Quality of Life Indicators and State of the Environment Reports

A1. Hart's Sustainable Community Indicators

Figure 25: Hart's Sustainable Community Indicators List

ECONOMY		
General Business Indicators		
Sustainability Indicators		*Traditional Indicators*
Ecological footprint		Gross Domestic Product
Hours of work at the average wage required to support basic needs		Median income per capita or per family
Employer payroll dedicated to training/education		Net job growth
Percent of employment by top five employers		Number of business permits issued per year
Per capita savings		Cost of electricity
Per capita debt		
Distribution of personal income		
Number of parents with satisfactory day care arrangements		
Sales of locally produced food		
Amount of local credit available		
Rate at which material is extracted from earth compared to rate of redeposition		
Rate at which renewable resources are used compared to renewal rate		
Production Indicators		
Sustainability Indicators		*Traditional Indicators*
Percent of material used in production from renewable resources harvested sustainably		Gross Domestic Product
Number of tourism jobs per tourist paying a living wage		Number of housing starts
Amount of energy used, per product and total for the company, including external use (commuting, transportation of inputs and outputs)		Cost of energy
Acres of farmland or forest managed sustainably versus unsustainably		Number of units sold or dollars earned
Fish harvest rate compared to the growth rate of fish		
Number of housing units built at different income levels compared to the number of people at those levels		
Cost of products compared to true cost to society and environment		
Energy Indicators		
Sustainability Indicators		*Traditional Indicators*
Total and per capita energy use		Cost of electricity, gasoline, natural gas, or oil
Percent reduction in energy use from non-renewable resources		Total amount of oil extracted
Percent of energy that comes from renewable sources used renewably		Cost of electricity to industry compared to national average
Heat loss from buildings (residential, commercial, governmental, and industrial)		
Average miles per gallon of private automobiles		
Energy use by industrial sector compared to number of jobs provided by sector		
Number of energy-using devices per household		
Percent of vehicles fueled with renewable energy		

Percent of energy coming from local renewable resources		
Emissions of greenhouse gases from transportation		
Transportation Indicators		
Sustainability Indicators		*Traditional Indicators*
Number of new housing or business development within five minutes of public transit		Waiting time at intersection
Number of new housing units clustered near compatible business development		Average speed on the road
Percent of population able to walk or bike to work, school, or shopping		Motor vehicle registrations
Ratio of tourists to local residents		Number of cars on the road
Amount of tax dollars spent on subsidizing single-occupancy vehicle use versus public transit		Percent of highways built to handle steady 55 mile per hour traffic flow
Percent of streets with adequate pedestrian and bicycle facilities		Number of people living within 50 miles of daily air passenger service
Ratio of fuel-efficient to fuel-inefficient vehicles, renewably fueled vehicles to non-renewably fueled vehicles, and low-emission to high-emission vehicles		Number of daily flights in and out of local airport
Percent of commuters using public transportation		Number of tourists or amount of dollars from tourism
Percent of workers living within 30 minutes of work		
Percent of land devoted to "car habitat"		
Change in vehicle miles traveled, total and per person, over time		
SOCIETY		
Education Indicators		
Sustainability Indicators		*Traditional Indicators*
Adult literacy rate		Operating expenditures per student
Participation in continuing and adult education classes		Scholastic Achievement Test scores
Number of lower-paid workers in employer-sponsored training		School dropout rates compared to state average dropout rate
Number of students who move during the school year		Total employment in education
Tuition cost as a percent of disposable income		Teacher Salaries
Ethnic/gender diversity of teaching staff		
Ethnic/gender diversity of elected and appointed officials		
Technical school graduates employed in field		
Government, Participation, Volunteerism, Cooperation Indicators		
Sustainability Indicators		*Traditional Indicators*
Percent of registered voters who vote in local elections		Personal or business tax rate
Number of elected officials who run unopposed		Voter registration
Number of residents involved in civic activities		Government expenditures per person
Racial and gender diversity of elected and appointed officials		
Adult literacy rate		
Amount of legislation and regulation enacted to encourage sustainable practices compared to those that encourage non-sustainable behaviour		

Amount that government agencies practise sustainable behaviour (recycling, buying recycling, redevelopment of land, energy conservation, etc.)		
Health Indicators		
Sustainability Indicators		*Traditional Indicators*
Percent of population that is physically active		Health care expenditures
Young female (age 14-17) pregnancy rate		Percent of population that smokes
Births to women with inadequate prenatal care		Number of hospitals within a certain number of miles of a community
Number of parents with satisfactory day care arrangements		Number of hospital beds
Non-emergency visits to emergency room		
Adult literacy rate		
Number of people or percent of population unable to afford health care		
Housing Indicators		
Sustainability Indicators		*Traditional Indicators*
Number of housing units available at different price ranges compared to number of families able to afford those price ranges		Number of housing starts
Percent of renters paying more than 30 percent of income for housing		Median value of houses in community
Distribution of affordable housing throughout the community compared to distribution of jobs		Waiting time for subsidized housing
Heat loss from residential buildings		Property tax rate
Number of housing units meeting energy efficiency standards		
Number or percent of owner-occupied housing units		
Number of housing units within walking distance of existing schools		
Percent of housing units built using renewable resources and green design principles		
Public Safety Indicators		
Sustainability Indicators		*Traditional Indicators*
Number of Neighbourhood Watch associations		Number of full-time state and local police
Number or percent of police on foot or on bicycles		Number of childcare slots available
Number of neighbourhood associations with a broader focus than crime prevention		Amount of money spent on crime prevention or mitigation
Number of convicted criminals who receive educational assistance		Average response time for emergency calls
Number of jobs at different education levels compared to number of people at different education levels		Number of reported crimes (violent, personal, property)
Number or percent of parents with satisfactory day care arrangements		
Number or percent of teens participating in volunteer efforts		
Recreation and Culture Indicators		
Sustainability Indicators		*Traditional Indicators*
Park and facility space per person by district or neighbourhood		Total seating for public visual/performing arts
Number of tourism establishments that are locally owned		Acres of parkland
Number of people using facilities on a daily, monthly, or yearly basis compared to the optimum number of users		Funding amount for recreational facilities
Number of jobs per tourist		Number of dollars spent by tourists

Percent of tourist dollars remaining in community		Number of people using facilities on a daily, monthly, or yearly basis
Number of tourism-related jobs with benefits that pay a living wage		
Amount of energy and water used and waste and wastewater generated per tourist		
Number of community gardens, community gardeners, and amount of food produced		
Number of people who feel they can rely on other members of their community		
ENVIRONMENT		
Ecosystem Indicators		
Sustainability Indicators		*Traditional Indicators*
Percent of land area that is impervious (roads, buildings, parking lots)		Number of permits issued
Percent of native plant species that are endangered versus healthy		Bags of highway litter collected per mile
New housing developments within five minutes of stores, transit, schools, etc.		Number of days with air quality in the "good" range
CO_2 emissions as percent of 1990 emissions		
Gallons of water used per day compared to available supply		
Number of acres of prime or unique farmland lost over the long term		
Population Indicators		
Sustainability Indicators		*Traditional Indicators*
Number of people in different age, ethnic, and economic groups within community		Number of people moving into or out of an area
Number of children per family compared to family's ecological footprint and global average ecological footprint		Number of people
Population growth rate		
Population density		
Availability and knowledge of birth control measures		
Adult literacy rate		
Land Use Indicators		
Sustainability Indicators		*Traditional Indicators*
Percent of land area that is impervious (roads, buildings, parking lots)		Number of subdivisions created
Percent of land in different uses: natural, wilderness, open space; sustainable vs. conventional farming; forestry, housing, transportation, commercial, industrial, degraded; contaminated; vacant lots		Number of building permits issued
New developments within five minutes of stores, transit, schools etc.		Total value of all land in community
Percent of development occurring in sensitive areas (wetlands, flood plains, prime farmlands, coastal zones)		
Resource Use Indicators		
Sustainability Indicators		*Traditional Indicators*
Total water use by humans compared to amount of water available for all uses		Sewage generation rates
Percent reduction in energy use from non-renewable sources		Solid waste generation rates
Percent and volume of waste converted back to beneficial uses		Energy expenditure as percent of GDP
Per person and total energy use		Cost of energy

Per person emissions of CO_2 compared to "Earth fair share"		Cost of material
Rate of harvest of fish compared to fish reproduction rate		Cost of water
Rate of harvest of timber compared to rate of regrowth		Cost of waste disposal
Acres of farmland or forest area being sustainably managed		Water use or wastewater treatment as percent of capacity of treatment plant
Percent of timber products or food coming from sustainably managed forests and farms		Number of people recycling
Percent of material goods designed to be recycled and then actually recycled		Percent of waste recycled
		Amount of proven reserves of fossil fuels or minerals

Source: Hart, Maureen. 1999. *Guide to Sustainable Community Indicators, Second Edition*. Hart Environmental Data. North Andover, MA.

A2. Maclaren's Canadian Municipal/Regional State of the Environment Report Indicators

Virginia Maclaren surveyed a number of Canadian municipalities or regions, yielding the following extensive list of economic, social, and environmental indicators (Figure 19) that are being reported across the country. This provides a glimpse of the scope and scale of existing reporting in Canada prior to this study. The list suggests there may be pockets of environmental, economic, and social data that could be unified in a common municipal and community sustainability and environmental reporting system.

Maclaren surveyed the following Canadian municipalities or regions to yield the indicators inventory:

1. Capital Region District (Victoria), B.C.
2. Vancouver, B.C.
3. Kelowna, B.C.
4. Calgary, Alberta
5. Regina, Saskatchewan
6. Sudbury, Ontario
7. Burlington, Ontario
8. Brant County, Ontario
9. Kingston, Frontenac, Lennox & Addington, Ontario
10. Wellington-Dufferin-Guelph, Ontario
11. Ottawa-Carleton, Ontario
12. Durham (includes Oshawa), Ontario
13. Waterloo, Ontario
14. Peel (includes Mississauga, Brampton, Caledon), Ontario
15. Middlesex-London, Ontario
16. Halton, Ontario
17. Hamilton-Wentworth, Ontario
18. York, Ontario
19. Toronto, Ontario
20. Communaute Urbaine de Montreal, Quebec
21. Beancour, Quebec
22. Maurice-Bois-Francs, Quebec (area between Montreal and Quebec City)

Figure 26: Virgina Maclaren's Survey of Canadian Municipal/Regional Economic, Social, and Environmental Indicators Reported in State of Environment or Other Reports

ECONOMIC Indicators	
Domain	**Indicators**
Economic: Employment	Bankruptcies and layoffs
	Employment by occupation
Economic: General	City corporation assets
	City corporation expenditures
	Consumer confidence
	Degree of self-containment
	Income
	Inflation
	Poverty
	Revenue from sport fishing industry
	Taxation rate
	Tourism
Economic: Land Use	Building permits
	Census farm capital
	Cost of agricultural fertilizer
	Cost of road construction and maintenance
	Cost of transit system
	Farm income and expenses
	Quality of converted agricultural land
	Cost of tree planting
	Urban forest budget
Economic: Pollution Control	Beaches clean-up program
	Cost of forest fire management
	Cost of land reclamation
	Cost of municipal source control
	Cost of PCB destruction
	Cost of recycling programs
	Cost of sewer/STP upgrades
	Fee per can of excess refuse
	Grants awarded
	HHW Collection Sessions 2
	Landfill tipping fees
	Revenue from sales of recyclables
	Spill response and prevention
	Water metres economics
HEALTH Indicators	
Domain	**Indicators**
Air Pollution	Public perception of air quality
Emotional	Self-reported wellness
	Social supports
	Stress
	Suicide rates
Exposure to Radiation	Distance to nuclear power facilities
	Exposure to electromagnetic fields
	Exposure to UV radiation
	Food irradiation
Health: General	Alcohol and drugs
	Births
	Body Mass Index (BMI) measure of obesity

	Deaths
	Diet
	Disease rates
	Immunization rates
	Mortality/morbidity rate
	Physical activity
	Smoking
	Teen pregnancy rate
Motor Vehicle Accidents	Traffic accidents
Nutrition	Food safety
	PCBs in food
	Pesticides in food
Poisoning	Aluminum exposure
	Calls to poison control
	Lead exposure
Respiratory disease	Chronic respiratory conditions
	Respiratory conditions
SOCIAL Indicators	
Domain	**Indicators**
Access to Health and Social Services	Acute care
	Child care
	Long-term care waiting list
	Mental health services
	Mobility (access to transit)
	Nutrition
Crime	Crime rate
	Fire protection
	Police force
	Public perception of safety
	School safety
Demographic	Age/sex distribution
	Family size
	Religious/ethnic distribution
Education	Education level
Governance	Public input to policy
	Voter participation
Housing	Affordability of housing
	Amount of commercial space
	Average area of residential land
	Average dwelling size
	Dwelling units
	Dwelling value
	Extent of residential area development
	Household type (married, children, lone parent)
	Housing availability
	Housing density
	Mix of housing types
	Residential units per hectare
Population	Number of households
	Number of people working in city
	Annual population growth
	Farm/rural and non-farm/urban population
	Population
	Population density
Recreation	Average provision of parkland
	Distribution of parks
	Estimated park use
	Open space recreation
	Predicted population growth and green space

	Publicly accessible waterfront
	Recreation facilities
	Recreation in green space
	Satisfaction
	User pay systems
Social Employment	Employment by occupation group
	Employment by sector
	Employment diversity
	Employment growth
	Employment rates by age, sex, and ethnicity
	Labour force diversity
	Number of welfare cases
	Unemployment rate
	Workforce composition
	Workplace density
ENERGY Indicators	
Domain	**Indicators**
	Biomass energy
	Electricity use
	Energy production infrastructure
	Energy source
	Energy supply
	General energy consumption
	Hydroelectricity sales
	Industrial energy consumption
	Natural gas consumption
	New homes with natural gas
	Nuclear energy
WASTE Indicators	
Domain	**Indicators**
Hazardous Waste	Biomedical waste generation
	Hazardous and special wastes
	Hazardous materials storage
	Industrial hazardous waste generation
	Inventory disposal
	Scrap tires
Household Hazardous Waste	Amount of HHW collected
	Amount of HHW generated
	HHW collection sessions
	HHW disposal sites
	Inventory of household hazardous wastes
Incineration/Fuel-Derived Waste	Amount incinerated
	Refuse-derived fuel
Organic Waste Management	Composters
	Yard waste
Recycling Programs	Number of recyclables diverted
	Number of refrigerators and freezers collected for refrigerant removal
	Catch basin and manhole cover recycling program
	Markets for recyclables
	Recycling programs
	Telephone directories
Snow-Related Waste	Amount of snow
	Contaminant concentrations of snow
	Snow disposal
	Use of road salt
Transportation of Dangerous Goods	Number of hazardous spills
	Gasoline storage
	Spill response/prevention

	Transportation of dangerous goods
Waste Collection	Composition of municipal waste
	Municipal waste pick-up
Waste Generation	Litter production
	Livestock manure
	Solid waste generation
	Total industrial and commercial waste
Waste Reduction and Diversion	Amount diverted from municipal stream
	Participation in waste reduction programs
	Projected apartment buildings included in waste reduction program
LAND USE Indicators	
Domain	**Indicators**
Aggregates	Area of land pit licensed
	Closed pits requiring remediation
	Pit extraction licences
	Resources of crushed stones
	Sand and gravel removal
	Total amount of aggregates produced
Agriculture	Agricultural land by use
	Agricultural land protected from development
	Agricultural land soil types
	Agricultural water use
	Area of farms
	Average farm size
	Crop type
	Environmentally sustainable farming practices
	Farm land area rented
	Loss of agricultural land by use
	Manure spreading
	New farmland (area of natural land converted)
	Number of animals
	Number of farms
	Participation in Ontario Environmental Farm Plan Program
	Proportion of total land area classified as farmland
Contaminated Lands	Amount of contaminated soil treated
	Number of PCBs in use
	Area of contaminated land
	Coal tar gasification sites
	Coal tar gasification sites cleaned up
	Contaminated sites not suited for redevelopment
	Current uses of former sites
	Former industrial sites
	Former mining sites
	Hazardous spills
	Lake-filled lands
	Land reclamation
	Locations of PCBs in use
	PCB concentration in landfill leachate
	PCB storage sites
	Reuse of sites containing soil polluting activity
	Sites cleaned up
	Sites likely to have produced or handled hazardous wastes
	Sites under assessment
	Soil acidity of barren lands
	Soil concentration of lead
	Soil radiation contamination
	Underground tanks containing fuel removed
Flora and Fauna	Birds

	Butterflies
	Endangered species
	Fish
	Fish population size
	Fish spawning
	Herpetofauna
	Invertebrates
	Mammals
	Rare vascular plants
	Riparian zone vegetation
	Species diversity
	Vegetation contamination
Green Space	Area in conversion areas
	Area of green space
	Conservation areas and parks
	Current zoning of greenway systems
	Designated ravine lands
	Greenbelt
	Greenway system
	Local greenland studies
	Naturalization of public lands
	Nature trails
	Publicly owned green space
Land Use: General	Activity before conversion
	Biophysical impact assessments
	Building density
	Buildings
	Conversion of rural to urban land
	Health of downtown areas
	Human settlement patterns
	Impervious area
	Land area by land use
	Land area by land zoning
	Land cover
	Paved area
	Quality of converted agricultural land
	Quality of urban environment
	Urban form diversity
	Use of newly converted land
Noise	Airport noise
	Noise complaints
	Resident exposure to noise
Open Space	Open space
	Ownership of vacant land
Pesticides	Agricultural pesticides
	City policy on pesticide use
	General pesticide use
	Pest control in buildings
	Pesticide licences
	Use by municipality
Transit	Population served
	Ridership
	Transit infrastructure (number of vehicles)
Transportation	Number of vehicles
	Number of vehicles commuting
	Average length of car trips
	Bicycle lanes
	Car trips
	Carpool lanes

	City corporation transport
	Commuting distance
	Length of bicycle routes
	Length of roads
	Modal split
	Number of drivers
	Parking services
	Peak period traffic
	Pedestrian-friendly streets
	People carpooling
	Retail fuel sales
	State of roads
	Total transportation area
	Traffic flow (number of traffic lights)
	Transport-related fuel consumption
	Vehicle occupancy rate
Urban Forest	Number of trees
	Area of forested land
	Average canopy coverage
	Condition of trees
	Farm woodlots
	Forest fires
	Inventory of insects and disease
	Life span of trees by location
	Minimum number of street trees planted
	Neighbourhoods with few trees
	Ownership of urban forest
	Proportion of farm woodlot to total wooded area
	Tree gain/loss
	Tree inventory
	Tree plantings
	Tree stocking target
	Trees adjacent to construction sites experiencing damage
Wetlands and Natural Areas	ANSIs
	Area of Crown land
	Area of local watershed
	Area of wetlands
	Constructed wetlands
	ESAs
	Loss of wetlands
	Nature interpretive programs
	Number of EIAs completed near ESAs
	Number of evaluated wetlands
	Significant landforms
	Significant wetlands
	Wetland area filled
	Wetland drainage
WATER Indicators	
Domain	**Indicators**
Consumption and Treatment	Amount treated
	Efficiency of water treatment
	Need for sprinkling bans
	Treatment plant connections
	Water conservation
	Water consumption
	Water metres
	Water treatment plants
General Water Quality and Quantity	Acidity of lakes
	Algal blooms

	Area of watershed
	Bacterial contamination
	Biological productivity
	Composite water quality index
	Suitability for aquatic biota
	Contamination of fish
	Depth of lake
	Duckweed
	Exotic species established
	Biodiversity
	Dissolved oxygen
	Temperature
	Land use in watershed
	Mitigation measures
	Monitoring measures
	Monitoring organizations
	Number of beach postings
	Number of residential lots on lakes
	PCB levels in herring gull eggs
	Rainfall
	River flow
	Shoreline land use
	Stream protection
	Surface area of lake
	Turbidity
	Water budgets
	Watershed management planning
Groundwater	Bacterial contamination of groundwater
	Dependence on groundwater
	General groundwater quality
	Giardia contamination of groundwater
	Groundwater clean-up programs
	Groundwater arsenic
	Groundwater calcium
	Groundwater chlorine
	Groundwater iron
	Groundwater flouride
	Groundwater hardness
	Groundwater manganese
	Groundwater magnesium
	Groundwater nitrates
	Groundwater NMDA
	Groundwater organics
	Groundwater pesticides
	Groundwater phenols
	Groundwater sodium
	Groundwater sulfur
	Groundwater supply and demand
	Groundwater testing
	Perception of groundwater quality
	Quality of water from private wells
Contaminant Concentration	Iron
	Aluminum
	Ammonia
	Arsenic
	BOD (Biological Oxygen Demand)
	Cadmium
	Chlorine
	Chromium

	COD (Chemical Oxygen Demand)
	Colour
	Conductance
	Copper
	Cyanide
	Fecal/Total coliform
	Hardness
	Lead
	Mercury
	Mirex
	Nickel
	Nitrate and nitrite
	Nitrogen
	PCB
	Pesticides and herbicides
	pH
	Phenols
	Phosphorous
	Total Organic Carbon
	TSP
	Zinc
Loadings	Acid loadings
	Ammonia loadings
	BOD loadings
	Coliform loadings
	Copper loadings
	Cyanide loadings
	Electronics industry loadings
	General discharges
	Hydrogen sulfide loadings
	Industrial discharges
	Iron loadings
	Lead loadings
	Lindane loadings
	Nutrient loadings to streams
	Phenol loadings
	Phosphorous loadings
	Pulp and paper industry loadings
	STP effluent loadings
	TKN loadings
	TSS discharge
	Zinc loadings
Municipal Water Supply	Aluminum in drinking water
	Ammonia in drinking water
	Amount of water supplied
	Atrazine in drinking water
	Cadmium in drinking water
	Cancer attributable to THN (trialomethane) from chlorinated drinking water
	Capacity of water source
	Chlorine residuals
	Chromium in drinking water
	Colour of drinking water
	Copper in drinking water
	Cryptosporidium in drinking water
	Fecal coliform in drinking water
	Fluoridation effectiveness
	Fluoride in drinking water
	General drinking water quality

	Giardia in drinking water
	Hardness of drinking water
	Iron in drinking water
	Sodium in drinking water
	Nitrates/nitrites in drinking water
	NMDA in drinking water
	PAH in drinking water
	Lead in drinking water
	PCBs in drinking water
	Public perception of drinking water quality
	pH of drinking water
	Phosphates in drinking water
	Phosphorous in drinking water
	Phtalates in drinking water
	Quality of bottled water
	Radio nucleotides in drinking water
	Source of municipal water supply
	Sulfates in drinking water
	Temperature of drinking water
	Tests of drinking water
	THM in drinking water
	Turbidity of drinking water
	Zinc in drinking water
Sediment Quality	Aluminum in sediments
	Arsenic in sediments
	Cadmium in sediments
	Chromium in sediments
	Copper in sediments
	General sediment quality
	Iron in sediments
	Manganese in sediments
	Mercury in sediments
	Nickel in sediments
	PAH in sediments
	Lead in sediments
	PCBs in sediments
	Phosphorous in sediments
	Radiation in sediments
	Sediment contaminant index
	Total organic carbon in sediments
	Toxicity to Daphnia Magna
	Waterfront sediment quality
	Zinc in sediments
Sewage Treatment	Destination of processed municipal sewage sludge
	Discharge of sewage
	Effluent monitoring
	Industrial sewer use compliance
	Private septic systems
	Sanitary sewers
	Sewage treatment efficiency
	Sewer replacements
	Storm water
	STP (Sewage Treatment Plant) effluent quality
	STP status
Sewage/Water Treatment Infrastructure	Number of manholes
	CSO (combined sewer outfalls) separation
	Length of water mains, sewer pipes, run-off pipes, and catch basins
	Number of CSOs

	Quality of private wells
	Sewered area
	Status of residential private water supply
	Water main breaks
AIR Indicators	
Domain	**Indicators**
Contaminant Concentration	Acid aerosols
	Benzoapyrene
	CFC consumption
	Carbon monoxide
	Coefficient of haze
	Dust fall
	Fluoridation rate
	Fluoride
	Hydrogen sulfide
	Lead in TSP
	Manganese
	Nickel
	Nitrogen oxide
	Nitrogen dioxide
	Ozone
	PAH
	Lead
	PCBs
	PM 10 (particulate of diameter less than 10 microns)
	PM 2.5 (particulate of diameter less than 2.5 microns)
	Pollen
	Respirable particulate
	Sulfur dioxide
	Stratospheric ozone
	Sulfate in TSP
	Total hydrocarbons
	Trace metals in TSP
	TRS (total reduced sulfur)
	TSP
	VOC (volatile organic compounds)
Emissions	Aircraft emissions
	Automotive emissions
	Carbon monoxide emissions
	Carbon dioxide emissions (CO_2)
	Commercial emissions
	Dry cleaning emissions
	Electrical utilities emissions
	Fire emissions
	Incineration emissions
	Industrial emissions
	Landfill emission of CO_2
	Manufacturing emissions
	Marine emissions
	Nitrogen oxide emissions
	Ozone emissions
	Off-highway engine emissions
	Railroad emissions
	Residential emissions
	Sulfur dioxide emissions
	Space-heating emissions
	Surface-coating emissions

	Total annual emissions
	TSP emissions
	Vehicle emissions
	Vehicle lead emissions
	Vehicle manganese emissions
	VOC emissions
General Air Quality	Air quality advisories
	Air quality index
	Ambient air temperature increase (global warming)
	Monitoring stations
	Public perception of air quality
	Standards and exceedances
	Ventilation standards
Indoor Air	Asbestos
	City building indoor air
	Complaints
	ETS (environmental tobacco smoke)
	General indoor air
	Radon concentrations
	RSP Concentrations (respirable suspended particulate)
	Time spent indoors

A3. Summary of Canadian and U.S. Municipal, Regional, and State Quality of Life and Sustainability Indicators

The following inventory and comparative analysis of Canadian and U.S. municipal, state, or regional economic, social, and environmental indicators was completed by Anielski (2001) for the City of Edmonton in developing quality-of-life indicators for Edmonton. The list provides a useful conceptual framework for organizing quality of life and sustainability indicators.

The following grid compares indicators adopted by the Buffalo-Niagara Region; Jacksonville, Florida; Orlando & Orange County, Florida; Pierce County, Washington; and Sustainable Calgary and Edmonton LIFE (Local Indicators for Excellence) compared with the quality-of-life indicators developed by the Federation of Canadian Municipalities (FCM) for 16 large urban centers (note that the FCM indicators are based on the FCM 2001 Quality of Life Indicators report and do not include environmental indicators). The FCM indicators represent 16 reporting municipalities. This grid shows the range of indicators that are potentially applicable at a municipal or community scale to measure quality of life and sustainability.

Figure 27: Canadian and U.S. Community Economic, Social, and Environmental Indicators Comparative Grid

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
ECONOMY								
Employment	Employment concentration by sector (manufacturing, technical, managerial, and professional)				1.3			[20]
	Unemployment rate by age group							
	Labour force participation (% employed compared to total population)							
	Net job growth				1.1			
	Total wage and salary jobs per employed resident							
	Number of basic industry jobs							
	Employment rate by age group							
	Permanent, temporary, and self-employment as % of population, % of total employed, and by age and sex							
	Percent of unemployment that is long term							
Income and Wages	Hours (average earnings) required to meet basic needs at minimum wage (population with adequate after-tax disposable income to meet basic needs)							
	Median hourly wages by age and sex							

[20] Percent of wage and salary jobs not in 5 most concentrated industries

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
	Weekly earnings (per job)				■ 1.2			■
	Employment income as % of total income			■				
	Manufacturing wage and salary earning as % of total income							■
	Manufacturing wage and salary jobs as % of total jobs							■
	Income distribution: disparity in family annual income (% of families with income in income quintiles)		■				■	
Employment Insurance and Social Assistance	Percent receiving employment insurance and social assistance, by family type			■				
Financial Health — Bankruptcy	Personal and business bankruptcy			■				
	Municipal expenditure on debt (debt servicing as % of municipal expenditures)		■					
Cost of Living — Food	Cost of a nutritious food basket (average weekly cost to purchase an assortment of food that provides a nutritious dietary balance by age group)		■		■ 1.5	■ *[21]		
Cost of Living — Housing	Housing affordability (home ownership)	■					■	■ [22]
	Median family income as a % of average value of dwelling (price and mortgage payments)			■		■		■
	Median non-family person income as a % of average rent of a two-bedroom apartment			■				■
	Median family income as % of average property tax on single family house							■
	Average rent of a two-bedroom apartment as % of medium family income			■			■	
	Gross rent spending (30% or more of household income on shelter costs)			■				
	Residential property tax per capita			■				
	Taxable real estate value (per capita)					■		■
	Housing starts					■		
	Real estate sales per capita			■				
	Average annual multi-family housing vacancy rate							■
	Number of subsidized housing units per person							■
Cost of Living - Utilities	Real household monthly service charge for wastewater treatment							■
	Real household connect charge for wastewater treatment							■
	Average monthly residential solid waste charge							■

[21] Cost of 1,000 KWH of electricity
[22] Percent of households able to afford buying median single-family house

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
Poverty	Food bank demand - number of people dependent on food banks				8.1[23]			
	Percentage of families that are low-income (LICO)							
	Child poverty							
	Students in free/reduced lunch programs							
	Providing shelter				8.2			
Business and Commerce	Number of business establishments							
	Net business creation (# new businesses established less businesses retired)							
	Development activity (housing starts, commercial, industrial, institutional, residential, and miscellaneous permits)							
	Emerging industry research and development patents (employment from research and development and no. patents)				Patents			
	Retail sales per capita (and as % of personal income)							
	Air traffic (number of passengers visiting and leaving Edmonton International Airport)							
	Tourism/bed tax revenues)							
	Airfares				1.7			
	Corporate revenues spent on training							
	Cost of doing business				1.4			
	Trade: foreign exports				1.6			
	Venture capital				5.7			
	Value of industrial and commercial property							
	Value of business personal property per worker							
Government	Local government employment				3.1			
	Local government revenue sources				3.2			
	School district revenue sources				3.3			
	Local government debt				3.4			
	Cost containment				3.5			
	Bond ratings				3.6			
	Award-winning financial reporting				3.7			
	Property revaluation				3.8			
	Regional cooperation				3.9			
	City human services expenditures per capita							
	Positive image of government							
	People feel comfortable voicing opinion							
	People who rate local government leadership as good/excellent							
	People who feel local public services are effective and interested							
Planning	Master planning and zoning				10.7			

[23] Feeding the hungry

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
	Alternative planning tools				10.8			
	County and regional planning				10.9			
	Planning coordination				10.10			
Transportation	Public transit usage				10.6			
	Average transit trips per hour per bus							
	Private vehicle usage (vehicle miles traveled)							
	Road conditions				10.5			
	Average commuting time							
	Number of persons per passenger car							
	Miles of road in urban/city per vehicle miles traveled							
	Miles of state road in rural county per vehicle miles traveled							
Technological Infrastructure	Internet infrastructure				5.1			
	Computer use				5.2			
	Regional internet presence				5.3			
	Technology-based businesses				5.4			
	Technology workforce				5.5			
SOCIETY-COMMUNITY								
Arts, Leisure, Recreation, and Culture	Hours of leisure relative to hours of work per week							
	Leisure activities (attendance and participation in social and recreational activities based on visitation to facilities, events, and festivals)							
	Audiences for arts and culture				11.1			
	Audiences for sports and recreation				11.2			
	Affordability of family outings				11.3			
	Support for the arts				11.4			
	Preserving history				11.6			
	Hosting visitors				11.7			
	Municipal government parks/recreation expenditures per capita							
	Sports conventions				11.8			
	Community centres per person							
Public Safety	Crime rates and rates of victimization							
	Violent crime				7.1			
	Property crime				7.2			
	Youth crime				7.3			
	Domestic violence				7.4			
	Drug offenses				7.5		[24]	
	Incarceration				7.6			
	Child and adult abuse				8.5			
	Fire				7.7			
	Emergency response				7.8			
	Motor vehicle accidents				7.9			

[24] Measure of psychological well-being

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
	Fear index: feeling of personal safety and security (how safe people feel)					[25]		
Community Design	Percentage of new and existing communities where density meets or exceeds city average; % of communities where occupants are within 400 metres of a mix of stores, services, transit, parks, and open space							
Sense of Community and Giving	Percentage of citizens with one or more persons outside their family they could call on in event of crisis							
	Community connectedness						[26]	
	Percentage of lone-parent families							
	Homelessness							
	Charitable donations per capita (United Way contributions per resident)							
	Regional reputation				11.9			
Equity	Discrimination complaints filed and in the workplace							
	Equity in homeownership				9.1			
	Housing discrimination				9.2			
	Occupational equity				9.3			
	Women in leadership				9.4			
	Interfaith relationships				9.5			
	Disability and work				9.6			
	Intergenerational equity				9.7			
	Sexual orientation				9.8			
Democratic and Political Involvement	Voter enrolment and turnout				3.10			
	Daily newspaper circulation							
	Public environmental awareness and satisfaction							
Cultural Diversity	Visible minorities employed by the municipal government							
Volunteerism	Number of inquiries for volunteer opportunities received by volunteer centres							
	Volunteer time (% of population volunteering per capita and hours volunteered)							
Education and Knowledge	Grade 3 achievement scores (student academic achievement; grade 3, grade 6, and grade 12)				4.3, 4.4, 4.5		[27]	
	Foundation for school				4.1			

[25] People feeling safe walking home at night
[26] Data not yet available
[27] Math and reading scores

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
	High school graduation rate							
	School mobility (% of students completing school year in the year they started)							
	Enrolment in post-secondary institutions							[28]
	Degrees awarded from county universities and community colleges							
	Dropout rate/graduation rate				4.7			
	Public school expenditures per student							
	Adult job-related education and training (# education and training activities, # job-related education/training activities, # employer-sponsored adult education/training activities)							
	Educational attainment level of education or schooling				4.8	[29]		
	Lifelong learning (% of population registered in adult continuing education course, borrowing from libraries)							
	Adult literacy							
	Environmental in-service training for teachers							
	Library circulation				5.3	[30]		
	Student Internet connections				4.3			
	Environmental content in the classroom							
	Student-teacher diversity and ratio				4.2			
Infants	Healthy birthweight babies (low birthweight)							
	Infant mortality							
	Substance-exposed newborns per 1,000 live births							
Children	Childhood in-patient asthma cases in local hospitals							
	Preschool children with developmentally appropriate behavior and skills (% of children)							
	Quality childcare				8.3			
	Early intervention to assist children (participation in Success-by-Six, Health-for-Two, and other programs)							
	Children in the care of public authorities							
Teens	Teen births per 1,000 residents							
	Alcohol and drug use by youth							
	At-risk youth				8.7			
Seniors	Elder care				8.4			

[28] Attending college or technical school as percent of persons aged 20 to 24 years
[29] % with post-secondary education
[30] Public library materials and book circulation per capita

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
	Status of elders							
Disabled	Serving the developmentally disabled				8.8			
Health and Wellness	Perceived quality of life						[31]	
	Self-rated health as good or better than same age bracket							
	Access to medical services (waiting lists for surgery, MRI, and continuing care services)							
	Number of hospital beds available for continuing care, acute care, psychiatric care, and other living centres							
	Premature mortality (below age 75)							
	Deaths from heart disease and cancer							
	Accidental deaths per 1,000 population							
	Persons per traffic accident death and per traffic accident injury							
	Suicide rates per 100,000 residents							
	Consumption and use of addictive substances (dollar sales of alcohol, rate of drug possession, tobacco sales, tobacco-related diseases)							
	Mental health				6.8		[32]	
	Alcohol and drug treatment				8.6			
	Crisis calls and response times by type[1] (* Calls to suicide distress line, women's shelters, sexual assault centres, gambling lines, rescue, and fire)		*			[33]		
	Smoking prevalence				6.7			
	Hospital discharges (as measure of hospital use)							
	Work hours lost due to illness or disability							
	Physical activity (# of children and adults engaged in regular physical activity)				6.6			
	(Health) Insurance coverage				6.9			
ENVIRONMENT								
Energy	Non-renewable energy consumption per capita (total energy (natural gas, electricity, and vehicle fuel use in barrels of oil per capita per year))							
	Renewable energy consumption (kwh/capital)							

[31] Perceived quality of life as "good" or "to improve"
[32] Drug charges used as proxy for psychological well-being
[33] Rescue and fire

Issue	Indicator	A. Sustainable Calgary	B. Edmonton LIFE — Local Indicators for Excellence	C. Federation of Canadian Municipalities Indicators	D. Buffalo-Niagara Region Indicators	E. Jacksonville, Florida	F. Orlando, Florida	G. Pierce County, Washington
	Total employment per industrial and commercial MWh (Megawatt hour) consumed							
Food and Local Agriculture	Food grown locally (farmers markets)							
Land use	Urban expansion (land development sustainability)				10.1		[34]	
	Farms and farmland				10.2			
	Office and industrial space				10.3			
	Residential development				10.4			
Waste	Domestic waste per capita (kg. per person)							
	Recycling (kg. per resident per year)				2.9			[35]
Water	Average water use (litres) per capita per day							
	River, lake, or surface water quality (fecal coliform count and upstream-downstream)				2.3			
	Groundwater quality and levels in aquifer wells							
	Gallons of wastewater processed as % of permitted capacity							
Air	Index of air quality (% of days air quality rated good)				2.1			
	Total air emissions (by type)							
Wildlife	Christmas bird species count							
Toxics	Amount of pesticide used by Calgary Parks and Recreation							
	Chemical releases				2.2			
	Hazardous waste sites				2.4			
	Brownfields				2.5			
	Mfg. workers per pound of toxic chemicals released into air							
	Mfg. workers per pound of toxic chemicals released into water							
Parks and Open Space	Urban green space (area of parks per 1,000 people)				11.5			
	Public tree canopy							
Ecosystem Health	Ecosystem health				2.6			
	Endangered lands				2.7			

Sources:

Edmonton LIFE — Local Indicators for Excellence. Edmonton Social Planning Council. 1997

Orlando and Orange County, Florida. *Compass Index of Sustainability 1990-1999.* March 2000. Personal communication with Alan AtKisson (AtKisson and Associates).

[34] Annual growth rate in land area converted to urban residential relative to available "undeveloped" or natural land area
[35] Percent of solid waste recycled

Pierce County, Quality of Life Benchmarks — Annual Report. Pierce Count, Department of Community Services. Pierce County, Washington. February 1998. http://www.co.pierce.wa.us/

Quality of Life in Canadian Communities. The FCM Quality of Life Reporting System. May 1999.

Quality of Life in Jacksonville: Indicators for Progress. www.jcci.org/qol/qol.htm. 1999

State of the Region: Performance Indicators for the Buffalo-Niagara Region in the 21st Century. Institute for Local Governance and Regional Growth. http://regional-institute.buffalo.edu. 1999

Sustainable Calgary: State of Our City Report 1998. Sustainable Calgary

A4. Federation of Canadian Municipalities Original List of Proposed Environmental Indicators for Canadian Municipalities

The following original long list of potential environmental indicators for the FCM Quality of Life Reporting system was prepared by Santiago Olmos, a Ph.D. candidate at Carleton University, in August, 2001. The list below constitutes a preliminary compilation of selected indicators — with some overlaps — found in official plans and other documents (e.g., environmental plans, state of the environment reports, etc.) of various Canadian municipalities. In the documents reviewed, these indicators are often grouped according to official plan goals or objectives. Documents from the following municipalities were consulted: Greater Vancouver Regional District, Richmond, Kamloops, Calgary, Regina, Winnipeg, Hamilton (formerly Hamilton-Wentworth), Halton, Peel, Toronto, York, and Ottawa (formerly Ottawa-Carleton).

Table 5: Federation of Canadian Municipalities Original Preliminary Long List of Proposed Environmental Indicators for Canadian Municipalities

<u>Energy</u>
Energy consumption (residential) [GWh/capita/year]
Per capita consumption of natural gas, gasoline
Percentage of energy supplied by renewable sources
Percentage of energy supplied by local sources
Percentage of vehicles using alternative fuels
<u>Atmosphere</u>
Air quality index (AQI)
Number of good air quality days/year
Number of hours/days when air quality rated moderate or worse
Number of air quality advisories
Carbon dioxide (CO_2) emissions by sector
Emissions of other GHGs (e.g., methane [CH_4], nitrous oxide [N_2O], etc.)
Number [or rate per 1,000 pop.] of hospitalizations due to respiratory illness
Number of odour complaints
Number of noise complaints
Indoor air quality
Tree coverage
<u>Water</u>
Per capita/household consumption of water (for all uses)
Average cost of water/litre
Percentage of population involved in water conservation programs
Amounts and quality of water resources
Quality of municipal/well water
Surface water quality: fecal and total coliform count
- dissolved oxygen
- total dissolved solids
- metals
- organic carbon
Stormwater quality: total suspended solids
- chemical oxygen demand
- total phosphorous

- total metals
Drinking water quality: total number of drinking water complaints/year
- coliform occurrence ratio
- annual average turbidity
- annual average trihalomethane concentrations
Total number of groundwater wells: domestic, industrial, other
Per capita water demand
Percentage of residences metred
Annual river flow volumes
Quantity of irrigated land (in hectares)
CSO discharges and contaminant loadings
Number of beach closings (in hours/days)
Area covered by watershed management plan
Aesthetic levels in municipal drinking water
Phosphorous loadings/concentrations in lakes/rivers
Oxygen levels in lakes/rivers
Number of rivers with riparian vegetation
Presence of coldwater fish
Percentage of stormwater management facilities that provide pollutant removal capability
<u>Transportation</u>
Public transit use/ridership (total or as percentage of population)
Transportation system usage and modal shares
Method of travel
Travel distances and time
Number of streets with sidewalks and bike lanes (expressed in kilometres)
Vehicle occupancy
Vehicle ownership (number of cars per capita/household)
Average vehicle trips per day
Number of people (or percentage of the population participating in) carpooling
Number of vehicle trips crossing city/regional boundaries
Impact of transportation on air quality (AQI), GHG emissions
Annual average vehicle emissions
Number of vehicle accidents
<u>Economy</u>
Employment levels/labour force participation
Average income
Income inequality
Percentage of population living below low-income cut-off
Total employment and share of employment growth
Education levels in the population
<u>Housing and Urban Form</u>
Supply of housing (including affordable housing — i.e., rental, subsidized)
Diversity of housing form by tenure/density
Proportion of rental housing in housing stock
Households spending 30% or more of income on housing
[Housing] vacancy rate
Number of new houses built/year
Redevelopment to total development ratio
Residential and non-residential densities
Gross urban density
Percentage of population living in communities with high population density
Percentage of population both working and living in region

Number of housing starts in downtown
Annual consumption of land area for urban development
Natural Areas, Green Space, Land Resources, and Rural Economy
Area of green zone/space (total and/or per capita, or as percentage of total area)
Area of [protected] agricultural land (in hectares) [lost due to Official Plan amendments]
Total (or per capita) area of park space
Amounts of preserved, protected, and enhanced green space
Ratio of green space to transportation space
Number and size of conservation areas
Area, extent, and connectedness of greenlands
Vegetative cover (amount and type)
Plant/animal diversity
Number of endangered species
Losses/gains in hectares of open space
Supply and distribution of open spaces and agricultural areas
Amount of polluted soil (in hectares)
Number of PCB storage sites
Amount of land cleared for development (in hectares/year)
Number of hectares farmed
Number of farms
Total gross farm receipts
Average farm incomes
Percentage of agricultural land where no or minimum tillage is used
Amount of pesticides used
Number of trees planted/year
Total number of trees in municipal inventory
Number, area, and quality of wetlands
Amount of wetland lost annually
Municipal Facilities/Operations
Energy consumption per square metre of municipal floorspace
Percentage of fleet vehicles using alternative fuels
CO_2 emissions of city fleet
Percentage of municipal-building energy from alternative resources
Waste
Per capita amount of waste generated (residential)
Total amount of waste landfilled
Number of neighbourhood recycling depots
Tonnage of material recycled
Bottle depot recovery rates

A5. City of Vancouver Environmental Trends and Indicators (1997)

The following is a list of environmental indicators used by the City of Vancouver and reported in their state of the environment report in 1997. Data sources are also provided.

Figure 28: City of Vancouver Environmental Trends and Indicators (April 1997)

Source:
http://www.city.vancouver.bc.ca/commsvcs/pandl/ENVIRO/envirotr.htm

Domain	**Data Source**
State of the Air	
Global temperature Anomalies	Trends 93 World Data Centre
Canadian carbon Dioxide Emissions	Trends 93 World Data Centre
Per Capita Energy use	State of the Environment Report for B.C.
1992 Greenhouse gas Emissions	Canada's National Report on Climate Change (1994)
Canadian carbon dioxide emissions by sector, 1990	Canada's National Report on Climate Change (1994)
Fuel Efficiency and Cost for New Automobiles	Environment Canada State of Environment Reporting Program
Population (City and Metro Vancouver)	Census of Canada and B.C. Ministry of Government Services
Annual Electricity Consumption	B.C. Hydro
Registered Vehicles	GVRD (Greater Vancouver Regional District)
Natural Gas Consumption	B.C. Gas (residential and space heating)
Average Journey to Work	City of Vancouver, The Economist Magazine (international comparisons), and Statistics Canada (Time-use surveys)
Est. Annual Cost for Transporting	GVRD
Changes in Greater Vancouver since 1985 (Includes % change in: population, total trips, transit trip increase, car trip increases, transit share trips, vehicle share trips, transit trip time and vehicle trip time)	GVRD
Changes in Vancouver since the Mid 1960's (includes % change: employment downtown and vehicle trip time)	City of Vancouver Engineering Department
Changes in key Characteristics for Vancouver (includes % change: population, employment and work trips produced)	GVRD
All trips Within Vancouver (auto, transit, walk, bike)	GVRD
Transit Ridership	B.C. Transit
Number of Vehicles Entering City	City of Vancouver Engineering Department
Number of Vehicles Exiting City	City of Vancouver Engineering Department
Maximum Monthly Air Quality Index	GVRD
Mean monthly Air Quality Index	GVRD
Annual GVRD Air Quality Complaints	GVRD, AQMP Working Paper, Residential Woodburning Stoves and Fireplaces
Carbon Monoxide (by source, 1990)	GVRD Emissions Inventory - 1990 Summary Report
Carbon Monoxide Emissions (trends since 1985; projections)	GVRD Air Quality Management Plan
Volatile Organic Compounds (VOCs) (by source, 1990)	GVRD Emissions Inventory - 1990 Summary Report
VOC Emissions (trends since 1985 and projections)	GVRD Air Quality Management Plan
Nitrogen Oxides (NO_x) (by source, 1990)	GVRD Emissions Inventory - 1990 Summary Report
Nitrogen Oxides Emissions (NO_x) (trends since 1985)	GVRD Air Quality Management Plan
Sulphur Oxides (SO_x) (by source 1990)'	GVRD Emissions Inventory - 1990 Summary Report
Sulphur Oxides Emissions (SO_x) (trends since 1985 and projections)	GVRD Air Quality Management Plan
Particulate Matter (by source, 1990)	GVRD Emissions Inventory - 1990 Summary Report

Domain	Data Source
Particulate Matter (by source, 1990)	GVRD Air Quality Management Plan
Total Air Emissions (trends since 1985 and projections)	GVRD Emissions Inventory - 1990 Summary Report
Drinking Water Quality and Conservation	
Source Water Turbidity for 1994	City of Vancouver, 1994 Water Quality Review
Average Turbidity (5 curbside testing stations)	City of Vancouver, 1994 Water Quality Review
Average Iron Levels in the City's Water Distribution System	City of Vancouver, 1994 Water Quality Review
pH Levels of Treated Water	City of Vancouver, 1994 Water Quality Review
Water Becteriology Summary (Coliform % positive tests, 1990-1994)	City of Vancouver, 1994 Water Quality Review
Per Capita Water Use (1965-1994)	City of Vancouver Engineering Department
Annual Watermain Breaks (1966-1994)	City of Vancouver Engineering Department
Receiving Water Quality	
City of Vancouver Sewer System (infrastructure length of sewers, manholes, catch basins, etc.)	City of Vancouver Engineering Department
Sewer Mains (kms)	City of Vancouver Engineering Department
Age of City's Sewer System (by year of construction)	City of Vancouver Engineering Department
Separated vs. Combined (stormwater and sanitary) Sewers (%)	City of Vancouver Engineering Department
Greater Vancouver's Untreated Sewage (ave. flow per day in million litres, 1962-1986)	State of Environment Report for B.C.
Iona Sewage Treatment Plant (Average Daily Flows) 1980-1994	GVRD
Iona Sewage Treatment Plant (Biochemical Oxygen Demand), 1980-1994	GVRD
Iona Sewage Treatment Plant (Oil and Grease), 1980-1994	GVRD
Iona Sewage Treatment Plant (Suspended Solids),1980-1994	GVRD
Iona Sewage Treatment Plant (Lead), 1980-1994	GVRD
Iona Sewage Treatment Plant (Copper), 1985-1994	GVRD
Fecal Coliform Count (English Bay), 1978-1994	City of Vancouver Engineering Department
Fecal Coliform Count (False Creek West)	City of Vancouver Engineering Department
State of the Land	
Number of City Parks (excludes golf courses)	Vancouver Board of Parks and Recreation
Total Area of All City Parks (196-1994), excludes golf course	Vancouver Board of Parks and Recreation
Park Area per 1000 Population (1961-1994), excludes golf courses	Vancouver Board of Parks and Recreation
Number of Street Trees (thousands)	Vancouver Board of Parks and Recreation
Solid Waste Management	
Per Capita Waste (kg/person/day)	State of the Environment Report for B.C.
Refuse Versus Recycling (Single Family Waste Stream, 1989-1994)	City of Vancouver Engineering Department
Summary of 1994 waste Reduction Programs	City of Vancouver Engineering Department
Hazardous Waste and Dangerous Goods	
Transporting Dangerous Goods (tonnes of dangerous goods by mode of transport)	Vancouver Transport of Dangerous Goods Study (1988)
Hazards Material Incidents (1992-1994)	City of Vancouver Fire Department

Domain	Data Source
Other Environmental Issues	
Heritage Building Demolition and Designation (1986-1994)	City of Vancouver Planning Department
Annual Electricity Consumption (1987-1995)	B.C. Hydro
Natural gas Consumption (1991-1995)	B.C. Gas
Inventory of Undesignated Heritage Buildings (1986-1994)	City of Vancouver Planning Department
Noise Complaint Inspections (1991-1995)	Vancouver Regional Health Board
Natural Gas Vehicles (1993-1995)	B.C. Gas
Childhood Cancer Trends (Environmentally-induced cancers)	SEER (?)

A6. Sustainable Calgary: State of Our City Report (2001)

The following is a list of 36 sustainability indicators developed by the citizen-based Sustainable Calgary State of Our City Project. The project was initiated by a group of citizens in 1996 to track the progress Calgary is making towards sustainability. The following table (Figure 23) provides a list of the Sustainable Calgary indicators and identifies data sources for the environmental indicators only.

Figure 29: Sustainable Calgary Sustainability Indicators (2001)

Indicators	Source of Data	Time Series
Community Indicators		
Crime Rate and Rate of Victimization		
Leisure Activity		
Membership in Community Associations		
Number of and Attendance at Public Festivals		
Sense of Community		
Valuing Cultural Diversity		
Volunteerism		
Economy Indicators		
Economic Diversification - Oil and Gas Reliance		
Food Bank Usage		
Hours Required to Meet Basic Needs at Minimum Wage		
Housing Affordability		
Income Equity: Gap Between Rich and Poor		
Unemployment Rate		
Education Indicators		
Adult Literacy		
Daycare Worker Salaries and Turnover		
Grade Three Achievement Scores		
Lifelong Learning - Library Use		
Pupil/Teacher Ratios		
Natural Environment Indicators		
Air Quality (Index of the Quality of Air: IQUA)	Alberta Environment (Index of Air Quality: 3 monitoring stations)	1991-1999
Bird Population Surveys (species and individual bird count)	Calgary Christmas Bird Count; Fall Migration Monitoring Program; 1992+	1992-1999
Food Grown Locally (community garden plots and vendors at farmers markets)	Farmers Market data and Alberta Agriculture, Food and Rural Development	1997-2000
Pesticide Use (kg. of active ingredient of pesticides used)	Calgary Parks and Recreation	1997-1999
Surface Water Quality (fecal coliform count)	Alberta Environment (Steers Ranch site downstream of Calgary, Bow River)	1970-2000
Water Consumption (litres per person)	City of Calgary; Calgary Waterworks	1984-1999

Indicators	Source of Data	Time Series
Resources Use Indicators		
Domestic Waste (kg. per person)	City of Calgary, Solid Waste Services Annual Report	1988-1999
Ecological Footprint	Derived from calculations of Canada's ecological footprint by Wackernagel and Rees	1900; 1950; 2000
Energy Use (energy consumption in litres of gasoline equivalent per person per year)	Combination of Enmax Inc. electricity usage, ATCO natural gas usage, and petroleum product usage (gasoline, diesel, aviation fluids, asphalt, propane, butane, and other products) based on provincial per capita figures	1990-1999
Population Density (density of people per square kilometre and residential built-up area occupied)	City of Calgary (derived from Census)	1970-2000
Transit Usage for Work Trips	Travel to Work Survey	1964-1999
Transportation Infrastructure Spending (% of infrastructure spending on roads, transit, and pathways)	City of Calgary Transportation Department	
Wellness Indicators		
Access to Primary and Alternative Health Resources		
Childhood Asthma Hospitalization Rates		
Healthy Birthweight Babies		
Self-Rated Health		
Support for the Most Vulnerable		
Youth Wellness		
Source: http://www.telusplanet.net/public/sustcalg/home.html		

A7. City of Calgary State of the Environment Report Indicators

The following is a list of the City of Calgary's State of the Environment report indicators. The table in Figure 24 shows the environmental indicators, the parameters measured, and the purpose of the indicator. We were unable to provide sources of indicator data.

Figure 30: City of Calgary's State of the Environment Report Indicators

Environment Indicators	**Parameter Measured**	**Purpose**
Index of the Quality of the Air	air quality — city-wide	measures ambient air quality in Calgary
Annual Average Vehicle Transit Ridership (1990-1996)	air quality — city-wide	measures trends in average vehicle emissions (1990-1995)
	air quality — Corporation/city-wide	measures use of alternative transportation as provided by the Corporation
City Fleet – CO_2 Emissions – 1996	air quality — Corporation	measures 1996 greenhouse gas emissions that can be attributed to the City Fleet
Average Vehicle Trips per Day	air quality — city-wide	measures passenger vehicle dependence
Surface Water Quality:	surface water — city-wide	measures the bacteriological, chemical, and physical health of surface water
• fecal and total coliform count		
• total dissolved solids		
• metals		
• organic carbon		
Stormwater Quality:	stormwater quality — city-wide	a limited measure of the physical, chemical, and bacteriological characteristics of stormwater run-off in Calgary
• total suspended solids		
• chemical oxygen demand		
• total phosphorus		
• total metals		
Drinking Water Quality:	drinking water — Corporation	measures customer satisfaction with the service as provided by the Corporation in addition to the bacteriological, chemical, and physical characteristics of drinking water in Calgary
• total number of drinking	city-wide	
water complaints/year		
• coliform occurrence ratio		
• annual average turbidity		
• annual average		
• trihalomethane concentrations		
Total Number of Groundwater Per Capita Water Demand (1984-1996)	groundwater — city-wide; water efficiency — city-wide	measures groundwater dependence; measures water use per person per year
Percent of Residences Metred (1986-1996)	water efficiency — city-wide/ Corporate	measures ratio of residences metered
City of Calgary Water Use (1990-1995)	water efficiency — Corporate	measures Corporate water efficiency
Annual river flow volumes (1990-1996)	water quantity — city-wide	measures river water quantity
Population Change (1987-2001)	land use — city-wide	measures current and projected

Environment Indicators	**Parameter Measured**	**Purpose**
Existing Land Use 1997	land use — city-wide/Corporate	measures land use distribution
Parkland per Capita	land use — Corporate	measures amount of parks per person (1993-1997)
Hectares (and number) of Natural Environment Parks	land use — Corporate	measures amount of natural and environmentally significant areas managed by Calgary Parks & Recreation
Number of Biophysical Impact Assessments completed	land use — Corporate	measures number of development projects assessed for environmental impacts
Number of Development Plans Issues (1994-1997)	land use — Corporate	measures growth in development plans
Total Amount of Pesticides Used by Calgary Parks & Recreation (1995-1997)	land use — Corporate	measures pesticide use of city-owned land by the Corporation
Number of Hectares of Public Land Treated with Pesticides (1997)	land use — Corporate	measures intensity of pesticide use by the Corporation
Total Number of Trees in Calgary Parks and Recreation Inventory (1992-1996)	land use — Corporate	measures tree planting and maintenance by the Corporation
Total Amount of Waste Landfilled at City Landfills (1980-1996)	waste management — Corporate/city-wide	measures waste production and disposal as managed by the Corporation
Number of Neighbourhood Recycling Depots (1991-1997)	waste management — Corporate/city-wide	measures recycling service provided by the Corporation
Tonnes of Material Recycled in Neighbourhood Recycling Depots (1993-1997)	waste management — Corporate/city-wide	measures waste diverted from landfill and managed by the Corporation
Bottle Depot Recovery Rates	waste management — city-wide	measures waste diverted from landfill
Number of kms of city-owned and installed noise barriers (1997)	noise — Corporate	measures Corporate contributions to the reduction traffic noise
Noise Complaints Received by Bylaw Enforcement (1994-1997)	noise — Corporate/city-wide	measures growth in noise complaints and awareness of the Noise Bylaw
Per Capita Energy Consumption (1990-1996) (residential/commercial/industrial/other)	energy use — city-wide	measures trends in energy use by sector per person per year
Energy Use at City-Owned Buildings (1993-1996)	energy use — Corporate	measures trends in energy use by City-owned buildings
Total Indicators = 32	Total Number of Indicators Measuring Corporate Issues = 13	
	Total Number of Indicators Measuring City-Wide Issues = 11	
	Total Number of Indicators Measuring Corporate and City-Wide Issues = 8	
Source: City of Calgary's State of the Environment Report		

A8. City of Edmonton State of the Environment Report Environmental Indicators

Figure 31: Edmonton's State of the Environment Environmental Indicators

Categories/Domain	Indicators	Data Sources (data gaps in red)
Climate Change	Tonnes of CO_2 equivalent emissions per year by source	
	CO_2 equivalent emissions per capita per year for the residential sector	
	Total amounts of specific greenhouse gases emitted per year by each sector	
Natural Heritage	Gross area of natural area in the city as % of total ctiy land area	
	Amount of protected natural area within the city boundaries	
Sustainable Urban Form	No recommended indicator	
Agricultural Lands	Total area of land within Edmonton's boundaries under active cultivation within areas identified for agricultural purposes	
	Area of land removed from agricultural use (lands defined in Plan Edmonton)	
Waste Management	Amount of waste per capita diverted and landfilled by sector	
Energy Management	Energy use within the City of Edmonton by sector	EPCOR
	Energy use per capita in the residential sector	
	Sources of energy used in Edmonton (renewable and non-renewable sources).	
Drinking Water	Percent compliance from tests at Rossdale and E.L. Smith plants that meet all water quality requirements (including internal standards and Canadian Drinking Water Guidelines)	
Surface Water	Alberta Surface Water Quality Index for the North Saskatchewan River upstream and downstream of Edmonton	Alberta Environment
Indoor Air	no recommended indicator	
Ambient Air	Percentage of time Edmonton's air is "good" as measured by IQUA (Alberta's air quality index)	Alberta Environment
	Percentage of time air quality meets the Canada-wide standard for ground-level ozone	
	Percentage of time that air quality meets the Canada-wide standard for fine particulate matter (PM)	
Ozone Layer	No recommended indicator	
Industrial Releases	Number, volume, and type of reportable spills and releases reported in Edmonton	NPRI?

Hazardous Materials	No recommended indicator	
Contaminated Sites	Number of known or suspected contaminated sites under city ownership	
	Number of development applications per year that require environmental assessment or remediation	
Pesticides	Amount and type of pesticides (insecticides, herbicides) used by sector in Edmonton	
Noise	Number of residential test sites where noise levels exceed a daily average noise level of 65dBA	
Light Pollution	No recommended indicator	
Electric and Magnetic Fields	No recommended indicator	
Acid Rain	Deposition of acid-forming substances in the Edmonton airshed	
Source: Edmonton's State of the Environment Report, Workshop Report, Workshop on Environmental Indicators, October 4, 2001, City of Edmonton, Office of the Environment		
(Note: sources have not been identified by the City of Edmonton Working Group, except where noted)		

A9. Edmonton LIFE (Local Indicators for Excellence) Quality of Life Indicators, 1998

Figure 32: Edmonton LIFE Quality of Life Indicators

Indicators	Data Sources
Healthy Environment Indicators	
Private Vehicle Usage (km. driven; vehicle-kilometres traveled per person, per day; litres of gasoline purchased per person per year)	City of Edmonton 1994 Travel Survey; Transportation Association of Canada (transportation indicators for 8 urban cities)
Energy Consumption Per Capita (avg. natural gas consumption (GJ) per residential customer; avg. electricity consumption per residential customer)	EPCOR, ATCO Utilities
Air Quality (% good air days; Index of Quality of Air: IQUA)	Alberta Environment
River Water Quality (Water Quality Index for the North Saskatchewan River, for recreation, aquatic life, agriculture; upstream and downstream from Edmonton)	Alberta Environment
Solid Waste Per Capita (volume of waste per capita to landfills; annual volume of "blue bag/box" material per capita)	City of Edmonton, Public Works Department
Urban Green Space (total area of parks per 1,000 people; number of parks)	City of Edmonton, Parks and Recreation Department
Environmental In-Service Training for Teachers (teacher in-services per year on environmental education)	FEESA; Destination Conservation
Environmental Content in the Classroom (number of units in school curricula focused on environmental education as % of number of total curriculum)	FEESA (Environmental Education Society), Alberta Education Society
Community Design (% of new communities and existing communities where density meets/exceeds the city average; % of communities where occupants are within 400 metres of a mix of stores, services, transit, parks, and open spaces)	Data under development
Total Air Emissions (atmospheric emissions from all reported sources in the Edmonton area)	Currently unavailable (possibly NPRI data); Alberta Environment and the Clean Air Strategy Alliance may be working on data set
Public Environmental Awareness and Satisfaction (individual awareness about environmental issues in Edmonton)	Not available; surveys would have to be conducted
Healthy Economy Indicators	
Net Business Creation	
Development Activity	
Municipal Expenditure on Debt	
Emerging Industry Research and Development Patents	
Labour Force Participation	
Adult Job-Related Education and Training	
Level of Education	
Households Below the Low-Income Cut-Off Level (LICO)	
Air Traffic	
Corporate Revenue Spent on Training	
People With Income to Meet Basic Needs	
Healthy Community Indicators	
Enrolment in Post-Secondary Institutions	
Charitable Donations Per Capita	
Voter Turnout	
Public Safety and Security	
Physical Urban Infrastructure	
Suicide Rates	

Indicators	**Data Sources**
Access to Medical Services	
Number of Hospital Beds	
Volunteer Time	
Leisure Activities	
Early Intervention to Assist Children	
Healthy People Indicators	
Disparity in Family Annual Income	
Nutritious Food Basket Index	
Low Birthweight Infants	
Student Academic Achievement	
Lifelong Learning	
Physical Activity	
Food Bank Demand	
Premature Deaths	
Crisis Support Calls	
Consumption and Use of Addictive Substances	
Preschool Children with Developmentally Appropriate Behaviour and Skills	
Source: http://www.edmspc.com/publ.htm#edmontonlife	

A10. City of Regina State of the Environment Report, 1994

Figure 33: Regina's State of the Environment Report, Environmental Indicators, 1994

Domain/Categories	Subdomain/Issues	Indicator	Description
Land Use	General	Urban form	Qualitative description of urban form, density of housing developments, and characteristics of downtown
	Green Space and Open Space	Open space	Total area
		Parks	Total number of parks, total area, area of parkland (ha) per 1,000 people
	Urban Forest	Tree plantings	Total number of trees planted
	Wetlands and Natural Areas	Environmentally significant areas	List of areas protected from development
	Flora and Fauna	No indicators developed	
	Agriculture	No indicators developed	
	Pesticides	City Corporation pesticide application policy	Qualitative description of city policy to reduce pesticide use
	Industrial/Contaminated Lands	Contaminated soils	Tonnes accepted for treatment at landfill/year
		Sites cleaned up	Number of contaminated sites that have been "'cleaned up"
	Aggregates	No indicators developed	
	Noise	Residents' exposure to noise	Maximum allowable noise levels (dBA) in residential areas
Transportation	Traffic	Number of vehicles	Total number of vehicles
		Transportation-related fuel consumption	Average vehicle fuel consumption (litres)
		Length of car trips	Average length of trip (km)
		Bike lanes	Length of roads with bike lanes (km)
	Transit	Transit ridership	Annual ridership
Air	General Air Quality	Air quality standards and exceedances	Average annual value of the AQI
		Climate	Number of sunshine days per year
	Contaminant Concentrations	CFCs	City policy to reduce CFCs (no data on actual concentration)
		Ozone	Maximum recorded concentration (ppb)
	Emissions	CO_2 emissions	Tonnes produced per year by city operations, % by source (electricity, natural gas, gasoline)
	Indoor Air Quality	Radon	Description of sources, health effects, and testing programs (no data)

Domain/Categories	Subdomain/Issues	Indicator	Description
Water	General Water Quality	No indicators developed	
	Water Loadings	No indicators developed	
	Contaminant Concentrations	No indicators developed	
	Sediment Quality	No indicators developed	
	Sewage Treatment	Current status of STPs	Number, qualitative description of treatment process, capacity m3/day
	Sewage/Water Treatment Infrastructure	Length of water mains, sewer pipes, run-off pipes owned and operated by the municipality (km)	
		Number of reservoirs, pumping stations owned and operated by the municipality	Total number of facilities
	Drinking Water Quality	No indicators developed	
	Water Consumption and Treatment	Water treatment	Qualitative description of process
		Amount of water treated	Total amount supplied per day (litres)
		Water consumption	Per capita demand (L/capita/year) – Canadian average, no Regina data
		Water conservation	Description of city's watering schedule program
	Groundwater	Dependence on groundwater as a drinking water supply	% of peak period water demand supplied by groundwater, amount of groundwater pumped from aquifers
	Aquatic Life	No indicators developed	
Waste	Waste Generation	Waste generation	Per capita waste generation – Canadian average, no Regina data
	Waste Collection	Waste pick-up	Amount of waste collected per capita (kg. per person per day)
	Disposal at Landfill	Amount of waste landfilled	Total waste landfilled (tonnes/yr) – Saskatchewan data, no Regina data
	Incineration/fuel-derived waste	No indicators developed	
	Reduction and Diversion	No indicators developed	
	Recycling Programs	Amount of recylable material diverted from landfill	Tonnes per year recycled – Saskatchewan data, no Regina data
	Organic Waste Management	Hazardous waste	Amount of solids (tonnes), liquids (L) disposed per year – Saskatchewan data only)
	Household Hazardous Waste (HHW)	No indicators developed	
	Hazardous Waste Materials and Spills	Hazardous materials storage	Number of hazardous substance storage facilities
		Spill response	Number of spills responded to annually by type, quantity of material spilled (L)

Domain/Categories	**Subdomain/Issues**	**Indicator**	**Description**
	Snow-Related Waste	No indicators developed	
Energy	General Energy Consumption	No indicators developed	
Source: City of Regina: State of the Environment Report, 1994			

A11. Hamilton Sustainability Indicators

Figure 34: City of Hamilton Sustainability Indicators, 2001

Subdomain/Issues	Indicators	Data Source
Local Economy	Rate of participation in the labour force	Human Resources, Development Canada, Hamilton Office
Agriculture and the Rural Economy	Hectares of agricultural land lost due to official plan amendments	City of Hamilton, Planning and Development
Natural Areas and Corridors	Cumulative area of significant natural areas protected	Hamilton/Halton Watershed Stewardship Project
Improving the Quality of our Water Resources	Total loading of nitrogen to Hamilton Harbour	City of Hamilton, Transportation, Operations and Environment Division, Water and Wastewater
	Total loading of phosphorus to Hamilton Harbour	City of Hamilton, Transportation, Operations and Environment
	Water consumption – all uses (metred accounts)	City of Hamilton, Finance Department, Utility Billing Section
	Number of “All Beaches Open for Swimming” days	City of Hamilton, Health Branch Environment/Dental Health Branch, Social and Public Health Services
Reducing and Managing Waste	Total residential waste generated	City of Hamilton, Transportation, Operations and Environment, Solid Waste Management
Consuming Less Energy	Average residential electricity consumption	Hydro-Electric Commissions
Improving Air Quality	Number of O_3 (ground level ozone) criteria exceedances	Ontario Ministry of Environment, West Central Region
	Average SO_2 (sulphur dioxide) concentration	Ontario Ministry of Environment, West Central Region
	Average PM_{10} (Inhalable Particulate Matter) concentration	Ontario Ministry of Environment, West Central Region
	Hospitalization rate for respiratory illness per 100,000 people	City of Hamilton, Social and Public Health Services, Community Support and Research Branch (Ontario Ministry of Health, Provincial Health Planning Database)
Changing our Mode of Transportation	Annual transit ridership per capita	Hamiton Street Railway
	Number of cars per capita	Ontario Ministry of Transportation, Licensing Administration Office
Land Use in the Urban Area	Number of new housing starts in the downtown core	City of Hamilton, Community Planning and Development Department
Arts and Heritage	Number of visits to historic sites, arts venues, and museums per capita	
Personal Health and Well-Being	Number of low birthweight babies born as % of total births	
	Hospitalization rate for falls by persons 65+ years	
	Rate of mortality due to heart disease	
Safety and Security	Number of robberies	
	Number of pedestrians and cyclists injured in motor vehicle accidents	Human Resources, Development Canada, Hamilton Office
Education	Percentage of 18-year-olds receiving a high school diploma	City of Hamilton, Planning and Development
	Number of adult education high school equivalency diplomas granted	Hamilton/Halton Watershed Stewardship Project
Community Well-Being	Shelter occupancy rate	City of Hamilton, Transportation, Operations and

and Capacity Building		Environment Division, Water and Wastewater	
	Number of applicants referred by the volunteer centre	City of Hamilton, Transportation, Operations and Environment	
Source: http://www.vision2020.hamilton-went.on.ca/indicators/index.html		City of Hamilton, Finance Department, Utility Billing Section	

Text of the **Framework Agreement on First Nation Land Management**

(signed in 1996)

Includes modifications resulting from

Amendment #1 1998
Amendment #2 1998
Amendment #3 2002
Amendment #4 2007
Amendment #5 2011

Texte de l'**Accord-Cadre relatif à la Gestion des Terres de Premières Nations**

(signé en 1996)

Comprend les changements apportés par les modifications suivantes

Modification #1 1998
Modification #2 1998
Modification #3 2002
Modification #4 2007
Modification #5 2011

Framework Agreement on First Nation Land Management

FRAMEWORK AGREEMENT ON FIRST NATION LAND MANAGEMENT

BETWEEN:

THE FOLLOWING FIRST NATIONS:

WESTBANK, MUSQUEAM, LHEIDLI T'ENNEH (formerly known as "LHEIT-LIT'EN"), N'QUATQUA, SQUAMISH, SIKSIKA, MUSKODAY, COWESSESS, OPASKWAYAK CREE, NIPISSING, MISSISSAUGAS OF SCUGOG ISLAND, CHIPPEWAS OF MNJIKANING, CHIPPEWAS OF GEORGINA ISLAND, SAINT MARY'S, as represented by their Chiefs and all other First Nations that have adhered to the Agreement

AND

HER MAJESTY THE QUEEN IN RIGHT OF CANADA, as represented by the Minister of Indian Affairs and Northern Development

WHEREAS:

The First Nations have a profound relationship with the land that is rooted in respect for the Spiritual value of the Earth and the gifts of the Creator and have a deep desire to preserve their relationship with the land;

The First Nations should have the option of

Accord-cadre relatif à la Gestion des Terres de Premières Nations

ACCORD-CADRE RELATIF À LA GESTION DES TERRES DE PREMIÈRES NATIONS

ENTRE :

LES PREMIÈRES NATIONS SUIVANTES :

WESTBANK, MUSQUEAM, LHEIDLI T'ENNEH (autrefois connue sous le nom de "LHEIT-LIT'EN"), N'QUATQUA, SQUAMISH, SIKSIKA, MUSKODAY, COWESSESS, OPASKWAYAK CREE, NIPISSING, MISSISSAUGAS OF SCUGOG ISLAND, CHIPPEWAS OF MNJIKANING, CHIPPEWAS OF GEORGINA ISLAND, SAINT MARY'S, représentées par leurs chefs et toutes les autres Premières Nations qui se sont jointes à l'Entente

ET

SA MAJESTÉ LA REINE DU CHEF DU CANADA, représentée par le ministre des Affaires indiennes et du Nord canadien

ATTENDU QUE :

Les premières nations entretiennent une relation profonde avec la terre, basée sur la valeur spirituelle qu'elles attribuent à la Terre et aux dons du Créateur et qu'elles ont le désir de préserver cette relation;

Les premières nations devraient avoir la possibilité de soustraire leurs terres aux withdrawing their lands from the land management provisions of the Indian Act in order to exercise control over their lands and resources for the use and benefit of their members;

The Parties wish to enter into a government to government agreement, within the framework of the constitution of Canada, to deal with the issues of land management;

The Parties understand that this Agreement must be ratified;

NOW THEREFORE,

In consideration of the exchange of promises contained in this Agreement and subject to its terms and conditions, the Parties agree that the First Nations shall have the option of exercising control over their lands and resources.

PART I
PRELIMINARY MATTERS

1. INTERPRETATION

1.1 In this Agreement,

"Canada" or "Crown" means Her Majesty the Queen in right of Canada; ("Canada")

"eligible voter" means a member of a First Nation who is eligible, pursuant to clause 7.2, to vote under this Agreement; ("électeurs")

"federal law" means a law enacted by

dispositions de la Loi sur les Indiens concernant la gestion des terres de façon à exercer un contrôle sur leurs terres et sur leurs ressources à l'usage et au profit de leurs membres;

Les parties souhaitent conclure un accord de gouvernement à gouvernement, dans le cadre de la constitution du Canada, concernant des questions touchant la gestion des terres;

Les parties reconnaissent que le présent accord doit être ratifié;

PAR CONSÉQUENT,

En contrepartie de l'échange des promesses figurant dans le présent accord et sous réserve de ses modalités, les Parties conviennent que les premières nations doivent avoir la possibilité d'exercer un contrôle sur leurs terres et sur leurs ressources.

PARTIE I
QUESTIONS PRÉLIMINAIRES

1. INTERPRÉTATION

1.1 Les définitions qui suivent s'appliquent au présent accord.

« Canada » ou « Couronne » Sa Majesté la Reine du chef du Canada; (« Canada »)

« code foncier » Code adopté par une première nation conformément au présent accord contenant les dispositions générales relatives à l'exercice des droits et pouvoirs de la première nation sur ses terres de

Canada and does not include a land code or a First Nation law; ("loi fédérale")

"federal legislation" means the legislation to be enacted by Canada under Part X; ("loi de ratification")

"First Nation" means a band that is a Party to this Agreement; ("première nation")

"First Nation land", in respect of a First Nation, means all or part of a reserve that the First Nation describes in its land code; ("terres de première nation")

"First Nation Lands Register" means the register established pursuant to clause 51 to register interests or land rights in First Nation land; ("registre des terres de premières nations")

"First Nation law" means a law enacted by a First Nation in accordance with its land code; ("texte legislative de la Première nation")

"interest", in relation to First Nation land in any province or territory other than Québec, means any interest, right or estate of any nature in or to that land, including a lease, easement, right of way, servitude, or profit à prendre, but does not include title to that land; ("intérêt")

"land code" means a code, approved by a First Nation in accordance with this Agreement, that sets out the basic provisions regarding the exercise of the First Nation's rights and powers over its First Nation land (although each First Nation can select its own name for the land code); ("code

première nation (les premières nations peuvent néanmoins donner l'appellation de leur choix à ce code foncier). (« land code »)

« Conseil consultatif des terres » Le conseil visé à l'article 38. (« Land Advisory Board »)

« droit foncier » Relativement aux terres de première nation dans la province de Québec, tout droit de quelque nature qu'il soit portant sur ces terres, à l'exclusion du titre de propriété; y sont assimilés les droits du locataire. (« land right »)

« électeurs » Les membres d'une première nation qui ont le droit de voter en vertu de l'article 7.2 du présent accord. (« eligible voters »)

« intérêt » Relativement aux terres de première nation situées dans toute province ou territoire autre que le Québec, tout intérêt, droit ou domaine de quelque nature qu'il soit portant sur ces terres, notamment un bail, une servitude, un droit de passage, un service foncier ou un profit à prendre, à l'exclusion du titre sur ces terres. (« interest »)

« loi de ratification » La loi adoptée par le Canada aux termes de la Partie X. (« federal legislation »)

« loi fédérale » Loi adoptée par le Canada mais ne comprend pas un code foncier ou un texte législatif d'une première nation. (« federal law »)

« membre » À l'égard d'une première

foncier")

"land right", in relation to First Nation land in the Province of Québec, means any right of any nature in or to that land excluding title, and includes the rights of a lessee; ("droit foncier")

"Lands Advisory Board" means the board referred to in clause 38; ("Conseil consultatif des terres")

"licence", in relation to First Nation land, ("permis")

(a) in a province or territory other than Québec, means any right of use or occupation of First Nation land, other than an interest in that land;

(b) in the Province of Québec, any right to use or occupy First Nation land, other than a land right in that land;

"member", in respect of a First Nation, means ("membre")

(a) a person whose name appears on the Band List, or

(b) a person who is entitled to have his or her name appear on the Band List;

"Minister" means the Minister of Indian Affairs and Northern Development, or such other member of the Queen's Privy Council as is designated by the Governor in Council for the purposes of this Agreement; ("ministre")

nation : (« member »)

a) personne dont le nom figure sur la liste de bande;

b) personne qui a droit à ce que son nom y figure.

« ministre » Le ministre des Affaires indiennes et du Nord canadien ou un membre du Conseil privé de la Reine désigné par le gouverneur en conseil aux fins du présent accord. (« Minister »)

« permis » Relativement aux terres d’une première nation : (« licence »)

a) dans une province ou un territoire autre que le Québec, tout droit d’usage ou d’occupation des terres de première nation, autre qu’un intérêt sur ces terres;

b) dans la province de Québec, tout droit d’utiliser ou d’occuper les terres de première nation autre qu’un droit foncier sur ces terres.

« première nation » Une bande qui est Partie au présent accord. (« First Nation »)

« registre des terres de premières nations » Le registre créé conformément à l'article 51 pour l'enregistrement des intérêts ou des droits fonciers sur les terres de premières nations. (« First Nation Lands Register »)

« terres de première nation » Dans le cas d'une première nation, tout ou partie d'une réserve décrite dans son code foncier. (« First Nation land ») "verifier" means the person appointed pursuant to clauses 8 and 44 to monitor and verify the opting in process for a First Nation. ("vérificateur")

« texte législatif de la première nation » Une loi ou un autre texte législatif adopté par une première nation conformément à son code foncier. (« First Nation law »)

« vérificateur » La personne chargée, en application des articles 8 et 44, de surveiller et de vérifier le processus d'adhésion d'une première nation. (« verifier »)

1.2 Terms that are defined or used in the Indian Act have the same meaning in this Agreement, unless the context otherwise requires.

1.2 Sauf indication contraire, les termes du présent accord qui sont définis ou utilisés dans la Loi sur les Indiens s'entendent au sens de cette loi.

1.3 This Agreement is not a treaty and shall not be considered to be a treaty within the meaning of section 35 of the Constitution Act, 1982.

1.3 Le présent accord ne constitue pas un traité et n'est pas considéré comme un traité au sens de l'article 35 de la Loi constitutionnelle de 1982.

1.4 The Parties acknowledge that the Crown's special relationship with the First Nations will continue.

1.4 Les Parties reconnaissent que la Couronne maintiendra la relation spéciale qu'elle entretient avec les premières nations.

1.5 This Agreement does not affect any lands, or any rights in lands, that are not subject to this Agreement.

1.5 Le présent accord ne s'applique pas aux terres ou aux droits sur ces terres qui ne sont pas visés par lui.

1.6 This Agreement is not intended to define or prejudice inherent rights, or any other rights, of First Nations to control their lands or resources or to preclude other negotiations in respect of those rights.

1.6 Le présent accord n'a pas pour but de définir les droits inhérents ou autres des premières nations d'exercer un contrôle sur leurs terres et leurs ressources ni d'y porter atteinte, ni d'empêcher que ces droits fassent l'objet d'autres négociations.

1.7 The parties agree that when a provision of this agreement contains both civil law and common law terminology, or terminology that has different meanings in the civil law and the common law, the civil law

1.7 Les parties conviennent, que lorsque une disposition du présent accord emploie à la fois des termes propres au droit civil et à la common-law ou des termes qui ont terminology or meaning is intended to apply to this provision with respect to First Nations in the Province of Quebec and the common law terminology or meaning is intended to apply with respect to First Nations in a province or territory other than Québec.

un sens différent dans l'un et l'autre de ces systèmes, l'intention est, d'appliquer à cette disposition la terminologie de droit civil ou le sens qu'on lui donne dans ce système en ce qui a trait aux Premières nations au Québec et la terminologie de common-law ou le sens qu'on lui donne dans ce système en ce qui a trait aux Premières nations dans toute province ou territoire autre que le Québec.

2. FIRST NATION LAND

2. TERRES D'UNE PREMIÈRE NATION

2.1 Land that is a reserve of a First Nation is eligible to be managed by that First Nation under a land code as First Nation land.

2.1 Les terres qui constituent une réserve d'une première nation sont admissibles à être gérées par celle-ci en vertu d'un code foncier à titre de terres de première nation.

2.2 First Nation land includes all the interests and rights or all the land rights and other rights, as well as the resources that belong to that land, to the extent that these are under the jurisdiction of Canada and are part of that land.

2.2 Les terres de première nation comprennent tous les intérêts et droits ou tous les droits fonciers et autres droits ainsi que les ressources relatifs à ces terres dans la mesure où ils relèvent de la juridiction du Canada et font partie de ces terres.

2.3 The Parties agree that First Nation lands are lands reserved for Indians within the meaning of section 91(24) of the Constitution Act, 1867.

2.3 Les parties reconnaissent que les terres de premières nations sont des terres réservées aux Indiens au sens du point 24 de l'article 91 de la Loi constitutionnelle de 1867.

3. INDIAN OIL AND GAS

3. PÉTROLE ET GAZ DES INDIENS

3.1 The Indian Oil and Gas Act will continue to apply to any First Nation lands, or interests or land rights in First Nation land, that are "Indian lands" within the meaning of that Act.

3.1 La Loi sur le pétrole et le gaz des terres indiennes continuera à s'appliquer aux terres de premières nations et aux intérêts ou droits fonciers sur les terres de premières nations qui sont des « terres indiennes » au sens de cette Loi.

3.2 Any interest or land right in First Nation land that is granted to Canada for the exploitation of oil and gas under a land code will be deemed to be "Indian lands" within the meaning of the Indian Oil and Gas Act.

3.2 Les intérêts ou droits fonciers sur les terres de première nation octroyés au Canada pour l'exploitation du pétrole et du gaz en vertu d'un code foncier seront réputés être des « terres indiennes » au sens de la Loi sur le pétrole et le gaz des terres indiennes.

3.3 Section 4 of the Indian Oil and Gas Act will continue to apply to revenues and royalties from oil or gas on First Nation land, despite anything to the contrary in clause 12.

3.3 L'article 4 de la Loi sur le pétrole et le gaz des terres indiennes continuera de s'appliquer aux revenus et aux redevances provenant du pétrole ou du gaz situés sur les terres de première nation, nonobstant toute disposition contraire de l'article 12.

4. RESERVES

4. RÉSERVES

4.1 Any reserve managed by a First Nation under a land code will continue to be a reserve within the meaning of the Indian Act.

4.1 Les réserves gérées par une première nation en vertu d'un code foncier demeurent des réserves au sens de la Loi sur les Indiens.

4.2 Any reserve, title to which is vested in Canada, and managed by a First Nation under a land code, will continue to be vested in Canada for the use and benefit of the respective First Nation for which it was set apart.

4.2 Toute réserve, dont le titre est détenu par le Canada et qui est gérée par une première nation en vertu d'un code foncier, continuera d'appartenir au Canada à l'usage et au profit de la première nation pour laquelle la réserve fut mise de côté.

4.3 Where a First Nation wishes to manage a reserve, the whole of the reserve will be included as First Nation land to avoid disjointed administration of the reserve, subject to clauses 4.4, 4.5 and 4.5A.

4.3 Lorsqu'une première nation souhaite gérer une réserve, l'ensemble de la réserve sera inclus comme terres de première nation de façon à éviter la double administration de la réserve sous reserve des articles 4.4, 4.5 et 4.5A.

4.4 Subject to clause 4.5A, a portion of a reserve may be excluded from a land code only if:

4.4 Sous réserve de l'article 4.5A, il est permis de soustraire une partie d'une réserve à l'application du code foncier seulement dans l'un ou l'autre des cas suivants :

(a) the portion of the reserve is in an environmentally unsound condition and the condition cannot be remedied

a) l'environnement y est si dégradé que

by measures that are technically and financially feasible before the land code is expected to be submitted for community approval;

des mesures réalisables sur les plans technique et économique ne permettront pas de l’assainir avant la présentation prévue du code foncier à l’approbation de la communauté;

(b) the portion of the reserve is the subject of ongoing litigation that is unlikely to be resolved before the land code is expected to be submitted for community approval;

b) cette partie de la réserve fait l'objet d'un litige qui ne sera probablement pas résolu avant la présentation prévue du code foncier à l’approbation de la communauté;

(c) the portion of the reserve is uninhabitable or unusable as a result of a natural disaster; or

c) cette partie de la réserve est inhabitable ou inutilisable en raison d'un sinistre naturel;

(d) there exist one or more other reasons which the First Nation and the Minister agree justify excluding a portion of a reserve.

d) l'exclusion est justifiée pour une ou plusieurs autres raisons convenues par la première nation et le ministre.

4.5 A portion of a reserve may not be excluded if the exclusion would have the effect of placing the administration of a lease or other interest or right in land in more than one land management regime.

4.5 Une partie de la réserve ne peut être exclue si l'exclusion avail pour effet d'assujettlr un bail ou tout autre intérêt ou droit foncier à plus d'un régime de gestion fonciére.

4.5A Land may be excluded from the application of the land code when it is uncertain whether the land forms part of the reserve. An exclusion for this reason shall be without prejudice to the right of the First Nation or Her Majesty to assert that the land forms part of the reserve. If excluding the land would have the effect of placing a lease, other interest or right in land in more than one land management regime, then all land that is subject to that lease, interest or right shall be excluded from the application of the land code.

4.5A Une terre peut être exclue de application du code foncier lorsqu'il y a incertitude quant à la question de savoir si la terre est située ou non dans la réserve. L'exclusion pour ce motif ne porte pas atteinte au droit de la première nation ou de Sa Majesté de faire valoir que la terre fait partie de la réserve. Si l'exclusion a pour effet d'assujettir un bail ou tout autre intérêt ou droit foncier à plus d'un régime de gestion foncière, toute la partie de la réserve qui est assujettie au bail ou autre intérêt ou droit foncier doit être exclue de l'application du code foncier.

4.6 The First Nation will make provision to amend the description of its First Nation land in its land code to include the excluded portion of the reserve when the First Nation and the Minister agree that the condition justifying the exclusion no longer exists and the individual agreement will be amended accordingly.

4.6 Lorsque la première nation et le ministre conviennent que la condition justifiant l'exclusion d'une partie d'une réserve n'existe plus, la première nation fera en sorte que la description des terres de première nation contenue dans son code foncier soit modifiée pour y inclure la partie jusqu'à présent exclue et l’accord distinct sera modifié en conséquence.

PART II
OPTING IN PROCEDURE

PARTIE II
PROCÉDURE D'ADHÉSION

5. DEVELOPMENT OF A LAND CODE

5.1 A First Nation that wishes to manage one or more of its reserves will first develop a land code.

5.2 The land code of a First Nation will

(a) describe the lands that are subject to the land code;

(b) set out the general rules and procedures that apply to the use and occupancy of First Nation land, including use and occupancy under

(i) licenses and leases, and

(ii) interests or land rights in First Nation land held pursuant to allotments under subsection 20(1) of the Indian Act or pursuant to the custom of the First Nation;

(b.1) set out the procedures that apply to the transfer, by testamentary disposition or succession, of any interest or land rights in First Nation land;

(c) set out the general rules and procedures that apply to revenues from natural resources belonging to First Nation land;

(d) set out the requirements for accountability to First Nation members for the management of moneys and First Nation lands under

5. ÉLABORATION D'UN CODE FONCIER

5.1 La première nation qui souhaite gérer une ou plusieurs de ses réserves doit préalablement élaborer un code foncier.

5.2 Les éléments suivants figurent dans le code foncier d'une première nation :

a) la description des terres qui y sont assujetties;

b) les règles générales - de procédure et autres - applicables en matière d'utilisation et d'occupation des terres de première nation, notamment :

(i) en vertu d'un permis ou d'un bail,

(ii) en vertu d'un intérêt ou d'un droit foncier sur les terres de première nation découlant soit de l'attribution de cet intérêt ou droit foncier en vertu du paragraphe 20(1) de la Loi sur les Indiens, soit de la coutume de la première nation;

(b.1) les règles de procédure applicables en matière de transfert d'intérêts ou de droits fonciers sur les terres de première nation, par disposition testamentaire ou succession;

c) les règles générales – de procédure et autres - applicables aux revenus tirés des ressources naturelles relatives aux terres de première nation;

d) les exigences touchant l'obligation de rendre compte de la gestion des fonds et des terres de première nation aux termes the land code;

(e) set out the procedures for making and publishing its First Nation laws;

(f) set out the conflict of interest rules for land management;

(g) identify or establish a forum for the resolution of disputes in relation to interests or land rights in First Nation lands, including the review of land management decisions where a person, whose interest or land right in First Nation land is affected by a decision, disputes that decision;

(h) set out the general rules and procedures that apply to the First Nation when granting or expropriating interests or land rights in First Nation land, including provisions for notice and the service of notice;

(i) set out the general authorities and procedures whereby the First Nation council delegates administrative authority to manage First Nation land to another person or entity; and

(j) set out the procedure by which the First Nation can amend its land code or approve an exchange of its First Nation land.

5.3 A land code could also contain the following provisions:

du code foncier devant les membres de la première nation;

e) les règles d'édiction et de publication des textes législatifs de la première nation;

f) les règles applicables en matière de conflit d'intérêts dans la gestion des terres;

g) la création ou l'identification d'une instance chargée de résoudre les différends concernant les intérêts ou les droits fonciers sur les terres de première nation, y compris la révision de toute décision en matière de gestion des terres contestée par une personne dont les intérêts ou les droits fonciers sur ces terres sont affectés par cette décision;

h) les règles générales – de procédure et autres - applicables à la première nation en matière d’attribution ou d'expropriation d’intérêts ou de droits fonciers sur des terres de première nation, y compris les dispositions en matière d’avis et de notification;

i) les pouvoirs et procédures généraux applicables en matière de délégation, par le conseil de la première nation à une autre personne ou entité, des pouvoirs de gestion des terres de première nation;

j) la procédure selon laquelle la première nation peut modifier son code foncier ou approuver un échange de ses terres de première nation.

5.3 Peuvent également figurer dans le code foncier :

(a) any general conditions or limits on the power of the First Nation council to make First Nation laws;

(b) in any province or territory other than Quebec, any general exceptions, reservations, conditions or limitations to be attached to the rights and interests that may be granted in First Nation land;

(b.1) in the province of Quebec, any general exceptions, reservations, conditions or limits to be attached to the land rights or other rights that may be granted in First Nation land;

(c) any provisions respecting encumbering, seizing, or executing a right or an interest or land right in First Nation land as provided in clause 15; and

(d) any other matter respecting the management of First Nation land.

a) les conditions ou limites générales applicables au pouvoir du conseil de la première nation d'édicter des textes législatifs de la première nation;

b) dans une province ou un territoire autre que le Québec, les exclusions, réserves, conditions ou délimitations générales applicables en matière d’attribution des droits et des intérêts sur les terres de première nation;

b.1) dans la province de Québec, les exceptions, réserves, conditions ou limites générales applicables en matière d’attribution des droits fonciers et autres droits sur les terres de première nation;

c) les dispositions, telles que prévues à l’article 15, concernant la saisie ou l’exécution d’un droit ou d’un intérêt ou droit foncier sur les terres de première nation, ou le fait de les gérer;

d) toute autre disposition concernant la gestion des terres de première nation.

5.4 In order to clarify the intentions of the First Nations and Canada in relation to the breakdown of a marriage as it affects First Nation land:

(a) a First Nation will establish a community process in its land code to develop rules and procedures, applicable on the breakdown of a marriage, to the use, occupancy and possession of First Nation land and the division of interests or land rights in that land;

5.4 Afin de préciser l’intention des premières nations et du Canada en ce qui a trait à l’échec du mariage et à ses effets sur les terres de premières nations :

a) une première nation établira, dans son code foncier, un processus communautaire pour l’élaboration de règles et de procédures applicables, au moment de l’échec d’un mariage, en matière d’usage, d’occupation et de possession des terres de première nation et en matière de partage des intérêts ou des droits fonciers sur ces terres;

(b) for greater certainty, the rules and procedures referred to in clause (a) shall not discriminate on the basis of sex;

(c) the rules and procedures referred to in clause (a) shall be enacted in the First Nation's land code or First Nation laws;

(d) in order to allow sufficient time for community consultation during the community process referred to in clause (a), the First Nation shall have a period of 12 months from the date the land code takes effect to enact the rules and procedures;

(e) any dispute between the Minister and a First Nation in respect of this clause shall, notwithstanding clause 43.3, be subject to arbitration in accordance with Part IX;

(f) for greater certainty, this clause also applies to any First Nation that has voted to approve a land code before this clause comes into force.

6. DEVELOPMENT OF INDIVIDUAL FIRST NATION AGREEMENT

6.1 The Minister and each First Nation that intends to manage its First Nation land will also enter into an individual agreement to settle the actual level of operational funding for the First Nation and the specifics of the transfer of administration between Canada and the First Nation.

b) il est entendu que les règles et procédures mentionnées à l'alinéa a) ne peuvent faire aucune distinction fondée sur le sexe;

c) les règles et procédures mentionnées à l'alinéa a) sont prévues soit dans le code foncier de la première nation, soit dans ses textes législatifs;

d) afin qu'il puisse y avoir une période suffisante pour consulter la communauté, tel que mentionné à l'alinéa a), la première nation dispose d'un délai de 12 mois, à compter de la date d'entrée en vigueur de son code foncier, pour adopter ces règles et procédures;

e) tout différend entre le ministre et une première nation au sujet du présent article est, par dérogation à l'article 43.3, porté en arbitrage en conformité avec la Partie IX;

f) il est entendu que le présent article s'applique également à toute première nation qui a voté en faveur de l'adoption d'un code foncier avant que le présent article n'entre en vigueur.

6. ÉLABORATION D'UN ACCORD DISTINCT AVEC CHAQUE PREMIÈRE NATION

6.1 Le ministre et la première nation qui entend gérer ses propres terres concluront également un accord distinct fixant le niveau du financement opérationnel destiné à la première nation ainsi que les modalités du transfert des responsabilités en matière d'administration entre le

Canada et la première nation.

6.2 The First Nation and the Minister will each choose a representative to develop the individual agreement and to assist in transferring administration of the First Nation land.

6.2 La première nation et le ministre désignent chacun un représentant chargé de préparer l'accord distinct et de faciliter le transfert de l'administration des terres de première nation.

6.3 Upon the request of a First Nation that is developing a land code, the Minister will provide it with the following information, as soon as practicable:

(a) a list of all the interests or land rights and licences, in relation to the proposed First Nation land, that are recorded in the Reserve Land Register and the Surrendered and Designated Lands Register under the Indian Act;

(b) all existing information, in Canada's possession, respecting any actual or potential environmental problems with the proposed First Nation land; and

(c) any other information in Canada's possession that materially affects the interests or land rights and licences mentioned in clause 6.3(a).

6.3 À la demande de la première nation qui élabore un code foncier le ministre lui fournit les renseignements suivants, dans les meilleurs délais :

a) une liste de tous les intérêts ou droits fonciers et permis concernant les terres de la première nation proposées, qui sont consignés dans le registre des terres de réserve et le registre des terres désignées et cédées aux termes de la Loi sur les Indiens;

b) tous les renseignements en la possession du Canada concernant les problèmes environnementaux réels ou potentiels concernant les terres de la première nation proposées;

c) tout autre renseignement en la possession du Canada qui touche notablement les intérêts ou droits fonciers et les permis mentionnés à l'alinéa 6.3 a).

6.4 An amendment to an individual agreement with the Minister must be made in accordance with the procedure in that agreement.

6.4 L'accord distinct conclu avec le ministre est modifié selon la procédure prévue dans celui-ci.

7. COMMUNITY APPROVAL

7. APPROBATION DE LA COMMUNAUTÉ

7.1 Both the First Nation's land code and its

7.1 Le code foncier de la première nation individual agreement with the Minister need community approval in accordance with this clause.

et l'accord distinct conclu avec le ministre doivent être approuvés par la communauté conformément au présent article.

7.2 Every person who is a First Nation member, whether resident on or off-reserve, who is at least 18 years of age, is eligible to vote on whether to approve their First Nation's proposed land code and its individual agreement with the Minister.

7.2 A le droit de voter, dans le cadre de l'approbation du projet de code foncier de la première nation et de l'accord distinct conclu avec le ministre, tout membre de la première nation qui a au moins 18 ans, qu'il réside ou non dans la réserve.

7.3 The land code and individual agreement will be considered approved by the community if

(a) a majority of eligible voters participate in the vote and at least a majority of the participating voters vote to approve them;

(b) the First Nation registers all eligible voters who signified, in a manner determined by the First Nation, their intention to vote, and a majority of the registered voters vote to approve them; or

(c) the community approves them in such other manner as the First Nation and the Minister may agree upon.

7.3 Le code foncier et l'accord distinct sont réputés validement approuvés par la communauté dans les cas suivants :

a) la majorité des électeurs participent au scrutin et au moins une majorité des électeurs participants ont exprimé un vote favorable;

b) la première nation inscrit tous les électeurs qui ont fait connaître, selon les modalités fixées par la première nation, leur intention de voter et une majorité des électeurs inscrits ont exprimé un vote favorable;

c) la communauté les approuve selon d'autres modalités fixées conjointement par la première nation et par le ministre.

7.4 The land code and individual agreement will not be considered approved if less than 25% plus one of all eligible voters voted to approve them.

7.4 Dans tous les cas cependant, le code foncier et l'accord distinct ne sont approuvés que si au moins vingt-cinq pour cent plus un des électeurs ont exprimé un vote favorable.

7.5 The First Nation council may, by resolution, increase the minimum percentage for community approval otherwise required under this clause.

7.5 Le conseil de la première nation peut, par résolution, augmenter le pourcentage minimum requis en vertu du présent article pour recueillir l’approbation de la communauté.

7.6 A First Nation will take reasonable steps to locate its eligible voters and inform them of

(a) their right to participate in the approval process and the manner in which that right can be exercised; and

(b) the content of this Agreement, the individual agreement with the Minister, the proposed land code and the federal legislation.

7.6 Le conseil de la première nation doit prendre des mesures raisonnables pour retrouver les électeurs et les informer :

a) de leur droit de participer au processus d'approbation et de la manière d'exercer ce droit;

b) du contenu du présent accord, de l'accord distinct conclu avec le ministre, du projet de code foncier et de la loi de ratification.

7.7 Reasonable steps to locate and inform eligible voters may include the following :

(a) mailing out information to eligible voters at their last known addresses;

(b) making enquiries of family members and others to locate eligible voters whose addresses are not known or are uncertain;

(c) making follow up contact with eligible voters by mail or telephone;

(d) placing advertisements in newspapers circulating in the community and in newspapers circulating in other localities where the number of eligible voters warrants;

(e) posting notices in the community;

(f) holding information meetings in the community and in other places where appropriate; and

7.7 Parmi les mesures raisonnables envisagées pour retrouver les électeurs et les informer, le conseil peut prendre les mesures suivantes :

a) envoyer par courrier de l’information aux électeurs à leur dernière adresse connue;

b) s’enquérir auprès des membres de la famille et d’autres personnes afin de retrouver les électeurs dont l'adresse est inconnue ou incertaine;

c) effectuer un suivi auprès des électeurs par courrier ou par téléphone;

d) publier des avis dans les journaux distribués dans la communauté et dans toute autre localité où le nombre d'électeurs le justifie;

e) afficher des avis dans la communauté;

f) tenir des réunions d'information dans la communauté et à tout autre endroit approprié;

(g) making copies of the documents referred to in clause 7.6(b) available at the administration office of the First Nation and in other places where appropriate.

g) rendre disponible, au bureau d'administration de la première nation et à tout autre endroit approprié, une copie des documents mentionnés à l'alinéa 7.6b).

7.8 A First Nation will, within a reasonable time before the vote, also take appropriate measures to inform other persons having an interest or land right in its lands of the federal legislation, the proposed land code and the date of the vote.

7.8 La première nation doit prendre dans un délai raisonnable avant le jour du scrutin, des mesures appropriées pour informer les autres personnes ayant un intérêt ou un droit foncier sur ses terres au sujet de la loi de ratification, du projet de code foncier et de la date du scrutin.

7.9 Where the federal legislation has not yet been enacted when a First Nation proceeds under this clause, Canada will provide the First Nation with a draft copy of its proposed legislation which the First Nation will use to inform its eligible voters and other persons.

7.9 Si la loi de ratification n'a pas encore été adoptée au moment où la première nation met en oeuvre le présent article, le Canada fournira à la première nation une ébauche du projet de loi que la première nation portera à la connaissance des électeurs et des autres personnes concernées.

7.10 An amendment to a land code must be made in accordance with the procedure in the First Nation's land code.

7.10 Le code foncier d'une première nation est modifié selon la procédure prévue dans celui-ci.

8. VERIFICATION PROCESS

8. PROCESSUS DE VÉRIFICATION

8.1 Where a First Nation develops a proposed land code and resolves to submit it to the community for approval, an independent person will be appointed as a verifier to monitor and verify the opting in process. The verifier will be chosen in accordance with clause 44.

8.1 Lorsqu'une première nation élabore un projet de code foncier et décide de le présenter à la communauté pour approbation, une personne indépendante doit être nommée à titre de vérificateur chargée de surveiller le processus d'adhésion et d'en vérifier la régularité. Le vérificateur est choisi conformément à l'article 44.

8.2 The representatives of the First Nation

8.2 Les représentants de la première nation and the Minister, who have been assisting in the process of transferring administration of the land, will meet with the verifier and provide information and advice to the verifier, after consulting with their respective Parties.

8.3 The First Nation will submit the following information to the verifier:

(a) a copy of the proposed land code;

(b) an initial list of the names of every First Nation member who, according to the First Nation's records at that time, would be eligible to vote on whether to approve the proposed land code; and

(c) a detailed description of the community approval process that the First Nation proposes to use under clause 7.

8.4 The verifier will

(a) decide whether the proposed land code conforms with the requirements of clause 5;

(b) decide whether the proposed community approval process conforms with the requirements of clause 7;

(c) determine whether the community approval process is conducted in accordance with the process that was confirmed; and

(d) certify as being valid a First

et du ministre, qui ont participé au processus de transfert de la gestion des terres, rencontrent le vérificateur et lui fournissent renseignements et avis, après avoir consulté leurs Parties respectives.

8.3 La première nation communique au vérificateur les documents suivants :

a) un exemplaire du projet de code foncier;

b) la liste initiale des membres de la première nation qui, selon les registres de la première nation disponibles à ce moment, auraient le droit de voter aux fins de l'approbation de ce code;

c) un exposé détaillé du processus d’approbation de la communauté proposé par la première nation aux termes de l'article 7.

8.4 Le vérificateur a pour mandat:

a) de décider de la conformité du projet de code foncier avec les exigences de l'article 5;

b) de décider de la conformité du processus d’approbation de la communauté proposé avec les exigences de l'article 7;

c) de décider de la conformité du déroulement du scrutin avec le processus retenu pour l’approbation de la communauté;

d) d'attester la validité du code foncier de

Nation's land code that is properly approved by the First Nation.

la première nation dûment approuvé par elle.

8.5 The verifier also has the power to make a final decision to resolve

(a) any dispute regarding whether a portion of a reserve may be excluded from a land code pursuant to clause 4.4; and

(b) any dispute regarding the specifics of the transfer of administration between Canada and the First Nation.

8.5 Le vérificateur a également le pouvoir de trancher de façon définitive :

a) tout différend ayant trait à la question de savoir si une partie d'une réserve peut être soustraite à l'application du code foncier selon l'article 4.4;

b) tout différend concernant les modalités du transfert des pouvoirs d'administration entre le Canada et la première nation.

8.6 A verifier will make decisions that are consistent with clauses 4.4 and 4.5.

8.6 Les décisions du vérificateur doivent être conformes aux paragraphes 4.4 et 4.5.

8.7 A verifier will not deal with disputes over funding.

8.7 Le vérificateur ne peut être saisi des différends concernant le financement.

8.8 Within 30 days of receiving the First Nation's information pursuant to clause 8.3, the verifier will issue a written notice to the First Nation and the Minister stating whether the proposed land code and community approval process are consistent with this Agreement.

8.8 Le vérificateur émet à la première nation et au ministre, dans les 30 jours de la réception des documents visés à l'article 8.3, un avis écrit indiquant si le projet de code foncier et le processus d'approbation de la communauté proposé sont conformes au présent accord.

8.9 The verifier will provide written reasons to the First Nation and the Minister in any case where he or she decides that the proposed land code and community approval process are not consistent with this Agreement.

8.9 Dans tous les cas où, à son avis, le projet de code foncier ou le processus proposé pour obtenir l'approbation de la communauté ne sont pas conformes au présent accord, le vérificateur consigne par écrit les motifs de cette décision qu'il transmet à la première nation et au ministre.

9. CONDUCT OF COMMUNITY VOTE

9. TENUE DU SCRUTIN

9.1 Once the verifier confirms that the

9.1 Après que le vérificateur ait décidé que proposed land code and community approval process are consistent with this Agreement, the First Nation may proceed to submit its proposed land code, and the individual agreement with the Minister, for community approval.

le projet de code et le processus proposé pour obtenir l'approbation de la communauté sont conformes au présent accord, la première nation peut soumettre à l'approbation de la communauté le projet de code foncier et l'accord distinct conclu avec le ministre.

9.2 The verifier will publish one or more notices advising the community of the date, time and place of the First Nation's approval vote.

9.2 Le vérificateur fait publier un ou plusieurs avis informant la communauté de la date, de l'heure et du lieu du scrutin.

9.3 The verifier may designate one or more assistants to help observe the conduct of the vote.

9.3 Le vérificateur peut s'adjoindre un ou plusieurs assistants pour l'aider à surveiller le déroulement du scrutin.

9.4 The verifier and any assistant observers will have complete authority to observe the approval process.

9.4 Le vérificateur et ses adjoints ont pleins pouvoirs pour surveiller le processus d'approbation de la communauté.

9.5 Within 15 days of the conclusion of the vote, the verifier will issue a written report to the First Nation and to the Minister on whether the community approval process was conducted in accordance with the process as previously confirmed.

9.5 Le vérificateur remet à la première nation et au ministre, dans les 15 jours suivant la fermeture du scrutin, son rapport écrit au sujet de la conformité du déroulement du scrutin avec le processus d'approbation retenu.

10. CERTIFICATION OF LAND CODE

10. CERTIFICATION DU CODE FONCIER

10.1 Where a First Nation approves a land code and its individual agreement with the Minister, the First nation council must, without delay, send a a true copy of the land code to the verifier together with a true copy of the fully signed individual agreement and a statement from the First Nation council that the land code and the individual agreement were properly approved.

10.1 Lorsque la première nation approuve le code foncier et l'accord distinct avec le ministre, le conseil de la première nation adresse au vérificateur, dans les meilleurs délais, une copie cértifée conforme de l'accord distinct entièrement signé et du code foncier approuvé ainsi qu'une déclaration du conseil de la première nation indiquant que le code foncier et l'accord distinct ont été dûment approuvés.

10.2 Upon receiving a copy of a First Nation's land code, signed individual agreement and statement, the verifier will, subject to clause 11, certify the land code as being valid.

10.2 Sur réception de la copie du code foncier, de i'accord distinct signée et de la déclaration, le vérificateur atteste la validité du code foncier, sous réserve de l'article 11.

10.3 The verifier will immediately provide the First Nation, the Lands Advisory Board and the Minister with a copy of any certified land code.

10.3 Le vérificateur adresse immédiatement à la première nation, au Conseil consultatif des terres et au ministre une copie du code foncier dont il a attesté la validité.

10.4 The Lands Advisory Board will, in such manner as it considers advisable, publish a notice announcing the certification of a land code and the date the land code takes effect and advising the public of the means of obtaining copies of it.

10.4 Le Conseil consultatif des terres publie, selon les modalités qu'il estime appropriées, un avis attestant la validité du code foncier, sa date d'entrée en vigueur et faisant connaître au public la façon de s'en procurer des copies.

10.4.1 Certified copies of the land code will be made available to the public at such places deemed necessary by the First Nation.

10.4.1 Des copies certifiées du code foncier seront mises à la disposition du public aux endroits que la première nation estime appropriés.

10.5 Once a land code is certified by a verifier and takes effect, the land code has the force of law and will be given judicial notice.

10.5 Dès que le code foncier reçoit l'attestation du vérificateur et qu'il entre en vigueur, il a dès lors force de loi et est admis d'office dans toute instance.

10.6 A land code that has been certified pursuant to this Agreement is deemed to have been validly approved by the First Nation.

10.6 Une fois sa validité attestée conformément au présent accord, le code est réputé avoir été dûment approuvé par la première nation.

10.7 A land code takes effect on the day that it is certified by the verifier or on such later date as may be specified in the land code.

10.7 Le code foncier entre en vigueur à la date de l'attestation de sa validité par le vérificateur ou à la date postérieure fixée dans le code.

11. DISPUTED VOTE

11. CONTESTATION DU VOTE

11.1 The Minister or any eligible voter may, within five days after the conclusion of the vote, report any irregularity in the voting

11.1 Le ministre ou tout électeur peut, dans les cinq jours suivant la clôture du scrutin, informer le vérificateur de toute process to the verifier.

irrégularité dont a été entaché le déroulement du scrutin.

11.2 A verifier will not certify a land code if he or she is of the opinion that the following two conditions exist:

(1) the process by which the land code was approved varied from the process previously confirmed by the verifier or was otherwise irregular; and

(2) the land code might not have been approved but for the irregularity in the process.

11.2 Le vérificateur ne peut attester la validité du code foncier s'il en vient aux conclusions suivantes :

(1) d'une part, le déroulement du scrutin n'est pas conforme au processus d'approbation qu'il a lui-même confirmé au préalable ou est autrement entaché d'irrégularité;

(2) d'autre part, le code n'aurait peut-être pas été approuvé sans cette irrégularité.

11.3 Before making a decision under this clause, the verifier will provide the First Nation and the Minister with a reasonable opportunity to make submissions on the issue.

11.3 Avant de prononcer une décision aux termes du présent article, le vérificateur donne à la première nation et au ministre l'occasion de présenter des observations.

11.4 Any decision by a verifier under this clause must be made within 10 days of the conclusion of the vote.

11.4 Toute décision du vérificateur en vertu du présent article doit être prise dans un délai de 10 jours suivant la conclusion du vote.

PART III

FIRST NATION LAND MANAGEMENT RIGHTS AND POWER

PARTIE III

DROITS ET POUVOIRS DE GESTION DES TERRES DE PREMIÈRE NATION

12. LAND MANAGEMENT POWERS

12.1 A First Nation with a land code in effect will, subject to clause 13, have the power to manage its First Nation land and exercise its powers under this Agreement.

12. POUVOIRS DE GESTION DES TERRES

12.1 Dès que le code foncier entre en vigueur, la première nation a le pouvoir de gérer ses terres de première nation et d'exercer ses pouvoirs en vertu du présent accord, sous réserve de l'article 13.

12.2 This power includes

(a) all the rights, powers and privileges of an owner, in relation to its First Nation land; and

(b) the authority to grant interests or land rights and licences in relation to its First Nation land and to manage its natural resources, subject to clauses 3, 18.5 and 23.6.

12.2 Elle peut notamment :

a) exercer tous les droits, pouvoirs et privilèges d’un propriétaire, pour ce qui est de ses terres de première nation;

b) sous réserve des articles 3, 18.5 et 23.6, attribuer des permis et des intérêts ou droits fonciers relatifs à ses terres de première nation et gérer ses ressources naturelles.

12.3 In any province or territory other than Quebec, an interest or licence granted in relation to First Nation land is subject to any exception, reservation, condition or limitation established by the First Nation in its land code.

12.3 Dans une province ou un territoire autre que le Québec, un intérêt ou un permis relatif aux terres de première nation est assujetti aux exclusions, réserves, conditions ou délimitations énoncées par la première nation dans son code foncier.

12.3A In the province of Quebec, a land right or licence granted in relation to First Nation land is subject to any exceptions, reservations, conditions or limits established by the First Nation in its land code.

12.3A Dans la province de Québec, un droit foncier ou un permis relatif aux terres de première nation est assujetti aux exceptions, réserves, conditions ou limites énoncées par la première nation dans son code foncier.

12.4 For any purpose related to First Nation land, a First Nation will have legal capacity to acquire and hold property, to borrow, to contract, to expend and invest money, to be a party to legal proceedings, to exercise its powers and to perform its duties.

12.4 À l'égard de ses terres de première nation, la première nation a la capacité juridique d'acquérir et de détenir des biens, de conclure des contrats et d'emprunter, de dépenser des fonds et de faire des investissements, d’ester en justice et d'exercer ses pouvoirs et attributions.

12.5 First Nation land, revenues, royalties, profits and fees in respect of that land will be managed by the First Nation council or its delegate for the use and benefit of the First Nation.

12.5 Le conseil de la première nation ou son délégué administre les terres de première nation ainsi que les revenus, les redevances, les recettes et les droits y afférents à l'usage et au profit de la première nation.

12.6 If a First Nation establishes an entity for the purpose of administering its First Nation land, the entity shall be deemed to be a legal entity with the capacity, rights, powers and privileges of a natural person.

12.6 Si la première nation met sur pied une entité pour gérer ses terres, l'entité est réputée être une entité juridique ayant la capacité, les pouvoirs, les droits et les privilèges d'une personne physique.

12.7 A First Nation has the right, in accordance with its land code, to receive and use all moneys acquired by or on behalf of the First Nation under its land code.

12.7 La première nation a, conformément à son code foncier, le droit de recevoir et d'utiliser les sommes acquises par ou pour le compte de la première nation en vertu de son code foncier.

12.8 Once a First Nation's land code takes effect, all revenue moneys collected, received or held by Canada for the use and benefit of the First Nation or its members before that date, and from time to time thereafter, shall cease to be Indian moneys under the Indian Act, except for the purposes of paragraph 90 (1) (a),and shall be transferred by Canada to the First Nation

12.8 À compter de la date d'entrée en vigueur du code foncier d'une première nation, les fonds perçus, reçus et détenus par la Canada à l'usage et au profit de la première nation ou de ses membres avant cette date, ainsi que ceux qui le sont après cette date, cessent d'être de l'argent des Indiens aux fins de le Loi sur les Indiens, sauf aux fins de l'alinéa 90(1)a), et sont transférés par le Canada à la première nation.

13. PROTECTION OF FIRST NATION LAND

13. PROTECTION DES TERRES DE PREMIÈRE NATION

13.1 Title to First Nation land is not changed when a First Nation's land code takes effect.

13.1 L'entrée en vigueur du code foncier d'une première nation n'a pas pour effet de modifier le titre des terres de première nation.

13.2 The Parties declare that it is of fundamental importance to maintain the amount and integrity of First Nation land.

13.2 Les Parties déclarent reconnaître l'importance fondamentale que revêt la préservation de la superficie et de l'intégrité des terres de première nation.

13.3 First Nation land will not be sold, exchanged, conveyed or transferred, except for any exchange or expropriation of First Nation land made in accordance with this Agreement.

13.3 Les terres de première nation ne sont pas susceptibles d'être vendues, échangées ou transférées, si ce n'est dans le cadre d'un échange ou d'une expropriation effectué en conformité avec le présent accord.

14. VOLUNTARY EXCHANGE OF FIRST NATION LAND

14.1 A First Nation has the right to exchange a parcel of First Nation land for another parcel of land, if that other parcel of land becomes First Nation land. An exchange of First Nation land may provide for additional compensation, including land that may not become First Nation land, and may be subject to any other terms and conditions.

14.2 Any exchange of First Nation land will require community approval in accordance with the process established in the land code.

14.3 First Nation land will only be exchanged for land that Canada consents to set apart as a reserve. In addition, the agreement of Canada is required on the technical aspects of the exchange.

14.4 The title to the land to be received in exchange for that First Nation land will be transferred to Canada and will be set apart by Canada as a reserve, as of the date of the land exchange or such later date as the First Nation may specify. This does not apply to land that is received by the First Nation as additional compensation and that is not intended to become First Nation land.

14.5 Where an exchange of First Nation land is approved by a First Nation in accordance with its land code, the First Nation can

14. ÉCHANGE VOLONTAIRE DE TERRES DE PREMIÈRE NATION

14.1 Une première nation a le droit d'échanger une parcelle des terres de première nation contre une autre parcelle, si cette autre parcelle fait dès lors partie des terres de première nation. L’échange peut également comporter une contrepartie supplémentaire, notamment des terres supplémentaires qui ne sont pas destinées à devenir des terres de première nation, et être assorti d'autres conditions.

14.2 Tout échange de terres de première nation doit être approuvé par les membres de la première nation selon les modalités prévues par le code foncier.

14.3 Des terres de première nation ne peuvent être échangées que contre des terres que le Canada accepte de mettre de côté à titre de réserve. L’accord du Canada est également requis quant aux aspects techniques de l'opération.

14.4 Le titre des terres reçues en échange des terres de première nation sera transféré au Canada, qui mettra ces terres de côté à titre de réserve, à la date de l'échange ou à la date ultérieure fixée par la première nation. Cette disposition ne s'applique pas aux terres remises à une première nation à titre de contrepartie supplémentaire et qui ne sont pas destinées à devenir des terres de première nation.

14.5 Lorsque l'échange des terres de première nation est approuvé par la première nation conformément à son code execute an authorization to Canada to transfer title to the land.

14.6 Upon the issuance to Canada of an authorization to transfer title to First Nation land under clause 14.5, Canada will transfer title to the land in accordance with the authorization and the applicable terms and conditions of the exchange.

14.7 A copy of the instruments or acts transferring title to First Nation land will be registered in the First Nation Lands Register.

14.8 As of the date of the land exchange, or such later date as the First Nation may specify, the description of First Nation land in the land code will be deemed to be amended to delete the description of the First Nation land that was exchanged and to add the description of the First Nation land received in exchange.

14.9 For greater certainty, the First Nation land that was exchanged will cease to be a reserve.

15. IMMUNITY FROM SEIZURE, ETC.

15.1 The Parties confirm that section 29 and subsections 89(1) and (2) of the Indian Act will continue to apply to any reserve that is First Nation land.

15.2 Subsection 89(1.1) of the Indian Act will continue to apply to all leasehold interests or leases that existed when the land code took effect if the First Nation land was

foncier, la première nation peut délivrer au Canada une autorisation de procéder au transfert du titre sur les terres en question.

14.6 Le Canada procède, sur réception de l'autorisation prévue à l'article 14.5, au transfert du titre sur les terres en question, en conformité avec cette autorisation et avec les conditions de l’échange.

14.7 Une copie des instruments ou actes de transfert du titre sur les terres de première nation sera enregistrée dans le registre des terres de premières nations.

14.8 À partir de la date de l'échange de terres, ou à la date ultérieure fixée par la première nation, la description des terres de première nation dans le code foncier est réputée être modifiée de façon à supprimer la description des terres de première nation qui ont été échangées et à ajouter celle des terres de première nation reçues en échange.

14. 9 Il est entendu que les terres de première nation qui ont été échangées cessent de constituer une réserve.

15. INSAISISSABILITÉ, ETC.

15. 1 Les parties confirment que l'article 29 et les paragraphes 89(1) et (2) de la Loi sur les Indiens continuent de s'appliquer aux réserves faisant partie des terres de première nation.

15.2 Le paragraphe 89(1.1) de la Loi sur les Indiens continue de s'appliquer à tous les baux ou intérêts à bail qui existaient lorsque le code foncier est entré en designated land at that time.

vigueur, dans le cas où les terres de première nation étaient des terres désignées à ce moment.

15.3 A land code may provide that some or all of the provisions of subsection 89(1.1) of the Indian Act are also applicable to other leasehold interests or leases in any First Nation lands.

15.3 Le code foncier peut énoncer que les dispositions du paragraphe 89(1.1) de la Loi sur les Indiens sont également applicables, en tout ou en partie, aux autres baux ou intérêts à bail sur les terres de première nation.

15.4 The Parties confirm that section 87 of the Indian Act continues to apply to First Nation land, so that

(a) the interest of an Indian or a First Nation in a reserve that is First Nation land remains exempt from taxation, subject to section 83 of the Indian Act; and

(b) the personal property or the movables of an Indian or a First Nation, situated on a reserve that is First Nation land, remains exempt from taxation.

15.4 Les parties confirment que l'article 87 de la Loi sur les Indiens continue de s'appliquer aux terres de première nation de façon à ce que:

a) le droit d'un Indien ou d'une première nation sur une réserve faisant partie des terres de première nation demeure exempté de taxation, sous réserve de l'article 83 de la Loi sur les Indiens;

b) les biens personnels ou les meubles d'un Indien ou d'une première nation situés sur une réserve faisant partie des terres de la première nation demeurent exemptés de taxation.

16. THIRD PARTY INTERESTS

16. INTÉRÊTS DES TIERS

16.1 Interests or land rights or licences held by third parties or Canada in First Nation land, that exist at the time the land code takes effect, continue in force according to their terms and conditions.

16.1 Les intérêts ou droits fonciers ou les permis que détiennent les tiers ou le Canada sur des terres de première nation lorsque le code foncier entre en vigueur continuent d'avoir effet selon leurs conditions.

16.2 Any rights of locatees in possession of First Nation land, either by custom or by allotment under the Indian Act, to transfer, lease and share in natural resource revenues will be defined in the land code.

16.2 Les droits des occupants en possession de terres de première nation, que ce soit conformément à la coutume ou par attribution aux termes de la Loi sur les Indiens, en matière de transfert, de bail et de partage des revenus provenant de ressources naturelles seront définis par le code foncier.

16.3 Once a land code takes effect, no interest, land right or licence in relation to First Nation land may be acquired or granted except in accordance with the land code.

16.3 Après l'entrée en vigueur du code foncier, les permis, les intérêts ou droits fonciers concernant les terres de première nation ne peuvent être acquis ou accordés qu'en conformité avec ce code.

16.4 For greater certainty, disputes in relation to third party interests shall be dealt with in the forum identified or established in a land code pursuant to clause 5.2(g).

16.4 Il est entendu que les différends relatifs aux intérêts des tiers sont réglés selon ce que prévoit le code foncier conformément à l'alinéa 5.2g).

17. EXPROPRIATION BY FIRST NATIONS

17. EXPROPRIATION PAR LES PREMIÈRES NATIONS

17.1 A First Nation with a land code in effect has the right to expropriate interests or land rights in First Nation lands without consent if deemed by the First Nation council to be necessary for community works or other First Nation purposes.

17.1 La première nation ayant un code foncier en vigueur a le droit d'exproprier sans consentement des intérêts ou droits fonciers sur ses terres de première nation, si le conseil de la première nation estime en avoir besoin pour réaliser des ouvrages communautaires ou à d’autres fins de la première nation.

17.2 A First Nation's power of expropriation will be exercised in accordance with the rules and procedures specified in its land code, its laws and this Agreement.

17.2 La première nation procède à l'expropriation conformément aux règles et procédures établies dans son code foncier, à ses textes législatifs et au présent accord.

17.3 In any province or territory other than Québec, an interest in First Nation land that a First Nation expropriates becomes the property of the First Nation free of any previous claim or encumbrance in respect of the interest.

17.3 Un intérêt sur les terres de première nation dans une province ou un territoire autre que le Québec exproprié par la première nation devient la propriété de celle-ci, libre de toute réclamation ou tout grèvement antérieurs quant à cet intérêt.

17.3A In the province of Québec, the First Nation that expropriates a land right in its First Nation lands becomes the holder of that

17.3A La première nation qui exproprie un droit foncier sur ses terres de première nation dans la province de Québec devient right free of any previous right, charge or claim in respect of that land right.

titulaire de ce droit foncier, libre de tout droit, charge ou réclamation antérieurs.

17.4 A First Nation that expropriates an interest or land right in First Nation land will give fair compensation based on the heads of compensation set out in the Expropriation Act (Canada).

17.4 La première nation qui exproprie un intérêt ou droit foncier sur ses terres de première nation est tenue de verser une indemnité équitable, calculée selon les règles énoncées dans la Loi sur l'expropriation (Canada).

17.5 A First Nation will establish a mechanism to resolve disputes over compensation it pays for expropriation.

17.5 La première nation est tenue de mettre sur pied un mécanisme de règlement des différends relatifs à l'indemnisation qu'elle paye pour les expropriations.

17.6 Any interest in First Nation land that was obtained pursuant to section 35 of the Indian Act or any interest or land right that has been acquired by Canada, or that is acquired after this Agreement comes into force by Canada in accordance with this Agreement, is not subject to First Nation expropriation.

17.6 Ne sont toutefois pas susceptibles d'expropriation par la première nation les intérêts ou les droits fonciers sur les terres de première nation obtenus sous le régime de l'article 35 de la Loi sur les Indiens ou qui ont été acquis par le Canada ou encore qui seront acquis par le Canada après l'entrée en vigueur du présent accord conformément à celui-ci.

17.7 A First Nation is not precluded from entering into an agreement with a utility or public body for the purpose of granting it an interest or land right in First Nation land that is exempt from expropriation by the First Nation.

17.7 Il n'est pas interdit à la première nation de conclure avec un organisme public ou une société de service public un accord lui attribuant un intérêt ou un droit foncier sur les terres de première nation non susceptible d'être exproprié par la première nation.

17.8 No expropriation of an interest or land right in First Nation land by a First Nation takes effect earlier than either of the following days:

17.8 L'expropriation par une première nation d'un intérêt ou d’un droit foncier sur les terres de première nation ne prend effet qu'à la première des dates suivantes :

(a) the date the notice of expropriation is registered in the First Nation Lands Register; or

a) la date d'inscription de l'avis d'expropriation dans le registre des terres de la première nation;

(b) the 30th day after the day the last copy of the notice is served.

PART IV
FIRST NATION LAW MAKING

18. LAW MAKING POWERS

18.1 The council of a First Nation with a land code in effect will have the power to make laws, in accordance with its land code, respecting the development, conservation, protection, management, use and possession of First Nation land and interests or land rights and licences in relation to that land. This includes laws on any matter necessary or ancillary to the making of laws in relation to First Nation land.

18.2 The following examples illustrate some of the First Nation laws contemplated by the Parties:

(a) laws on the regulation, control and prohibition of zoning, land use, subdivision control and land development;

(b) laws on the creation, regulation and prohibition of interests or land rights and licences in relation to First Nation land;

(c) laws on environmental assessment and protection;

(d) laws on the provision of local

b) le 30e jour suivant la signification de la dernière copie de cet avis.

PARTIE IV
POUVOIRS DE LÉGIFÉRER DE LA PREMIÈRE NATION

18. POUVOIRS DE LÉGIFÉRER

18.1 Le conseil de la première nation ayant un code foncier en vigueur peut édicter des textes législatifs, conformément à celui-ci, concernant le développement, la conservation, la protection, la gestion, l'utilisation et la possession des terres de première nation et des intérêts ou droits fonciers et permis les concernant. Cela comprend les textes législatifs portant sur des questions nécessaires ou afférentes à l'élaboration des textes législatifs relatifs aux terres de première nation.

18.2 Les exemples qui suivent illustrent certaines des fins pour lesquelles les premières nations peuvent adopter des textes législatifs, comme l’envisagent les Parties :

a) pour réglementer, régir ou interdire le zonage, l'aménagement, l'utilisation, le lotissement ou la mise en valeur des terres;

b) pour créer et réglementer les permis et les intérêts ou les droits fonciers relatifs aux terres de première nation ou prévoir des interdictions à cet égard;

c) pour régir la protection de l'environnement et l'évaluation environnementale;

services in relation to First Nation land and the imposition of equitable user charges; and

(e) laws on the provision of services for the resolution, outside the courts, of disputes in relation to First Nation land.

d) pour régir la prestation de services locaux relatifs aux terres de première nation et l'imposition de frais équitables à leurs usagers;

e) pour régir la prestation de services de règlement extrajudiciaire des différends relatifs aux terres de première nation.

18.3 A land code will not address the taxation of real or personal property or of immovables or movables. Section 83 of the Indian Act will continue to apply.

18.3 Le code foncier ne traite pas de l'imposition des biens réels ou personnels ou des immeubles ou meubles. L'article 83 de la Loi sur les Indiens continue de s'appliquer.

18.4 In any proceeding, a copy of a First Nation law, appearing to be certified as a true copy by an officer of the First Nation is, without proof of the officer's signature or official character, evidence of its enactment on the date specified in the law.

18.4 La copie d'un texte législatif de la première nation paraissant certifiée conforme par un fonctionnaire de la première nation fait foi, dans le cadre de toute procédure, de son adoption à la date qui y est inscrite sans qu'il soit nécessaire de prouver l'authenticité de la signature ou la qualité officielle du signataire.

18.5 This Agreement does not affect or extend existing rights and powers, or create additional rights and powers, related to fisheries.

18.5 Le présent accord ne modifie en rien les droits et pouvoirs actuels relatifs aux pêcheries, ni ne crée des droits ou pouvoirs additionnels à cet égard.

19. ENFORCEMENT OF FIRST NATION LAWS

19. CONTRÔLE D'APPLICATION DES TEXTES LÉGISLATIFS DE LA PREMIÈRE NATION

19.1 To enforce its land code and its First Nation laws, a First Nation will have the power to

(a) establish offences that are punishable on summary conviction;

(b) provide for fines, imprisonment,

19.1 Aux fins de contrôle d'application de son code foncier et de ses textes législatifs, la première nation peut :

a) créer des infractions punissables par procédure sommaire;

b) prévoir des peines, notamment les

restitution, community service, and alternate means for achieving compliance; and

amendes, l'emprisonnement, la restitution, les travaux d'intérêt collectif ou toute autre mesure de nature à assurer l'observation de ces textes;

(c) establish comprehensive enforcement procedures consistent with federal law, including inspections, searches, seizures and compulsory sampling, testing and the production of information.

c) établir, conformément aux lois fédérales, des mesures de contrôle d'application de ces textes notamment en matière d'inspection, de perquisition, de saisie, de prise d'échantillons, d'examen et de communication de renseignements.

19.2 First Nation laws may adopt or incorporate by reference the summary conviction procedures of the Criminal Code for the purpose of enforcement.

19.2 Les textes législatifs de la première nation peuvent, à ces fins, reproduire ou incorporer par renvoi la procédure sommaire du Code criminel.

19.3 Persons may be appointed by the First Nation or the Governor in Council to act as justices of the peace for the purposes of enforcement. If no justice of the peace is appointed, then First Nation laws will be enforced through the provincial courts.

19.3 La première nation ou le gouverneur en conseil peut nommer des juges de paix chargés d'assurer le contrôle d’application des textes législatifs de la première nation. En l'absence de juges de paix, les poursuites relatives aux textes législatifs de la première nation sont instruites devant les tribunaux provinciaux.

19.4 A person appointed as a justice of the peace under this clause will have jurisdiction to try offences established by or under a land code or a First Nation law.

19.4 Il relève de la compétence du juge de paix nommé aux termes du présent article d'instruire les poursuites relatives aux infractions créées par un code foncier ou par un texte législatif de la première nation.

19.5 Decisions made by a justice of the peace appointed under this clause may be appealed to a court of competent jurisdiction.

19.5 Les décisions du juge de paix nommé aux termes du présent article sont susceptibles d'appel devant un tribunal compétent.

19.6 The First Nation will protect the independence of each justice of the peace it appoints in a way similar to that in a province, for example tenure, removal and

19.6 La première nation est tenue de protéger l'indépendance des juges de paix qu'elle nomme, de façon analogue à ce que font les provinces, par exemple la durée de remuneration.

leur mandat, leur destitution et leur rémunération.

19.7 The First Nation and Canada may enter into agreements for the training, supervision and administrative support for justices of the peace appointed by the First Nation. Provinces may also be parties to such agreements with First Nations.

19.7 La première nation et le Canada peuvent conclure des ententes concernant la formation, la surveillance et le soutien administratif des juges de paix nommés par la première nation. Les provinces peuvent également être parties à ces ententes avec les premières nations.

19.8 The First Nation and Canada will enter into an agreement for the appointment, training, supervision and administrative support for any justice of the peace appointed under this clause by the Governor in Council. The affected province will be invited to participate in the development of and be a party to such agreement.

19.8 La première nation et le Canada sont tenus de conclure une entente relativement à la nomination, la formation, la surveillance et le soutien administratif des juges de paix nommés aux termes du présent article par le gouverneur en conseil. La province concernée sera invitée à participer à l'élaboration de cette entente et à être partie à celle-ci.

19.9 For the purpose of prosecuting offences, the First Nation will follow one or more of these options:

(a) retain its own prosecutor;

(b) enter into an agreement with Canada and the government of the province to arrange for a provincial prosecutor; or

(c) enter into an agreement with Canada to arrange for a federal agent to prosecute these offenses.

19.9 Aux fins des poursuites, la première nation peut se prévaloir d'une ou de plusieurs des mesures suivantes :

a) embaucher ses propres procureurs;

b) conclure avec le Canada et le gouvernement provincial concerné une entente prévoyant le recours à un procureur provincial;

c) conclure avec le Canada une entente prévoyant le recours à un mandataire fédéral.

20. APPLICATION OF FEDERAL LAWS

20. APPLICATION DES LOIS FÉDÉRALES

20.1 Federal laws applicable on First Nation land will continue to apply, except to the extent that they are inconsistent with the

20.1 Les lois fédérales applicables sur les terres de première nation continuent de s'appliquer à celles-ci sauf dans la mesure federal legislation.

20.2 Notwithstanding any inconsistency with the federal legislation, the Emergencies Act will apply on First Nation land, but any appropriation of an interest or land right in First Nation land under the Emergencies Act shall be authorized expressly by an order in council.

20.3 For greater certainty, and subject to Part VII, the Atomic Energy Control Act or any successor legislation continue to apply to First Nation lands.

21. INAPPLICABLE SECTIONS OF INDIAN ACT AND REGULATIONS

21.1 Once a land code takes effect, the First Nation, its members and its First Nation land will not be subject to the following:

(a) sections 18 to 20 and 22 to 28 of the Indian Act;

(b) sections 30 to 35 of the Indian Act;

(c) sections 37 to 41 of the Indian Act;

(d) sections 49, 50(4) and 53 to 60 of the Indian Act;

(e) sections 66, 69 and 71 of the Indian Act;

où elles sont incompatibles avec la loi de ratification.

20.2 La Loi sur les mesures d'urgence est applicable sur les terres de première nation, même si elle est incompatible avec la loi de ratification. Cependant, la réquisition d’intérêts ou de droits fonciers sur les terres de première nation aux termes de la Loi sur les mesures d'urgence doit être expressément autorisée par un décret.

20.3 Sous réserve de la partie VII, il est entendu que la Loi sur le contrôle de l’énergie atomique, ou toute loi qui la remplace, continue de s’appliquer sur les terres de première nation.

21. INAPPLICABILITÉ DE CERTAINS ARTICLES DE LA LOI SUR LES INDIENS ET DES RÈGLEMENTS Y AFFÉRENTS

21.1 Dès l'entrée en vigueur de son code foncier, la première nation, ses membres et les terres de première nation, cessent d'être assujettis aux dispositions suivantes :

a) les articles 18 à 20 et 22 à 28 de la Loi sur les Indiens;

b) les articles 30 à 35 de la Loi sur les Indiens;

c) les articles 37 à 41 de la Loi sur les Indiens;

d) l'article 49, le paragraphe 50(4) et les articles 53 à 60 de la Loi sur les Indiens;

e) les articles 66, 69 et 71 de la Loi sur les

Indiens;

(f) section 93 of the Indian Act;

f) l'article 93 de la Loi sur les Indiens;

(g) regulations made under section 57 of the Indian Act; and

g) les règlements pris en application de l'article 57 de la Loi sur les Indiens;

(h) regulations made under sections 42 and 73 of the Indian Act to the extent that they are inconsistent with this Agreement or the land code or the laws of the First Nation.

h) les règlements pris en application des articles 42 et 73 de la Loi sur les Indiens dans la mesure où ils sont incompatibles avec le présent accord, avec le code foncier ou avec les textes législatifs de la première nation.

22. EXISTING FIRST NATION BY-LAWS

22. RÈGLEMENTS ADMINISTRATIFS ACTUELS DE LA PREMIÈRE NATION

22.1 A First Nation will continue to have the authority under the Indian Act to make by-laws.

22.1 La première nation conserve le pouvoir d'adopter des règlements administratifs aux termes de la Loi sur les Indiens.

PART V ENVIRONMENT

PARTIE V ENVIRONNEMENT

23. GENERAL PRINCIPLES

23. PRINCIPES GÉNÉRAUX

23.1 The council of a First Nation with a land code in effect will have the power to make environmental laws relating to First Nation land.

23.1 Le conseil de la première nation ayant un code foncier en vigueur a le pouvoir d'édicter des textes législatifs de nature environnementale concernant les terres de première nation.

23.2 The Parties intend that there should be both an environmental assessment and an environmental protection regime for each First Nation.

23.2 Les Parties s'entendent pour qu’il y ait un régime de protection de l'environnement et un régime d'évaluation environnementale pour chaque première nation.

23.3 The principles of these regimes are set out below.

23.3 Les principes de ces régimes sont énoncés ci-dessous.

23.4 The environmental assessment and protection regimes will be implemented through First Nation laws.

23.4 Les régimes de protection et d'évaluation environnementales seront mis en oeuvre par des textes législatifs de la première nation.

23.5 The Parties agree to harmonize their respective environmental regimes and processes, with the involvement of the provinces where they agree to participate, to promote effective and consistent environmental regimes and processes and to avoid uncertainty and duplication.

23.5 Les Parties conviennent d'harmoniser leurs régimes et processus environnementaux respectifs, en invitant les provinces à participer à cette opération si celles-ci le souhaitent, dans le but de promouvoir l'uniformité et l'efficacité des régimes et processus environnementaux et d'éviter les incertitudes et le double emploi.

23.6 This Agreement is not intended to affect rights and powers relating to migratory birds or endangered species. These matters may be dealt with in the context of other negotiations. This Agreement is not intended to determine or prejudice the resolution of these issues.

23.6 Le présent accord n'a pas pour effet de modifier les droits et pouvoirs concernant les oiseaux migrateurs et les espèces en voie de disparition. Ces questions pourront faire l'objet d'autres négociations. Le présent accord n'a pas pour objet de déterminer la résolution de ces questions ou d'y porter préjudice.

24. ENVIRONMENTAL MANAGEMENT

24. GESTION DE L'ENVIRONNEMENT

24.1 Subject to clause 27, a First Nation with a land code in effect will develop an environmental protection regime, with the assistance of the appropriate federal agencies to the extent that they agree to participate.

24.1 Sous réserve de l'article 27, une première nation qui a un code foncier en vigueur élaborera un régime de protection environnementale, avec l'appui des organismes fédéraux concernés, dans la mesure où la province accepte de participer.

24.2 Each First Nation agrees to harmonize environmental protection with the province in which the First Nation is situated, where the province agrees to participate

24.2 Chaque première nation accepte d'harmoniser son régime de protection environnementale avec celui de la province où elle est située, dans la mesure où la province accepte de participer.

24.3 The First Nation environmental protection standards and punishments will have at least the same effect as those in the laws of the province in which the First Nation is situated.

24.3 Les normes de protection environnementale et penalités de la première nation devront avoir au moins l'effet équivalent a celui des lois de la province où se situe la première nation.

24.4 For greater certainly, if there is an inconsistency between the provision of a federal law respecting the protection of the environment and a provision in a land code or First Nation law respecting the protection of the environment, the federal provision will prevail to the extent of any inconsistency.

24.4 Il est entendu qu'en cas d'incompatibilité entre une disposition d'une loi fédérale en matière de protection de l'environnement et une disposition d'un code foncier ou d'un texte législatif des premières nations en matière de protection de l'environnement, la disposition fédérale l'emporte dans la mesure de l'incompatibilité.

25. ENVIRONMENTAL ASSESSMENT

25. ÉVALUATION ENVIRONNEMENTALE

25.1 Subject to clause 27, a First Nation will, with the assistance of the Lands

25.1 Sous réserve de l'article 27, la première nation s'efforce, avec l'aide du

Advisory Board and the appropriate federal agencies, make best efforts to develop an environmental assessment process within one year after the First Nation's land code takes effect, or within such longer period as the Minister and the First Nation may agree to.

Conseil consultatif des terres et des organismes fédéraux intéressés, d'élaborer un processus d'évaluation environnementale dans l'année suivant l'entrée en vigueur du code foncier de la première nation ou dans un délai plus long convenu entre le ministre et la première nation.

25.2 The First Nation and the Minister will, in the individual agreement referred to in clause 6, address how to conduct the environmental assessment of projects on First Nation land during the interim period until the First Nation's environmental assessment process is developed.

25.2 L'accord distinct conclu entre la première nation et le ministre conformément à l'article 6 doit prévoir les modalités de l'évaluation environnementale des projets devant être réalisés sur les terres de première nation au cours de la période transitoire, jusqu'à ce que la première nation ait élaboré un processus d'évaluation environnementale.

25.3 The First Nation's environmental assessment process will be consistent with requirements of the Canadian Environmental Assessment Act.

25.3 Le processus d'évaluation environnementale mis sur pied par la première nation doit être compatible avec les exigences de la Loi canadienne sur l'évaluation environnementale.

25.4 The First Nation's environmental assessment process will be triggered in appropriate cases where the First Nation is approving, regulating, funding or undertaking a project on First Nation land. The assessment will occur as early as possible in the planning stages of the project before an irrevocable decision is made.

25.4 Sera un élément déclencheur du processus d'évaluation environnementale dans les cas indiqués, tout projet sur les terres de première nation devant être réalisé, financé, approuvé ou réglementé par celle-ci. Cette évaluation doit s'effectuer le plus tôt possible au cours des premières étapes de la planification du projet avant que des décisions irrévocables ne soient prises.

25.5 The Parties agree that section 10 of the Canadian Environmental Assessment Act will not apply to projects located on First Nation land.

25.5 Les Parties conviennent que l'article 10 de la Loi canadienne sur l'évaluation environnementale ne s'applique pas aux projets situés sur les terres de première nation.

25.6 The Parties agree to use their best efforts to implement the principle that the First Nation's environmental assessment process be used where an environmental assessment of a project on First Nation land is required by the Canadian Environmental Assessment Act.

25.6 Les Parties s'efforceront de mettre en œuvre le principe selon lequel le processus d'évaluation environnementale de la première nation sera appliqué lorsque la Loi canadienne sur l'évaluation environnementale exige qu'un projet devant être réalisé sur des terres de première nation fasse l'objet d'une telle évaluation.

25.7 The Parties agree to develop a plan to harmonize their respective environmental assessment processes, with the involvement of the provinces where they agree to participate.

25.7 Les Parties conviennent d'élaborer un plan visant à harmoniser leurs processus d'évaluation environnementale respectifs, avec la participation des provinces si celles-ci le souhaitent.

26. OTHER AGREEMENTS

26. AUTRES ENTENTES

26.1 The First Nation and Canada recognize that it may be advisable to enter into other agreements with each other and other jurisdictions to deal with environmental issues like harmonization, implementation, timing, funding and enforcement.

26.1 La première nation et le Canada reconnaissent qu'il pourrait être souhaitable de conclure d'autres ententes, entre elles et avec d'autres gouvernements, dans le domaine de l'environnement, notamment au sujet des questions d'harmonisation, de mise en oeuvre, de calendrier, de financement et de contrôle d'application.

26.2 Where matters being negotiated pursuant to clause 26.1 normally fall within provincial jurisdiction, or may have significant impacts beyond the boundaries of First Nation land, the parties will invite the affected province to be a party to such negotiations and resulting agreements.

26.2 Si une question faisant l'objet de négociation en vertu de l'article 26.1 relève normalement de la compétence de la province, ou si de telles questions sont susceptibles d'avoir des effets importants à l'extérieur des terres de première nation, les Parties inviteront la province concernée à être partie à ces négociations et à l'entente qui en résulte.

27. RESOURCES

27. RESSOURCES

27.1 The Parties understand that the obligation of a First Nation to establish

27.1 Les Parties reconnaissent qu'une première nation ne peut remplir son environmental assessment and environmental protection regimes depends on adequate financial resources and expertise being available to the First Nation.

obligation relative à l'établissement de régimes de protection et d'évaluation environnementales que si elle dispose des ressources financières et de l'expertise nécessaires.

PART VI FUNDING

PARTIE VI FINANCEMENT

28. APPROPRIATION

28. CRÉDITS

28.1 Any amounts provided by Canada to the First Nations pursuant to funding arrangements in relation to First Nation land shall be paid out of such moneys as may be appropriated by Parliament for this purpose.

28.1 Les sommes versées par le Canada aux premières nations conformément aux ententes en matière de financement à l'égard des terres de première nation sont prélevées sur les crédits affectés à cette fin par le Parlement.

29. DEVELOPMENTAL FUNDING

29. FINANCEMENT DE DÉMARRAGE

29.1 Canada and the Lands Advisory Board will enter into a funding arrangement to allow the First Nations to develop land codes and community approval processes for their land codes, to negotiate the individual agreements mentioned in clause 6 and to seek community approval under clause 7.

29.1 Le Canada et le Conseil consultatif des terres sont tenus de conclure une entente de financement pour permettre aux premières nations d'élaborer leur code foncier et leur processus d'approbation de la communauté relatif à ce code, de négocier l'accord distinct mentionné à l'article 6 et d'obtenir l'approbation de la communauté prévue à l'article 7.

30. OPERATIONAL FUNDING

30. FINANCEMENT DE FONCTIONNEMENT

30.1 An individual agreement between the Minister and a First Nation will determine the resources to be provided by Canada to the First Nation to manage First Nation lands and make, administer and enforce its laws under a land code. The agreement will determine specific funding issues, for example period of time, and terms and

30.1 L'accord distinct conclu entre le ministre et la première nation fixera les ressources que le Canada s'engage à fournir à la première nation pour que celle-ci gère les terres de première nation et édicte, administre et applique les textes législatifs de la première nation pris en vertu du code foncier. L'accord précisera conditions.

30.2 A method for allocating such operating funds as may have been appropriated by Parliament will be developed by the Parties and the Lands Advisory Board.

30.3 Unless a First Nation and Canada agree otherwise, an individual agreement respecting the provision of funding under this clause will have a maximum term of five years and will include provisions for its amendment and renegotiation.

31. LANDS ADVISORY BOARD FUNDING

31.1 Canada will enter into a funding arrangement with the Lands Advisory Board for the five year period following the coming into force of this Agreement.

PART VII
EXPROPRIATION OF FIRST NATION LAND BY CANADA

32. RESTRICTIONS

32.1 In accordance with the principle stated in clause 13.2, the Parties agree, as a general principle, that First Nation lands will not be subject to expropriation.

32.2 Despite the general principle against expropriation, First Nation land may be expropriated by Canada

(a) only with the consent of the

les différents aspects du financement, par exemple sa périodicité et ses modalités.

30.2 Les Parties et le Conseil consultatif des terres sont tenus d’élaborer une méthode d'attribution des fonds de fonctionnement autorisés par le Parlement.

30.3 À défaut d'entente contraire de la première nation et du Canada, l'accord distinct concernant le financement prévu par le présent article sera en vigueur pour une durée maximale de cinq ans et prévoira des dispositions concernant sa modification et sa renégociation.

31. FINANCEMENT DU CONSEIL CONSULTATIF DES TERRES

31.1 Le Canada est tenu de conclure avec le Conseil consultatif des terres une entente de financement qui portera sur une période de cinq ans à partir de l'entrée en vigueur du présent accord.

PARTIE VII
EXPROPRIATION DE TERRES DE PREMIÈRES NATIONS PAR LE CANADA

32. RESTRICTIONS

32.1 Conformément au principe énoncé à l'article 13.2, les parties conviennent qu'en règle générale, les terres de première nation ne peuvent faire l’objet d’une expropriation.

32.2 Malgré le principe général voulant que les terres ne puissent faire l’objet d’une expropriation, le Canada peut toutefois exproprier les terres de première nation, si les conditions suivantes sont

Governor in Council; and

(b) only by and for the use of a federal department or agency.

réunies :

a) le gouverneur en conseil y consent;

b) l'expropriation est faite par un ministère ou un organisme fédéral pour ses seuls besoins.

32.3 The Governor in Council will only consent to an expropriation of First Nation land if the expropriation is justifiable and necessary for a federal public purpose that serves the national interest.

32.3 Le gouverneur en conseil ne consentira à l'expropriation de terres de première nation que si cela est justifiable et nécessaire à des fins d'intérêt public national relevant de la compétence fédérale.

32.4 When making a decision to expropriate First Nation land, the Governor in Council, in addition to other steps that may be required before making such a decision, will at a minimum follow these steps:

(a) it will consider using means other than expropriation and will use those other means where reasonably feasible;

(b) it will use non-First Nation land, where such land is reasonably available;

(c) if it must use First Nation land, it will make reasonable efforts to acquire the land through agreement with the First Nation, rather than by expropriation;

(d) if it must expropriate First Nation land, it will expropriate only the smallest interest or land right necessary and for the shortest time required; and

32.4 Avant de donner son consentement à une expropriation de terres de première nation, le gouverneur en conseil, en plus des autres mesures qui peuvent être requises, prendra au moins les mesures suivantes :

a) il envisagera d'autres moyens que l'expropriation et utilisera ces moyens lorsque cela est raisonnablement faisable;

b) il utilisera des terres autres que celles d'une première nation, lorsque de telles terres sont raisonnablement disponibles;

c) s'il faut utiliser des terres de première nation, il s'efforcera de procéder à l'acquisition des terres par convention avec la première nation et non par expropriation;

d) s'il doit exproprier des terres de première nation, il veillera à ce que l'expropriation se limite au strict nécessaire, tant en ce qui touche l'étendue de l'intérêt ou du droit foncier que la

(e) in every case, it will first provide the First Nation with information relevant to the expropriation.

période pour laquelle il est exproprié;

e) dans tous les cas, il communiquera d'abord à la première nation tous les renseignements se rapportant à l'expropriation.

32.5 Prior to the Governor in Council issuing an order consenting to the expropriation of First Nation land, the federal department or agency will make public a report on the reasons justifying the expropriation and the steps taken in satisfaction of this clause and will provide a copy of the report to the First Nation.

32.5 Avant que le gouverneur en conseil ne prenne un décret consentant à l'expropriation de terres de première nation, le ministère ou l'organisme fédéral est tenu de publier un rapport qui énonce les motifs la justifiant et les mesures prises en application du présent article et de fournir en même temps une copie de ce rapport à la première nation.

32.6 Where a First Nation objects to a proposed expropriation it may refer the issue to an independent third party for a neutral evaluation under Part IX, within 60 days of the release of the report referred to in clause 32.5.

32.6 Si une première nation s'oppose à un projet d'expropriation, elle peut, dans les 60 jours de la publication du rapport mentionné à l'article 32.5, renvoyer l'affaire à une tierce partie indépendante pour conciliation aux termes de la Partie IX.

32.7 An order of the Governor in Council consenting to the expropriation will not be issued earlier than

(a) the end of the 60 day period referred to in clause 32.6; or

(b) the day the opinion or recommendation of the neutral evaluator is released, where the First Nation referred the proposed expropriation to an independent evaluator under clause 32.6.

32.7 Un décret du gouverneur en conseil consentant à l'expropriation ne sera pas émis avant :

a) soit l'expiration du délai de 60 jours prévu à l'article 32.6;

b) soit le jour où l'opinion ou la recommandation du conciliateur est publiée, si la première nation renvoie le projet d'expropriation à un conciliateur, en application de l'article 32.6.

33. COMPENSATION BY CANADA

33. INDEMNISATION PAR LE CANADA

33.1 In the event of the expropriation of First Nation land by Canada under this Part, Canada will provide compensation to the First Nation in accordance with this clause.

33.1 Si le Canada exproprie des terres de première nation sous le régime de la présente partie, il est tenu d'indemniser la première nation conformément aux termes du présent article.

33.2 The compensation will include alternate land of equal or greater size or of comparable value. If the alternate land is of less than comparable value, then additional compensation will be provided. The alternate land may be smaller than the land being expropriated only if that does not result in the First Nation having less land area than when its land code took effect.

33.2 L'indemnité comprendra des terres substitutives ayant une superficie égale ou supérieure ou ayant une valeur comparable à celles qui ont été expropriées. Si les terres substitutives ont une valeur inférieure aux terres expropriées, le Canada est alors tenu d'offrir une indemnité supplémentaire. Les terres substitutives peuvent avoir une superficie moindre que les terres expropriées seulement si, à la suite de l'opération, la première nation dispose d'une superficie de terres qui n'est pas inférieure à celle qu'elle avait lorsque son code foncier est entré en vigueur.

33.3 The total value of the compensation provided by Canada under this clause will be based on the following:

(a) the market value of the land or interest or land right that is acquired;

(b) the replacement value of any improvement to the land that is acquired;

(c) the damages attributable to disturbance;

(d) the value of any special economic advantage arising out of or incidental to the occupation or use of the affected First Nation land to the extent that this value is not otherwise

33.3 La valeur totale de l'indemnité versée par le Canada aux termes du présent article doit tenir compte des éléments suivants :

a) la valeur marchande des terres ou de l’intérêt ou du droit foncier acquis;

b) la valeur de remplacement des améliorations apportées aux terres acquises;

c) les dommages attribuables au trouble de jouissance;

d) la valeur de tout avantage économique particulier découlant ou résultant de l'occupation ou de l'utilisation des terres de première nation concernée, dans la mesure où cette valeur n'a pas déjà donné lieu à compensated;

(e) damages for any reduction in the value of a remaining interest or land right; and

(f) damages for any adverse effect on any cultural or other special value of the land.

33.4 If the value and nature of the compensation cannot be agreed upon by the federal department or agency and the affected First Nation, either party may refer a dispute on compensation to arbitration under Part IX.

33.5 In any province or territory other than Québec, any claim or encumbrance in respect of the interest, or in Québec any right, charge or claim in respect of the land right, expropriated by Canada may only be claimed against the amount of compensation that is otherwise payable to the person or entity whose interest or land right is being expropriated.

33.6 Interest on the compensation is payable from the date the expropriation takes effect, at the same rate as for prejudgment interest in the superior court of the province in which the First Nation land is located.

34. STATUS OF LANDS

34.1 Where less than the full interest or only part of the land right of the First Nation in

une indemnité;

e) les dommages attribuables à la diminution de la valeur de l'intérêt ou du droit foncier non exproprié;

f) les dommages attribuables aux répercussions négatives sur la valeur culturelle ou toute autre valeur particulière de ces terres.

33.4 En cas de différend relatif à la valeur ou à la nature de l'indemnité, le ministère ou l'organisme fédéral ou la première nation peut saisir un arbitre de tout différend relatif à l'indemnité aux termes de la Partie IX.

33.5 Dans les provinces ou territoires autres que le Québec, le recouvrement de toute réclamation ou tout grèvement concernant l'intérêt exproprié par le Canada, ou dans la province de Québec, le recouvrement de tout droit, charge ou réclamation concernant le droit foncier ainsi exproprié, ne peut être demandé que jusqu'à concurrence de l'indemnité par ailleurs payable à la personne ou à l'entité dont l'intérêt ou le droit foncier est visé par l'expropriation.

33.6 L'indemnité porte intérêt à partir de la prise d'effet de l'expropriation, au taux applicable à l'intérêt avant jugement applicable devant la Cour supérieure de la province où sont situées les terres de première nation.

34. STATUT DES TERRES

34.1 Dans les cas où l'expropriation par le Canada porte sur moins que la totalité de

First Nation land is expropriated by Canada,

(a) the land retains its status as First Nation land;

(b) the land remains subject to the land code and to any law of the First Nation that is otherwise applicable, except to the extent the land code or law is inconsistent with the expropriation; and

(c) the First Nation may continue to use and occupy the land, except to the extent the use or occupation is inconsistent with the expropriation.

l'intérêt ou seulement sur une partie du droit foncier de la première nation sur les terres en question :

a) les terres conservent leur statut de terres de première nation;

b) les terres demeurent assujetties au code foncier et aux textes législatifs adoptés par la première nation, sauf dans la mesure où le texte ou le code foncier est incompatible avec l'expropriation;

c) la première nation peut continuer à utiliser et à occuper ces terres, sauf dans la mesure où cette utilisation ou cette occupation est incompatible avec l'expropriation.

34.2 Alternate land accepted by the First Nation as part of the compensation will become both a reserve and First Nation land.

34.2 Les terres substitutives acceptées par la première nation comme partie de l'indemnité deviennent à la fois une réserve et des terres de première nation.

35. REVERSION OR RETURN OF INTERESTOR LAND RIGHTIN FIRST NATION LAND

35. RÉVERSION OU RETOUR D'UN INTÉRÊT OU DROIT FONCIER SUR LES TERRES DE PREMIÈRE NATION

35.1 In any province or territory other than Québec, where an expropriated interest in First Nation land which is less than the full interest of the First Nation in the land is no longer required by Canada for the purpose for which it was expropriated, the interest in land will revert to the First Nation.

35.1 Dans une province ou territoire autre que le Québec, lorsque l'intérêt exproprié est moindre que la totalité de l'intérêt de la première nation sur les terres en question, cet intérêt est, lorsqu'il n'est plus nécessaire au Canada aux fins de l'expropriation, retourné à la première nation.

35.1A In the province of Québec, where the expropriated land right in First Nation land constitutes only part of the land right of the First Nation in the land, and it is no longer required by Canada for the purpose for

35.1A Dans la province de Québec, lorsque l'expropriation porte seulement sur une partie du droit foncier de la première nation sur les terres en question, which it was expropriated, the land right will return to the First Nation.

le droit foncier est, lorsqu'il n'est plus nécessaire au Canada aux fins de l'expropriation, retourné à la première nation.

35.2 The Minister responsible for the expropriating department or agency, without the consent of the Governor in Council, may decide that the interest or the land right is no longer required and determine the disposition of any improvements.

35.2 Le ministre responsable du ministère ou de l'organisme à l'origine de l'expropriation peut, sans le consentement du gouverneur en conseil, décider que l'intérêt ou le droit foncier exproprié n'est plus nécessaire et il peut déterminer comment disposer des améliorations.

36. RETURN OF FULL INTEREST OR ENTIRE LAND RIGHT IN FIRST NATION LAND

36. RETOUR DE LA TOTALITÉ DE L'INTÉRÊT OU DU DROIT FONCIER SUR LES TERRES DE PREMIÈRE NATION

36.1 Where the full interest or the entire land right of a First Nation in First Nation land was expropriated but is no longer required by Canada for the purpose for which it was expropriated, the land will be returned to the First Nation on terms negotiated by the First Nation and the federal department or agency, at the time of the expropriation or at a later date as agreed to by them.

36.1 Lorsque la totalité de l'intérêt ou le droit foncier entier de la première nation sur les terres en question a été exproprié et qu'il n'est plus nécessaire au Canada aux fins de l'expropriation, les terres seront retournées à la première nation selon les conditions négociées par la première nation et le ministère ou l'organisme fédéral, soit au moment de l'expropriation, soit à une date ultérieure convenue par eux.

36.2 Where the terms and conditions of the return cannot be agreed upon by the First Nation and the federal department or agency, either party may refer the dispute to arbitration under Part IX.

36.2 En cas de différend relatif aux conditions du retour, la première nation ou le ministère ou l'organisme fédéral peut renvoyer l'affaire à un arbitre nommé aux termes de la Partie IX.

36.3 The Minister responsible for the expropriating department or agency, without the consent of the Governor in Council, may decide that the land is no longer required and determine the disposition of any

36.3 Le ministre responsable du ministère ou de l'organisme à l'origine de l'expropriation peut, sans le consentement du gouverneur en conseil, décider que les terres expropriées ne sont plus nécessaires improvements.

et il peut déterminer comment disposer des améliorations apportées aux terres concernées.

37. APPLICATION OF EXPROPRIATION ACT

37. APPLICATION DE LA LOI SUR L'EXPROPRIATION

37.1 Any provisions of the Expropriation Act, (Canada) that are applicable to an expropriation of First Nation land by Canada continue to apply, unless inconsistent with this Agreement.

37.1 Les dispositions de la Loi sur l'expropriation (Canada) applicables à l'expropriation de terres de première nation par le Canada continuent de s'appliquer dans la mesure où elles ne sont pas incompatibles avec le présent accord.

PART VIII
LANDS ADVISORY BOARD

PARTIE VIII
CONSEIL CONSULTATIF DES TERRES

38. LANDS ADVISORY BOARD

38. CONSEIL CONSULTATIF DES TERRES

38.1 The Lands Advisory Board shall consist of at least three members appointed:

(a) Prior to September 1, 2003, by the Councils of the original First Nation parties to this Agreement; and

(b) After September 1, 2003, by the Councils of the First Nations that have ratified this Agreement, whether they ratify the Agreement on, before or after that date.

38.1 Le Conseil consultatif des terres sera formé d'au moins trois membres nommés :

a) avant le 1er septembre 2003 par les conseils des premières nations qui étaient parties initiales au présent accord;

b) après le 1er septembre 2003 par les conseils des premières nations qui ont ratifié le présent accord, qu'ils l'aient ratifié à cette date, ou avant ou après cette date.

38.2 The Lands Advisory Board will have all necessary powers and capacity to properly perform its functions under this Agreement.

38.2 Le Conseil consultatif des terres possédera tous les pouvoirs et la capacité nécessaires à l'exercice efficace de ses attributions en vertu du présent accord.

38.3 The Lands Advisory Board will select a chairperson to preside over the Board and, subject to the direction of the Board, to act

38.3 Le Conseil consultatif des terres est tenu de choisir un président qui peut, sous réserve des instructions du conseil, agir on its behalf.

39. FUNCTIONS OF THE LANDS ADVISORY BOARD

39.1 In addition to any other functions specifically assigned to it by the Parties, the Lands Advisory Board will be responsible for the following functions:

(a) developing model land codes, laws and land management systems;

(b) developing model agreements for use between First Nations and other authorities and institutions, including public utilities and private organizations;

(c) on request of a First Nation, assisting the First Nation in developing and implementing its land code, laws, land management systems and environmental assessment and protection regimes;

(d) assisting a verifier when requested by the verifier;

(e) establishing a resource centre, curricula and training programs for managers and others who perform functions pursuant to a land code;

(f) on request of a First Nation encountering difficulties relating to the management of its First Nation lands, helping the First Nation in obtaining the expertise necessary to resolve the difficulty;

pour le compte du conseil.

39. ATTRIBUTIONS DU CONSEIL CONSULTATIF DES TERRES

39.1 Outre les autres attributions que pourraient lui confier les Parties, le Conseil consultatif des terres possédera les attributions suivantes :

a) il élabore des modèles de code foncier, de textes législatifs et de systèmes de gestion des terres;

b) il élabore des modèles d'ententes destinés à être utilisés entre les premières nations et les autres autorités et institutions, notamment les sociétés de service public et les organismes privés;

c) à la demande d'une première nation, il assiste celle-ci dans l'élaboration et la mise en oeuvre de son code foncier, de ses textes législatifs, de ses systèmes de gestion des terres, et de ses régimes de protection et d'évaluation environnementales;

d) il apporte son aide au vérificateur, à la demande de ce dernier;

e) il met sur pied un centre de ressources, des cours et des programmes de formation à l'intention des gestionnaires et des autres personnes qui exercent des attributions aux termes d'un code foncier;

f) à la demande d'une première nation qui éprouve des difficultés dans la gestion des terres de la première nation, il l'aide à obtenir l’expertise dont elle a besoin pour résoudre les difficultés;

(g) proposing regulations for First Nation land registration;

g) il propose des règlements concernant l'enregistrement des terres de première nation;

(h) proposing to the Minister such amendments to this Agreement and the federal legislation as it considers necessary or advisable;

h) il propose au ministre les modifications au présent accord et à la loi de ratification qu'il estime souhaitables ou nécessaires;

(i) in consultation with First Nations, negotiating a funding method with the Minister; and

i) en consultation avec les premières nations, il négocie avec le ministre un mécanisme de financement;

(j) performing such other functions or services for a First Nation as are agreed to between the Board and the First Nation.

j) il exerce les autres attributions ou fournit à une première nation les services dont le conseil et celle-ci peuvent convenir.

39.2 The Lands Advisory Board will have authority to adopt rules for the procedure at its meetings and generally for the conduct of its affairs.

39.2 Le Conseil consultatif des terres a le pouvoir d'adopter des règles de procédure pour la tenue de ses réunions et, d'une façon générale, pour l’exercice de ses activités.

40. RECORD KEEPING

40. TENUE DES DOSSIERS

40.1 The Lands Advisory Board will maintain a record containing

(a) the name of each First Nation that approves a land code;

(b) a copy of that land code;

(c) a copy of each amendment to a land code; and

(d) the dates on which each was approved and certified.

40.1 Le Conseil consultatif des terres est tenu de maintenir un registre dans lequel figurent :

a) le nom des premières nations ayant adopté un code foncier;

b) une copie de ces codes fonciers;

c) une copie des modifications apportées aux codes fonciers;

d) les dates auxquelles les codes ont été approuvés et celles auxquelles leur validité a été attestée.

40.2.1 The Lands Advisory Board shall, in consultation with the Minister, prescribe procedures for a First Nation to authorize the signing of this Agreement and for the formal signature of the First Nations to this Agreement, and shall advise the Minister when a First Nation has completed the procedures.

40.2.1 Le Conseil consultatif des terres doit, en consultation avec le ministre, prescrire les procédures qu'une première nation doit suivre pour autoriser la signature du présent accord et les procédures régissant la signature formelle de cet accord par les premières nations et il doit aviser le ministre lorsqu'une première nation a complété les procédures.

40.2.2 Subject to sub-clause 40.2.1, a First Nation may only become a signatory under this section with the consent of Canada, and Canada shall advise the Lands Advisory Board if and when such consent is given.

40.2.2 Sous réserve de l'article 40.2.1, une première nation peut devenir signataire en vertu de cet article seulement avec le consentement du Canada, et ce dernier doit aviser le Conseil consultatif des terres lorsque le consentement a été accordé.

40.2.3 The Lands Advisory Board shall receive and record the adhesion of a First Nation party to this Agreement, made after January 1, 2001,and advise the Minister that the said First Nation has signed the Framework Agreement.

40.2.3 Le Conseil consultatif des terres doit recevoir et inscrire l'adhésion d'une première nation qui est Partie au présent accord, intervenue après le 1er janvier 2001, et aviser le ministre de la signature de l'accord par celle-ci.

41. ANNUAL REPORT

41. RAPPORT ANNUEL

41.1 Within 90 days following the end of each year of operation, the Lands Advisory Board will deliver to the Parties an annual report, in both official languages, on the work of the Board for that year.

41.1 Le Conseil consultatif des terres remet aux Parties, dans les 90 jours suivant la fin de son année de fonctionnement, un rapport annuel, dans les deux langues officielles, concernant les travaux accomplis pendant cette année.

41.2 The Minister will cause a copy of the Lands Advisory Board's annual report to be laid before each House of Parliament within the first 30 sitting days of that House after the Minister receives it.

41.2 Le ministre est tenu de présenter le rapport annuel du Conseil consultatif des terres aux deux Chambres du Parlement dans les 30 premiers jours de séance de chaque Chambre suivant sa réception par le ministre.

42. LANDS ADVISORY BOARD NO LONGER IN EXISTENCE

42. DISPARITION DU CONSEIL CONSULTATIF DES TERRES

42.1 In the event that the Lands Advisory Board is no longer in existence, the functions of the Lands Advisory Board under this Agreement will be performed by the Parties, except as follows:

(a) the functions set out in clauses 29 and 39, except clause 39.1(g), will be performed by the First Nations; and

(b) the functions set out in clauses 10 and 40 will be assumed by the First Nations Lands Register.

42.1 En cas de disparition du Conseil consultatif des terres, les attributions de celui-ci en vertu du présent accord seront exercées par les Parties, sous réserve des dispositions suivantes :

a) les attributions énumérées aux articles 29 et 39, sauf pour ce qui est de l'alinéa 39.1g), seront exercées par les premières nations;

b) les attributions prévues aux articles 10 et 40 seront assumées par le bureau du Registre des terres des premières nations.

PART IX
DISPUTE RESOLUTION

PARTIE IX
RÈGLEMENT DES DIFFÉRENDS

43. GENERAL PRINCIPLES

43.1 The Parties are committed to resolving any dispute that may arise out of this Agreement among themselves, amicably and in good faith. Where they cannot resolve a dispute through negotiation, the Parties agree to establish and participate in the out-of-court processes referred to in this Part to resolve the dispute.

43.2 Nothing in this Agreement is to be construed as preventing the Parties from using mediation to assist them in reaching an amicable agreement in respect of any issue in dispute. Where a Party has referred a dispute to mediation, the other Party is obliged to attend an initial meeting with the mediator. However, either Party can end a mediation process any time after the initial meeting.

43.3 Subject to clause 43.4, any dispute

43. PRINCIPES GÉNÉRAUX

43.1 Les Parties s'engagent à résoudre entre elles, à l'amiable et de bonne foi, les différends qui peuvent découler du présent accord. Lorsque les Parties n'arrivent pas à s'entendre pour résoudre un différend par la négociation, elles conviennent de mettre sur pied les processus extrajudiciaires de règlement des différends décrits dans la présente partie et d'y avoir recours.

43.2 Les dispositions du présent accord n'empêchent pas les Parties de recourir à la médiation en vue de régler à l'amiable un différend. Lorsqu'une partie a soumis un différend à un médiateur, l'autre partie est tenue d'assister à une première rencontre avec le médiateur. L'une ou l'autre des Parties peut toutefois mettre fin à la médiation en tout temps après cette première rencontre.

43.3 Sous réserve de l'article 43.4, les arising from the implementation, application or administration of this Agreement, the federal legislation, an individual agreement or an environmental management agreement may be resolved in either of two ways:

(a) Neutral evaluation - it may be referred to neutral evaluation by one party to the dispute; or

(b) Arbitration - it may be referred to arbitration by both parties to the dispute.

différends découlant de la mise en oeuvre, de l'application ou de l'administration du présent accord, de la loi de ratification, d'un accord distinct ou d'un accord en matière de gestion de l'environnement peuvent être résolus selon l'un des deux moyens suivants :

a) la conciliation — le différend peut être renvoyé à un conciliateur par l'une des parties impliquées dans le différend;

b) l'arbitrage — le différend peut être soumis à l'arbitrage par les deux parties impliquées dans le différend.

43.4 Any dispute respecting compensation for First Nation land expropriated by Canada or the terms and conditions for the return of the full interest or the entire land right in First Nation land will be referred to arbitration.

43.4 Sont soumis à l'arbitrage, les différends portant sur l'indemnité à verser par le Canada en raison de l'expropriation par celui-ci de terres de première nation, ou sur les conditions du retour de la totalité de l'intérêt ou du droit foncier entier sur les terres de première nation.

43.5 Any objection by a First Nation to a proposed expropriation under Part VII that has been referred to neutral evaluation will be evaluated and a report submitted by the neutral evaluator to the First Nation and Canada within 60 days of the referral to the neutral evaluator.

43.5 Toute opposition, par la première nation, à un projet d'expropriation en vertu de la Partie VII qui aura été porté devant un conciliateur sera évalué par ce dernier. Par la suite, un rapport sera soumis, par ce dernier, à la première nation et au Canada dans un délai de 60 jours suivant le dépôt de l'opposition devant le conciliateur.

44. PANELS OF ARBITRATORS, ETC.

44.1 The Parties and the Lands Advisory Board will jointly establish lists of mutually acceptable persons willing to act as mediators, arbitrators, verifiers and neutral evaluators.

44. LISTES D'ARBITRES, ETC.

44.1 Les Parties et le Conseil consultatif des terres sont tenus d'établir conjointement des listes de personnes mutuellement acceptables prêtes à agir en qualité de médiateur, d'arbitre, de vérificateur et de conciliateur.

44.2 Parties who become involved in a dispute may select mediators, arbitrators and neutral evaluators from the appropriate list, or may agree to the appointment of an individual who is not on the list.

44.2 Les parties à un différend peuvent choisir, parmi ces listes, un médiateur, un arbitre et un conciliateur ou s'entendre sur la nomination d'une personne qui ne figure pas sur ces listes.

44.3 The selection and assignment of verifiers and the procedure to be followed by verifiers will be arranged by the Lands Advisory Board, Canada and the First Nation.

44.3 Le Conseil consultatif des terres, le Canada et la première nation choisiront les vérificateurs, définiront leurs attributions et fixeront la procédure que ces derniers doivent utiliser.

44.4 Individuals appointed to act as mediators, arbitrators, verifiers or neutral evaluators must be unbiased and free from any conflict of interest relative to the matter in issue and have knowledge or experience to act in the appointed capacity.

44.4 Les personnes nommées en qualité de médiateur, d'arbitre, de vérificateur ou de conciliateur doivent être impartiales et ne pas se trouver en situation de conflit d'intérêts par rapport aux questions en litige; elles doivent par ailleurs posséder la compétence ou l'expérience nécessaires pour agir en cette qualité.

45. NEUTRAL EVALUATION

45.1 Where a dispute is referred to neutral evaluation, the evaluator will where appropriate,

(a) identify the issues in the dispute;

(b) assess the strengths of each party's case;

(c) structure a plan for the progress of the case;

(d) encourage settlement of the dispute; and

(e) provide the parties with a non-binding opinion or recommendation to resolve the dispute.

45. CONCILIATION

45.1 Lorsque la situation l'exige, le conciliateur saisi d'un différend exerce les fonctions suivantes :

a) il précise les questions sur lesquelles porte le différend;

b) il évalue le bien-fondé des arguments des parties;

c) il établit un plan afin de faire progresser la situation;

d) il encourage le règlement du différend;

e) il remet aux parties une opinion ou une recommandation non exécutoire visant à mettre fin au différend.

46. ARBITRATION

46.1 Unless otherwise agreed by the Parties, each arbitration will be conducted in accordance with this clause.

46.2 The procedure will follow the Commercial Arbitration Code, which is a schedule to the Commercial Arbitration Act.

46.3 If no appropriate procedural provision is in that Code, the parties in dispute may adopt the Commercial Arbitration Rules in force from time to time of the British Columbia International Commercial Arbitration Centre.

46.4 The arbitrator will establish the procedures of the arbitration, subject to this clause.

47. RELATED ISSUES

47.1 The parties to a dispute will divide the costs of the dispute resolution process equally between themselves.

47.2 Any person whose interests will be adversely affected by a dispute that is referred to a dispute resolution process may participate in the process, if

(a) all parties to the process consent; and

(b) the person pays the costs of his or her participation, unless otherwise agreed by the other parties to the dispute.

47.3 The decision of a verifier and a

46. ARBITRAGE

46.1 Sauf entente contraire des Parties, l'arbitrage s'effectuera conformément au présent article.

46.2 La procédure qui sera suivie est celle du Code d'arbitrage commercial, figurant à l'annexe de la Loi sur l'arbitrage commercial.

46.3 Si ce Code ne contient pas de disposition procédurale appropriée, les parties au différend peuvent suivre les Règles d'arbitrage commercial établies à l’occasion par le British Columbia International Commercial Arbitration Centre.

46.4 L'arbitre est tenu de déterminer la procédure d’arbitrage à suivre, sous réserve du présent article.

47. QUESTIONS CONNEXES

47.1 Les parties à un différend assument les frais relatifs à sa résolution à parts égales.

47.2 Toute personne dont les intérêts seraient lésés par un différend porté devant l'un des mécanismes de règlement des différends peut participer au mécanisme de règlement si :

a) d’une part, toutes les parties au mécanisme y consentent;

b) d’autre part, cette personne assume les frais de sa participation, sauf entente contraire des autres parties au différend.

47.3 La décision du vérificateur et la

decision or award of an arbitrator will be final and binding on the participating parties.

décision ou sentence d'un arbitre sont définitives et lient les parties qui ont participé aux mécanismes de règlement.

47.4 No order shall be made, processed, entered or proceeding taken in any court, whether by way of injunction, mandamus, certiorari, prohibition or quo warranto to contest, review, impeach or limit the action of a person acting as a verifier, an arbitrator or a neutral evaluator under this Agreement.

47.4 Aucune ordonnance ne peut être rendue, exécutée ou inscrite, et aucune poursuite ne peut être initiée devant une cour par voie d'injonction, de mandamus, de certiorari, de prohibition ou de quo warranto pour contester, réviser, empêcher ou limiter une mesure prise par le vérificateur, l'arbitre ou le conciliateur nommé sous le régime du présent accord.

47.5 Despite clause 47.4, judicial review may be taken under the Federal Court Act within 30 days of a decision of a person acting as a verifier, an arbitrator or a neutral evaluator under this Agreement in respect of such person exceeding his or her jurisdiction, refusing to exercise his or her jurisdiction or failing to observe a principal of natural justice.

47.5 Malgré l'article 47.4, une demande de révision judiciaire peut, dans les 30 jours qui suivent la décision prise par toute personne agissant comme vérificateur, arbitre ou conciliateur sous le régime du présent accord, être présentée en vertu de la Loi sur les Cours fédérales au motif que cette personne a outrepassé sa compétence, refusé de l’exercer ou n'a pas respecté un principe de justice naturelle.

PART X
RATIFICATION AND ENACTMENTS BY THE PARTIES

PARTIE X
RATIFICATION PAR LES PARTIES ET MESURES LÉGISLATIVES

48. RATIFICATION OF AGREEMENT

48. RATIFICATION DE L'ACCORD

48.1 The Parties agree that they will seek to ratify this Agreement and implement it in the following manner:

(a) each First Nation agrees to develop a land code and to seek community approval; and

(b) following community approval by two First Nations, Canada agrees to recommend to Parliament the

48.1 Les Parties conviennent de ratifier le présent accord et de le mettre en oeuvre de la façon suivante :

a) chaque première nation s'engage à élaborer un code foncier et à le soumettre à l’approbation de la communauté;

b) une fois un code approuvé par deux premières nations, le Canada s'engage à recommander au Parlement l'adoption enactment of legislation.

48.2 This Agreement will be considered to have been ratified by a First Nation when the First Nation approves a land code, and to have been ratified by Canada when the federal legislation comes into force.

49. ENACTMENTS BY THE PARTIES

49.1 Canada agrees that the federal legislation that it recommends to Parliament will be consistent with and will ratify this Agreement.

49.2 In the event of an inconsistency or conflict between the federal legislation and any other federal enactment, the federal legislation will prevail to the extent of the inconsistency or conflict.

49.3 In the event of any inconsistency or conflict between the land code of a First Nation and the provisions of a First Nation law or of a by-law made by its council under section 81 of the Indian Act, the land code will prevail to the extent of the inconsistency or conflict.

PART XI
OTHER MATTERS

50. LIABILITY

50.1 The First Nation will not be liable for acts or omissions of Canada or any person or entity authorized by Canada to act in relation to First Nation land that occurred before the First Nation's land code takes effect.

d'une loi de ratification.

48.2 Le présent accord sera réputé avoir été ratifié par une première nation lorsque celle-ci aura approuvé un code foncier, et il sera réputé avoir été ratifié par le Canada au moment de l'entrée en vigueur de la loi de ratification.

49. MESURES LÉGISLATIVES ADOPTÉES PAR LES PARTIES

49.1 Le Canada s'engage à ce que la loi de ratification qu'il présentera au Parlement soit conforme au présent accord et ait pour effet de le ratifier.

49.2 En cas d'incompatibilité ou de conflit entre la loi de ratification et une autre loi fédérale, la loi de ratification l'emporte dans la mesure de l’incompatibilité ou du conflit.

49.3 En cas d’incompatibilité ou de conflit entre le code foncier d’une première nation et des dispositions de ses textes législatifs ou de règlements administratifs pris par son conseil en vertu de l’article 81 de la Loi sur les Indiens, le code foncier l’emporte dans la mesure de l’incompatibilité ou du conflit.

PARTIE XI
AUTRES QUESTIONS

50. RESPONSABILITÉ

50.1 La première nation n'est pas responsable des actes ou omissions du Canada ou d'une personne ou entité autorisée par le Canada à agir à l'égard des terres de première nation et qui surviendraient avant l'entrée en vigueur du code foncier de la première nation.

50.2 Canada will not be liable for acts or omissions of the First Nation or any person or entity authorized by the First Nation to act in relation to First Nation land that occur after the First Nation's land code takes effect.

50.2 Le Canada n'est pas responsable des actes ou omissions de la première nation ou d'une personne ou entité autorisée par celle-ci à agir à l'égard des terres de première nation et qui surviendraient après l'entrée en vigueur du code foncier de la première nation.

50.3 Canada will indemnify a First Nation for any loss arising from an act or omission by Canada, or any person or entity acting on behalf of Canada, in respect of First Nation land that occurred before the First Nation's land code takes effect.

50.3 Le Canada s'engage à indemniser la première nation de toute perte découlant d'un acte ou d'une omission du Canada, ou d'une personne ou entité agissant pour son compte, à l'égard des terres de première nation et qui surviendrait avant l'entrée en vigueur du code foncier de la première nation.

50.4 The First Nation will indemnify Canada for any loss arising from an act or omission by the First Nation, or any person or entity acting on behalf of the First Nation, in respect of First Nation land that occurs after the land code takes effect.

50.4 La première nation s'engage à indemniser le Canada de toute perte découlant d'un acte ou d'une omission de la première nation, ou d'une personne ou entité agissant pour son compte, à l'égard des terres de première nation et qui surviendrait après l'entrée en vigueur du code foncier.

50.5 No action or other proceeding lies or shall be commenced against a person acting as a member of the Lands Advisory Board, a mediator, verifier, neutral evaluator or arbitrator for or in respect of anything done, or omitted to be done, in good faith, during the course of and for the purposes of carrying out his or her functions under this Agreement.

50.5 Aucune action ni autre procédure ne peut être intentée contre une personne agissant en qualité de membre du Conseil consultatif des terres, de médiateur, de vérificateur, de conciliateur ou d'arbitre pour avoir, de bonne foi, agi ou omis d’agir dans l'exercice de ses fonctions ou dans le but de les exercer aux termes du présent accord.

51. FIRST NATION LANDS REGISTER

51. REGISTRE DES TERRES DE PREMIÈRES NATIONS

51.1 Canada will establish a First Nation

51.1 Le Canada est tenu d'établir un

Lands Register to record documents respecting First Nation land or interests or land rights in First Nation land. It will be administered by Canada as a subsystem of the existing Reserve Land Register.

registre des terres de premières nations où seront consignés les documents relatifs aux terres de premières nations ou aux intérêts ou aux droits fonciers sur celles-ci. Ce registre sera administré par le Canada à titre de sous-système du registre actuel des terres de réserve.

51.2 A separate register will be maintained for each First Nation with a land code in effect.

51.2 Un registre distinct sera créé pour chaque première nation ayant un code foncier en vigueur.

51.3 The Governor in Council will be authorized in the federal legislation to make regulations respecting the First Nation Lands Register. These regulations will be developed by the Lands Advisory Board and the Minister.

51.3 La loi de ratification autorisera le gouverneur en conseil à prendre un règlement concernant le registre des terres de premières nations. Ce règlement sera élaboré conjointement par le Conseil consultatif des terres et le ministre.

52. STATUS OF DOCUMENTS

52. STATUT DES DOCUMENTS

52.1 The Statutory Instruments Act, or any successor legislation, will not apply to a land code or to First Nation laws.

52.1 La Loi sur les textes réglementaires ou les lois qui pourraient la remplacer, ne s'appliqueront pas au code foncier, ni aux textes législatifs des premières nations.

53. PROVINCIAL RELATIONS

53. RAPPORT AVEC LES PROVINCES

53.1 Where Canada and a First Nation intend to enter into an agreement that is not referred to in this Agreement but is required to implement this Agreement and where it deals with matters that normally fall within provincial jurisdiction, or may have significant impacts beyond the boundaries of First Nation land, Canada and the First Nation will invite the affected province to be a party to the negotiations and resulting agreement.

53.1 Si le Canada et une première nation entendent conclure une entente qui n'est pas mentionnée dans le présent accord mais qui est nécessaire à la mise en oeuvre du présent accord, et si cette entente traite des questions qui relèvent normalement de la compétence des provinces ou risque d'avoir des effets importants à l'extérieur des terres de première nation, le Canada et la première nation inviteront la province concernée à participer aux négociations de l'entente ainsi qu'à l'entente qui en résulte.

54. TIME LIMITS

54.1 The time limits in this Agreement for the doing of anything may be waived on consent.

55. OTHER REGIMES

55.1 Nothing in this Agreement prevents a First Nation, at any time, from opting into any other regime providing for community decision-making and community control, if the First Nation is eligible for the other regime and opts into it in accordance with procedures developed for that other regime.

55.2 Sub-clause 38.1 and clause 57 do not apply to a First Nation to which sub-clause 55.1 applies.

56. REVIEW PROCESS

56.1 The Lands Advisory Board will, on a continuing basis, consult with representatives of the Parties for the purpose of assessing the effectiveness of this Agreement and the federal legislation.

56.2 Within four years of the federal legislation coming into force, the Minister and the Lands Advisory Board or their representatives will jointly conduct a review of this Agreement. It will focus on the following issues, among others:

(a) the functioning of land management under this Agreement;

(b) the adequacy and appropriateness of the funding arrangements;

54. DÉLAIS

54.1 Les Parties peuvent, par consentement mutuel, renoncer aux délais prévus par le présent accord.

55. AUTRES RÉGIMES

55.1 Aucune disposition du présent accord n’empêche une première nation, en tout temps, d'adhérer à tout autre régime en matière de prise de décision et de contrôle par la communauté, à la condition que cette première nation soit admissible à adhérer à cet autre régime et y adhère, conformément à la procédure prévue par cet autre régime.

55.2 Le paragraphe 38.1 et l’article 57 ne s’appliquent pas à une première nation à laquelle le paragraphe 55.1 s’applique.

56. MÉCANISME D'EXAMEN

56.1 Le Conseil consultatif des terres est tenu de consulter régulièrement les représentants des Parties dans le but d'évaluer l'efficacité du présent accord et de la loi de ratification.

56.2 Dans les quatre ans de l'entrée en vigueur de la loi de ratification, le ministre et le Conseil consultatif des terres ou leurs représentants procéderont conjointement à un examen du présent accord. Cet examen portera notamment sur les points suivants :

a) le fonctionnement de la gestion des terres aux termes du présent accord;

b) le caractère adéquat et approprié des modalités de financement;

(c) the role of the Lands Advisory Board;

(d) whether there is a demand by other First Nations to use this Agreement;

(e) changes that may improve the functioning of First Nation land management;

(f) the dispute resolution processes; and

(g) such other issues as may be agreed to by the Parties.

56.3 Canada and the First Nations will make best efforts to complete this review within one year. Following completion of the review, the Minister will meet with representatives of the First Nations to discuss the results of the review.

57. AMENDMENTS

57.1 Until September 1, 2003, this Agreement may be amended by agreement of the parties, provided that the amendments to Part VIII may be made with the consent of Canada and 2/3 of the original First Nation parties to this Agreement.

57.2 No amendment affecting the powers, authorities, obligations, operations or operational funding of a First Nation that has ratified this agreement is effective with respect to that First Nation without the consent of that First Nation.

c) le rôle du Conseil consultatif des terres;

d) l'identification d'autres premières nations désirant se prévaloir du présent accord;

e) les changements qui pourraient améliorer le fonctionnement de la gestion des terres de première nation;

f) les mécanismes de règlement des différends;

g) toute autre question convenue par les Parties.

56.3 Le Canada et les premières nations sont tenus de s'efforcer d'achever cet examen dans un délai d'un an. À la fin de l'examen, le ministre rencontrera les représentants des premières nations pour en analyser les résultats.

57. MODIFICATIONS

57.1 Le présent accord peut être modifié jusqu’au 1er septembre 2003 avec le consentement des parties, pourvu que les modifications à la Partie VIII soient apportées avec le consentement du Canada et des deux tiers des premières nations qui étaient Parties initiales au présent accord.

57.2 Aucune modification ayant une incidence sur les pouvoirs, les autorités, les obligations, les opérations ou les fonds de fonctionnement d’une première nation qui a ratifié le présent accord ne peut entrer en vigueur à l’égard de cette dernière sans son consentement.

57.3 After September 1, 2003, this Agreement, may, subject to 57.2, be amended with the consent of Canada and 2/3 of the First Nations which have ratified the Agreement, before, on or after that day.

57.3 Sous réserve du paragraphe 57.2, après le 1er septembre 2003, le présent accord peut être modifié avec le consentement du Canada et des deux tiers des premières nations qui l'ont ratifié que ce soit à cette date, ou avant ou après cette date.

58. RECITALS

58.1 The recitals form part of this Agreement.

58. PRÉAMBULE

58.1 Les dispositions figurant au préambule font partie du présent accord.

59. COMING INTO FORCE

59.1 This Agreement will come into force in respect of Canada and a First Nation when Canada and that First Nation both ratify this Agreement under Part X.

59.2 Despite clause 59.1, such provisions of this Agreement as are necessary to allow a First Nation to ratify this Agreement before Canada ratifies this Agreement will have effect as of the day Canada and that First Nation both sign this Agreement.

59. ENTRÉE EN VIGUEUR

59.1 Le présent accord entrera en vigueur pour ce qui est du Canada et d'une première nation au moment où le Canada et cette première nation auront tous deux ratifié le présent accord conformément à la Partie X.

59.2 Malgré le paragraphe 59.1, les dispositions du présent accord nécessaires à sa ratification par une première nation avant que le Canada ne l'ait ratifié entrent en vigueur le jour où le Canada et cette première nation auront tous deux signé le présent accord.

FRAMEWORK AGREEMENT ON

FIRST NATION LAND MANAGEMENT

EXECUTIVE SUMMARY

INTRODUCTION

The *Framework Agreement on First Nation Land Management* was signed by the Minister of Indian Affairs and Northern Development and 13 First Nations on February 12, 1996. One other First Nation was added as of December 1997. The Agreement was ratified by Canada through the *First Nations Land Management Act*, assented to June 17, 1999

The Agreement is an initiative by these 14 First Nations to take over the governance and management control of their lands and resources. This First Nation designed and driven *Framework Agreement* with Canada has expanded from the original 14 First Nation signatories to 84 First Nation Signatories in 2013. The *Framework Agreement* applies only to those First Nations who choose to ratify it.

The *Framework Agreement* is <u>not</u> a treaty and <u>does not affect</u> existing treaty or other constitutional rights of the First nations. .

The *Framework Agreement* provides the option to govern and manage reserve lands outside the *Indian Act.* The option to regain control of reserve land through a land code can only be undertaken with the consent of the community. A land code replaces approximately 30 sections of the *Indian Act*.

TAKING CONTROL OF LAND GOVERNANCE

A First Nation signatory to the *Framework Agreement* develops its land governance system by creating its own Land Code, drafting a community ratification process and entering into an individual Agreement with Canada. The specific steps are set out in the *Framework Agreement*:

The Land Code: Drafted and approved by the community, will be the basic land law of the First Nation and will replace the land management provisions of the Indian Act. The Minister of Indian Affairs and Northern Development will no longer be involved in the management and decision making of a First Nation's reserve lands. The Land Code does not have to be approved by the Minister or AANDC.

The Land Code is drafted by each First Nation and provides for the following matters:

- Identifies the reserve lands to be governed by the First Nation under its Land Code,
- Sets out the general rules and procedures for the use and occupation of these lands by First Nation members and others,
- Provides financial accountability for revenues from the lands (except oil and gas revenues, which continue under the Indian Oil and Gas Act),
- Provides the procedures for making and publishing First Nation land laws,
- Provides conflict of interest rules,
- Provides a community process to develop rules and procedures applicable to land on the breakdown of a marriage,
- Identifies a dispute resolution process,
- Sets out procedures by which the First Nation can grant interests in land or acquire lands for community purposes,
- Allows the delegation of certain land management responsibilities,
- Sets out the procedure for amending the Land Code,
- Deals with any other matter respecting the governance of First Nation reserve land and resources.

Individual Transfer Agreement: An Individual Agreement between each community and the Minister will be negotiated to deal with such matters as:

- The reserve lands to be managed by the First Nation,
- The specifics of the transfer of the administration of land from Canada to the First Nation,
- The transitional and operational funding to be provided by Canada to the First Nation for land governance.

Community Ratification Process: In order for the First Nation to assume control over its lands, the Land Code and the Individual Agreement must be ratified by the voting age members of the First Nation. All members of the First Nation who are at least 18 years of age, whether living off-reserve or on-reserve, have the right to vote on the Land Code and the Individual Agreement. The procedure for the community ratification process is developed by the community in accordance with the *Framework Agreement*.

Federal Legislation: Canada agreed to ratify the *Framework Agreement* by enacting federal legislation that is consistent with the *Framework Agreement.* The *First Nations Land Management Act* was enacted and given royal assent on June 17, 1999.

Verification: An independent person selected jointly by the First Nation and Canada, called a Verifier, confirms that the community ratification process and Land Code are consistent with the *Framework Agreement.* The Verifier monitors the community ratification process to ensure that the rules are followed.

Recognition of Land Governance Authority: If the community ratifies their own Land Code and the Individual Agreement, control over First Nation lands and resources are no longer be subject to the *Indian Act*, but recognized to be under the governance authority of the First Nation.

TITLE TO FIRST NATIONS

Reserve lands under the *Indian Act* are held by Her Majesty and are set apart for the use and benefit of a First Nation. This will not change under the *Framework Agreement.* These lands remain a federal responsibility under section 91(24) of the *Constitution Act, 1867.* In addition, the First Nation's land will be protected against future surrender for sale.

LEGAL STATUS AND POWERS OF FIRST NATIONS

The *Framework Agreement* provides First Nations with all the legal status and powers needed to govern and manage their lands and resources. While First Nations will not be able to sell their land, they will be able to lease or develop their lands and resources, subject to any limits imposed by their own community Land Code.

Law-Making Powers: A First Nation governing its lands under a Land Code will have the power to make laws in respect of the development, conservation, protection, management, use and possession of First Nation land. The Land Code does not authorize laws relating to the taxation of real or personal property. Such laws must be made separately pursuant to section 83 of the *Indian Act.* The First Nation's Council can also continue to make by-laws under section 81 of the *Indian Act.*

Land Management: The *Framework Agreement* provides the First Nation with all the powers of an owner in relation to its First Nation Land, except for control over title or the power to sell it. The First Nation's Council can manage land and resources, as well as revenues from the land and resources, in accordance with its Land Code.

Third Party Interests: Interests in First Nation land held by third parties, or by Canada, will continue in effect according to their terms and conditions under a Land Code. No new interests or licences may be acquired or granted except in accordance with the Land Code.

First Nation Expropriation: The First Nation will have the option to acquire lands for community purposes upon payment of fair compensation to those who interests are affected.

Accountability: A Land Code will make provision for a First Nation to report to its members and to be accountable for the governance of their lands, resources and revenues.

Marriage Breakdown: A First Nation will be able make rules on the rights of spouses to interests in First Nation land if their marriage breaks down. The community must, within 12 months of passage of its Land Code, develop and enact rules and procedures on this topic. The new rules and procedures will ensure the equality of women and men.

Registration of Interests: All documents pertaining to land interests of a reserve will be recorded in the First Nation Land Registry System (FNLRS).

The FNLRS is:

- Electronic
- Provides for Instant Registration
- Priority based
- Paperless
- Backed by Regulation (Unlike the *Indian Act* registry system)

The FNLRS system and regulations are landmark achievements. These regulations made it possible for reserve to have greater land certainty, mortgageability, title insurance and drastically reduced or eliminated land transaction costs

PROTECTION OF FIRST NATION LAND

The preserving of the quantity and quality of existing First Nations lands is a fundamental principle of the *Framework Agreement.* Some aspects of this principle are summarized below:

Taxation and Seizure under Legal Process: The current exemption of reserve lands, and personal property situated on-reserve, will continue under the relevant provisions of the *Indian Act.*

Environmental Protection: A First Nation with a land code in effect will be required to develop an environmental protection regime. A First Nation will have the power to make environmental assessment and protection laws and will harmonize these laws with federal and respective provincial environmental laws.

Voluntary Exchange of Lands: A First Nation may decide that it is advantageous to exchange some of its First Nation lands for other lands. Provision can be made in its Land Code for a procedure to negotiate and approve such exchanges. An exchange of land cannot occur without the consent of the First Nation community.

No Provincial Expropriation: Under the *Framework Agreement* there can be no expropriation of First Nation land by a provincial or municipal government or agency.

Restricted Federal Expropriation: Canada's power to expropriate First Nation land is greatly restricted. That power can only be exercised with Cabinet approval and only when the expropriation is justified and necessary for a federal public purpose that serves the national interest. Compensation must include provision for equivalent lands so that the land base of the First Nation is not diminished.

Enforcement: The First Nation will have full power to enforce its land and environmental laws and may enter into further agreements with other jurisdictions to assist in such enforcement. A First Nation can appoint its own Justice of the Peace or special prosecutor to try offences created under a Land Code or a First Nation law. First Nation laws may make provision for search and seizure, fines, imprisonment, restitution, community service or alternate means for achieving compliance with its laws.

CONTINUING FEDERAL RESPONSIBILITY

Canada will remain liable for and will indemnify a First Nation for losses suffered as a result of any act or omission by Canada, or its agents, that occurred before the Land Code comes into effect. After that date, the First Nation is responsible for its own acts or omissions in managing its lands.

DISPUTE RESOLUTION

The First Nation will establish its own processes for dealing with disputes in relations to its lands and resources. These can include mediation, neutral evaluation and arbitration. In the case of a disagreement between the First Nations and Canada on the meaning or implementation of the *Framework Agreement,* there are provisions in the *Framework Agreement* to resolve the dispute outside the courts.

LANDS ADVISORY BOARD AND RESOURCE CENTRE

The First Nations party to the *Framework Agreement* established a Lands Advisory Board and Resource Centre to assist them in implementing their own land governance regimes, including developing model land codes, laws, documents, agreements and management systems.

FIRST NATIONS INVOLVED

The following is a list of the 40 First Nations who signed the *Framework Agreement* <u>and</u> who have enacted Land Codes pursuant to the *Framework Agreement.*

BC
1.Beecher Bay
2.Kitselas
3.Leq' a: mel
4.Lheidli T'enneh
5.Matsqui
6.Musqueam
7.Seabird Island
8.Shx'wha:y Village
9.Skawahlook
10.Sliammon
11.Snaw Naw As (Nanoose)
12.Songhees
13.Squiala
14.Sumas
15.Tsawout
16.Tsawwassen(a)
17.Tsekani (Mcleod Lake)
18.Ts'kw'aylaxw (Pavilion)
19.T'sou-ke
20.Tsleil-Waututh
21.Tzeachten
22.Westbank(b)
23.We Wai Kai (Cape Mudge)
24.We Wai Kum (Campbell River)

MB
1.Chemawawin
2.Opaskwayak
3.Swan Lake

SK
1.Kahkewistahaw
2.Kinistin
3.Muskeg Lake
4.Muskoday
5.Whitecap Dakota
6.Flying Dust

ON
1.Anishinaabeg of Naongashiing
2.Georgina Island
3.Henvey Inlet
4.Mississauga
5.Nipissing
6.Scugog Island
7.Whitefish Lake

(a) Now implementing treaty
(b) Now implementing full self-government

Lake Simcoe Watershed

2013 Environmental Monitoring Report (2007-2011 data)

Lake Simcoe Region
conservation authority

Acknowledgements

The LSRCA is pleased to acknowledge the cooperation and support of its provincial, municipal, and federal partners whose contributions have aided in the development of this report.

120 Bayview Parkway, Box 282
Newmarket ON L3Y 4X1
905.895.1281

www.lsrca.on.ca

Table of Contents

1) Introduction

Lake Simcoe Watershed	1
Tourism and Recreation	2
Oak Ridges and Oro Moraines	2
Polders	3
Issues in the watershed	3
Actions being undertaken	4

2) Methods

Tributary Water Quality	6
Surface Water	6
Groundwater	8
Tributary Water Quantity	10
Surface Water	10
Groundwater	11
Tributary Biology	12
Fish	12
Benthic Invertebrates	13
Diatoms	14
Temperatures	14
Lake Simcoe Nearshore	15
Physical	15
Chemical	16
Biological	16

3) Setting the Scene

Climate	18
Temperature	18
Precipitation	18
Climate Change	19
Land Use and Population	20
Urban Land Use	21
Sewage Tretment Plants	23
Agricultural Land Use	24
Recreation	26

Invasive Species 27

4) PHOSPHORUS LOADS

What is phosphorus loading? 28

Phosphorus loading to Lake Simcoe 29

Sources of Phosphorus 31

Tributary load 31

Polders 33

Sewage Treatment Plants 34

Septic Systems 35

Atmosphere 36

5) NEARSHORE MONITORING

Program Overview 37

Physical Monitoring 38

Water Clarity 38

Temperature 39

Dissolved Oxygen 39

Water Chemistry 40

Water column total phosphorus 40

Water column chlorophyll *a* 40

Sediment Chemistry (total phosphorus) 41

Biological Monitoring 42

Aquatic Macrophytes 42

Changes over time 43

Benthic Invertebrates 44

Zebra Mussels 45

Total Phosphorus in the Holland River 46

6) WATER QUALITY

Surface Water 47

Phosphorus 47

Chloride 50

Total Suspended Solids 54

Metals 58

TABLE OF CONTENTS

Groundwater 61

Chloride 61

Nitrite + nitrate 63

7) WATER QUANTITY

Tributary Water Quantity 65

Stream Flow 65

Baseflow and Quickflow 67

Trends 68

Groundwater Quantity 70

Groundwater levels 70

Trends 70

8) TRIBUTARY BIOLOGY

Fish 73

Benthic Invertebrates 76

Temperature 79

Diatoms 82

Invasive Species 83

REFERENCES

APPENDIX I Period of Record for Lake Simcoe Water Quality Monitoring Stations

THE LAKE SIMCOE WATERSHED

The Lake Simcoe watershed is a 3,400 km^2 area of land which drains into Lake Simcoe in its centre, which is approximately 722 km^2 in area. The watershed drains 18 subwatersheds (Figure 1-1), which cross 20 municipal boundaries. This includes two regional municipalities (York Region and Durham Region), Simcoe County, and the Cities of Barrie, Orillia, and Kawartha Lakes. The watershed supports a population of over 400,000 people.

The Lake Simcoe watershed contains a number of significant natural features, including the Oak Ridges Moraine, Oro Moraine, and numerous woodland and wetland areas; as well as significant agricultural areas such as the Holland Marsh and other polders.

The Lake Simcoe watershed has been under pressure since the arrival of European settlers in the early 1800s. The initial changes included the removal of natural features to accommodate agriculture and the damming of watercourses in order to power mills. The land use changes have continued since, and now, 200 years later, a significant proportion of the watershed has been changed from its natural state, and its issues include water quality degradation, particularly from phosphorus, which has led to eutrophication; habitat loss and fragmentation; the introduction of invasive species; and climate change. These pressures will continue to intensify as the watershed population grows and natural areas are removed.

The watershed also provides numerous opportunities for recreation, including ice fishing and fishing in the summer, which contribute significantly to the local economy; boating, which is particularly popular given the lake's connection to the Trent-Severn waterway; snowmobiling; windsurfing; swimming; hiking; cycling; and canoeing. These opportunities attract watershed residents as well as many visitors, as the watershed is within an hour's drive of half of the province's population. The lake's ice fishing is well known, and has been known to attract international visitors.

# on map	Subwatershed Name	# on map	Subwatershed Name
1	West Holland River	10	Talbot River
2	East Holland	11	Ramara Creeks
3	Georgina Creeks	12	Oro Creeks North
4	Maskinonge River	13	Hawkestone Creek
5	Black River	14	Oro Creeks South
6	Pefferlaw River	15	Barrie Creeks
7	Beaver River	16	Lovers Creek
8	Whites Creek	17	Hewitts Creek
9	Upper Talbot River	18	Innisfil Creeks

Figure 1-1: The subwatersheds that drain to Lake Simcoe

Tourism and recreation

Tourism and recreation are a significant source of income for many watershed communities. The population of many lakeside communities increases significantly during the summer months, when cottagers return. Boating and fishing are hugely popular activities, and support industries such as boat and ice hut rentals, depending on the season, baitfish dealers, accommodations such as hotels and bed and breakfast establishments, restaurants, marinas, and outfitting businesses. Snowmobiling is another popular activity that supports many of the same industries.

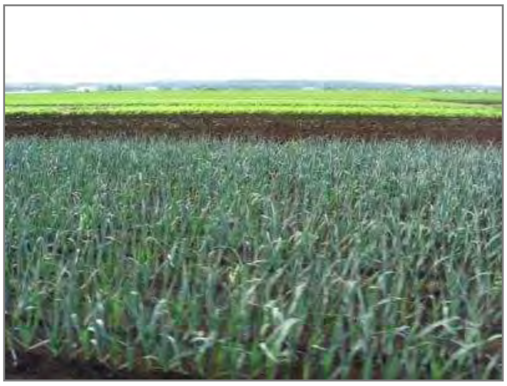
The watershed is also home to 24 conservation areas which are owned and/or managed by the Lake Simcoe Region Conservation Authority. In addition, there are four provincial parks classified as 'Recreation,' which contain amenities such as campgrounds, beaches, hiking trails, and opportunities for winter recreation. These are Bass Lake, Mara, McRae Point, and Sibbald Point Provincial Parks. There are two additional parks, Duclos Point and the Holland Landing Prairie, which are classed as Nature Reserve and do not contain any recreation facilities. These conservation areas and parks are a significant draw for residents of the Greater Toronto Area, who are looking for camping and recreation facilities nearby.

Oak Ridges and Oro Moraines

Sections of two moraines, the Oak Ridges Moraine, and the Oro Moraine, fall within the Lake Simcoe watershed. The Oak Ridges Moraine forms the southern boundary of the watershed, and the Oro Moraine can be found along the northwest boundary.

These moraines are geological landforms that were left behind by a glacial retreat occurring 12,000 - 13,000 years ago. As the ice melted, huge volumes of silts, sands, and gravels that had accumulated along their edges were deposited, leaving a ridge of rolling hills behind.

The moraines are extremely important contributors to the health of Lake Simcoe, as they act as water recharge and discharge systems; their permeable sands and gravels absorbing and collecting rain and melted snow, which then slowly filter into the deep aquifers below the ground. This clean, cool groundwater is then discharged to streams and wetlands along the base of the moraine, supporting numerous sensitive species, and is also used as a source of drinking water for many private landowners and watershed communities. The moraines contribute flow to the headwaters of a number of Lake Simcoe's tributary rivers, have relatively high levels of natural cover, and support a number of sensitive species.



Polders

Polders are wetlands that have been drained for agricultural use. Because they are low-lying, excess water accumulates, and must be pumped off and discharged to watercourses. This water contains phosphorus, sediment, and other contaminants, and has an impact on water quality in the receiving tributaries and in the lake. There are five polders in the watershed, the Keswick, Colbar, Bradford, Deerhurst, and Holland Marshes, occupying approximately 37 km^2, with the Holland Marsh being the largest of these at 28 km^2.

Issues in the watershed

There are numerous issues of concern regarding the health of the Lake Simcoe watershed; many of which stem from changing land uses. The removal of natural cover to accommodate land uses such as agriculture, urban development, golf courses and other recreation facilities, transportation and utility corridors, and aggregate operations can have significant impacts on watershed health, impacting water quality and quantity, and the health of terrestrial and aquatic communities.

Along with land use change has come inputs of nutrients and other contaminants to the watershed's watercourses and, ultimately, to the lake itself. Inputs of high levels of the nutrient phosphorus have caused many of the issues we have been addressing in the watershed for the past few decades. This phosphorus has caused a process referred to as eutrophication in the lake and in some of its tributary rivers. Generally speaking, high levels of phosphorus have caused the excessive growth of aquatic plants and algae near the mouths of a number of tributaries, and in several areas of the lake, such as Cook's and Kempenfelt Bays and other areas along the shoreline. As these plants die off they are decomposed by bacteria, a process which consumes dissolved oxygen in the water, rendering it unavailable for use by fish and other aquatic organisms. While some species are more tolerant of low oxygen levels, sensitive species, particularly lake trout and lake whitefish, are unable to tolerate these conditions, and for many years their populations have been sustained by stocking efforts, with little to no natural reproduction occurring. Phosphorus reduction efforts have been undertaken by the LSRCA and its partners under the Lake Simcoe Environmental Management Strategy since the early 1980s, and eventually reductions in phosphorus loads were realized. Coincident with these reductions was an increase in dissolved oxygen levels, and fisheries monitoring work began to show evidence of natural reproduction in lake trout and whitefish populations in the mid-2000s. This is certainly a positive step, although stocking will still be required to sustain populations, as the amount of natural reproduction occurring is still very low. In 2008, the province of Ontario released the Lake Simcoe Protection Act, which provided a legislative framework for protecting the Lake Simcoe watershed. The corresponding Lake Simcoe Protection Plan was released the following June, which directs efforts for protecting and restoring the watershed. In this Plan, the Ontario Ministry of the Environment (MOE) has set an aggressive phosphorus loading target of 44 tonnes/year; the average was approximately 86 tonnes per year in the most recent period of record (2005-2009). It is thought that the target level would correspond to a dissolved oxygen level of 7 mg/L, which is the minimum required to sustain healthy populations of lake trout.

Actions being undertaken

The Lake Simcoe Region Conservation Authority and its partners continue to work to improve conditions in the watershed. This work includes:

- The development of Subwatershed Plans, which highlight subwatershed conditions, assess the current management framework, and identify actions that should be undertaken to improve subwatershed conditions
- Undertaking stewardship works throughout the watershed through our Landowner Environmental Assistance Program (LEAP)
- Completing works under the Source Water Protection program, including the development of a Source Protection Plan for this area
- Working with landowners and developers to minimize the impacts of their undertakings on the health of the watershed
- Assessing the effectiveness of stormwater controls in the watershed's urban areas, and recommending stormwater retrofits, where possible
- Providing education programs and materials to inform watershed residents of what is happening in their watershed, and actions that they can take to reduce their impact on the environment

Some of the most important activities that the LSRCA undertakes are through our monitoring program. Through this program, LSRCA staff monitor the watershed's tributary streams and rivers, as well as conditions in the lake. This monitoring work supports a number of the LSRCA's other programs, including subwatershed planning, helping to identify potential areas for undertaking stewardship works, assessing the effectiveness of on-the-ground projects that have been completed, verifying the effectiveness of new technologies and practices, and helping to pinpoint areas of concern in the watershed.

Tributary monitoring includes:

- collecting samples to assess the quality of ground and surface water
- measuring surface water flows and ground water levels
- sampling the fish and benthic invertebrate (aquatic insects, molluscs, crustaceans, and worms) communities
- deploying dataloggers to measure the temperature of stream water
- collecting single-celled algae, called diatoms, to assess stream conditions

Tributary monitoring activities, including benthic invertebrate sampling (left), water quality sampling (centre), and electrofishing (right)

Our nearshore sampling program which, as its name implies, occurs in the nearshore area of the lake, entails:

- Surveying the composition and extent of aquatic plant communities, and noting changes over time
- Assessing the benthic invertebrate community, including noting the levels of invasive species such as zebra and quagga mussels
- Sampling water and sediment to test for a range of nutrients and other chemical parameters

These monitoring works, and the results found through the monitoring program, are the focus of the following report. This report identifies which monitoring works are undertaken where, what the results were for some key parameters under each facet of the monitoring program, and if there are any trends identified in the data. Unless otherwise indicated, the reporting period for this report is the five-year period from 2007-2011. It is anticipated that the LSRCA will complete a monitoring report every five years.

Conducting sampling on the lake – collecting samples using a Petite Ponar Grab (top) and using a Secchi disc to determine water clarity (bottom)

This section of the LSRCA Monitoring Report 2013 provides a description of the components of the monitoring program, explaining how and when monitoring is undertaken and why that particular component is monitored. The LSRCA monitoring program includes monitoring of the quality and quantity of surface and groundwater, the status of the aquatic communities within the watercourses of the Lake Simcoe watershed (which include fish, benthic invertebrates, and diatoms, as well as the spread of invasive aquatic species and the location of species of concern), and the physical and biological components of the Lake Simcoe-nearshore environment,.

The information collected from the monitoring program is used to establish the current status of a particular parameter, track both short and long term trends, identify and locate stressors and where possible predict future changes.

TRIBUTARY WATER QUALITY

The chemical, physical and microbiological characteristics of natural water make up an integrated index we define as "water quality". Water quality is a function of both natural processes and anthropogenic impacts. For example, natural processes such as weathering of minerals and various kinds of erosion are two actions that can affect the quality of groundwater and surface water. There are several different types of anthropogenic influences, such as point sources and non-point sources of pollution. Point sources of pollution are direct inputs of contaminants to the surface water or groundwater system and include municipal and industrial wastewater discharges, ruptured underground storage tanks, and landfills. Non-point sources include, but are not exclusive to, agricultural drainage, urban runoff, land clearing, construction activity, and land application of waste that typically travel to waterways through surface runoff and infiltration. Contaminants delivered by point and non-point sources can travel in suspension and/or solution and are characterized by routine sampling of surface waters in the Lake Simcoe watershed.

Surface Water

Description (how and when):

Samples are routinely collected from 25 monitoring stations throughout the Lake Simcoe watershed (some of the numbered sites on Figure 2-1 contain more than one sampling station) as part of two monitoring programs, the LSPP (Lake Simcoe Protection Plan) program and the PWQMN (Provincial Water Quality Monitoring Network) program. The stations represent most of the subwatersheds of Lake Simcoe (except Oro Creeks South and Georgina Creeks). The water quality stations are at major tributaries and representative creeks, but there are also stations at the Art Janse Pumping Station of the Holland Marsh and at Atherley Narrows, the outflow of Lake Simcoe. From approximately the same stream bank location on each sampling event, a simple grab sample is collected using a reaching pole or drop bucket and the sample is contained in a new polyethylene container pre-rinsed with the stream water. Samples are kept on ice in a cooler for transportation and are sent to the laboratory expediently to make sure samples are analyzed within perishability limits. The stations are numbered in Figure 2-1, and their corresponding station names are shown in Table 2-1 below.

Samples from both programs are analyzed in the Laboratory Services Branch of the Ministry of Environment, and are assessed using the Provincial Water Quality Objectives (PWQO) (Ministry of Environment, 1994). Samples collected under the LSPP program are analyzed for eight key chemical parameters and are collected year round, every two weeks during the spring, summer, and fall and every three weeks in the winter months. Sampling dates are shifted or added to coincide with storm/rain events especially during the spring freshet. Samples under the PWQMN program are collected eight times a year on a monthly basis during the ice-free period and analyzed for 32 chemical parameters. The key chemical parameters include nutrients (such as phosphorus), total suspended solids, chloride, and a suite of metals (iron for example). Physical parameters including pH, temperature, dissolved oxygen, and conductivity are measured instantaneously at each site using a YSI sonde.

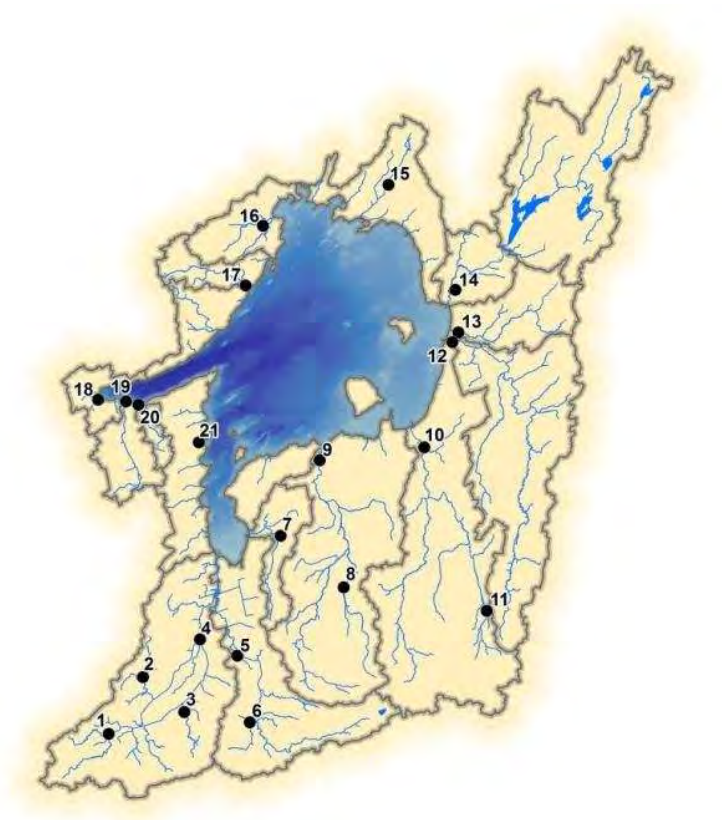


Figure 2-1: Location of surface water quality sampling stations.

Importance of component:

Water quality sampling of the tributaries provides information required for calculating nutrient and chloride loads from tributaries to Lake Simcoe. The program also provides long-term data for trend monitoring, assessment of phosphorus reduction efforts, research initiatives, comparison to provincial and federal water quality guidelines, and to track the environmental conditions of subwatersheds. These efforts support the water quality and phosphorus loading objectives of the Lake Simcoe Protection Act and Plan and the Phosphorus Reduction Strategy.

Table 2-1: Water quality monitoring station names corresponding to numbers in Figure 2-1. The monitoring program undertaken at each site is also noted

# on map	Station Name (program)	# on map	Station Name (program)
1	Upper Schomberg (LSPP/PWQMN)	12	Beaver (LSPP/PWQMN)
2	North Schomberg (LSPP)	13	Whites (LSPP)
3	Kettleby (LSPP)	14	Talbot (LSPP)
4	West Holland (LSPP)	15	Ramara (LSPP)
5	East Holland (LSPP/PWQMN)	16	Bluffs (LSPP)
6	Tannery (PWQMN)	17	Hawkestone (LSPP/PWQMN)
7	Maskinonge (LSPP/PWQMN)	18	Hotchkiss (LSPP)
8	Mount Albert (PWQMN)	19	Lovers (LSPP/PWQMN)
9	Black (LSPP/PWQMN)	20	Hewitt's (LSPP)
10	Pefferlaw (LSPP/PWQMN)	21	Leonards (LSPP)
11	Uxbridge (PWQMN)		

Groundwater

Description (how and when):

Samples are collected during the spring and fall from 13 monitoring wells at 10 locations throughout the Lake Simcoe watershed as part of the Provincial Groundwater Monitoring Network (PGMN) (monitoring well locations are numbered in Figure 2-2, with corresponding Well ID numbers and location names shown below in Table 2-2). Three aquifer depths are sampled at site 5 on the map, and two are sampled at site 9. Samples are collected manually using high density polyethylene tubing with a footvalve or using low density polyethylene tubing and a 12 volt stainless steel groundwater pump. Prior to the start of sampling the water Levelogger is removed and a static water level and a calculation is performed to determine the volume of water within the well casing. The well is pumped for a minimum of an hour or until three casing volumes have been removed to ensure that the sample being taken is representative of water from the aquifer and not stagnant water from the well. A probe (i.e. YSI sonde) is used to measure the chemical parameters such as pH, temperature, dissolved oxygen, and conductivity from the discharged water. Once the parameter measurements and the static water level within the casing have stabilized, the sample is taken. All samples are unfiltered except for the metals samples which are filtered through a 0.45 micron in-line filter that is attached to the end of the sampling tube. Samples are kept on ice in a cooler for transportation and are sent to the laboratory expediently to ensure that the samples are analyzed within their perishability limits.

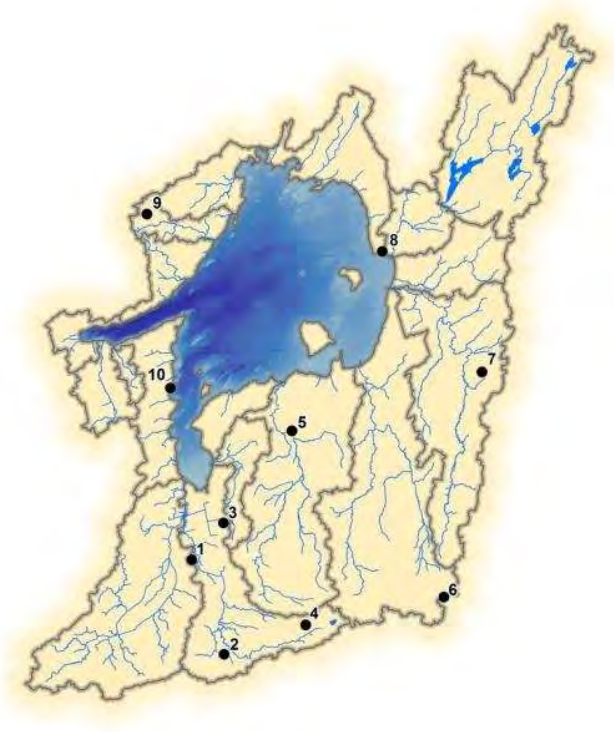


Figure 2-2: Location of groundwater quality monitoring stations.

Samples collected in the spring are analysed by Maxxam Analytics and samples collected in the fall are analysed by the Laboratory Services Branch of the Ministry of the Environment. The laboratories analyze the samples for the key chemical parameters including phosphorus, nitrogen, total suspended solids, chloride, dissolved organic carbon and dissolved inorganic carbon, and a suite of metals (iron for example).

Importance of component:

Sampling of water quality in groundwater monitoring wells provides long-term data for trend analysis, comparison to other monitoring wells across the province that are a part of the PGMN program, and to track the environmental conditions of the aquifers studied.

# on map	Well ID #	Location Name (depth)	# on map	Well ID #	Location Name (depth)
1	W0000063-3	Holland Landing (shallow)	**6**	W0000032-1	Durham Forest (deep)
2	W0000283-1	Aurora (intermediate)		W0000039-1	Durham Forest (intermediate)
3	W0000025-1	Queensville (shallow)	**7**	W0000062-1	Cannington (shallow)
4	W0000071-1	Ballantrae (deep)	**8**	W0000408-1	Ramara (shallow)
5	W0000298-2	Baldwin (shallow)	**9**	W0000408-1	Oro-Medonte (deep)
	W0000298-3	Baldwin (intermediate)		W0000408-1	Oro-Medonte (shallow)
	W0000298-4	Baldwin (deep)	**10***	W0000408-1	Innisfil (shallow)

*Well decommissioned in 2010

Table 2-2: Provincial Groundwater Quality Monitoring Network Well ID numbers, station names, and sampling depths, as shown in Figure 2-2. Sampling depths correspond to the depth of the well screen below the surface. In general, shallow wells have a total depth less than 10 m, intermediate wells have a total depth between 10 and 30 m, and deep wells have a total depth greater than 30 m.

TRIBUTARY WATER QUANTITY

Water quantity monitoring includes the evaluation of precipitation, stream flow, baseflow, and groundwater. These parameters are very useful when examining issues such as contaminant and nutrient loading to the lake, water availability for different kinds of consumption, as well as anthropogenic impacts on water resources. Water quantity can be impacted by land use practices such as paving, clearing of land, groundwater withdrawals, and alteration of river channels. Such changes in land use can lead to decreased infiltration rates, affecting groundwater recharge and increasing runoff rates, which increases the chances of downstream flooding. Groundwater withdrawal for urban, industrial, or agricultural uses can also impact baseflow of local streams.

Surface Water

Description (how and when):

There are currently 17 hydrometric gauges within the Lake Simcoe watershed. Seven of these are maintained by Water Survey of Canada, nine are maintained by LSRCA, and one is operated by a partnership between Parks Canada Trent Severn Waterway Authority and the LSRCA.

At each gauge, water level (stage) is recorded continuously using either a float recorder or constant flow bubbler and data logger combination. Data is accessed remotely in near real time or downloaded at regular intervals using a personal computer. The continuous stage record is converted to continuous discharge (volume of water per unit time) using stage-discharge relationships calculated for each site. To establish the stage-discharge relationships, routine discrete measurements are performed using the standard mid-section method and a velocity meter or with an Acoustic Doppler Channel Profiler (ADCP). These are plotted against corresponding stage readings from staff gauges installed at each hydrometric gauge using Kisters WISKI hydrologic software.

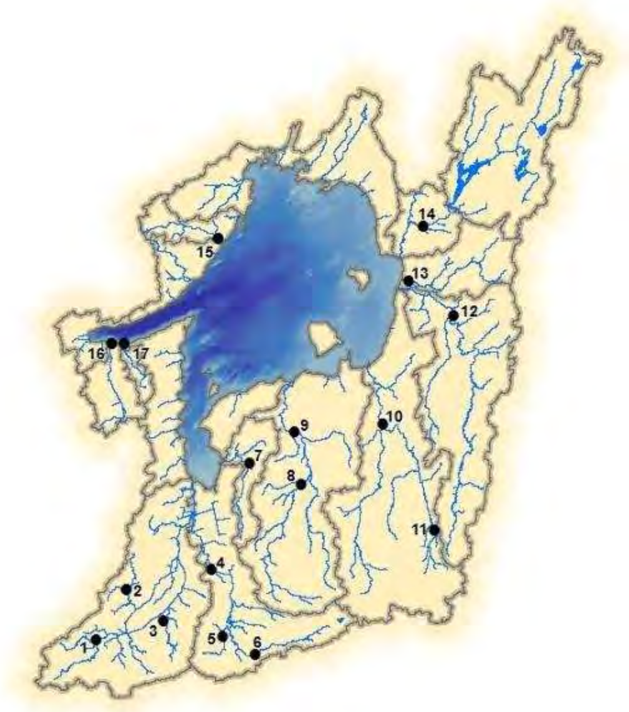


Figure 2-3: Location of flow monitoring stations.

Table 2-3: Water quantity monitoring station names (corresponds to numbering in Figure 2-3)

# on map	Station Name	# on map	Station Name	# on map	Station Name
1	Upper Schomberg	7	Maskinonge	13	Whites
2	North Schomberg	8	Black - Holborn	14	Talbot
3	Kettleby	9	Black - Baldwin	15	Hawkestone
4	Holland Landing	10	Pefferlaw	16	Lovers
5	Tannery	11	Uxbridge	17	Hewitts
6	Vandorf	12	Beaver		

Importance of component:

Stream flow information collected from these gauges has many uses in the Lake Simcoe and surrounding watersheds, including:

- Water resource management and allocation – this data helps to identify how much water is available and how much growth a water supply can support as well as the potential effects of the growth;
- Engineering and urban design – information gained from this monitoring is valuable for the engineering and design of infrastructure projects (such as bridges, culverts, and roads)
- Recreation and navigation – the Trent Severn Waterway Authority relies on accurate stream flow and level information to ensure safe river and lake depths for boat travel
- Flood planning and forecasting – stream flow information is very useful for flood forecasting and high water emergency planning and response, and for identifying floodplain mapping to protect public assets and infrastructure
- Supporting water quality monitoring – using flow information to determine loading volumes of various substances to the lake, and characterizing and evaluating instream conditions.
- Trends in stream flow characteristics

Groundwater

Description (how and when):

Water level and temperature data are collected continuously on an hourly basis from 13 monitoring wells located throughout the Lake Simcoe watershed as part of the Provincial Groundwater Monitoring Network (PGMN) using Solinst Leveloggers (Figure 2-2). The loggers are installed at a set depth; and the data are downloaded quarterly, with manual static water level dip checks being taken to verify the accuracy of the logger data. The manual static water level dip checks are taken with a Solinst Water Level Meter from the same surveyed point of the well casing and are used to correct shifts in the elevations recorded by the logger or eliminate erroneous data. The downloaded data files are sent to the Ministry of the Environment to be incorporated into the Provincial Groundwater Management Information System (PGMIS). A Barologger is used to collect barometric pressure data at the same sampling interval as the Leveloggers and used to compensate the data before the quality check process can commence. Quality checks of the data are undertaken to remove dropped or spiked values that occur while the logger was removed from the well casing due to sampling or logger performance issues.

Importance of component:

The Provincial Groundwater Monitoring Network (PGMN) program provides long-term data for trend analysis, comparison to other sites across the province, and providing information on the changing conditions throughout the watershed from climate change, development, or water taking practices.

TRIBUTARY BIOLOGY

The biological communities within the watercourses of the Lake Simcoe watershed are important indicators of the health of the aquatic ecosystem. Changes in the composition of fish and benthic communities can signify changes in water quality, temperature, flows, and instream habitat.

Fish

Description:

Fish sampling in the Lake Simcoe watershed is conducted between June 1st and September 30th. A total of 451 sites have been monitored over a 10 year period between 2002 and 2011. Of these, 50 are routine monitoring sites that are sampled each year. Assessment of the sites follows the most recent version of the Ontario Stream Assessment Protocol (OSAP). The majority of the sampling is completed using backpack electrofishers, while boats, punts, and shore units are utilized only when necessary. Most fish are identified (to a species level) and enumerated on site and released alive; some specimens may be retained for confirmation of identification. Fish habitat is evaluated by collecting geomorphology data at all new sites or at sites that have not been measured in five or more years. All field data collected is entered into the OSAP database.

Fish population data is analyzed using a modified version of the original Index of Biotic Integrity (IBI) created by James Karr. This IBI was modified by the Toronto Region Conservation Authority to be relevant for Oak Ridges Moraine watercourses (OMNR and TRCA, 2005).

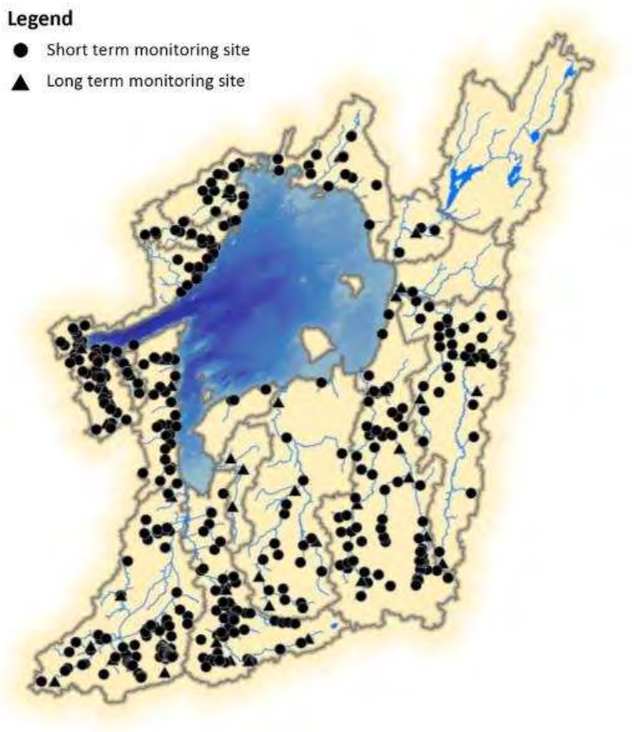


Figure 2-4: Location of fish sampling stations.

Importance of component:

Fish sampling provides data for trend monitoring, individual site assessments and subwatershed assessments. Analysis of fish communities also provides important information on important issues including the introduction and movement of invasive species, and the presence or absence of coldwater indicator species such as brook trout for watershed planning and permitting, and can also be used as a measure of stewardship success.

Benthic Invertebrates

Description:

Benthic invertebrate sampling in the Lake Simcoe watershed is generally conducted in the fall between September 1st and November 30th, with a small number of sites on watercourses that dry up in the summer being conducted in the spring between May 15th and June 15th. In total, 234 sites were monitored from 2002 to 2011. Of these, 50 are routine monitoring sites that are sampled each year. Assessment of the benthic invertebrate communities follows the most recent version of the Ontario Benthos Biomonitoring Network (OBBN). All samples are collected into 1L jars and preserved in formalin at the site. The routine monitoring sites are identified to a family level and enumerated in house. Exceptions to the OBBN protocol include sampling one riffle instead of two, to save time and money; however, 300 invertebrates are sampled, instead of the recommended 100 to ensure that there is sufficient diversity.

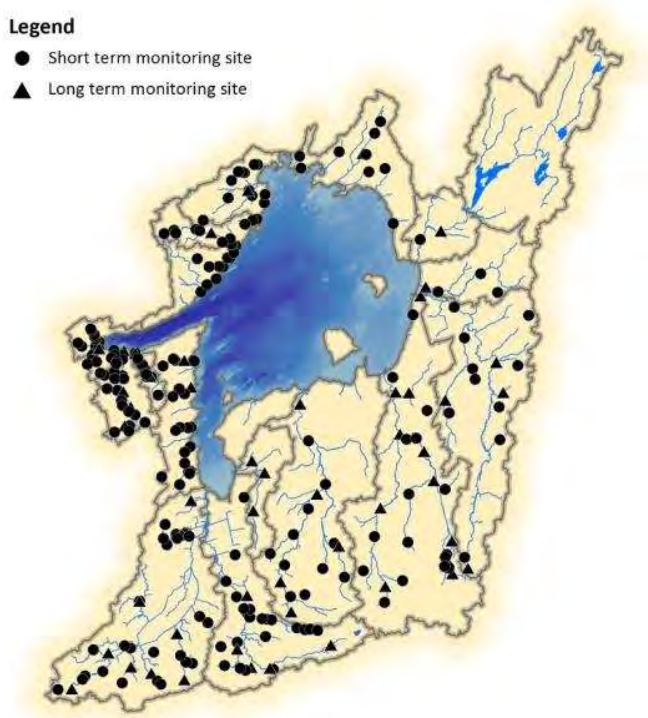


Figure 2-5: Location of benthic invertebrate sampling stations.

Data analysis consists of three main indices: Hilsenhoff Family Biotic Index (Hilsenhoff, 1998), the BioMap index (Griffiths, 1999), and %EPT [the percentage of the invertebrates that belong to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)]. The family index is a modified Hilsenhoff index that uses tolerance values derived from Mandaville's work (Mandaville, 2002), and is the index used in this report.

Importance of component:

Benthic biomonitoring is a cost effective way of collecting important water quality information for watershed reports and watershed planning/permitting. It also provides data for trend monitoring, individual site assessments, and subwatershed assessments.

Diatoms

Description:

Diatoms (Bacillariophyceae) are single-celled algae encased in frustules (cell walls) of silicon dioxide that live free-floating in the water column or attached to rocks, plants, sand grains, and other substrates. They are used as indicators of environmental conditions. They are collected in the fall from 50 tributary locations also used for benthic invertebrate monitoring, with sampling being initiated in 2011. Samples are collected at each site by scraping material from all habitats (e.g. rocks, plants, logs, twigs). In the laboratory, diatoms are separated from organic material using hydrogen peroxide, permanently mounted onto microscope slides, then enumerated and identified by oil immersion microscopy. Data are used to assess environmental conditions at each site, and provide a record of change between years.

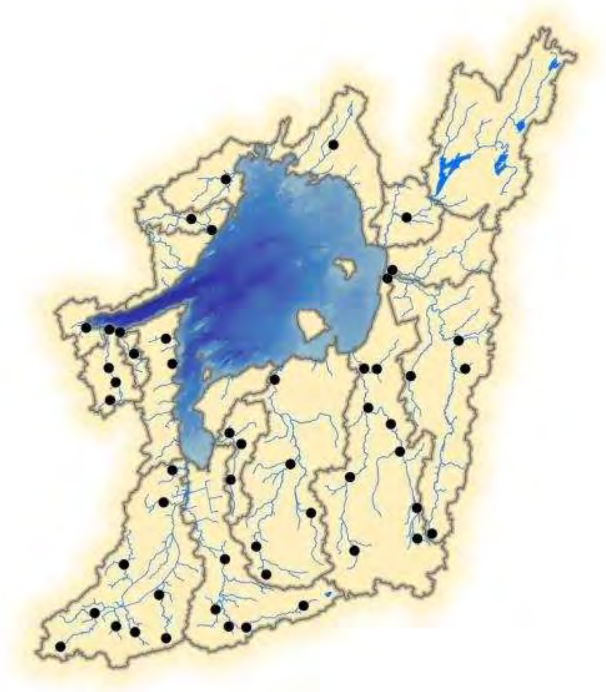


Figure 2-6: Location of diatom sampling locations.

Importance of component:

The ecological optima and tolerances of diatoms have been well studied, making these organisms excellent, and highly accurate, indicators of many environmental variables (e.g. pH, phosphorus, nitrogen, chloride). A short life cycle enables rapid species response (under 24 hours) to changing environmental conditions. In the Lake Simcoe watershed, diatoms are used to track the flow of phosphorus and chloride from land to lake, determine "hotspots" of environmental concern, and assess the effectiveness of remediation and lake management efforts.

Temperature

Description:

Temperature monitoring has been conducted since 2003 at 338 sites, of which 50 are routine monitoring sites. Hobo temperature loggers are installed in wadeable streams adjacent to fish monitoring stations (at least 10 m downstream of electrofishing sites) and as close to the stream bed as possible without resting on the bottom. The loggers are set for a delayed start (~1 day after deployment) to log temperatures on an hourly basis from May until the end of October. Data collection follows the most recent version of the OSAP (Section 5). Data is downloaded using the Hobo software and transferred to Kisters WISKI hydrologic software and the OSAP database.

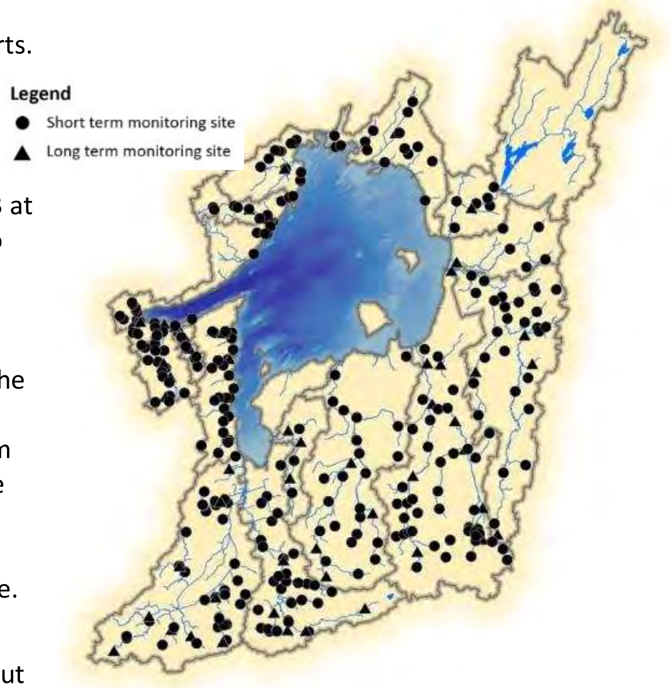


Figure 2-7: Location of tributary temperature monitoring stations.

Collected data is analyzed using "A Simple Method to Determine the Thermal Stability of Southern Ontario Trout Streams" (Stoneman, C.L. and M.L. Jones, 1996). This analysis defines if a stream at the point where the logger was located is cold, cool, or warm water habitat. Typically, the average maximum summer water temperatures for a cold water system is 14°C. Cool water is approximately 18°C and warm water systems have an average summer maximum daily water temperature of approximately 23°C (Stoneman and Jones, 1996).

Importance of component:

Water temperature information is collected to see if sections of watercourses are thermally stable and if they can support cold water species. Analysis of water temperature provides important information for watershed reports and watershed planning/permitting.

LAKE SIMCOE NEARSHORE

The LSRCA nearshore monitoring team carries out year-round, scientific studies on the lake, with routine water quality samples at 29 lake stations (8 open-water and 21 nearshore) and six Holland River stations. An additional 142 sites are monitored annually for changes to biological communities and a further 952 sites sampled every five years for long-term community changes.

The LSRCA program to investigate environmental changes in Lake Simcoe was started in May 2008 and is a science-based program on the lake to address changes to Lake Simcoe's health, nearshore biological communities, and specifically target issues of concern to watershed residents. Over the past four years, studies have targeted water quality and changing sediment chemistry; changes to communities of lake organisms such as aquatic plants, benthic invertebrates, and algae; and the impact of invasive species.

Water Quality - Physical Monitoring

Description:

Physical water quality analyses are carried out year round, bi-weekly at the 21 lake and six river monitoring stations. Using a YSI 6600V2 sonde, depth profiles are constructed for key limnological variables including pH, temperature, dissolved oxygen, chlorophyll *a*, and cyanobacterial pigments. Water clarity is recorded using a Secchi disk, bi-weekly at the lake and river stations, and irregular intervals at all other sample stations. These data enable the tracking of changes in lake health between seasons and from year to year.

Importance of component:

These analyses give a direct, *in situ*, measurement of lake health and are used to immediately assess water quality until more detailed results are obtained by lab chemical analysis.

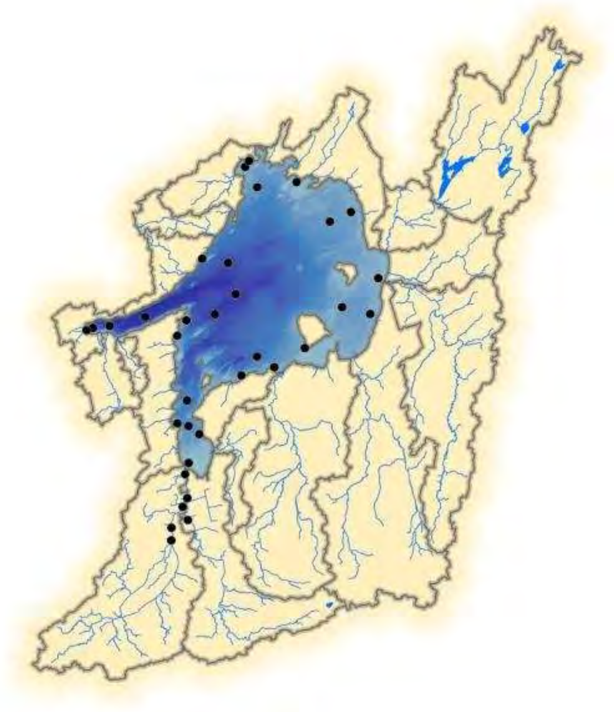


Figure 2-8: Location of physical and chemical monitoring sites for the LSRCA nearshore monitoring program (includes 21 nearshore, eight open-water, and six Holland River sites)

Water Quality - Chemical Monitoring

Description:

Water samples for chemical analyses are collected year round, monthly at ten lake stations, and bi-weekly at the six Holland River stations, using a Van Dorn sampler (Figure 2-8 displays sampling sites). Water chemistry is measured for a number of reasons: to track phosphorus reduction efforts, to detect seasonal changes, and to determine the oxygen availability for aquatic biota. Analyses for over 50 limnological variables are carried out at a contracted laboratory (Inductively-Coupled Plasma Mass Spectrometry (ICP-MS) instrumentation is used to measure many of these). Key limnological variables include phosphorus, nitrogen, dissolved organic carbon, and metals. Concurrent to these water samples, sediments are also sampled at each location using a Petite Ponar Grab to determine the amount of phosphorus available for plant uptake, and to look at the potential changes to nutrient cycling due to the presence of dreissenid mussels. Changes are tracked for eight chemical variables including sediment, nitrogen, and phosphorus.

Importance of component:

Routine monitoring and the direct laboratory analyses of water and sediment samples are the most accurate way to assess water quality. These data are used to track changes in lake environmental conditions, as well as to develop and calibrate biological indicators of limnological change.

Biological Monitoring

Description:

A central activity of the LSRCA nearshore monitoring program has been undertaking the development of biological indicators to infer and track changes in the environmental health of Lake Simcoe. In addition to directly inferring limnological variables (e.g. pH, nutrients, dissolved oxygen, temperature), these studies serve to track changes in biological communities and the presence of invasive species.

Aquatic Plants: A survey of 215 sample sites (Figure 2-9) is carried out every five years (surveyed in 2008 with the next survey in 2013) to monitor for changes in species diversity and community, presence and expansion of invasive species, and changes in aquatic plant habitat such as maximum depth of colonization. On years without a full survey, routine monitoring is carried out three times a year (to record seasonal changes in diversity) at 20 stations in five locations. Samples are collected by Lake Rake® (qualitative analyses) and Petite Ponar Grab (quantitative analyses), identified and enumerated in the laboratory, and biomass (amount of plants per unit area) calculated.

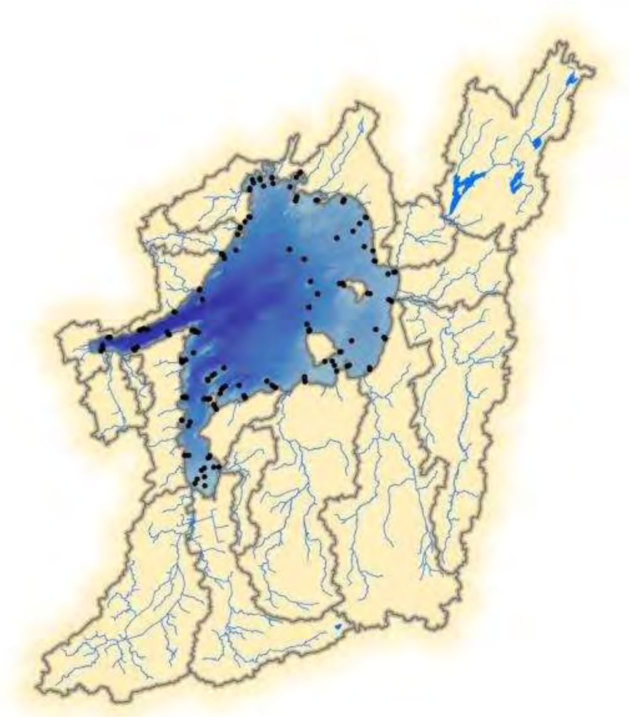


Figure 2-9: Location of survey sites for aquatic plants undertaken through the LSRCA nearshore monitoring program

Benthic Invertebrates: 52 sites are sampled annually in October and are divided by depth to assess the three main lake habitats: 18 shoreline samples (0-1 m depth), 24 littoral samples (~7 m depth), and 10 profundal samples (>20 m depth) (Figure 2-10). At each station, triplicate samples are taken using a Petite Ponar Grab, preserved in 10% buffered formalin, then sorted and identified in the laboratory. These data are used to assess changes in the biodiversity of lake communities (i.e. benthic and fish communities), track presence and impact of invasive species, and infer limnological variables (e.g. annual minimum hypolimnetic dissolved oxygen, water temperature, water turbidity, and presence of organic contaminants). In 2009-10, additional surveys were carried out to assess the impacts of invasive dreissenid (zebra and quagga) mussels in Lake Simcoe. A total of 747 sites were sampled (Figure 2-11) with 43,952 mussels enumerated, shell-length measured, and used to determine species biomass. These data were used to determine distribution of the two species, areas of dense colonization, and population trends.
An investigation currently underway is to replicate sample sites from 1928 to study long-term benthic community changes over an 85-year time period.

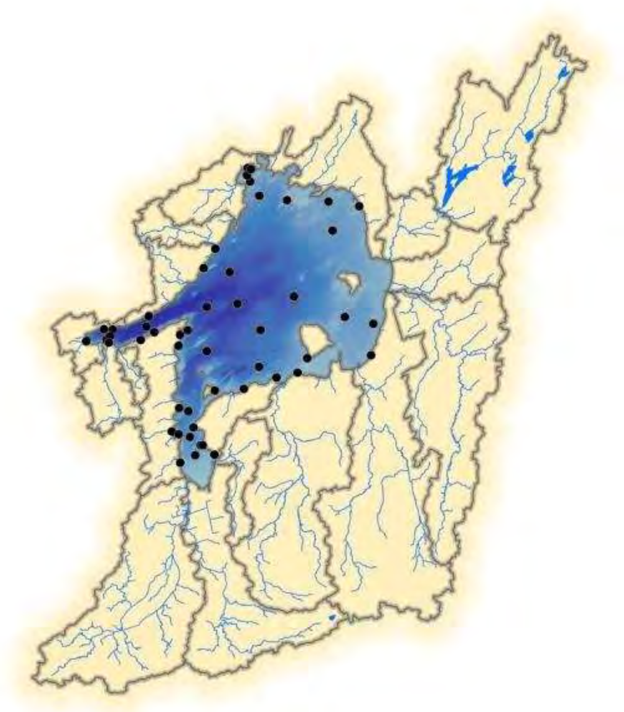


Figure 2-10: Location of benthic invertebrate sampling undertaken through the LSRCA nearshore monitoring program

Importance of component:

These data directly measure the diversity, health, and changes in the biological communities of Lake Simcoe. Using established limnological techniques, the data are directly comparable to other studies and are used to track changes through time. The calibration of species with environmental conditions enables the use of biological community diversity in assessing ecological changes.

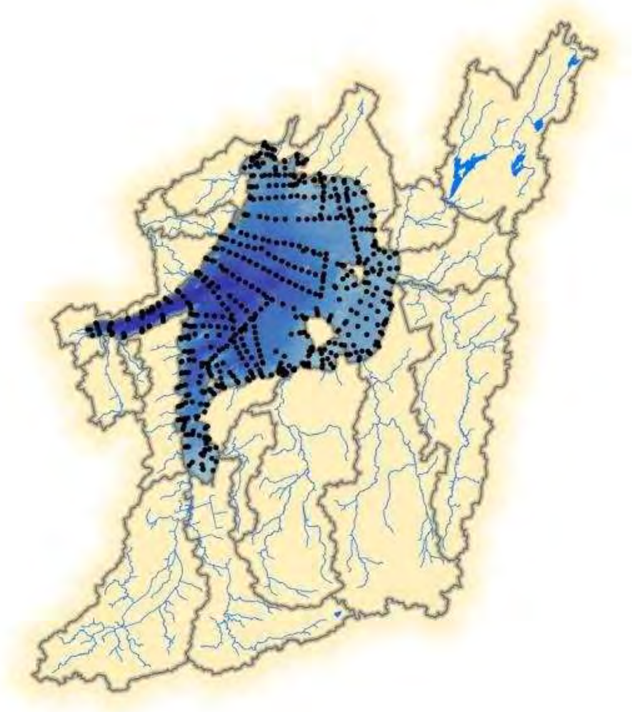


Figure 2-11: Location of dreissenid mussel sampling undertaken through the LSRCA nearshore monitoring program

Many factors affect the conditions in the Lake Simcoe watershed. Some of these, such as spring floods, are natural and annual variations are generally accommodated well by natural systems. Others, such as land use change, the inputs of point source and non-point source contaminants, climate change, and the introduction of invasive species are anthropogenic and often have dramatic results. This section describes these effects as seen in the Lake Simcoe watershed.

CLIMATE

A watershed's climate can have a significant impact on its conditions. The air temperature affects the water temperature in streams and in the lake, thus affecting the aquatic communities living there. It also influences the timing and duration of life cycle events for a number of species living in the watershed. The amount and frequency of precipitation can have a number of effects, depending on where, when, how, and in what form it falls. The influence of climate on natural systems can be exacerbated by land use changes, as natural areas do have some built in capacity to adapt to gradual changes or short term events.

Temperature

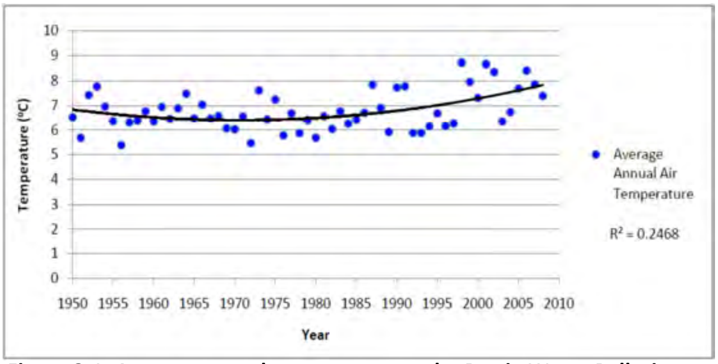


Figure 3-1: Average annual temperature at the Barrie Water Pollution Control Centre meteorological monitoring station

The long term mean annual temperature in the Lake Simcoe watershed, for the years 1971-2000, is 6.7° C. The mean temperatures for the coldest and warmest months, January and July, are -8.1°C and 20.5°C, respectively. The average annual temperature showed a slight decreasing trend from the beginning of the period of record in 1950, until the late 1970s when it began to increase, for an overall increase of 0.67°C over the past 58 years (SGBLS SPC, 2011; Figure 3-1).

Precipitation

The amount of precipitation that a watershed receives can have a significant influence on the conditions in the watershed. Wetter than normal years can lead to impacts on water quality, as more contaminants are washed from ground surfaces into watercourses; and can cause flooding issues. Lower than normal precipitation levels can cause stress to areas such as wetlands and other communities that are dependent on moist soils, and can lead to decreases in levels of both surface and groundwater, which can have impacts on fish and benthic invertebrate communities.

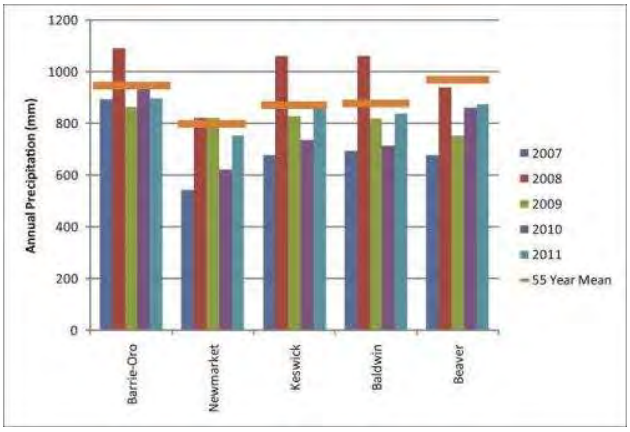


Figure 3-2: Precipitation normals for five Lake Simcoe climate stations

Precipitation amounts vary greatly across the Lake Simcoe watershed, largely due to lake effect snowfall in the north and west section of the watershed. The mean for precipitation across the watershed is 911 mm/year; with the minimum and maximum being 798 mm/yr and 1046 mm/yr, respectively. There have recently been some notable years with respect to precipitation. Dry years were seen in 2007 and 2010, and 2008 was wetter than normal (Figure 3-2). The impact of the changes in precipitation can be seen in the results of our monitoring. For example; the phosphorus loads were significantly higher in 2008, which was the wettest year since 1969 (LSRCA data).

Climate Change

The issue of climate change has been brought to the forefront in the last two decades. For the Oak Ridges Moraine in the south of the watershed, models run to estimate the effects of climate change predict the following conditions by 2100 (in comparison to climate data for the period from 1971 to 2000):

- A 4.4°C increase in maximum temperature in the warmest month
- A 4.3°C increase in maximum temperature in the coldest month
- The growing season will start earlier and end later in the year, with an increase of 36.5 days
- A 9.6 mm increase in annual precipitation, with the summer seeing a 12.7 mm/yr decrease and the winter seeing a 3.8 mm increase (McKenney *et al.*, 2010)

While it is difficult to know the precise impacts at this point, predications include intesnse storms in fall and winter and lower precipitation during summer months; the potential for water shortages during the summer as demand exceeds supply; loss or damage to aquatic and terrestrial habitat; loss or damage to infrastructure; decreasing water quality; decreased opportunities for winter recreational activities; and crop damage, a modified gorwing season, and decrased effectiveness of herbicides and pesticides (. Changes in the way precipitation falls, both timing and intensity, are anticipated to impact the movement of pollutants through the watershed, particularly the amount of phosphorus that reaches Lake Simcoe.

Increasing annual temperatures have been observed in the watershed(Figure 3-2), but seasonal changes are not yet evident. The amount of winter precipitation falling as snow has decreased, a trend that will likely continue with rising temperatures (SGBLS SPC, 2011). This will likely have an impact on surface flow and groundwater recharge characteristics in the watershed. Long term analysis will be required to monitor changes in climate in this area.

LAND USE AND POPULATION

Much of the land within the Lake Simcoe watershed has changed dramatically, particularly since the arrival of European settlers in the early 1800s. The initial changes were mainly for agricultural uses, but the amount of urban land use has increased significantly over the past few decades. As can be seen in the image at right, of the land that has been altered in the watershed (Figure 3-4), the majority has been converted to rural/agriculture and urban land uses. The issues associated with these land uses, as well as their impacts on the watershed's natural systems, are discussed later in this chapter.

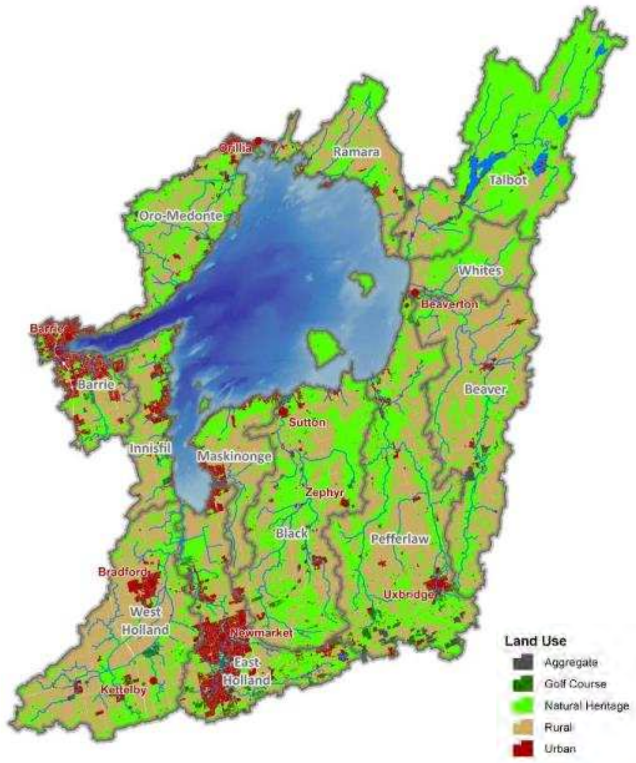


Figure 3-4: Land use in the Lake Simcoe watershed

Over 400,000 people currently reside in the Lake Simcoe watershed. With the growth projected for the watershed's municipalities in the Province of Ontario's *Growth Plan for the Greater Horseshoe, 2006*, however, this population is anticipated to rise to over 600,000 people by 2031. While this plan strives to minimize the impact of population growth through such activities as intensification in existing urban areas, this population increase is bound to have impacts on the watershed's natural areas and resources. It will be important to implement best management practices in existing areas and ensure that new developments utilize Low Impact Development practices to mitigate these impacts to the extent possible.

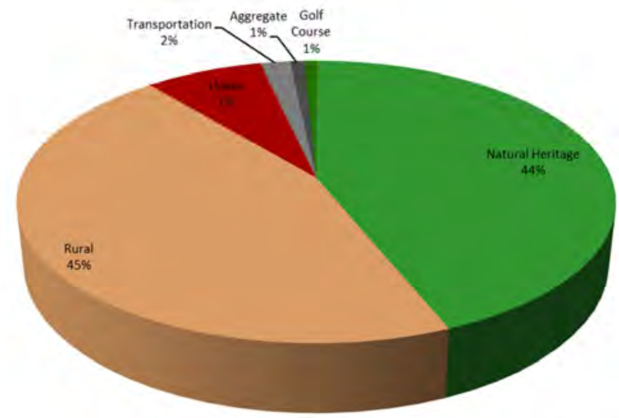


Figure 3-5: A breakdown of land uses in the Lake Simcoe watershed

As can be seen in Figure 3-5, there is a fairly high level of natural cover still remaining in the Lake Simcoe watershed (44% of the land use). This is a higher level than has previously been reported (38%), as the watershed boundary was expanded to include the lands within the Upper Talbot River subwatershed under the Lake Simcoe Protection Plan (LSPP). The Upper Talbot has a high level of natural heritage cover (over 80%), and its inclusion in the watershed boundary demonstrates how large concentrations of natural features in certain areas of the watershed can affect the watershed-wide percentage.

The LSPP sets a goal of 40% *high quality* natural heritage coverage. *High quality* has currently been defined in the LSPP as natural areas greater than 25 ha in size. These areas have been mapped by the Ministry of Natural Resources, and while 44% is a relatively healthy level of natural cover, many of these areas are in patches smaller than 25 ha, and would thus not be considered high quality. This highlights the importance of preserving existing natural features, and undertaking restoration efforts where possible in order to maintain watershed health.

URBAN LAND USE

The development of land for urban, industrial, and institutional uses is among the most drastic changes to a natural system. Levels of impervious cover increase as natural surfaces are covered in impervious concrete, asphalt, and roof tops. Watercourses are often altered to accommodate development and the majority of the vegetation in the riparian area is often removed, leaving narrow corridors. Forests, wetlands, and grasslands are often removed, filled in, or significantly reduced in size. These changes can have dramatic impacts on virtually all aspects of watershed health, and can be observed in the results of the monitoring work that is undertaken in the watershed. The evidence seen throughout the watershed includes:

- changes to the flows in urban watercourses, including shorter time to peak flows, higher peak flows and increased flow velocities, and decreased baseflow as little of the precipitation that falls percolates into the ground, but is instead forced to flow overland to storm drains and watercourses;
- degraded water quality due to contaminants being transported via overland flow including sediment, nutrients, metals, and chloride from winter salt; as well as decreased dissolved oxygen concentrations;
- changes to sediment transport, including bank erosion due to high flows, and sediment deposition as the velocity of the water slows and sediment drops out of suspension;
- changing temperature regimes, as water temperature tends to increase as it flows over impervious surfaces, particularly in the summer months; and
- changes to aquatic communities due to all of the above impacts.

Many of these impacts are demonstrated in the diagram below:

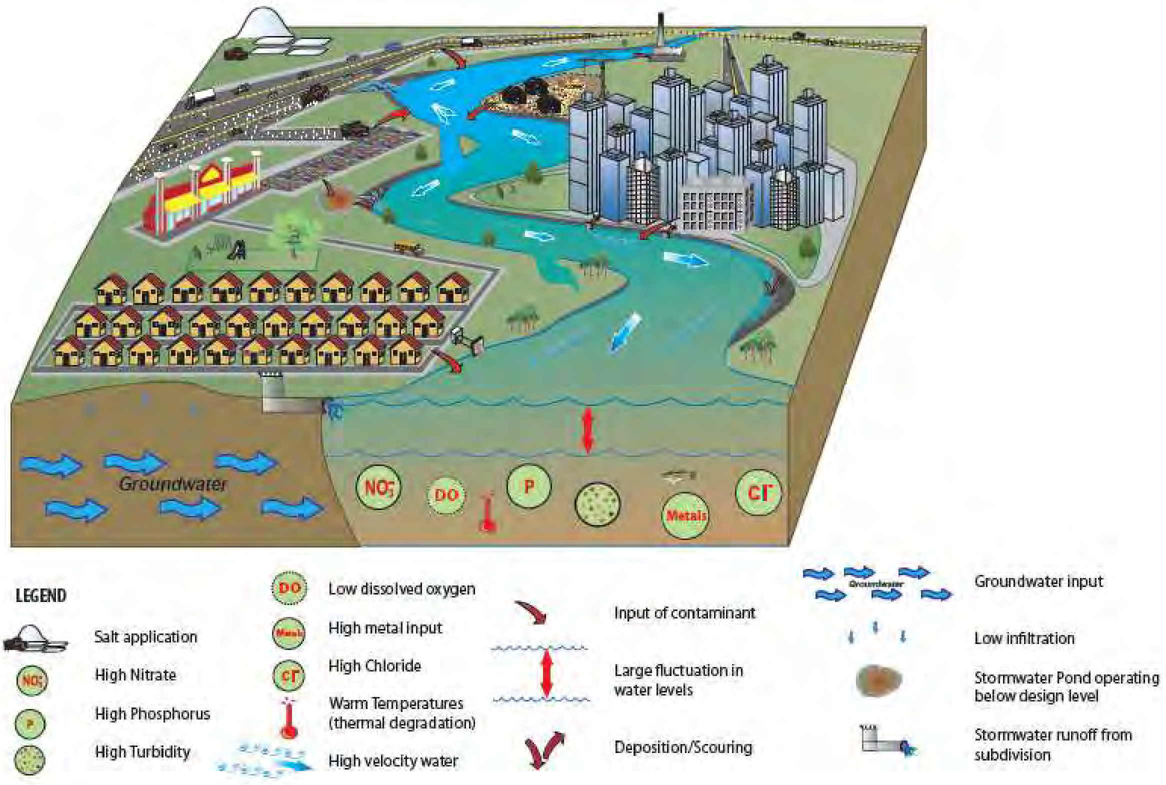


Figure 3-6: Potential impacts of urban land uses in a subwatershed

A number of activities have been and are currently being undertaken to help mitigate some of the issues discussed above. The Lake Simcoe Protection Plan contains several policies to address some of these concerns, including a number around treating stormwater, some around limiting the impacts of construction activities in new developments, requirements for monitoring of water quality in the watershed, and the completion of a Phosphorus Reduction Strategy, which was undertaken in 2009. In addition, the Lake Simcoe Conservation Authority continues to undertake works, both through its stewardship and science and research programs, including projects to mitigate bank erosion, working with municipalities to complete stormwater retrofits, assessing the effectiveness of existing and new technologies, and undertaking water quality monitoring to detect where water quality issues are occurring and see whether actions being undertaken to deal with these issues are successful. Subwatershed plans developed by the LSRCA and its partners also contain recommendations aimed at reducing the impacts of urban areas and making sure that new urban areas are built in a more environmentally sustainable manner; including the use of Low Impact Development practices, protecting and restoring sensitive habitats, minimizing impervious surfaces, the use of effective erosion and sediment controls during construction, and controlling the use of winter salt. The photos below (Figure 3-7) depict a project undertaken through the LSRCA's stewardship program to mitigate significant bank erosion and channel braiding and create a naturalized stream channel and fish habitat in an urban area.

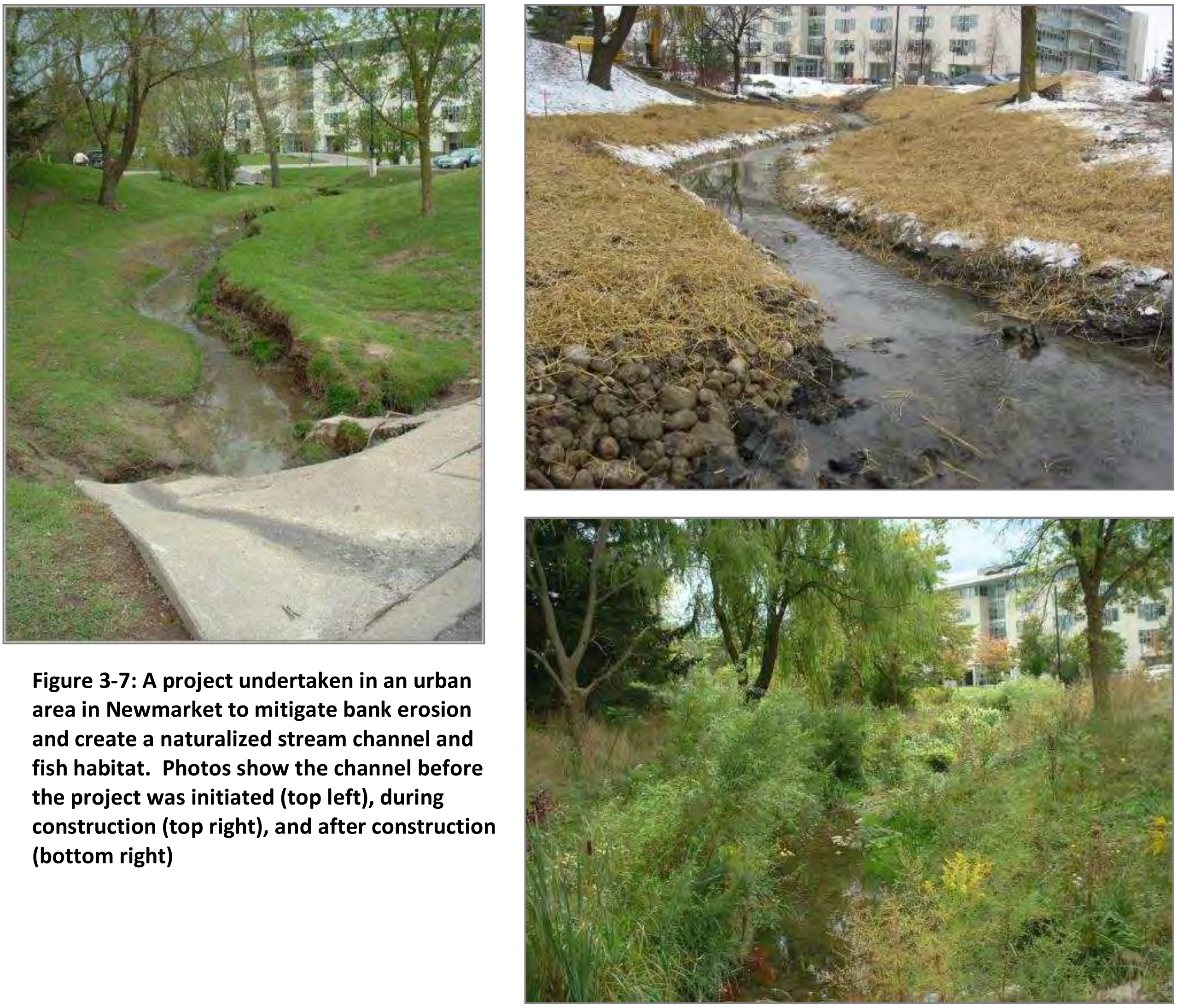


Figure 3-7: A project undertaken in an urban area in Newmarket to mitigate bank erosion and create a naturalized stream channel and fish habitat. Photos show the channel before the project was initiated (top left), during construction (top right), and after construction (bottom right)

SEWAGE TREATMENT PLANTS

Within the Lake Simcoe watershed there are 15 sewage treatment plants. All but one of these are municipal sewage treatment plants (STPs), the other is an industrial sewage treatment plant. The main contaminant of concern from these sources is phosphorus. Seven of these facilities discharge directly to the lake, the rest to its tributaries. These point sources contribute to the phosphorus load in the Lake Simcoe watershed, accounting for an average of 6% of the load to the lake in the 2004-2009 reporting period. The locations of these point sources are shown in the Figure 3-8.

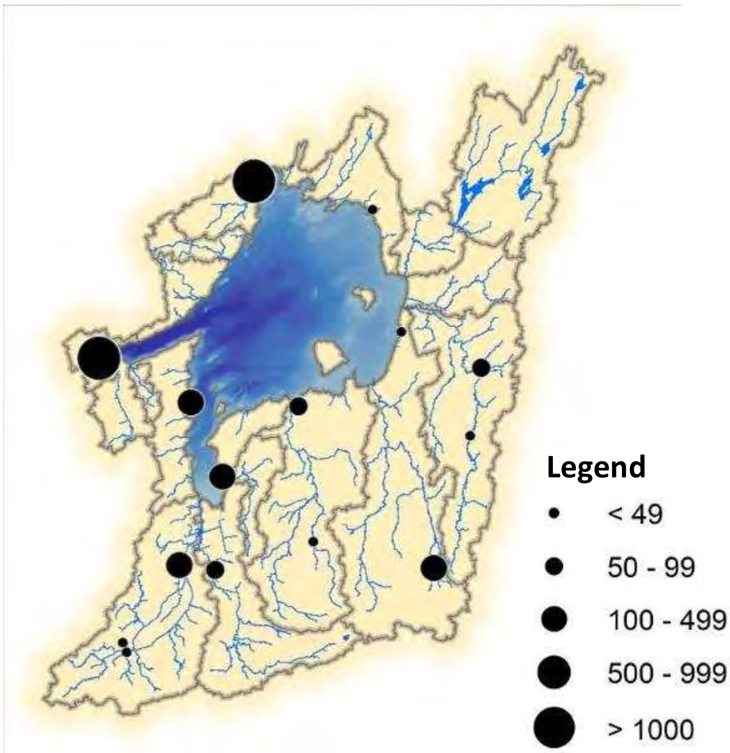


Figure 3-8: Phosphorus inputs from water pollution control plants in the Lake Simcoe watershed

With the growing population in the watershed, it will be necessary to utilize the most up-to-date technologies for removing phosphorus and other contaminants from wastewater in order to maintain and/or improve the water quality in the watershed.

In order to reduce the contribution to the phosphorus load from STPs an interim regulation, Ontario Regulation 60/08, was introduced under the Ontario Water Resources Act, to limit phosphorus loads from STPs to 7.3 tonnes/year, with a limit being set for each facility. The limits set in this regulation expired in 2010, and new phosphorus effluent limits and loading caps were introduced in the Province's Phosphorus Reduction Strategy, which was released in June of 2010. The Phosphorus Reduction Strategy established a baseline load for all STPs in the watershed of 7.2 tonnes/year (consistent with 7% of the annual phosphorus load, which was the estimated contribution from this source at the time the Strategy was published), which would be applied to each STP at its next expansion or by 2015, whichever occurs first. This is to give STP owners a reasonable timeframe to plan required upgrades or expansions. The Phosphorus Reduction Strategy states that 'to ensure that the STP contribution of phosphorus meets the whole-lake phosphorus-laoding goal for Lake Simcoe of 44 T/yr, their total load must be reduced to 7% of 44 T/yr, which works out to 3.2 T/yr.' Details around these further reductions will be determined after 2015.

AGRICULTURAL LAND USE

Close to half of the land within the Lake Simcoe watershed is used for agricultural purposes (Figure 3-9), including hay and pasture, cropland, and turf and sod operations. The removal of natural features to accommodate these uses, as well as the associated activities, causes a number of changes in a natural system. The impacts observed in the Lake Simcoe watershed include:

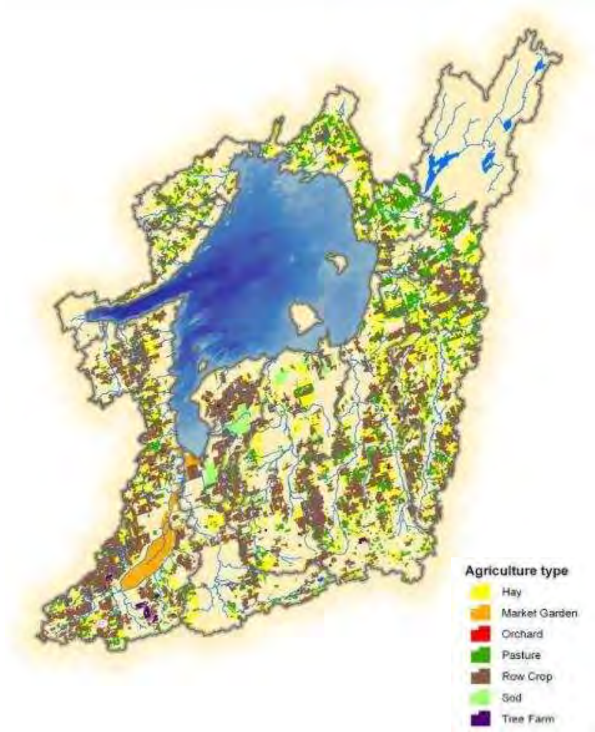


Figure 3-9: Distribution of agricultural land uses in the Lake Simcoe watershed

- Degraded water quality, due to the contribution of contaminants such as nutrients, sediment, pesticides, and, potentially, bacteria to watercourses. The sources of these contaminants include the erosion of exposed soils, particularly shortly after a fertilizer application; grazing of cattle; and bank erosion. This can lead to eutrophication of the waterbody and the deterioration of aquatic habitat;
- Channelized watercourses and the removal of their riparian vegetation to provide additional space for planting. This leaves little habitat value for aquatic communities, and removes the opportunity for the filtering of contaminants as runoff passes through the riparian area. In addition, watercourses are dammed in many areas to create water retention ponds, causing extensive changes to aquatic habitat;
- The presence of tile drains, which can impact the local hydrology – while they drain excess water from fields, they can also lower the water table, making less water available for wetlands. The size of ephemeral ponds, and the amount of time that they contain water can be significantly affected; these pond are critical for the survival of certain species of frogs, salamanders, and waterfowl.

A number of these impacts are demonstrated in the diagram below:

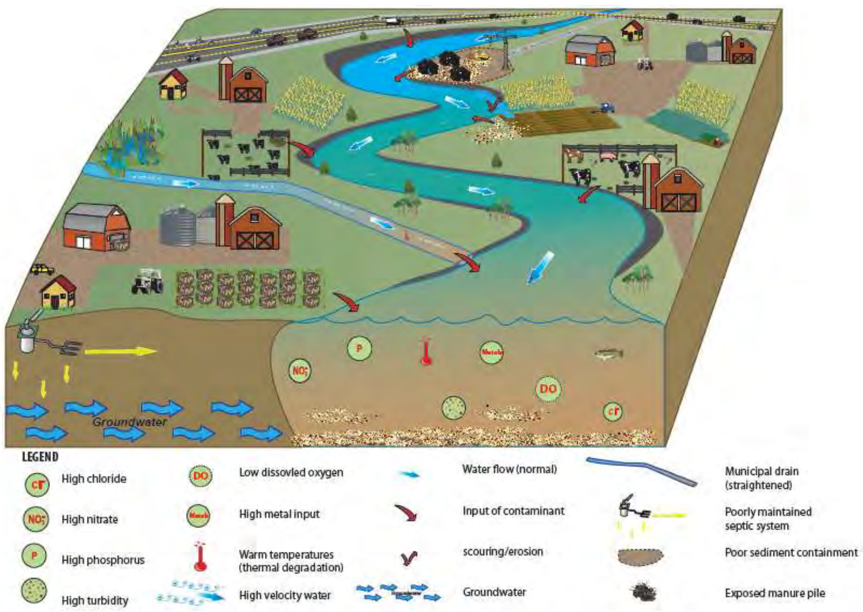


Figure 3-10: Potential impacts of agricultural practices on a watershed

Many activities have been undertaken around the watershed to reduce the impacts of agricultural activities; however, much remains to be done. The Lake Simcoe Protection Plan includes policies around agricultural impacts, such as that requiring the development of the Phosphorus Reduction Strategy, which deals in part with phosphorus inputs from agricultural sources; those around water conservation and efficiency; the development of a stewardship network; and the promotion of best management practices and pilot projects to promote new and innovative practices. A good deal of the work that has been undertaken by the LSRCA through the Landowner Environmental Assistance Program (LEAP) has been to undertake agricultural best management practices; these types of projects continue to be a prominent part of the LEAP. There are a number of other programs operating throughout the watershed that undertake similar works as well. The subwatershed plans that have been developed so far also contain a number of recommendations around agricultural practices; including those around prioritizing and implementing best management practices, leaving vegetated stream buffers intact and planting buffers where they have been removed, and naturalizing agricultural drains. Examples of stream buffer restoration in agricultural areas are shown in the Figure 3-11 below:

Figure 3-11: Riparian plantings undertaken in agricultural areas to mitigate bank erosion and prevent nutrients and sediment from reaching the watercourse

RECREATION

The Lake Simcoe watershed is home to a number of recreational activities, including boating, angling, swimming, hiking, cycling, golfing, birdwatching and snowmobiling (examples are shown in Figure 3-12). Many of these activities, if not managed correctly and undertaken in a responsible manner, can have negative effects on the natural system. These effects include the build-up of garbage and debris; impacts on water quality from the dumping of black or grey water and chemicals from boats; soil erosion, from boat wakes as well as from the improper construction and/or use of trails; loss of habitat; introduction and spread of invasive species; and inputs of nutrients and pesticides into watercourses. As natural areas diminish further and the population of the watershed grows, there will be ever more stress on the remaining natural areas as watershed residents seek recreational opportunities.

In contrast, the issues being seen in the watershed can also have an effect on the quality of recreation activities. Excessive growth of plants and algae, as well as zebra mussels, in the lake affects swimming and boating activities; invasive species can affect hiking trails and fishing experiences; water quality and quantity issues have an impact on fish communities; and so on.

Figure 3-12: Common recreational activities in the Lake Simcoe watershed

INVASIVE SPECIES

Native systems have a natural balance of trophic levels and many species interacting, each fulfilling a specific role within the system. The introduction of non-native species disrupts this natural balance, often with profound impacts. This is due in part to the physiological characteristics of many non-native species that become invasive, as well as the inability of the natural system to cope with the changes. The characteristics that make these species invasive include: prolific, often frequent reproduction; fast growth; the ability to disperse easily; and a tendency to be habitat generalists, easily able to adapt and thrive in a wide variety of environmental conditions. They take advantage of stresses in the native ecosystem, including disturbances such as urbanization, agriculture, contaminant inputs, recreational trails, and roads. As they are less robust, these native systems and the species that live within them are not as able to sustain themselves in the face of increased competition for resources by the invading species, and are eventually replaced by the invading species. Where they successfully colonize, invasive species tend to decrease biodiversity, and can impact the entire system, as they generally have few if any predators; and the species that depend on the native species that is replaced will also suffer. This pattern can reverberate throughout the system, causing major shifts in community composition, and can be exacerbated with the introduction of multiple invasive species in a short period.

The extent of terrestrial invasive species in the Lake Simcoe watershed is not well known; however, aquatic invasive species are quite well tracked through the aquatic monitoring program. Species commonly found are shown in Figure 3-13.

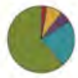
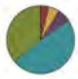
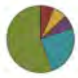
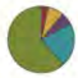
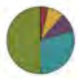
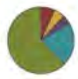
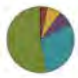
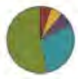
Figure 3-13: Invasive species found in the Lake Simcoe watershed. Top left: round goby (photo credit: Matt Vardy); middle-right: zebra mussels (photo credit: LSRCA); bottom left: rusty crayfish (photo credit: Doug Watkinson, DFO, Winnipeg)

Information presented in this chapter is based on the report *'Annual Water Balances and Total Phosphorus Loads to Lake Simcoe (2007-2009)'* released by LSRCA and the Ministry of theEnvironment in 2013.

What is phosphorus loading?

The total amount of phosphorus that gets carried into Lake Simcoe is called the phosphorus load. This is expressed in metric tonnes or in kilograms (1 tonne = 1,000 kg), and is measured over a hydrological year. A hydrological year goes from June 1st to May 31st, for example, the 2009 hydrological year is from June 1, 2009 to May 31, 2010. It is important to measure how much phosphorus is going into the lake in order to understand and address the problems associated with it. Phosphorus is measured from five main sources in order to calculate the annual load, these include tributaries, polders, sewage treatment plants (STPs), septic systems and atmospheric deposition (Figure 4-1, Table 4-1).

Table 4-1: Total phosphorus loads for the years 1998-2009, and the relative contribution from the measured sources

Year	Load by source	Total TP load (tonnes)	Year	Load by source	Total TP load (tonnes)
1998		66	2004		77
1999		77	2005		74
2000		72	2006		71
2001		54	2007		97
2002		68	2008		116
2003		73	2009		72

Phosphorus source

- Polders
- STPs
- Septics
- Atmospheric
- Tributaries

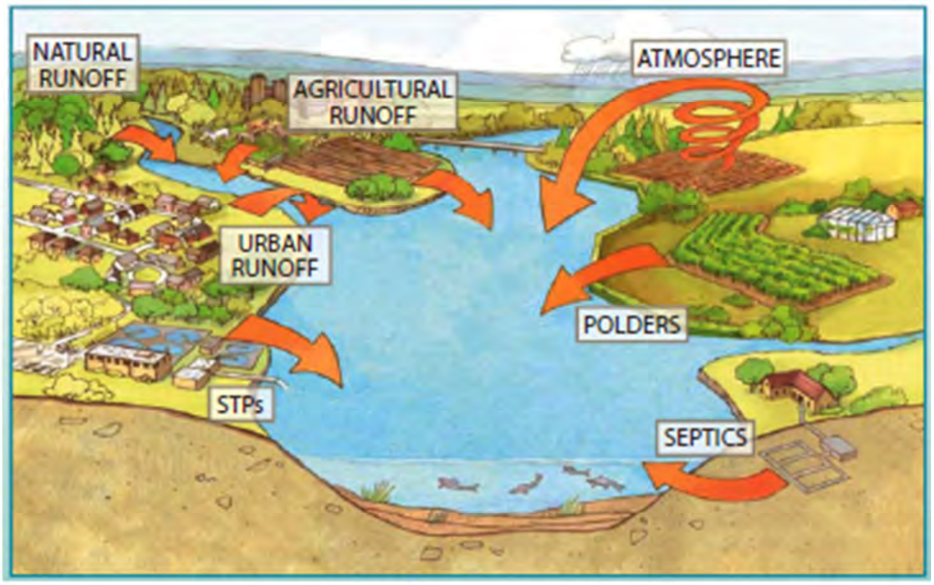


Figure 4-1: Sources of phosphorus loading in the Lake Simcoe watershed

Phosphorus loading to Lake Simcoe

The estimated annual total phosphorus loads to Lake Simcoe for the most recent reporting period (2007 to 2009) range from 71.9 to 115.5 tonnes per year. The largest source was from tributaries, ranging from 47.4 to 80.6 tonnes per year.

The amount of phosphorus loading to the lake changes from year to year (Figure 4-2). Changes in land use and the climate, for example, will influence the amount of phosphorus loading.

Loads from tributaries are most affected by yearly fluctuations in climate. This was very apparent in the 2007 and 2008 hydrological years, when water flows were greater than normal (Figure 4-2). In 2007, the winter and spring flows in particular were very high, and 2008 was almost twice as wet compared to the 1990-2006 average annual tributary flow. Based on records going all the way back to 1969, the 2008 hydrologic year was the wettest year by far (see Water Quantity section for more detail).

These very high flows in 2007 and 2008 were the main reason that loads were higher in these years. In 2009, when loads returned to similar levels seen in 2006 and earlier, tributary flow was also more typical.

Total phosphorus loading

Hydrological Year	Tonnes/Year
2007	97.4
2008	115.5
2009	71.9

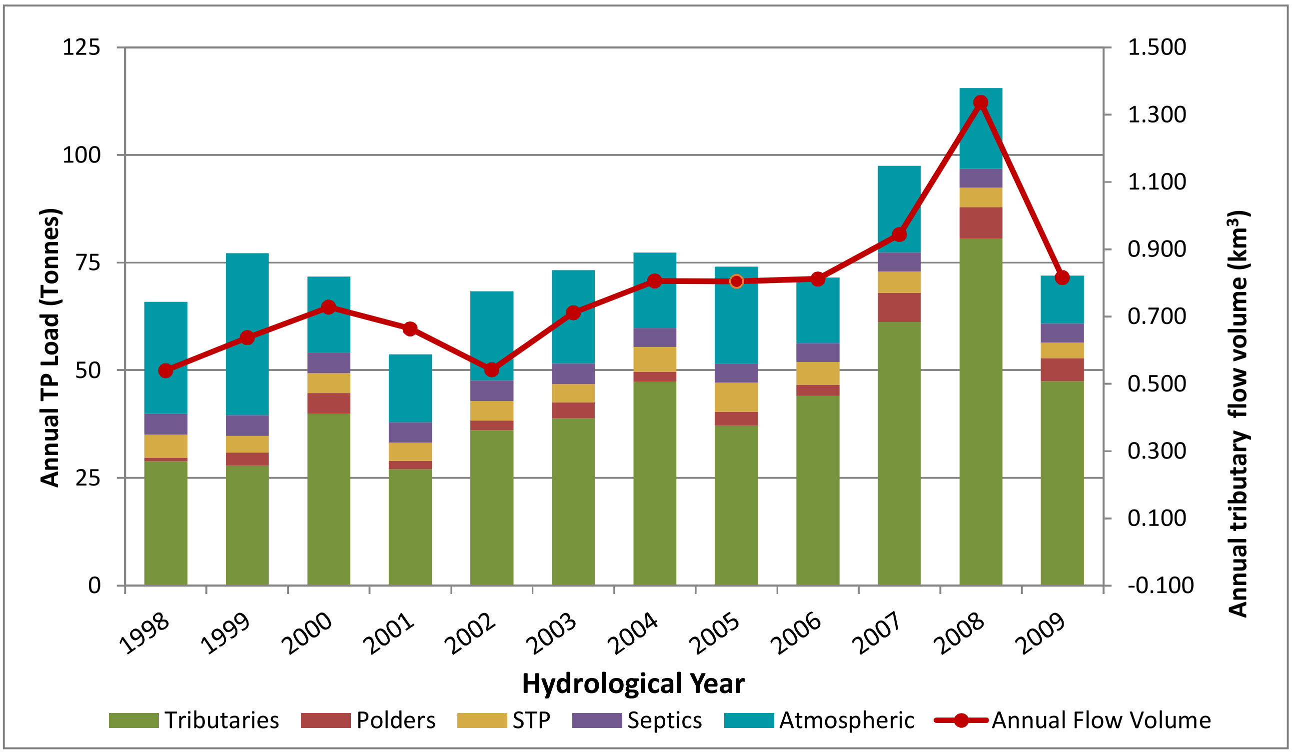


Figure 4-2: Annual phosphorus loads and annual flow volume, 1998-2009, highlighting the most recent period of record (2007-2009)

The phosphorus loads are presented in Figure 4-3 below in two ways: average annual total load by subwatershed and average annual phosphorus export rate by subwatershed for the 2007 to 2009 hydrologic years. The phosphorus export rate is calculated as the phosphorus load divided by the land area. These two ways of representing the data help us to understand how land use and subwatershed size affect phosphorus loading.

The highest phosphorus loads occur in the West and East Holland River subwatersheds; on average the loadings are 14.5 and 12.9 tonnes per year, respectively. The reason these have the highest loads are that they are large subwatersheds that are heavily urbanized or highly agricultural and also have high flow volumes. Barrie Creeks had the highest export rate at 109 kilograms per square kilometres per year. It is also a heavily urbanized subwatershed.

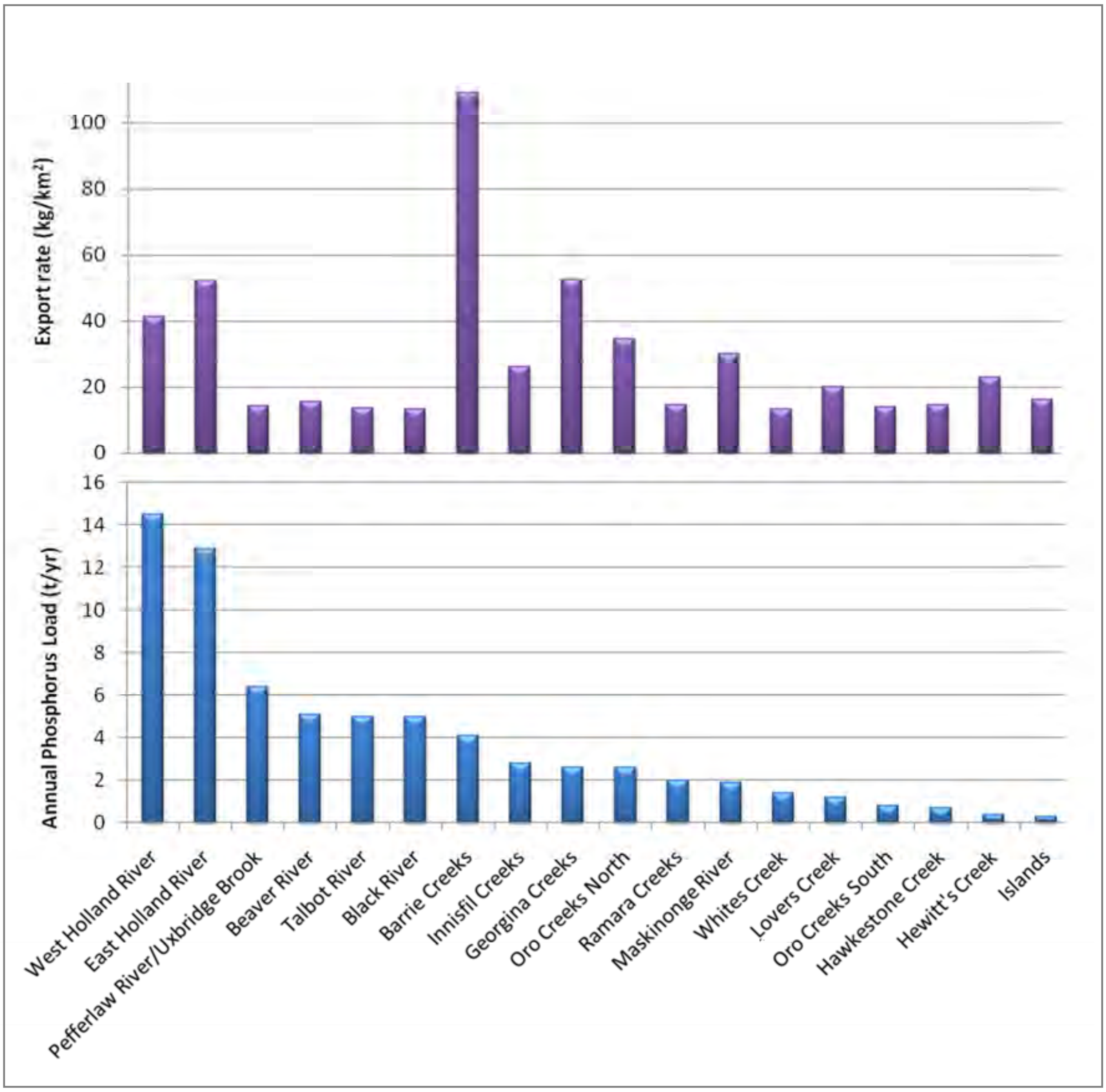


Figure 4-3: Phosphorus loads and export rates for each subwatershed

Sources of Phosphorus

Tributary load

When water from rain or melted snow flows over land, it can pick up dirt, dust, oil, salt, fertilizers, manure, animal waste, and detergents. These particles, which can contain phosphorus, are washed into creeks and rivers, and eventually into the lake. Creeks and rivers — referred to as tributaries — collect phosphorus from urban, agricultural and natural areas. Phosphorus can also be deposited directly on tributaries from the atmosphere.

For the purposes of understanding phosphorus loads, each tributary subwatershed is divided into urban and non-urban areas. In urban areas, the main source of phosphorus is stormwater runoff. Sewage treatment plants, which are located in urban areas, are accounted for separately. In non-urban areas, phosphorus comes from agricultural and natural/other areas.

Total tributary loading

Hydrological Year	Tonnes/Year
2007	61.2
2008	80.6
2009	47.4

A. What is measured?

In order to estimate how much phosphorus is entering Lake Simcoe through the tributaries, flow and phosphorus concentration are monitored. Phosphorus is measured in many of the tributaries throughout the watershed (referred to as monitored subwatersheds). Tributaries where phosphorus is not monitored are referred to as unmonitored subwatersheds and islands (Figure 4-4).

Monitored subwatersheds

In monitored subwatersheds, phosphorus samples are collected year round; winter months are sampled less frequently, and extra sampling is carried out during periods of heavy rain and in the spring when the snow melts (see Tributary Water Quality in the Methods section for more details). These data are used to determine loadings for all areas upstream of the monitoring stations, including urban and non-urban areas.

For areas downstream from the monitoring stations, since no further samples are taken, phosphorus must be estimated based on other sources of information. For urban areas, stormwater loading rates are estimated based on the Ministry of the Environment Storm Water Analysis and Monitoring Program. For non-urban areas, estimates are based on upstream measurements.

<u>Unmonitored subwatersheds and islands</u>

Loads from unmonitored subwatersheds and islands need to be included in the total load to the lake. Phosphorus loads for unmonitored areas are therefore estimated based on loads in monitored areas most similar in land use.

Please refer to Figure 4-4 below to view the monitored and unmonitored subwatersheds for the 2007–2009 reporting period.

B. Why is tributary load an important factor?

Urban areas

The lake, which for some time has been showing signs of damage from human activities, is under increasing stress due to urban growth. Currently, seven percent of the watershed is urban. Urban development changes the land from natural, porous surfaces like soil and grasses to hard surfaces like pavement and asphalt. Rainwater and snow melt cannot seep into the ground naturally, so the stormwater runs over the hard surfaces and washes into creeks, rivers, and eventually the lake. Stormwater runoff can also increase erosion in streams causing dirt and debris to be carried downstream.

Agricultural areas

Currently, 45 per cent of the Lake Simcoe watershed is made up of agricultural areas, including a variety of crops, livestock, and vegetable farming. Rainfall and melting snow cause water to run over the ground in agricultural areas, picking up fertilizers and contaminants from feedlots, manure storage, and bare fields. Factors that can increase the phosphorus loads from agricultural sources include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive, or poorly timed application of irrigation water and fertilizers.

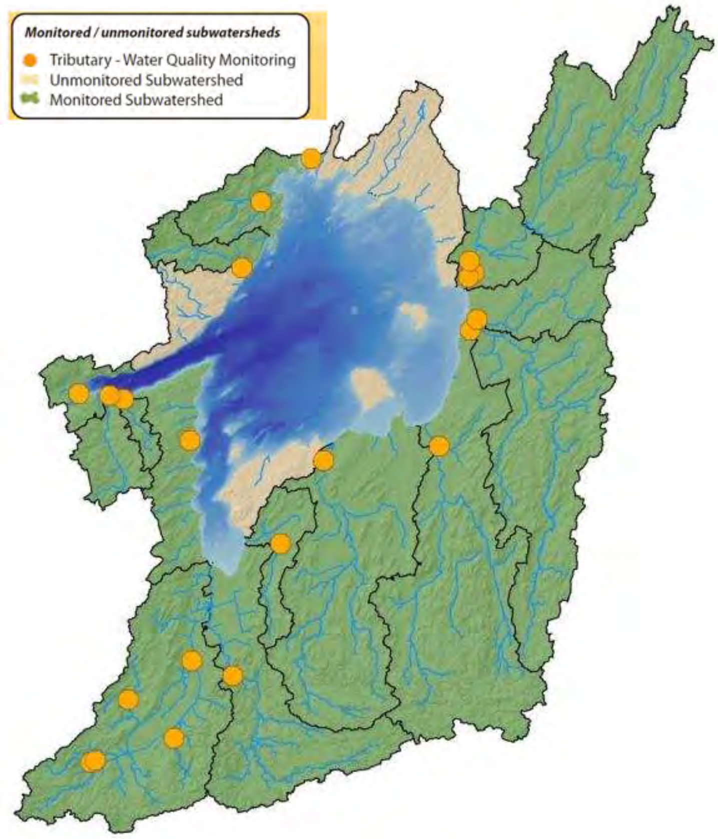


Figure 4-4: Monitored and unmonitored subwatersheds (coloured green and beige, respectively) and water quality monitoring stations

C. What is being done?

In the past, it was common practice to channel stormwater directly into streams, rivers, or the lake without treating it. Recent efforts have been made to intercept and treat stormwater, although in some older urban areas stormwater still reaches waterways untreated. The LSRCA and MOE, in partnership with municipalities and the development community, have identified opportunities where municipal stormwater facilities could be introduced or upgraded to improve overall treatment and phosphorus removal. As well, we are promoting the use of Low Impact Development (LID). LID is a term used to describe stormwater management techniques that mimic the natural flow of water as it infiltrates into the soil. This minimizes the impact of urban development by reducing the volume of stormwater runoff as well as potential pollutants the runoff may carry.

Farmers and other land owners have been working with the LSRCA and the provincial government to reduce phosphorus loading to Lake Simcoe by implementing agricultural best management practices. Examples of this are appropriate manure and fertilizer storage and application, and planting of cover crops and windbreaks. Information about current programs to help offset the costs of implementing measures to further reduce phosphorus inputs to the lake is available online at www.lsrca.on.ca and www.ontario.ca\lakesimcoe.

Polders

Polders are drained wetlands used for agriculture. Pump-off water from polders is also a source of phosphorus to rivers downstream. The watershed's five polders (the Keswick, Colbar, Bradford, Deerhurst, and Holland marshes) are former wetlands that were drained so that the rich soils could be used for agriculture.

Total polder loading	
Hydrological Year	Tonnes/Year
2007	6.8
2008	7.2
2009	5.3

A. What is measured?

Samples are collected at the outlet of the Holland Marsh as part of our regular sampling routine. These data are used to estimate loadings from the Holland Marsh, which are then used in calculations to estimate phosphorus loadings from the other polders. The estimated loads from the polders are shown in the table at the right.

B. Why are polders an important factor?

Water levels in the polders are controlled by a series of pumps and canals. Because polders are low-lying, excess water accumulates and must be pumped off. Pump-off water is generally very high in phosphorus from fertilizers, and the load from this source is greater in years with high rain and snowfall because more water has to be pumped off the fields.

C. What is being done?

Options are currently being investigated to find cost-effective ways to promote and implement agricultural best management practices. These include reducing the application of fertilizer and investigating the feasibility of treating pump-off water from the Holland Marsh.

Sewage treatment plants (STPs)

Municipalities operate sewage treatment plants (STPs) that process our sewage before disposing of it into the lake or to rivers flowing into the lake. Although the sewage is treated to a high standard, it still contains phosphorus.

Total STP loading	
Hydrological Year	Tonnes/Year
2007	5.0
2008	4.6
2009	3.7

A. What is measured?

There are 14 municipal and one industrial sewage treatment plants (STPs) in the Lake Simcoe watershed, all of which are operating at a level that meets or is better than regulatory standards. Seven of the plants discharge directly into Lake Simcoe while the other eight discharge into watercourses that eventually drain into the lake. Sewage effluent is monitored from these facilities to ensure it meets criteria defined by the province. The estimated loads from the STPs are shown in the table at the right.

B. Why are STPs an important factor?

One consequence of a growing population is the need to provide sanitary services and potable water to the people living within the community. When water from toilets, sinks, washing machines, etc. runs down the drain, it goes to an STP where it is treated and then discharged into the lake or a river. With a watershed population in excess of 400,000, municipal STPs are handling a very large amount of water. Although the discharge is treated to a high standard, it still contains phosphorus.

C. What is being done?

The STPs in the Lake Simcoe watershed are among the most effective in Ontario at removing phosphorus. In March 2008, interim limits were placed on STPs around Lake Simcoe to help protect water quality. In 2010, under the Phosphorus Reduction Strategy, baseline phosphorus effluent concentrations (limits) and loading caps were established for each STP. In June 2012, the Environmental Compliance Approvals for all of the STPs were amended to include the new phosphorus limits and loads. These replaced the historical phosphorus caps and the limits from the interim regulation. The new requirements are to be met by 2015 or by the next expansion, whichever comes first.

Lake Simcoe Region conservation authority

Septic Systems

Septic systems, in particular those that are located in close proximity to the lake and watercourses and are faulty, improperly sized, or poorly maintained, are a potential source of phosphorus to rivers and lakes downstream.

Total septics loading	
Hydrological Year	Tonnes/Year
2007	4.4
2008	4.4
2009	4.4

A. What is measured?

A significant amount of phosphorus from toilets, sinks and washing machines flows through private septic systems. This section includes those adjacent to the lake. Others are captured in the tributary loads, described above. The estimated loads from septic systems adjacent to the lake are shown in the table at right.

B. Why are septic systems an important factor?

Discharge from a residential septic tank is rich in phosphorus. It is normally dispersed by the drainage tiles and absorbed into the ground where contaminants decompose. However, if soil conditions are poor, phosphorus can be picked up by surface water and carried into the lake. Also, many cottages are now being used year-round and the original septic systems in place may not be designed to properly handle this greater use.

C. What is being done?

Effective January 2, 2011, the Ontario Building Code Act was amended to require a mandatory maintenance inspection, within five years, for all sewage systems within 100 metres of the Lake Simcoe shoreline. On January 1, 2016, this mandatory inspection will also apply to sewage systems within 100 metres of any river or stream in the Lake Simcoe watershed. This phased approach targets priority areas within the watershed.

The LSRCA provides financial assistance through its Landowner Environmental Assistance Program (LEAP) to help property owners upgrade their septic systems.

Atmosphere

Phosphorus is carried in the atmosphere and is deposited directly onto the lake in rain, snow, or dust. The phosphorus comes from sources many miles away and from closer to the lake. Sources include dust from land disturbed by agriculture, unpaved roads, and aggregate operations, as well as soil that has been left bare by construction.

Total atmosphere loading	
Hydrological Year	Tonnes/Year
2007	20.1
2008	18.7
2009	11.1

A. What is measured?

In order to measure how much phosphorus is entering Lake Simcoe from the atmosphere, samples are collected at precipitation collectors throughout the watershed. The collectors capture "wet and dry" deposition, including phosphorus in the rain and snow (wet) and the phosphorus attached to soil and dust particles deposited on the collectors (dry). Samples are analyzed for phosphorus and then loads are calculated by multiplying the phosphorus concentration in the sample by the amount of precipitation. The estimated loads from the atmosphere are shown in the table at right.

B. Why are atmospheric sources an important factor?

Atmospheric phosphorus comes from natural sources like pollen, human sources like the burning of fossil fuels, and through wind transport of disturbed soils. When land is stripped of vegetative cover for uses such as construction, aggregate operations, unpaved roads, or bare fields between crops, wind blows the soil away. Pollutants (including phosphorus in various forms) become airborne and eventually fall to the surface.

C. What is being done?

Windborne dust is an important source of the phosphorus load from the atmosphere. Because these particles are carried in the air, they can come from many kilometres outside the Lake Simcoe watershed. Studies on windborne sources of phosphorus are underway. Preliminary results indicate that the primary source of dust is soil erosion as a result of agricultural practices. Dust also comes from unpaved roads, aggregate operations and construction sites. Best practices to control soil erosion and excess dust include adopting and enforcing soil conservation by-laws, preserving existing vegetation, and controlling the speed of traffic over unpaved roads. In the agricultural sector, best practices include leaving soil intact instead of turning it over (no-till techniques), planting windbreaks, leaving un-harvested plant material on the field, and using cover crops to hold the soil in place.

PROGRAM OVERVIEW

As was described in Chapter 2, the LSRCA has been monitoring the nearshore areas of Lake Simcoe since 2008. The nearshore zone is the area between zero and 20 metres in depth, and encompasses 67% of the lake area. This work has included monitoring of the physical characteristics, such as clarity, temperature, and the dissolved oxygen content of the water; the chemical characteristics of the water and sediment; and the biological community, including the composition and distribution of aquatic plants and benthic invertebrates, as well as tracking the spread of invasive species such as zebra and quagga mussels.

The nearshore monitoring program has addressed a previous monitoring gap in the Lake Simcoe watershed. Prior to the initiation of the program, the watercourses draining into Lake Simcoe and the pelagic zone of the lake itself were well monitored by the LSRCA and MOE. However, we have since learned that the nearshore zone responds earlier and much differently to environmental changes than other areas of the watershed, and is impacted by changes in both the aquatic and terrestrial environments , including zebra mussel colonization, changes to nutrient inputs and surface water runoff, the removal of terrestrial natural vegetative cover and other land use changes, the loss of habitat due to shoreline hardening, and the loss of species diversity.The nearshore program aims to complement existing monitoring that is undertaken in other areas of the watershed to formulate a complete picture of watershed health.

Figure 5-1: ***R/V Ouentironk*, LSRCA's lake research vessel**

PHYSICAL MONITORING

WATER CLARITY

The depth to which sunlight penetrates into Lake Simcoe greatly affects a variety of lake processes: the depth of the upper, warmer, epilimnion (the upper layer of a waterbody when it becomes stratified in the summer months); mixing of the water column; primary production by plants and algae; cycling of nutrients; the maximum depth and area of plant colonization; and length of the ice-free, or open-water, season. The primary measure of water clarity, or transparency, is the depth to which an observer can see a Secchi disk suspended in the water column.

In most nutrient-rich lakes, the water column is turbid and green in colour due to suspended particles and algae abundantly growing in the presence of excess phosphorus. Due to scattering by these algae and particles, sunlight cannot penetrate very far into the water column, and a shallow Secchi depth is recorded; aquatic plants are restricted to relatively shallow depths in these lakes. In Lake Simcoe, Secchi depth records from 1980 to 1995 are relatively shallow (for example at Brechin the mean depth was 3.8 m) and lake users report the water having a green colour. Since 1995, Secchi disk depth has averaged 7.2 m with maxima of 9-10 m (Figure 5-2). A contributor to this increase in water clarity was invasion by zebra mussels (*Dreissena polymorpha*) which, due to their high rate of filtering water and removing particles, increased the transparency of the water column. As a demonstration (Figure 5-3), two 4L jars were filled with water from the Holland River (which does not have a population of zebra mussels and therefore still has turbid water): the jar on the right shows the turbid green of river water, the jar on the left shows an identical water sample 20 minutes after a small handful of zebra mussels was added to the jar. While phosphorus loads to Lake Simcoe have shown modest declines in response to lake management plans, the lake remains nutrient rich. As algae and particles are quickly removed from the water column, aquatic plants have made use of available phosphorus and increased light transparency to increase their abundance and area of habitats.

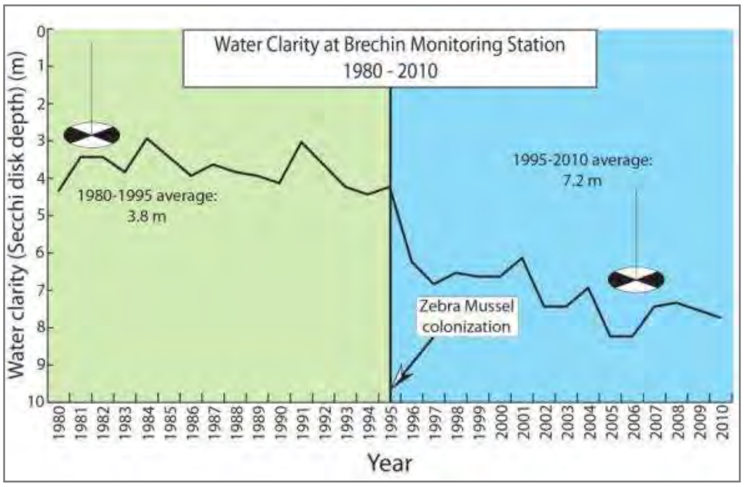


Figure 5-2: Water clarity at Brechin (data from MOE and LSRCA)

Figure 5-3: A demonstration of the filtering capacity of zebra mussels: two jars were filled with water from the Holland River (which does not have zebra mussels, and therefore still has water which is turbid and green in colour). A handful of zebra mussels was deposited into the jar on the left 20 minutes prior to this photo being taken.

TEMPERATURE

Lake Simcoe exhibits typical seasonal temperature patterns for a temperate region lake. Kempenfelt Bay is dimictic and strongly stratified; whereas Cook's Bay and the main basin are weakly stratified and polymictic due to wind action. As with the Great Lakes and other aquatic systems, Lake Simcoe is being affected by climate change. Since the start of monitoring by MOE in 1980, Lake Simcoe has experienced an earlier onset of water column stratification in spring and a later onset of fall overturn which has resulted in a longer ice-free period (an increase of a month when comparing 2008 to 1980). Similarly, the period of ice cover on Lake Simcoe has been steadily decreasing from a five-year running average of 118 days (1853-1900) to 76 days (2000-2013). The five years of longest ice cover were all prior to 1900: 1857 and 1870 (140 days), 1881 (139 days), 1861 (132 days), and 1867 (131 days, tied with 1931). The five years with shortest ice cover have all been since 2000: 2000 and 2010 (71 days), 2009 (70 days), 2002 (34 days), and 2012 (0 days) the first time since record keeping began (1853) that Lake Simcoe did not entirely freeze over (http://www.naturewatch.ca/english/icewatch/). These changes are being reflected in biological communities such as pelagic (open-water) diatom species which, since the 1990s, have been dominated by species which thrive under longer periods of lake stratification.

DISSOLVED OXYGEN

Since historic lows in dissolved oxygen starting in the 1950s, indicated by the collapse of recruitment in coldwater fish species (lake trout, lake whitefish, lake herring), and recorded anoxia in the 1980s, the concentration of deepwater dissolved oxygen in Lake Simcoe has improved dramatically in response to lake management strategies. Improvements in the health and sustainability of the coldwater fish community and the natural recruitment of lake trout are evidence of this positive trend in dissolved oxygen. While isolated events of low deepwater dissolved oxygen continue to occur, predominantly in fall, these events are less frequent and of shorter duration.

The nearshore zone of Lake Simcoe experiences a greater variation in dissolved oxygen. Our monitoring data in Cook's Bay records a daily cycle during summer with the water column being supersaturated by oxygen during daylight (from plant and algae photosynthesis) and a rapid decline to hypoxic or anoxic conditions after sunset (due to plant respiration).

WATER CHEMISTRY

<u>Water column total phosphorus:</u> Total phosphorus data show fluctuations based on annual lake processes (e.g. seasonal changes in algae and plant biomass which use and release nutrients) and supply to the lake (e.g. precipitation and inflow from tributaries). Overall, the nearshore zone of Lake Simcoe has a higher total phosphorus concentration than open-water areas (Fig. 5-4a) due to terrestrial-source inputs and retention by aquatic plants and zebra mussel cycling. Total phosphorus in the nearshore zone also shows more variation than in the open-water, as the nearshore is more influenced by individual precipitation events, whereas the open-water zone shows slower cycles more influenced by seasonal climate patterns. Lake-wide, total phosphorus concentrations have remained relatively stable since the spike seen in the wetter year of 2009, but have shown declines since the 1980s, particularly in Cook's Bay, where the MOE reported mean total phosphorus in 1980 was ~ 35 µg/L, compared to our records of 15-20 µg/L in 2008.

<u>Water column chlorophyll *a*:</u> Chlorophyll *a* is a pigment produced by algae (and other plants) and is a key component of photosynthesis, which converts sunlight and carbon dioxide to oxygen. The concentration of chlorophyll *a* in the water is an indicator of how much algae is present. In Lake Simcoe, chlorophyll *a* concentrations are low, compared to other lakes with similar phosphorus concentrations, as algae are consumed by zebra mussels. As expected with relatively higher total phosphorus concentrations, the nearshore zone has a relatively higher algal biomass than open-water areas (Fig. 5-4b). Due to reduced on-ice snow cover in winter 2010-11, the increased nearshore chlorophyll *a* records an under ice algal bloom.

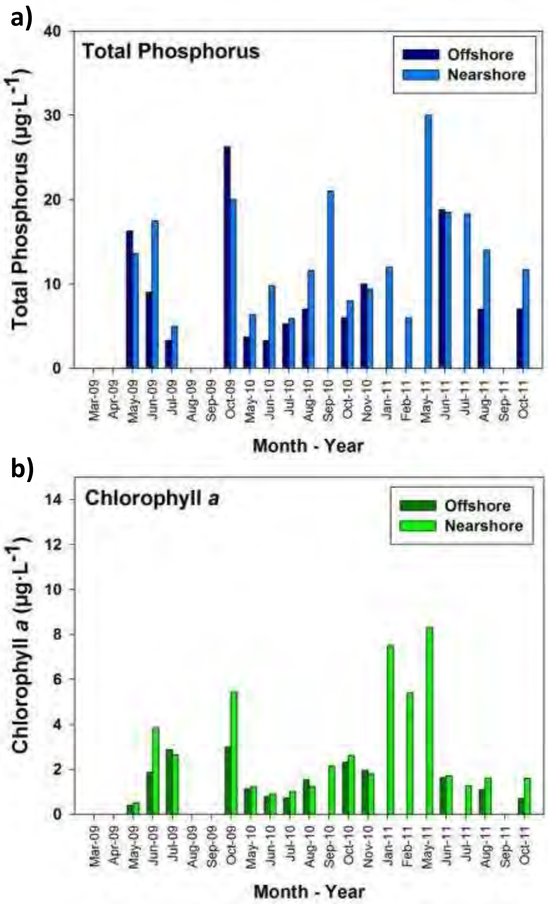


Figure 5-4: Concentrations of total phosphorus (a) and chlorophyll *a* (b) in the open water and nearshore zones of Lake Simcoe (LSRCA data)

SEDIMENT CHEMISTRY (TOTAL PHOSPHORUS)

Sediment phosphorus varies considerably across Lake Simcoe with high values being recorded near nutrient inputs at Barrie, as well as the Black, Beaver, and Talbot River subwatersheds. A high value of 1400 $\mu g \cdot g^{-1}$(or parts per million) was recorded along the eastern shoreline in the vicinity of the outlets of the Beaver and Talbot Rivers. Of particular interest are the very low sediment total phosphorus values recorded in southern Cook's Bay (340 $\mu g \cdot g^{-1}$) near the highest nutrient inputs from the Holland River. While one would expect this area to have the highest sediment TP concentrations, this area also has Lake Simcoe's highest biomass of aquatic plants (Figure 5-5), which obtain up to 97% of their nutrients from lake sediments.

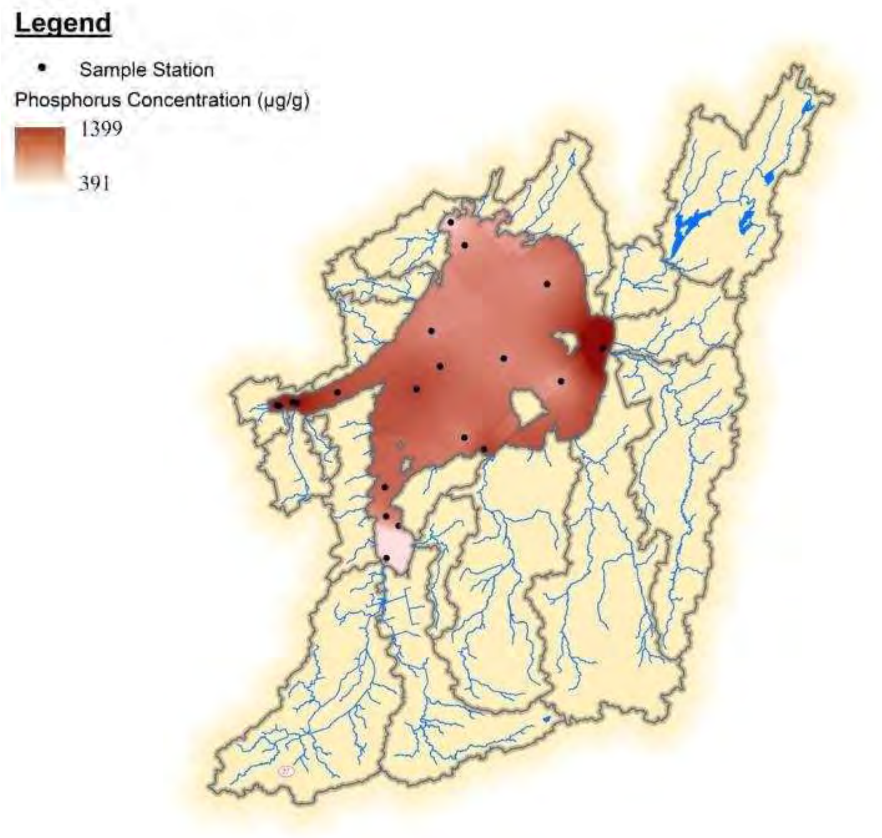


Figure 5-5: Distribution of sediment phosphorus concentrations in the nearshore are of Lake Simcoe (LSRCA data)

BIOLOGICAL MONITORING - AQUATIC MACROPHYTES

Studies to determine the biomass of Lake Simcoe's aquatic macrophytes were first undertaken in 1971, with additional studies occurring in 1984, 1987, and 2006. However, the most detailed of these studies (1984, 1987, 2006) focused only on Cook's Bay. The LSRCA began its surveys in 2008, a study which covered the entire lake, encompassing over 200 sites along the nearshore. The study results documented 20 species of submerged and floating macrophytes found in the lake, and also recorded several areas of high plant biomass in the lake, as depicted in dark green on the map at right (Fig. 5-6).

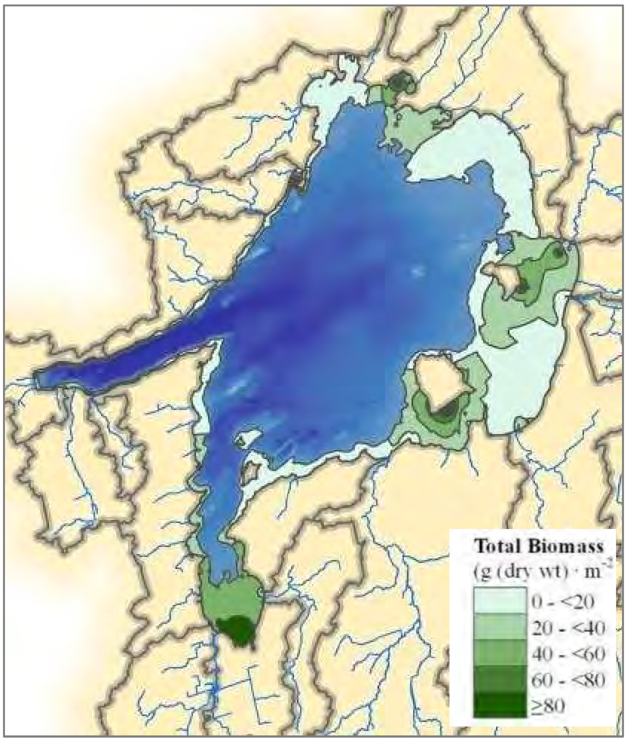


Figure 5-6: Plant biomass in Lake Simcoe's nearshore (LSRCA data)

The five most abundant species (by weight, accounting for over 90% of the plant biomass) found in the lake were:

- *Ceratophyllum demersum* (coontail), at 34.5% of the total plant biomass
- *Myriophyllum spicatum* (Eurasian watermilfoil, an invasive species), 21%
- *Chara* spp. (muskgrass), 19.5%
- *Zosterella dubia* (water stargrass), 10.5%
- *Elodea* spp. (waterweed), 5%

The various species of plants tended to occupy specific areas of the available habitat. Shallow areas (less than 3.5 m deep) were dominated by *M. spicatum* on silt substrates or a combination of *M. spicatum* and *Chara* spp. on sandy substrates. *M. spicatum*'s dominance at these depths is likely due to its high light requirement, high photosynthetic and growth rates, rapid dispersal through fragmentation, rapid uptake of sediment nutrients, and ability to outcompete other shallow water species by shading the substrate with thick canopies. *M. spicatum* is replaced at sites deeper than 3.5 m by *C. demersum*, which is more tolerant of low light levels, and therefore tends to be dominant at these depths. Plants were not found at depths greater than 10.5 m.

Likely reasons that high levels of plant biomass were observed at certain sites include: (1) shelter from wind and waves – the bays and leeward side of the islands allow larger growth without the fragmentation of the plants; (2) substrate – these sheltered areas allow the accumulation of finer sediments which are rich in phosphorus; (3) the input of large amounts of phosphorus draining from the tributary subwatersheds in the vicinity – the larger subwatersheds drain larger areas, and thus have high phosphorus loads from the sheer volume of water, despite the fact that the actual concentration in the water may be low.

Figure 5-7: Three of the most common plant species found in Lake Simcoe *(from left)*: *Ceratophyllum demersum* (photo: Friends of Chorlton Meadows, UK), ***Myriophyllum spicatum*** (photo: Wisconsin DNR), ***Chara* spp.** (photo: Alabama DCNR)

Changes over time

Since the initial studies of the lake's aquatic macrophytes, there have been significant changes to their distribution, species composition, and density. Figure 5-8 depicts some of these changes.

Since 1984, the maximum depth of plant colonization has increased from 6.5 m to 10.5 m, which has resulted in a large increase in potential habitat. This is demonstrated by a doubling in the areal coverage of macrophytes (Depew *et al.*, 2011), increasing from 9.5 km^2 in 1984 to 18.1 km^2 in 2008. The mean wet weight biomass has also increased from 1.2 kg/m^2 (in 1984) to 3.1 kg/m^2 (in 2008).

The most significant change in the distribution of plant species is the increase in the distribution of the invasive species *M. spicatum*, which was only recorded at five sites near the Maskinonge River in 1984. In 1984 the mean biomass of *M. spicatum* was only 44.5 g/m^2; while in 2008 it had increased to 272.5 g/m^2. This increase has come at the expense of other shallow water species, particularly *Chara* spp., which was dominant in 1984 at 123.3 g/m^2 wet weight, but declined to 7.9 g/m^2 in 2008. Changing environmental conditions in the lake since 1984 have also resulted in an increase in the biomass of other species that are common in nutrient-enriched lakes, such as *C. demersum, Vallisneria americana*, and *Elodea* spp., likely as a result of increasing water clarity due to the removal of algae and suspended particles by the filtering of dreissenid (zebra) mussels. For example, *C. demersum* occupied the deeper habitats in both 1984 and 2008, but its area of colonization has expanded significantly, most likely due to the increased light penetration, enabling it to grow in deeper areas. In addition, warmer water temperatures, a longer period of water column stratification, and reduced cover has allowed a longer growing season for aquatic plants.

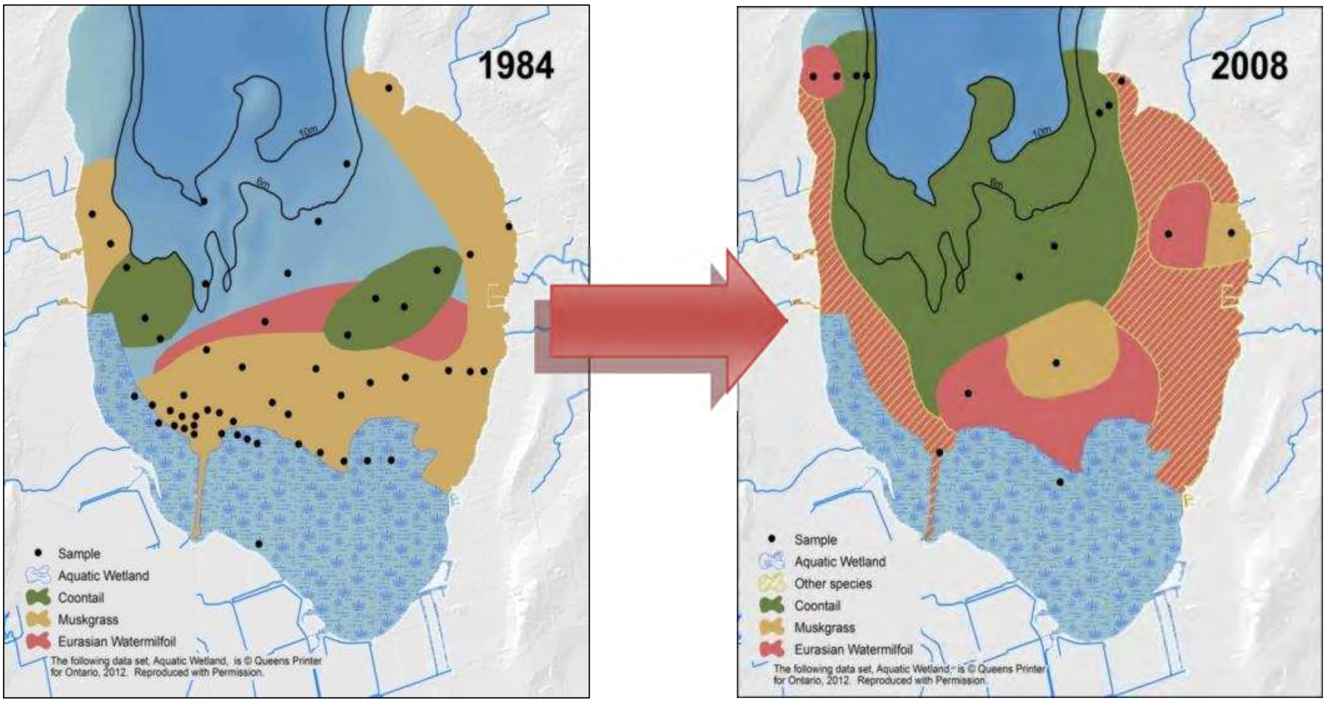


Figure 5-8: Changes in the composition and distribution of the aquatic macrophyte community in Cook's Bay from 1984 to 2008. These changes can be attributed to increasing water clarity, and the associated increase in depth of sunlight penetration, due to the filtering activity of zebra mussels as well as a longer growing period.

BIOLOGICAL MONITORING – BENTHIC INVERTEBRATES

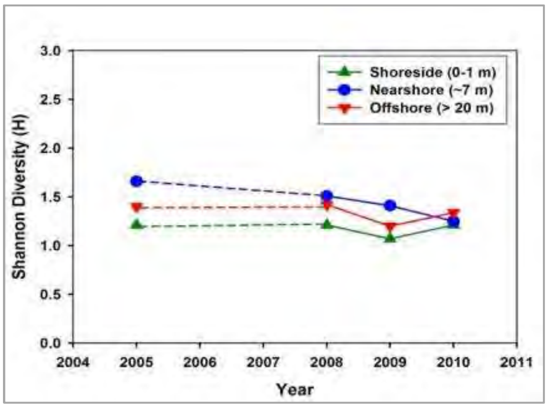


Figure 5-9: Diversity of the benthic community among monitored habitat types

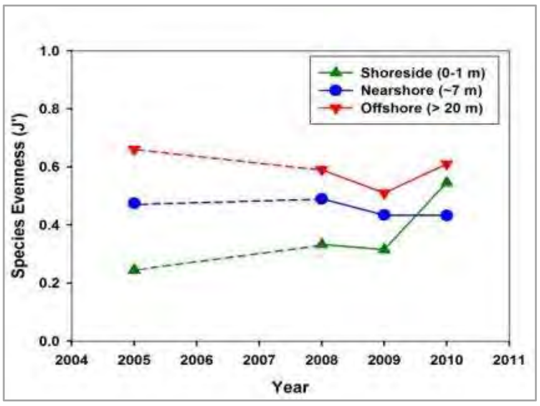


Figure 5-10: Species evenness among monitored habitat types

Monitoring of benthic invertebrates in Lake Simcoe is one of the key activities of the LSRCA Nearshore Monitoring Program. These animals, predominantly larval stages of common insects, respond quickly to environmental changes in the lake and, as a food source for fish, can be used to track changes in Lake Simcoe's fish community. One of the first benthic invertebrate studies in North America was carried out on Lake Simcoe in 1926 and developed many of the methods still in use today. At that time, there was 185 species of benthic invertebrates in the lake with 16 species of bivalves (native mussels and clams). In our monitoring since 2008, LSRCA has recorded 105 species living in Lake Simcoe, with only four species of bivalves, two of which are invasive species (*Dreissena polymorpha*, zebra mussel; *D. rostriformis bugensis*, quagga mussel). This loss of species diversity in the bivalve community clearly shows the impact of invasive species in Lake Simcoe.

LSRCA's studies since 2008, which use methods based on a preliminary study in 2005, have shown no significant change in the diversity of the benthic community among the three habitat types monitored: shoreline, nearshore, and offshore (Figure 5-9). In terms of species evenness, or how equally the community is distributed among the taxa recorded, the community has been relatively stable with the exception of shoreline habitats which recorded a large increase in the evenness score between 2009 and 2010 (Figure 5-10). The cause of this increase was a significant decline in the formerly dominant amphipod taxa (Figure 5-11a), likely due to predation by invasive gobies. With fewer amphipod taxa, the evenness score increased because the community was more evenly balanced. In the littoral zone, dreissenids (mostly zebra mussels) have been the dominant taxa until 2009-2010 when abundances started declining (Figure 5-11b). The cause of this decline may be due to the expansion of another invasive species in Lake Simcoe, the round goby (*Neogobius melanostormus*), which feeds on zebra mussels. In Lake Erie, the expansion of round goby resulted in a substantial decline of zebra mussel populations in that lake. Changes in the profundal zone (Figure 5-11c) include a steady increase in the abundance of dreissenids (in this habitat, quagga mussels) which are expanding in the cooler, deeper habitat.

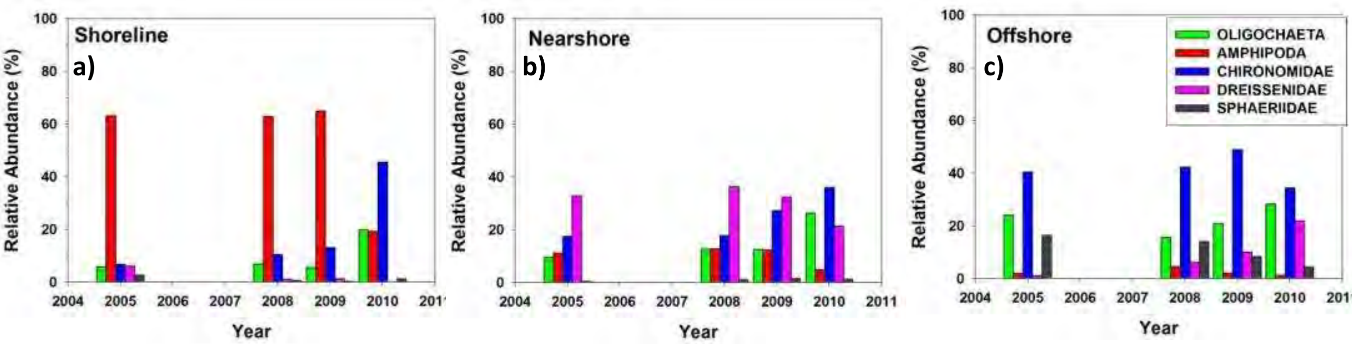


Figure 5-11: Relative abundance of benthic invertebrate taxa in the shoreline, nearshore, and offshore zones (note the common legend for the three graphs is displayed on the profundal zone graph to the right)

ZEBRA MUSSELS

Since becoming established in Lake Simcoe around 1995 (zebra mussels) and 2004 (quagga mussels), *Dreissena* spp. mussels have been a dominant group in the Lake Simcoe benthic community. In 2009-10, LSRCA undertook a specialized study to map the extent of these invasive mussels and determine population trends. Samples were collected at 747 sites in Lake Simcoe with almost 44,000 mussels being collected, measured, and weighed. The results of this study show high populations on hard substrates, boulder, cobble, sand, and shell in Lake Simcoe (Figure 5-12) They were found to be limited to a depth of less than 20 m due to temperature (zebra mussels are intolerant of cooler water) and habitat (substrates are mostly mud below this depth). One exception is in Kempenfelt Bay where dreissenids are recorded to depths of 31 m. Further studies are being carried out to determine how these animals exist in deeper water in Kempenfelt Bay. Overall, Lake Simcoe has an average of 4015 invasive mussels per m^2, with a composition of 75% zebra mussels, and 25% quagga mussels, although the percentage of quaggas is showing a steady increase.

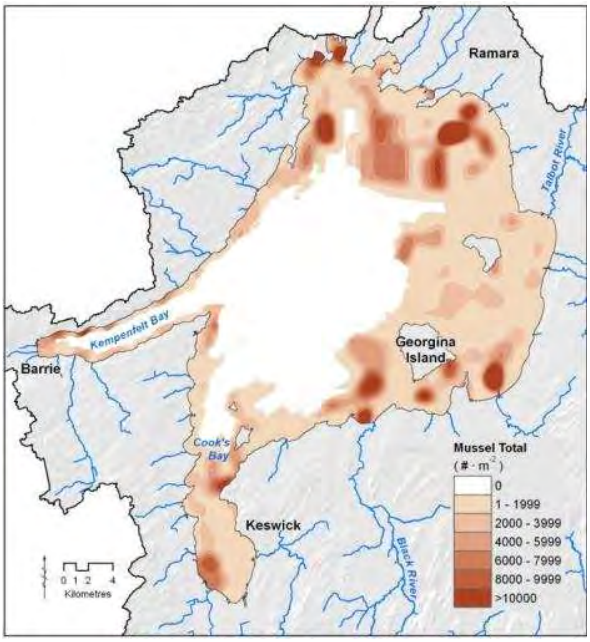


Figure 5-12: Distribution of zebra mussels along Lake Simcoe's nearshore

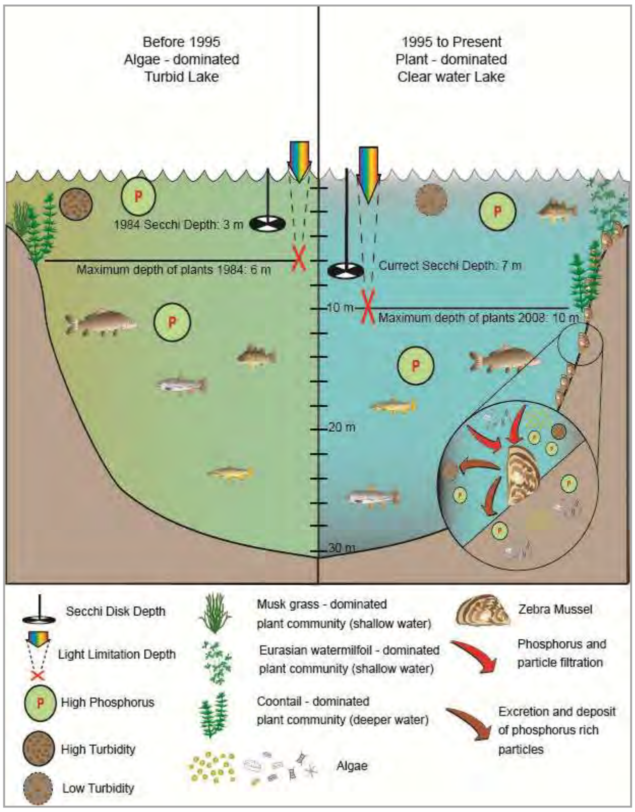


Figure 5-13: Changes to the lake ecosystem following the establishment of zebra mussels

As mentioned above, zebra mussels have had a profound impact on the ecology of Lake Simcoe, especially in terms of a sudden increase in water clarity following their lake-wide colonization by ~1995. Typically, lakes have two stable ecological states: (1) a clear water state, which has low concentrations of phosphorus, high water clarity, and is dominated by aquatic plants; (2) a turbid state which has a high concentration of phosphorus, low water clarity, and is dominated by algae living in the water column. In Lake Simcoe, the increase in phosphorus loading following European settlement and land clearance resulted in the lake being transformed from a clear water state to the turbid state. Since zebra mussels have a high filter rate and efficiency (they filter an equivalent volume to Lake Simcoe every five days) there was a significant increase in water clarity (see Fig. 5-2). The result is a new stable state "engineered" by these invasive species which has high water clarity and high phosphorus (Figure 5-13) – a perfect environment for aquatic plants which has resulted in a large increase in plant biomass and habitat available for colonization (Figure 5-8).

TOTAL PHOSPHORUS IN THE HOLLAND RIVER

The Holland River (comprised of the East Holland and West Holland tributaries) is the largest tributary of Lake Simcoe and contributes the largest phosphorus inputs at an annual mean (2007-2009) of 27 tonnes; 14.5 t from the agricultural West Holland River and 12.9 t from the East Holland River which drains the urban areas of Aurora and Newmarket. Total phosphorus (TP) concentrations (Figure 5-14) are significantly higher than the maximum recorded in Lake Simcoe (black dashed line on graph) and show a strong correlation with precipitation and surface run-off. Chlorophyll *a* data, while also much higher than in Lake Simcoe, records typical annual trends with low concentrations under ice during winter, and peaks during the summer.

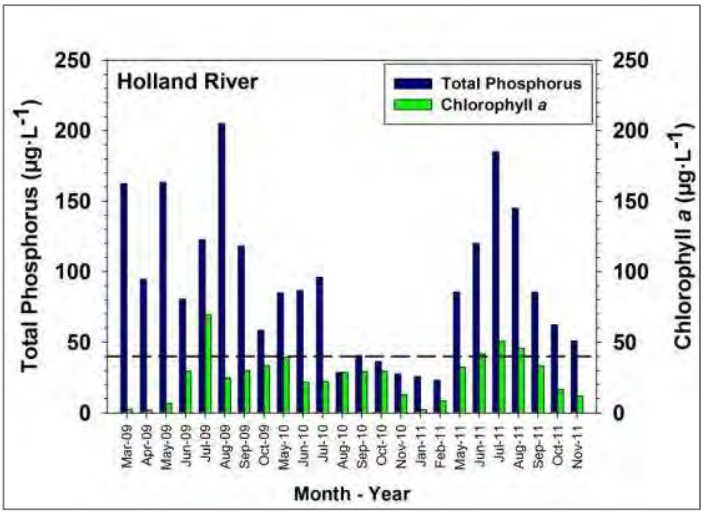


Figure 5-14: Total phosphorus (TP) and chlorophyll-*a* in the Holland River. Note the black dashed line is the maximum TP recorded in Lake Simcoe.

The Holland River also has very high sediment phosphorus concentrations. This phosphorus is bound to either mineral particles in the sediment, or more loosely to compounds that include iron. During periods of warm water and a stratified water column, dissolved oxygen is depleted near the sediment surface. Under these low oxygen conditions, this loosely-bound phosphorus is released from the sediment back into the water column. Our monitoring data (Figure 5-15) records that while the concentration of mineral-bound P is stable in Holland River sediments, the more loosely-bound phosphorus is released from sediment during periods of strong water column stratification and algal growth when dissolved oxygen reaches low concentrations near the sediment surface (e.g. September 19 in Figure 5-15).

Figure 5-16: Duckweed growth in the lower Holland River

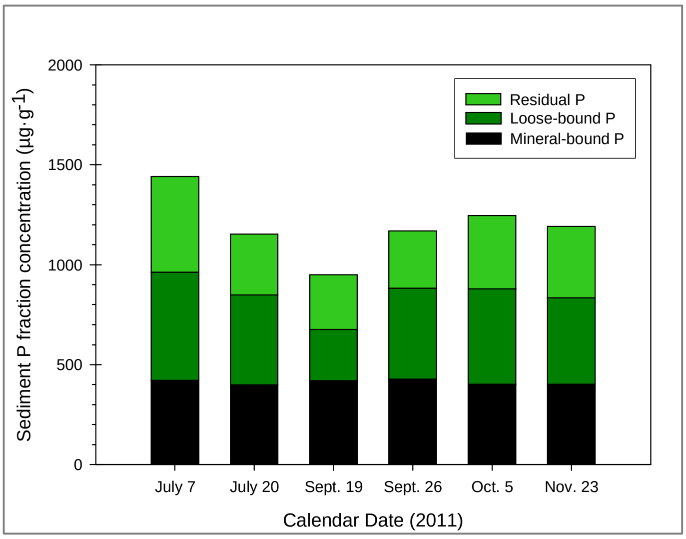


Figure 5-15: West Holland River sediment phosphorus concentrations, broken down by form of phosphorus (July to November 2011)

PHOSPHORUS

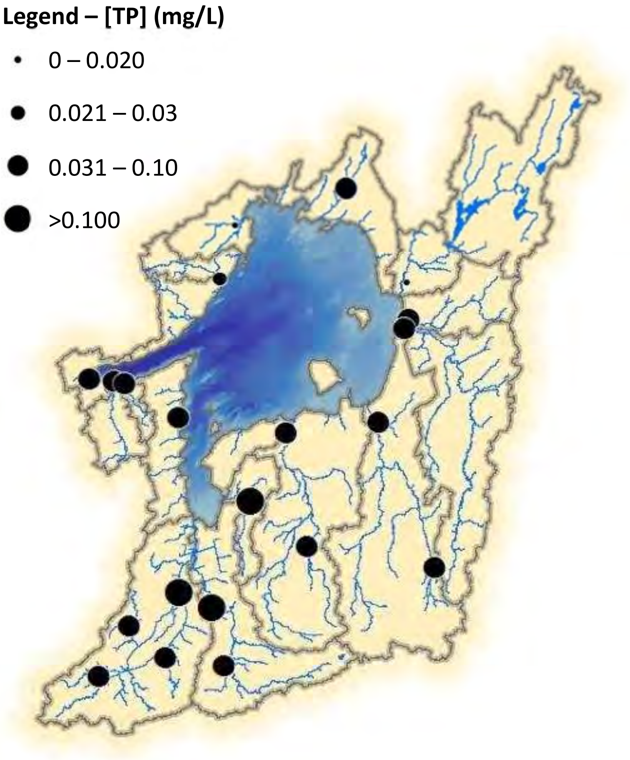


Figure 6-1: Average total phosphorus concentrations (2007-2011) at Lake Simcoe water quality stations (Provincial Water Quality Objective = 0.030 mg/L)

Phosphorus is a naturally occurring nutrient that, when present in high concentrations, has a negative impact on the health of aquatic ecosystems. It has been found to be the most prevalent pollutant in the Lake Simcoe watershed, and as such is scrutinized closely through our monitoring activities. The concentrations found through monitoring the tributaries are measured against the Provincial Water Quality Objective (PWQO), which is 0.03 mg/L for phosphorus.

The impacts of land use on phosphorus concentration become obvious when looking at the distribution across the watershed. The stations with the highest concentrations are generally found in the subwatersheds with the highest levels of urban and agricultural land uses in the basin. These include the East Holland station, found downstream of Newmarket and Aurora, with an average concentration of 0.15 mg/L; the West Holland station, downstream of the Holland Marsh, at 0.14 mg/L; and the Maskinonge station, found in the subwatershed with the highest level of agriculture, at 0.12 mg/L. Conversely; Bluff's and Hawkestone Creeks, which have among the highest level of natural cover in the basin, have the lowest average concentration for the study period, at 0.02 mg/L. The Beaver River, Pefferlaw River, and Black River stations, which are all found in subwatersheds with relatively high levels of natural cover, all display lower total phosphorus concentrations, at 0.03 mg/L, 0.04 mg/L, and 0.04 mg/L, respectively (Figure 6-1).

Just over half of the monitoring stations fail to meet the PWQO the majority of the time. The most degraded station was found to be the East Holland, where 97% of the samples fail to meet the PWQO; and this number is over 90% at the West Holland River, Tannery Creek, and Maskinonge River stations. At the Hawkestone Creek station, only 16% of the samples fail to meet the PWQO, indicating a significantly healthier subwatershed (Table 6-1).

Table 6-1: Summary of total phosphorus conditions at the Lake Simcoe water quality stations. Results expressed as long and short-term trend and the proportion (%) of samples collected at specific concentration ranges

Monitoring station	% of samples	Short-term trend	Long-term trend	Monitoring station	% of samples	Short-term trend	Long-term trend
West Holland River		↔	↓	Kettleby Creek		↔	↓
Tannery Creek		↑	↓	North Schomberg		↔	↓
Mt. Albert Creek		↑	↔	Talbot River		↔	↓
Beaver River		↔	↓	Whites Creek		↔	↔
Pefferlaw River		↑	↓	Uxbridge Brook		↔	N/A
Lovers Creek		↑	↑	Hewitt's Creek		N/A	N/A
Upper Schomberg River		↔	↓	Leonard's Creek		N/A	N/A
Maskinonge River		↔	↑	Bluff's Creek		N/A	N/A
East Holland River		↔	↓	Hotchkiss Creek		N/A	N/A
Black River		↔	↔	Ramara Drain		N/A	N/A
Hawkestone Creek		↔	↔				

Total phosphorus(mg/L)

- 0-0.020
- 0.021-0.030
- 0.031-0.100
- >0.100

↑ Increasing Trend ↔ No trend

↓ Decreasing Trend N/A Insufficient data available for determining trend

Short term trend - 2002-2011 (or from the initiation of the station to 2011, if monitoring began later than 2002)
Long term trend - 1980-2011

Green in the pie charts indicates samples below the PWQO (0.03 mg/L); red indicates samples above the PWQO

Trends

Seasonal Kendall trend analysis has been completed on the phosphorus data for all stations with a suitable dataset for this analysis. Trends were calculated for both the long-term (1980 - 2011 – see Appendix A) and short-term (about 2002-2011); these are shown in Table 6-1.

Long-term trends

The majority of stations show decreasing concentrations in the long-term analysis; examples of this are shown in Figure 6-2. Four stations show no trend, equating to stable concentrations, and only two stations show an increasing trend in concentrations. The Maskinonge River and Lovers Creek stations, both of which show a statistically significant increasing trend over the long-term, are likely displaying the impacts of urban growth and intensive agricultural activity.

Short-term trends

Examination of the short-term trends shows that the decreasing trend that was so apparent in the long-term data does not hold in the more recent data. Four stations show statistically significant increasing trends in the short-term period, although it is important to note that, generally, the increases seen in recent years are on a much smaller scale than the decreases that have been achieved over the long-term (Figure 6-2). For example, the increase in concentrations in Tannery Creek between 2002 and 2009 is very slight. The remaining twelve stations show no trend.

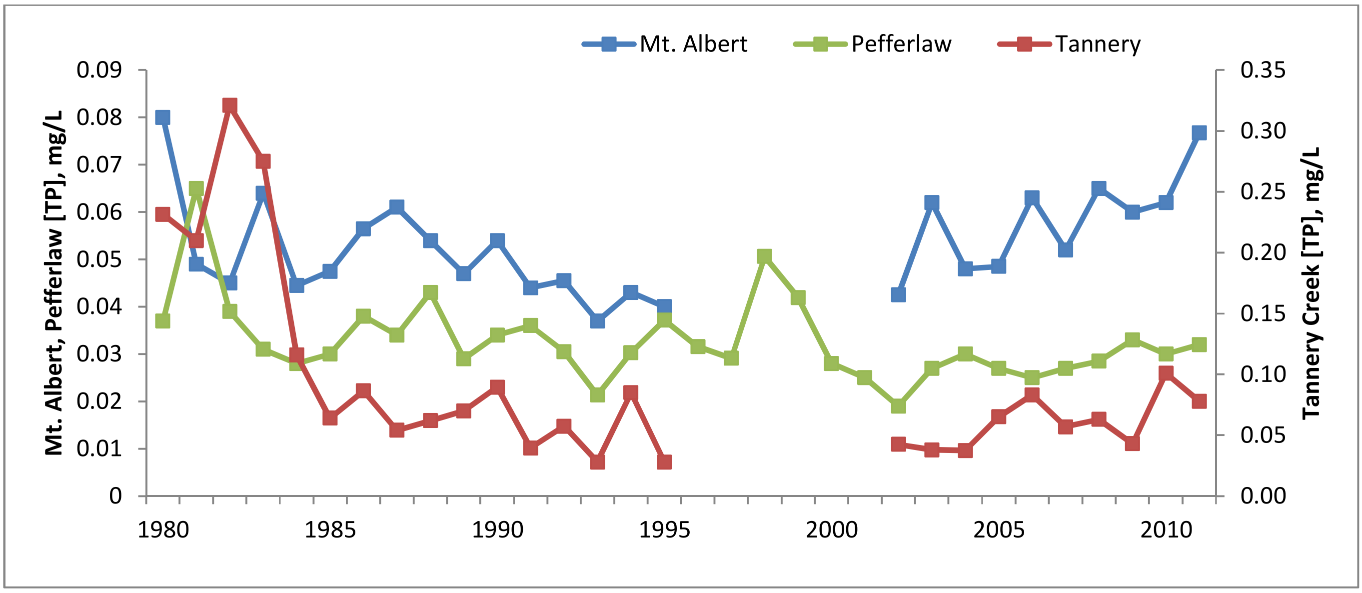


Figure 6-2: Median annual total phosphorus concentrations at the Mt. Albert Creek, Pefferlaw River, and Tannery Creek stations, displaying the decreasing trend in the long-term and increasing trend in the short-term that is being seen at some stations in the watershed. Note the scale for Tannery Creek is two orders of magnitude greater than that of Mount Albert and Peferlaw.

The data show that great strides have been made in phosphorus reduction activities since the initiation of the monitoring program. However, in looking at the data it also becomes apparent that the larger, more easily achieved reductions, such as taking waste water treatment plants offline and the use of phosphorus-free detergents were completed early on in the program, and reductions are now becoming more difficult to achieve. This can be seen through the trend analysis, where stations that had been showing reductions over the long-term are now seeing no trend, or in a few cases are actually seeing an increasing trend.

CHLORIDE

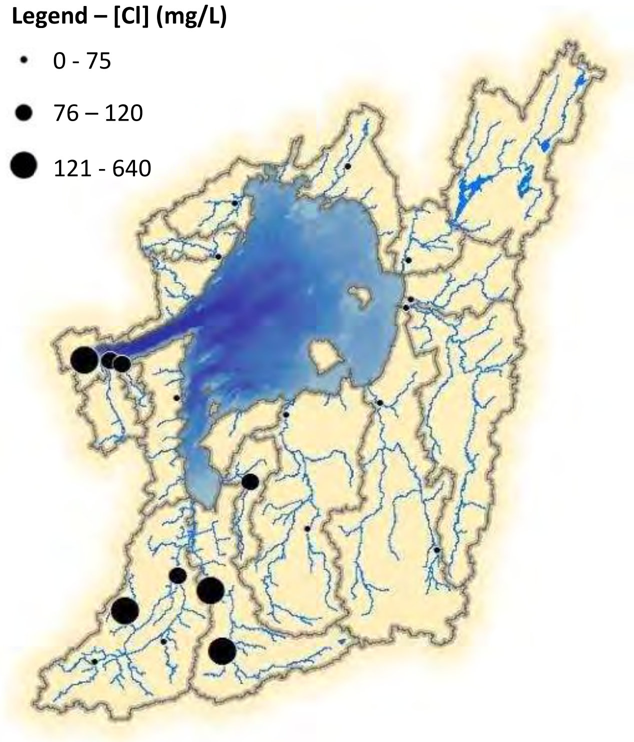


Figure 6-3: Average chloride concentrations (2007-2011) at Lake Simcoe water quality stations

Chloride is a naturally occurring element widely distributed in the environment. Chloride is an essential element for the health of all organisms, humans included; however, at elevated levels it can have detrimental impacts. Background chloride concentrations in natural surface waters are typically below 10 mg/L. Increased levels of chloride in surface waters are typically the result of salt application in winter months. In 2001 The *Canadian Environmental Protection Act* defined road salts containing chloride as toxic. This was based on research that found that the large amount of road salts being used can negatively impact ground and surface water, vegetation, and wildlife. While elevated chloride levels are primarily found around urban centres and major roads and highways, chloride levels have been found to be steadily increasing across the Lake Simcoe watershed, and throughout Ontario (MOE, 2011) as well as in Lake Simcoe itself (Eimers and Winter, 2005).

Recently the guidelines for chloride in surface waters were revised and the current Canadian Water Quality Guideline (CWQG) for the protection of aquatic life is 120 mg/L for chronic (long-term) exposure and a benchmark concentration of 640 mg/L was set for acute (short-term) exposure. The acute guideline estimates the point at which severe effects to the aquatic ecosystem are likely to occur over a 24 to 96 hour exposure period.

With respect to the chronic guideline, the majority of samples are below the guideline at all but five stations, those stations being Tannery Creek, Lovers Creek, East Holland River, North Schomberg, and Hotchkiss Creek. With winter salt being the main source of chloride in surface waters it is not surprising that all five of these stations are within an urban catchment or near a major highway (Figure 6-3). Of all stations only three reported exceedances of the acute guideline, these being East Holland River (5% of samples), North Schomberg River (3%), and Hotchkiss Creek (10%). The maximum concentration recorded (2007 to 2011), occurred in Hotchkiss Creek at 3510 mg/L in November, 2008 (Table 6-2).

Table 6-2: Summary of chloride conditions at the Lake Simcoe water quality stations. Results expressed as long and short-term trend and the proportion (%) of samples collected at specific concentration ranges

Monitoring station	% of samples	Short-term trend	Long-term trend	Monitoring station	% of samples	Short-term trend	Long-term trend
West Holland River		↔	↑	Kettleby Creek		↑	↑
Tannery Creek		↓	↔	North Schomberg		↓	↔
Mt. Albert Creek		↑	↑	Talbot River		↓	N/A
Beaver River		↔	↑	Whites Creek		↔	↑
Pefferlaw River		↑	↑	Uxbridge Brook		↑	N/A
Lovers Creek		↑	↑	Hewitt's Creek		N/A	N/A
Upper Schomberg River		↑	↑	Leonard's Creek		N/A	N/A
Maskinonge River		↔	↑	Bluff's Creek		N/A	N/A
East Holland River		↔	↑	Hotchkiss Creek		N/A	N/A
Black River		↑	↑	Ramara Drain		N/A	N/A
Hawkestone Creek		↔	↑				

Chloride concentration (mg/L)

- 0-75
- 121-640
- 76-120
- >640

↑ Increasing Trend   ↔ No trend

↓ Decreasing Trend   **N/A** Insufficient data available for determining trend

Short term trend - 2002-2011 (or from the initiation of the station to 2011, if monitoring began later than 2002)

Long term trend - entire period of record for each station to 2011

Green in the pie charts indicates samples below the CWQG chronic objective (120 mg/L); yellow indicates samples between the chronic objective and the acute objective (640 mg/L); red indicates samples above the CWQG acute objective

Trends

Seasonal Kendall trend analysis has been completed on the chloride data for all stations with a suitable dataset for this analysis. Trends were calculated for both the long-term (entire period of record for each station – see Appendix A) and short-term (about 2002-2011); these are shown in Table 6-2.

Long-term trends

When examining the period of record for 14 long-term stations, all but two are showing an increasing trend in chloride concentrations. This trend is not unique to the Lake Simcoe watershed, with similar trends being observed across Canada. These trends have been driven by increasing urbanization, increasing density of road networks, and changes to road clearing practices with the requirement for more “bare pavement” policies on roadways. As a result, Canada has seen an increase in annual road salt tonnage and application rates since the 1970s. Lovers Creek and the East Holland River are shown in Figure 6-4 below as examples of stations with an obvious increasing trend.

In the Lake Simcoe watershed increasing trends in long-term data are found in subwatersheds with a wide range of conditions, from mostly urban, to mostly agricultural, to predominantly natural. The two stations that do not show a trend in long-term dat do however, show regular exceedances of the chronic guideline, these being Tannery Creek and the North Schomberg River. Although high chloride levels are routinely observed here, it is important to note that the short-term trends show a decreasing trend.

Short-term trends

It is encouraging that an examination of chloride trends over the last decade (approximately 2002-2011) shows that some progress is being made. Of these 16 stations, three are showing decreasing trends, including Tannery Creek and North Schomberg River, and a further six are showing no trend, indicating concentrations may be stabilizing. One of the stations showing no trend is East Holland River, which was also one of the stations that recorded exceedances of the acute guideline. This is incouraging as it suggests that some progress is being made in salt management practices in the East Holland Subwatershed. Seven stations are recording increasing concentrations in the short-term data (Table 6-2). A sufficient period of record has not yet been collected at Hotchkiss Creek to allow for trend calculation.

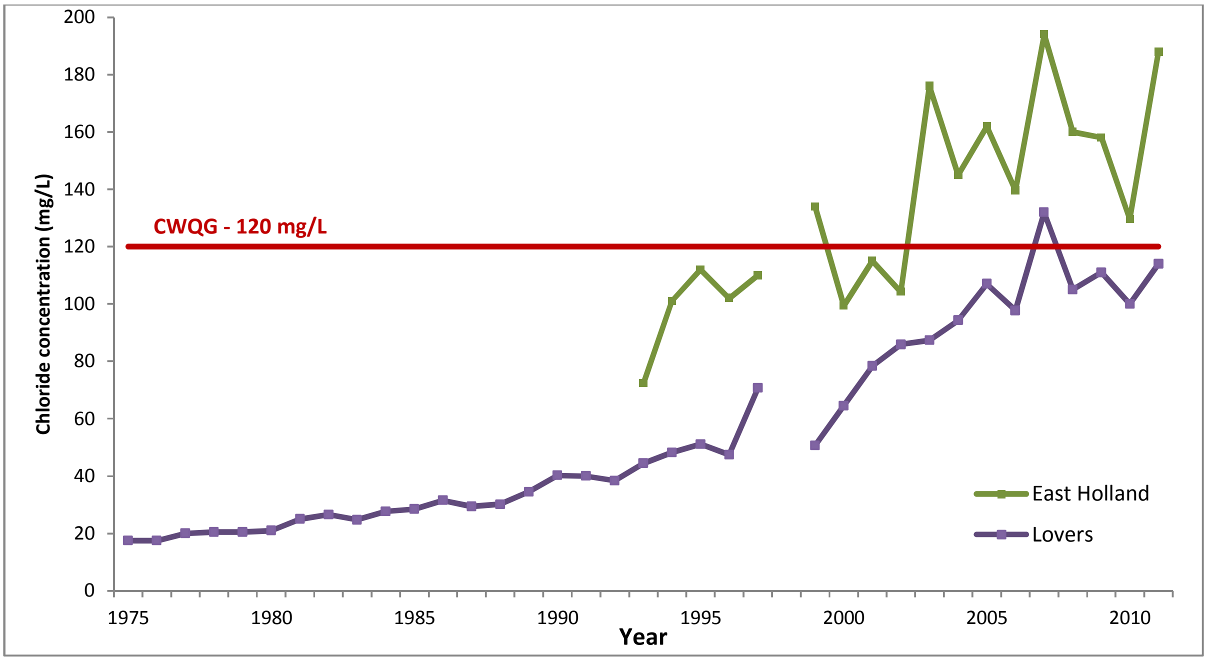


Figure 6-4: Increasing trend in the median annual chloride concentration (mg/L) at the East Holland River and Lovers Creek water quality stations

Since 2001, greater attention and emphasis has been placed on the storage and application of road salt, most notably with the *Canadian Environmental Protection Act* designation of road salt as a toxic substance. This also led to Environment Canada publishing of a Code of Practice for the Environmental Management of Road Salts in 2004 that was widely adopted by Canadian municipalities. While the added attention and adoption of a Code of Practice has likely played a role in the stabalizing or declining trends observed in the short-term data, the amount of road salt applied in a given year is greatly influenced by the severity of the winter. Therefore, year-to-year climate fluctuations are also likely exerting an influence on trends in chloride concentrations. Of key importance will be focusing attention on those systems that are recording exceedances of the acute guideline, as these systems are being highly impacted by chloride concentrations. However, it is important to note that if we fail to manage road salt use, it has the potential to affect the health of Lake Simcoe over the long term; therefore chloride concentrations in all systems will need to be addressed.

TOTAL SUSPENDED SOLIDS

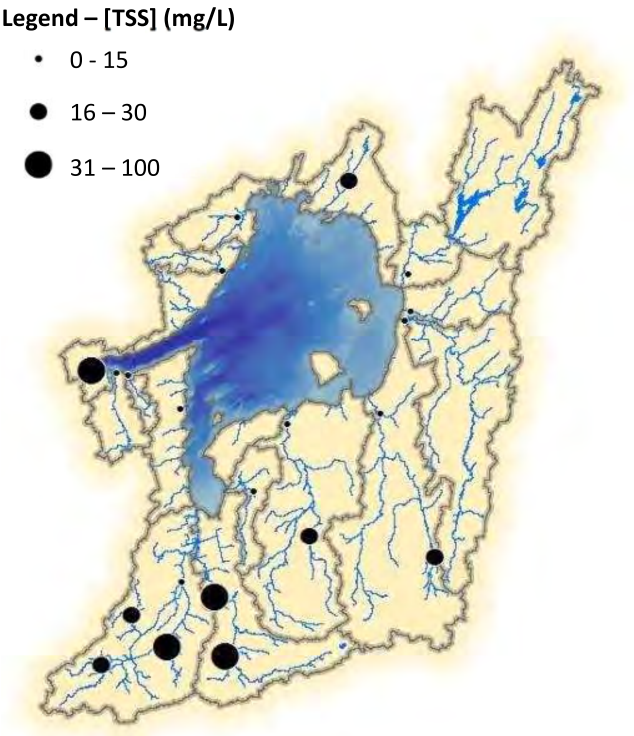


Figure 6-5: Average total suspended solids concentrations (2007-2011) at Lake Simcoe water quality stations (Canadian Water Quality Guideline – 30 mg/L)

The water quality parameter Total Suspended Solids (TSS) is a measure of any material in suspension in the water column. This can include a wide variety of material, such as silt, microorganisms, decaying plant and animal matter, and industrial wastes. This is an important measure because TSS can act as a transport mechanism for a variety of other parameters, some in a benign form, such as clay-bound aluminum, while others can cause water quality issues. For example, sediment-bound phosphorus can cause excessive nutrient loading downstream. Excessive amounts of TSS may also have negative impacts on fish and benthic organisms. For example, reduced water clarity can inhibit the ability of aquatic organisms to find food. High TSS concentrations would be expected during and following rain events as soil from pervious areas and accumulated grit and dirt from impervious surfaces are washed into streams.

The Canadian Council of Ministers of the Environment (CCME) outlines that TSS concentration should not exceed background concentrations by 25 mg/L for short-term exposures (24 hour period; Canadian Water Quality Guideline, 1999). Background levels are site-specific, but can be generalized for the watershed at 5 mg/L in clear flow conditions, making the short-term guideline about 30 mg/L. On a regular basis, the concentrations should be even lower to avoid chronic exposure. Higher concentrations are acceptable during high flow events. The majority of samples for most stations in the Lake Simcoe watershed are below 30 mg/L except during storm events.

The East Holland River had a high number of samples (collected at the Holland Landing station) over the short-term exposure guideline (55%), many of which occurred in low flow conditions. TSS concentrations were sometimes extremely high during storm events (maximum = 485 mg/L). Tannery Creek, which is a tributary of the East Holland River system, has a similar pattern of elevated TSS, though not as extreme. These sites, which have constantly elevated concentrations of TSS, are particularly at risk for problems associated with TSS (Figure 6-5, Table 6-3).

Other systems with numerous samples containing elevated TSS concentrations include Mount Albert Creek, Upper Schomberg River, and North Schomberg River. The elevated concentrations typically occur during high flows and are not extremely high (Figure 6-5, Table 6-3). A similar pattern with low concentrations during low flows and higher concentrations during high flows is also seen in Kettleby and Hotchkiss Creeks, however the pattern is exaggerated in these systems. The low flow concentrations are very low (approximately 5 mg/L) and the high flow concentrations are extremely high (maximum = 770 mg/L in Kettleby Creek and 890 mg/L in Hotchkiss Creek). Farming practices and pressures from urban development might explain these exaggerated patterns. Further monitoring would provide more insight.

Table 6-3: Summary of total suspended sediment conditions at the Lake Simcoe water quality stations. Results expressed as long and short-term trend and the proportion (%) of samples collected at specific concentration ranges

Monitoring station	% of samples	Short-term trend	Long-term trend	Monitoring station	% of samples	Short-term trend	Long-term trend
West Holland River		↔	↓	Kettleby Creek		N/A	N/A
Tannery Creek		↑	N/A	North Schomberg		N/A	N/A
Mt. Albert Creek		↔	N/A	Talbot River		N/A	N/A
Beaver River		↔	↓	Whites Creek		N/A	N/A
Pefferlaw River		↔	↓	Uxbridge Brook		↑	N/A
Lovers Creek		↔	↔	Hewitt's Creek		N/A	N/A
Upper Schomberg River		↔	↓	Leonard's Creek		N/A	N/A
Maskinonge River		↔	↑	Bluff's Creek		N/A	N/A
East Holland River		↔	N/A	Hotchkiss Creek		N/A	N/A
Black River		↔	N/A	Ramara Drain		N/A	N/A
Hawkestone Creek		↔	N/A				

Total suspended solids(mg/L)

- 0-15
- 16-30
- 31-100
- >100

↑ Increasing Trend

↔ No trend

↓ Decreasing Trend

N/A Insufficient data available for determining trend

Short term trend - 2003-2011
Long term trend - entire period of record to 2011

Green in the pie charts indicates samples below the Canadian Water Quality Guideline (CWQG) (30 mg/L); red indicates samples above the CWQG

Trends

Seasonal Kendall trend analysis has been completed on the TSS data for all stations with a suitable dataset for this analysis. Trends were calculated for both the long-term (entire period of record for each station – see Appendix A) and short-term (about 2002-2011); these are shown in Table 6-3.

Though it is important to explore the water chemistry datasets available, there are limitations to the datasets that should be taken into consideration when interpreting the results of Seasonal Kendall trend analysis. These limitations for TSS include varying sampling frequency through the time period, low sampling frequency for some stations, and/or periods where no samples were collected.

There was typically less data available for trend analysis of TSS in comparison with other water chemistry parameters (chloride and total phosphorus). There was also a gap in long-term stations from about 1996 to 2002. If more than 33% of the time period had no samples (i.e. the gap), they were not used in analysis. While there is the potential that these variations in sampling frequency could bias the results, techniques have been used to minimize error. However the trend analysis of TSS should be interpreted with caution. Continued, consistent monitoring in the future with help to mitigate some of these challenges and help build a more robust TSS dataset.

Long-term trends

Long-term TSS datasets suitable for examining trends are only available for six stations. Four stations, the West Holland River, Beaver River, Pefferlaw Brook, and Upper Schomberg River, show a decreasing trend of TSS. The Maskinonge River station shows and increasing trend and Lovers Creek station does not show a trend (Table 6-3). The decreasing trend in the long-term for the West Holland River and Beaver Rivers are displayed graphically in Figure 6-6.

Short-term trends

Examination of the short-term trends shows a different pattern than the long-term datasets. There were 12 stations in this analysis, with none of the stations showing a decreasing trend. Ten stations do not show a trend with only Tannery Creek and Uxbridge Brook showing an increasing trend (Table 6-3).

These trends are similar to phosphorus where concentrations are decreasing in comparison to the earlier parts of the record, but have been stabilizing or increasing in the last decade or so. Fortunately, the majority of stations have TSS concentrations that are below the guideline during clear flows. As long as reduction activities (typically aimed at phosphorus) continue to be undertaken, TSS concentrations should remain stable during this period of urban development and continued agricultural activity in various parts of the watershed. That said, certain tributaries, such as the East Holland River, are impacted by high levels of TSS and further efforts are required to improve the water quality.

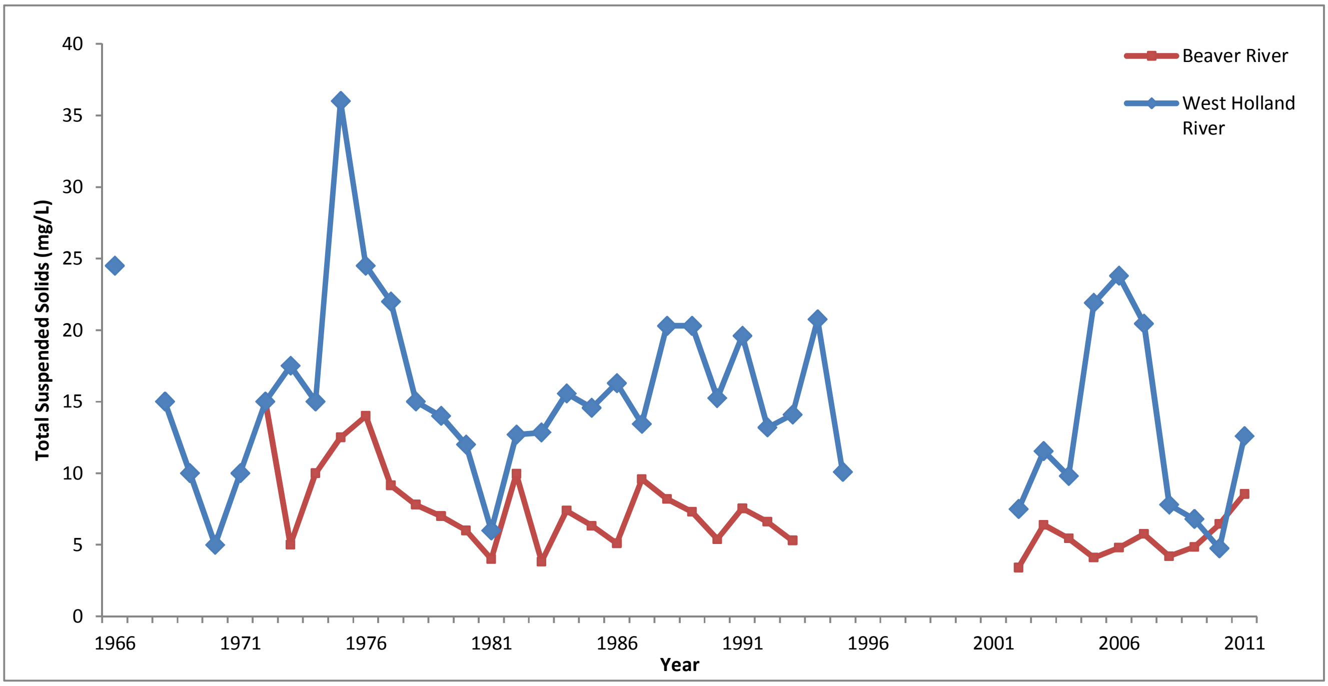


Figure 6-6: Trends in median annual concentration of total suspended solids at the Beaver River and West Holland River stations. Both stations display a decreasing trend in the long-term. In the short-term, the Beaver Rivers displays an increasing trend, while the West Holland River continues to show a decreasing trend, although there is a great deal of inter-annual variability.

METALS

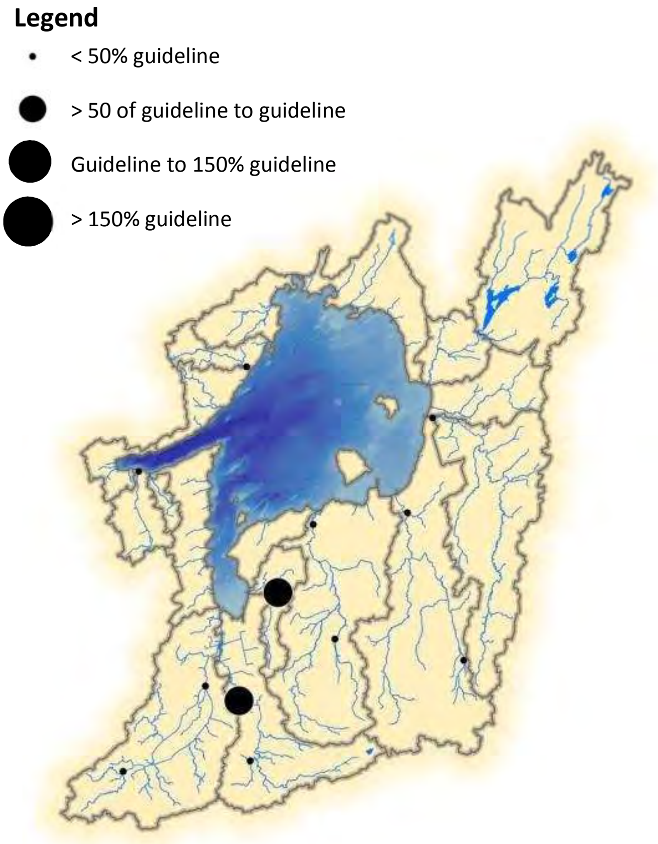


Figure 8-7: Metals (combination of zinc, copper, and lead) (2007-2011) at Lake Simcoe water quality stations. Note: the size of the marker corresponds to the division into which average concentrations of at least two of the three metals fall. The majority of metals samples are below the guidelines.

Metals are monitored in surface waters at 12 stations throughout the Lake Simcoe watershed (Figure 8-7). A total of 20 different metals are analyzed. For the purposes of this report, three metals (copper, lead, and zinc) were selected to examine the potential impact of metals on the health of the aquatic ecosystem in Lake Simcoe tributaries. These metals are good indicators of anthropogenic influences such as urbanization and agricultural activities. As there are no real point sources of metals contamination in Lake Simcoe tributaries, the metals concentrations detected are typically a combination of natural background concentrations and non-point sources such as soil disturbance, pesticide and fungicide application, automotive tire and breakpad wear, burning of fossil fuels, and many more. Elevated concentrations in the Lake Simcoe watershed are typically a result of human activities.

Both copper and zinc are essential elements that play a role in normal biological processes. However, at elevated concentrations all three metals will have toxic effects on aquatic organisms. The water quality guidelines for these metals are therefore set to avoid toxic impacts to sensitive aquatic organisms and are 5µg/L for copper and lead, and 20 µg/L for zinc (Figure 6-7). In the 2007 to 2011 data set the majority of samples recorded values below the metals guideline. For Beaver River 96% of samples met the metals guidelines and 94% of samples met guidelines at the Black River, Hawkestone, Lovers Creek, Mount Albert Creek, and West Holland River stations. The lowest compliance was 79% at the East Holland River station. Overall, while there are some samples exceeding guidelines for metals in the watershed, they are generally not considered to be a serious concern (Table 6-4).

Table 6-4: Summary of conditions of selected metals at the Lake Simcoe water quality stations. Results expressed as long- and short-term trend and the proportion (%) of samples collected at specific guideline ranges

Monitoring station	% of samples	Monitoring station	% of samples
West Holland River		Upper Schomberg River	
Tannery Creek		Maskinonge River	
Mt. Albert Creek		East Holland River	
Beaver River		Black River	
Pefferlaw River		Hawkestone Creek	
Lovers Creek		Uxbridge Brook	

Metals (includes copper, zinc, and lead)

- 50% guideline to guideline
- >guideline to 150% guideline
- >50% guideline to guideline
- > 150% guideline

Sections of the pie charts indicate the number of samples of copper, zinc, and lead at each station that fall into the noted ranges

Trends

Due to the fact that a large proportion of the metals data set falls below the laboratory analytical detection limit, Seasonal Kendall trend analysis could not be performed on any metals data set. Examination of the data set over time instead consisted of observing the percentage of samples that were above the detection limit to determine if there has been any discernible shift in concentration over time, possibly indicating increasing or decreasing concentrations. This analysis was limited to data from after 2003, as there were changes to analytical methods before this time that changed the method detection limit.

For copper, there appeared to be a general shift to having more sample concentrations greater than the detection limit as time went on (Figure 6-8). Most copper concentrations at Holland Landing were greater than the detection limit for the entire period. Zinc showed no discernible pattern, although the two most recent years had the most concentrations above the detection limit. Most of the concentrations at East Holland River, Tannery Creek, West Holland River, and Uxbridge Brook were greater than the detection limit for zinc for the entire period. For lead, almost all samples at all stations were below the detection limit for the entire period.

There are some indications that metals concentrations are increasing in the watershed; continuing or increasing anthropogenic activities have the potential to see metals continuing to increase in concentration, if not curtailed. However, the majority of metals concentrations are below the relevant guideline indicating that, at this time, metals concentrations in the Lake Simcoe tributaries are not impacting the aquatic system.

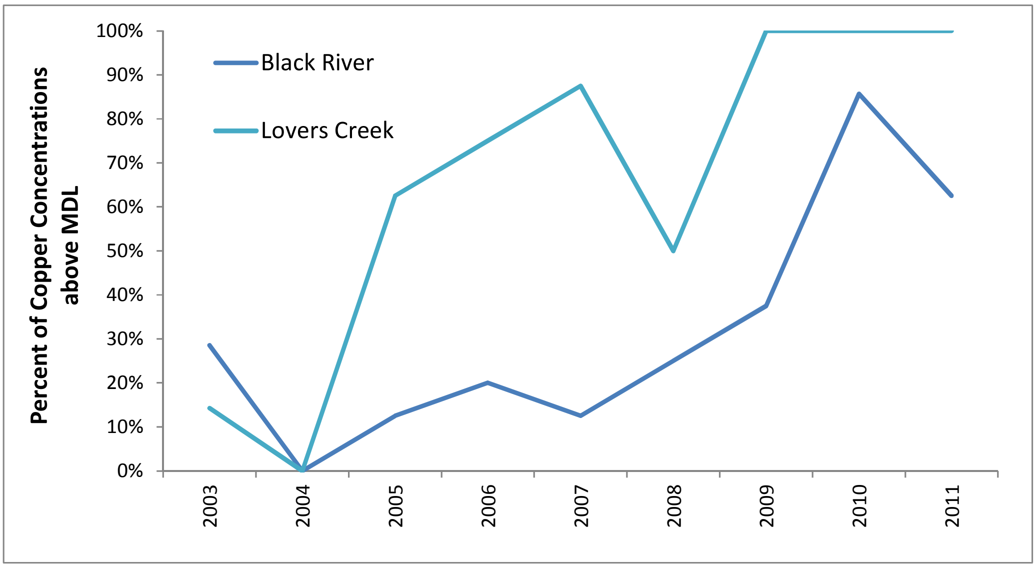


Figure 6-8: Median annual concentration of zinc (µg/L) at the Mount Albert Creek and Lovers Creek water quality stations, showing decreasing trends over the long-term, but increasing trends in the short-term data

CHLORIDE

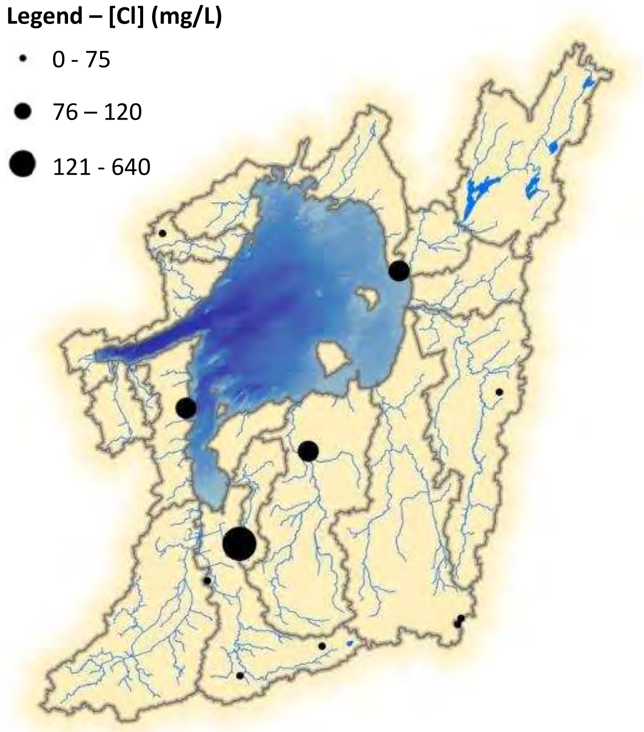


Figure 6-9: Average chloride concentrations (2007-2011) at Lake Simcoe groundwater quality monitoring stations

Table 6-5: Summary of chloride concentration results at selected Provincial Groundwater Monitoring Network stations (2007-2011)

Monitoring station	% of samples
Queensville (shallow)	
Baldwin (shallow)	
Ramara (shallow)	
Innisfil (shallow)	

Chloride concentration (mg/L)

0-75 mg/L
121-640 mg/L
76-120 mg/L
>640 mg/L

Note: none of the other wells showed concentrations of chloride over 75 mg/L

Green in the pie charts indicates samples below the CWQG chronic objective (120 mg/L); yellow indicates samples between the chronic objective and the acute objective (640 mg/L); red indicates samples above the CWQG acute objective

Chloride is a naturally occurring element that can be found at high concentrations (i.e. greater than the water quality standards) under natural conditions. The concentration of chloride in groundwater can be related to the type of rock the groundwater is coming from; however, high concentrations of chloride can also be related to anthropogenic impacts (e.g. winter salt and landfills). When determining the source of chloride in groundwater it is necessary to have an understanding of the type of aquifer and the recharge location for that particular well.

In general, chloride is not harmful to humans but can indicate higher concentrations of sodium which are a concern to people on sodium restricted diets. Because of the close connection of groundwater to surface water, the concentrations found within the groundwater monitoring wells are measured against the Canadian Water Quality Guideline (CWQG) for the purposes of this report, which is 120 mg/L for chronic (long-term) exposure, and 640 mg/L for acute (short-term) exposure.

The impacts of land use on chloride concentration become obvious when looking at the distribution within the various aquifer complexes across the watershed. The highest concentrations of chloride are found in shallow wells that obtain their recharge locally to that well; all of these in the vicinity of roadways (Figure 6-9). These include wells in Queensville, with an average concentration of 906 mg/L; Innisfil, at 263 mg/L (this well was decommissioned in 2010); Baldwin, at 140 mg/L; and Ramara, at 130 mg/L. The remaining ten wells are located within intermediate or deep aquifers, or a shallow aquifer further from urban areas; with average concentrations ranging from 1 to 27 mg/L, well below the CWQG. All of the samples exceed the guideline at the Queensville well; 88% of the samples at the Innisfil well; 72% at Baldwin; and 42% at Ramara. Samples at the rest of the wells meet the CWQG for chloride all of the time. Results are summarized in Table 6-5.

The samples from wells with the highest concentrations of chloride are within shallow aquifers and near urban areas, which suggests these wells are influenced by anthropogenic activities, such as winter salt use.

Trends

Groundwater sampling has been occurring in the LSRCA watershed since 2004, although consistent sampling only began in 2007; therefore it is not possible to determine long-term trends at the present time. However, an examination of the short-term trends over the last five years indicates that many of the wells show seasonal trends (e.g. Baldwin well, Figure 6-10). Seasonal trends can be an indication that they are influenced by seasonal recharge events and the quality of water being recharged. In addition, the more prominent seasonal trends are seen in wells located within shallow aquifers which tend to be more influenced by local recharge events.

Only two stations have shown an increasing trend, Innisfil and Holland Landing. This may be due to increasing winter salt use or the storage of snow in the vicinity of the wells. Conversely, samples from six wells, Cannington (shallow), Aurora (intermediate), Baldwin (shallow), Oro-Medonte (deep), Baldwin (deep), and Ramara (shallow), show a decline in chloride concentration starting between 2007 (Ramara) and 2010 (Baldwin) (Figure 6-10). The remaining wells show no trends. Since the wells that show trends are either within a shallow aquifer or a deep aquifer near urban activities it suggests these wells are influenced by anthropogenic activities, such as winter salt use.

The decline in chloride concentrations the past few years could be due to the decrease in snow, resulting in a reduction in the amount of winter salt being applied. The implementation of salt management plans by municipalities may also be playing a role. Further sampling is needed to understand the long-term trends and confirm the sources of chloride found within the wells.

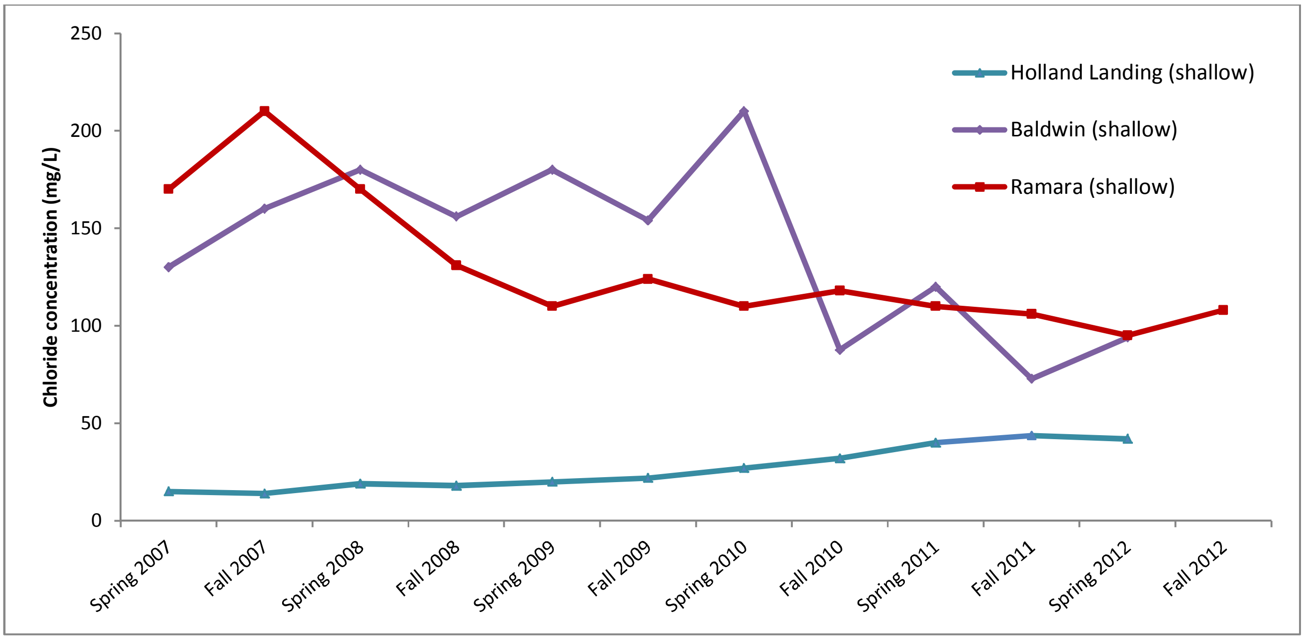


Figure 6-10: Average seasonal chloride concentrations for the Holland Landing, Baldwin, and Ramara PGMN wells (all shallow wells). A decreasing trend is seen in both Baldwin and Ramara, while concentrations are seen to be increasing at Holland Landing.

NITRITE + NITRATE

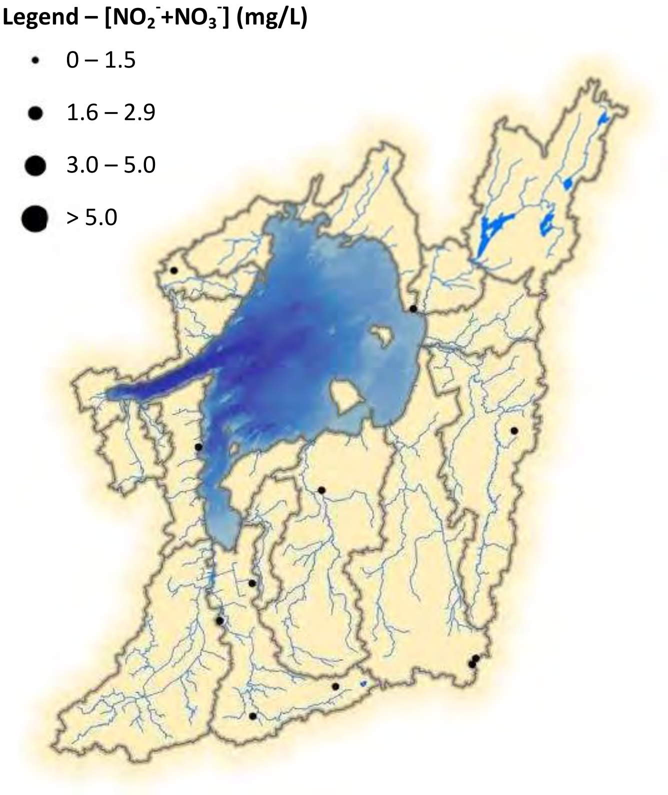


Figure 6-11: Average nitrite+nitrate concentrations (2007-2011) at Lake Simcoe groundwater quality monitoring stations (CWQG is 2.9 mg/L)

Nitrogen occurs naturally in rocks and groundwater. The forms of nitrogen found in water include nitrite (NO_2) and nitrate (NO_3^-). The concentration of nitrogen in groundwater can be significantly increased by anthropogenic activities such as applications of excessive amounts of fertilizer and manure, and poorly functioning septic systems.

The interim Canadian Environmental Quality Guideline for the protection of aquatic life is 2.9 mg/L. All wells within the watershed exhibit low concentrations of nitrate + nitrate, with almost all samples falling well below of the guideline. The average concentrations range from 0.01 to 0.9 mg/L (Figure 6-11). Samples with concentrations being consistently low are normally an indication of background groundwater levels found within the target aquifers. Of all wells, the Aurora (intermediate) well has exhibited the highest concentrations, with values ranging from 0 to 3.56 mg/L.

Trends

Groundwater sampling has been occurring in the LSRCA watershed since 2004 with consistent sampling only since 2007, therefore long-term trends are unknown at the present time. However, an examination of the past five years of data shows no obvious trends.

A few wells show higher concentrations for nitrate + nitrite within the fall samples. This may be an indication that the spring groundwater samples are being diluted during the spring recharge event(s), creating artificially low concentrations (Figure 6-12).

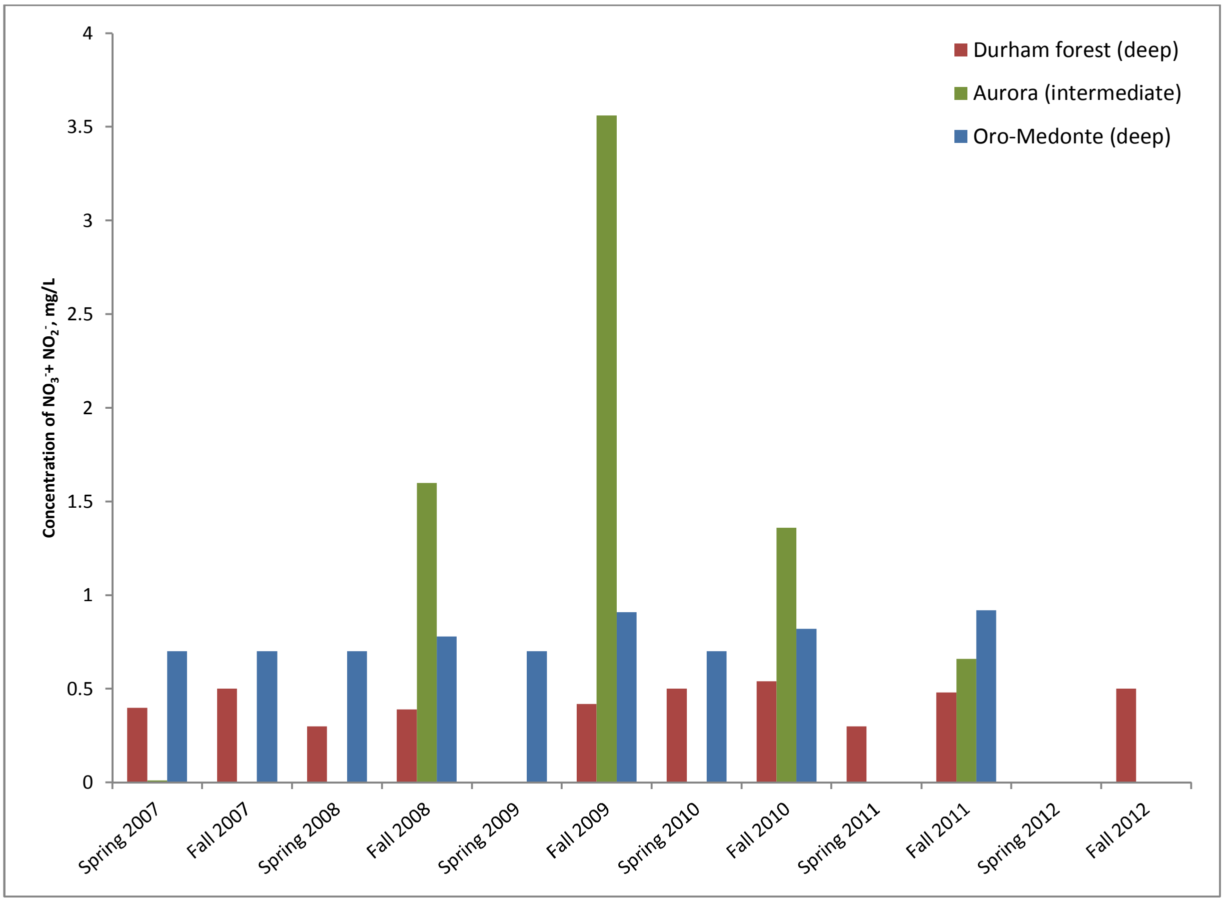


Figure 6-12: Nitrite + nitrite concentrations at selected Provincial Groundwater Monitoring Network stations. These wells generally show higher concentrations in some of the fall samples, which may indicate that samples are being diluted during spring recharge events, creating artificially low concentrations.

STREAM FLOW

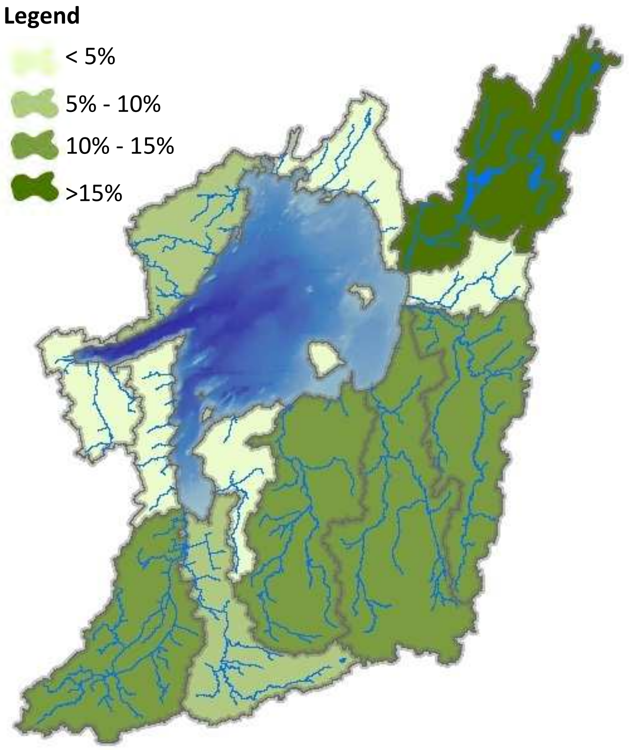


Figure 7-1: Percentage of total tributary flow from each subwatershed into Lake Simcoe for the period 2007-2010

The near continuous data set generated by a typical stream flow station, coupled with the longer period of record, makes stream flow one of the more powerful datasets for characterizing and assessing changes a watershed over time. As stream flow is greatly influenced by the landscape it drains, changes to this landscape will be reflected in changing streamflow thresholds. Established streamflow thresholds also allow for yearly climatic variation to be examined and put into perspective.

2007 – 2010 – Four Years of Highly Variable Flow

The years 2007-2010 were highly unusual from a stream flow perspective in that they captured both the driest and the wettest conditions recorded at a number of gauges. All of the long-term Lake Simcoe flow gauges exhibited much lower than average annual discharge in 2007, greater than average annual discharge in 2008 and 2009, followed by a return to average annual discharge in 2010. Discharge to lake from each tributary during this period is shown in Figure 7-1

2007 – Low Water Conditions

The summer (Jun –Aug) of 2007 was one of the driest recorded in the Lake Simcoe watershed. The East Holland and Pefferlaw Rivers (45- and 41-year records, respectively) observed their lowest summer discharge with average discharges of 0.249 and 1.060 m^3/s, respectively. The Black, Beaver, and Schomberg Rivers all observed their second lowest recorded summer average discharges in 2007 with average discharges of 0.348, 0.188 and 0.029 m^3/s, respectively. See Table 7-1.

2008 – Extreme Winter Flow Events

2008 was much wetter than 2007, with the Beaver River exhibiting the greatest annual discharge in a 41-year period of record (0.147 km^3); 0.038 km^3 or 26% of the record high stream flow occurred in April. The spring freshet alone (Mar-May) accounted for 42% of the 2008 annual flow. The next greatest monthly discharge in 2008 was in December with a volume of 0.020 km^3, almost three times greater than the Beaver River long-term average December discharge volume (Table 7-1). The large December discharge resulted from rain-on-snow events that occurred in late December of 2008. The Pefferlaw, Black, East Holland, and Schomberg Rivers all exhibited annual discharges that were greater than the long-term average and also had very high December discharge volumes resulting from these rain on snow events.

2009 – An Unusually Wet Year

2009 was also an extremely wet year, with the East Holland, Pefferlaw, and Black Rivers all observing their greatest recorded annual discharges with annual volumes of 0.152, 0.106 and 0.065 km^3. The Beaver River observed a very high discharge volume in 2009, second only to 2008, making 2008 and 2009 the two wettest years in the period of record of the Beaver River gauge. The Schomberg River also observed greater than average annual discharge in 2009 but not to the same extent as other Lake Simcoe gauges (Table 7-1). Seasonally, each of the long-term Lake Simcoe gauges had very high winter (Dec-Feb), spring (Mar-May), and summer (Jun-Aug) discharges in 2009. Again the high winter discharges resulted from rain on snow events; these occurred in February of 2009. Despite the depleted snow pack that resulted from the winter melt in 2009, the spring freshet was also very high. Numerous large precipitation events that occurred during March and April augmented the spring freshet flow; moreover approximately 135 mm of precipitation fell in April 2009, twice the long-term average precipitation for April (based on catch from eight precipitation gauges located throughout the Lake Simcoe watershed). The wet winter and extremely large spring freshet saturated the Lake Simcoe watershed maintaining high stream flow levels throughout the summer of 2009 despite only moderate precipitation rates. Fall (Sep – Nov) 2009 had more typical stream flow levels despite low precipitation rates; approximately half of the historic normal precipitation was received in the months of September and November of 2009.

2010 – Normal Flow Conditions Return

2010 brought a return to a more typical flow regime for the Lake Simcoe river systems. Annually, the long-term Lake Simcoe gauges returned to average volumes (Table 7-1) with Pefferlaw, Beaver, Black, East Holland, and Schomberg discharging 0.095, 0.076, 0.061, 0.039 and 0.008 km^3, respectively. The greatest seasonal volume was observed in the spring, with March having the greatest monthly discharge, which is typical for the Lake Simcoe tributaries. The second greatest seasonal flow contribution was seen in the fall, with fairly typical monthly volumes. The third greatest discharge volume in 2010 occurred in the winter, with slightly greater than average discharges resulting from mild temperatures in January and February. Unlike 2008 and 2009, 2010 lacked the large rain-on-snow events that caused the extremely high winter discharge volumes. Summer was the driest season in 2010 with August having the lowest flows of the year.

Table 7-1: Ranked total annual and total winter discharge (1 = wettest on record)

	Period of Record (years)	Greatest annual discharge (rank)				Wettest year in period of record		Greatest winter discharge (rank)				Wettest winter in period of record
River		2007	2008	2009	2010		River	2007	2008	2009	2010	
East Holland [1966-2010]	45	44	6	1	30	2009	East Holland [1966-2010]	17	14	2	29	1997
Schomberg [1967-88, 1991-97, 2003-2010]	37	34	8	3	30	1996	Schomberg [1967-88, 1991-97, 2003-2010]	12	11	4	29	1996
Beaver [1967-02, 2005, 2007-2010]	41	37	1	2	30	2008	Beaver [1967-02, 2005, 2007-2010]	15	8	1	29	2009
Pefferlaw [1969-75, 1980-2010]	38	36	2	1	23	2009	Pefferlaw [1969-75, 1980-2010]	17	8	1	22	2009

BASEFLOW AND QUICKFLOW

The water that flows through streams and rivers could be simplified as being supplied by either precipitation in the form of rain and snow, or by groundwater that discharges to streams from aquifers and surface water bodies such as groundwater-fed wetlands and ponds. Typically, stream flow generated by precipitation events (quickflow) is characterized by high energy, short duration flow with higher water levels and greater water velocities that cause more erosion and greater sediment transport. Stream flow generated by groundwater (baseflow) is lower energy and longer duration, with slower water velocities and less erosional forces and therefore less sediment transport.

Both quickflow and baseflow are important components of a river's natural flow regime and provide the different environmental conditions necessary to support the many ecological, hydrological, and physiological functions of rivers. Hydrograph separation techniques (which are mathematical equations) allow for the partitioning of stream flow into quickflow and baseflow to analyze the flow regime of a river and identify natural or anthropogenic factors that might influence or alter river functions, such as:

Natural influences

- Watershed size, slope, and aspect
- Groundwater discharge
- Precipitation
- Evapotranspiration

Anthropogenic influences

- Water taking
- Water control structures (e.g. dams, diversion canals)
- Land use (e.g. urbanization, agriculture)

Hydrograph separations were performed and annual baseflow index values were calculated for the 2007-2010 monitoring period for five of the Lake Simcoe gauges with a relatively long continuous period of record (i.e. > eight years). The hydrograph separation for the East Holland River is shown in Figure 7-2; this figure displays the relatively small contribution of baseflow to streamflow due to the high levels of impervious surfaces and the associated lack of storage in this urban subwatershed, and also displays the influence of this land use on quickflow. While the baseflow contribution does vary throughout the year, its highs and lows are muted in comparison with the peak flows which tend to increase and peak quickly after a precipitation event or snow melt, and then quickly return to normal. This occurs because of the quick flow of precipitation over paved surfaces, as well as the efficient conveyance of these waters to local watercourses and stormwater ponds. The baseflow index is the percentage of the total annual flow that is generated by baseflow, and is a useful metric for examining the low flow characteristics of a system, including the influence of catchment land use and topography, the stability and significance of groundwater contributions, and the system's response to drought. Baseflow indices for the subwatersheds analyzed are shown in Figure 7-3.

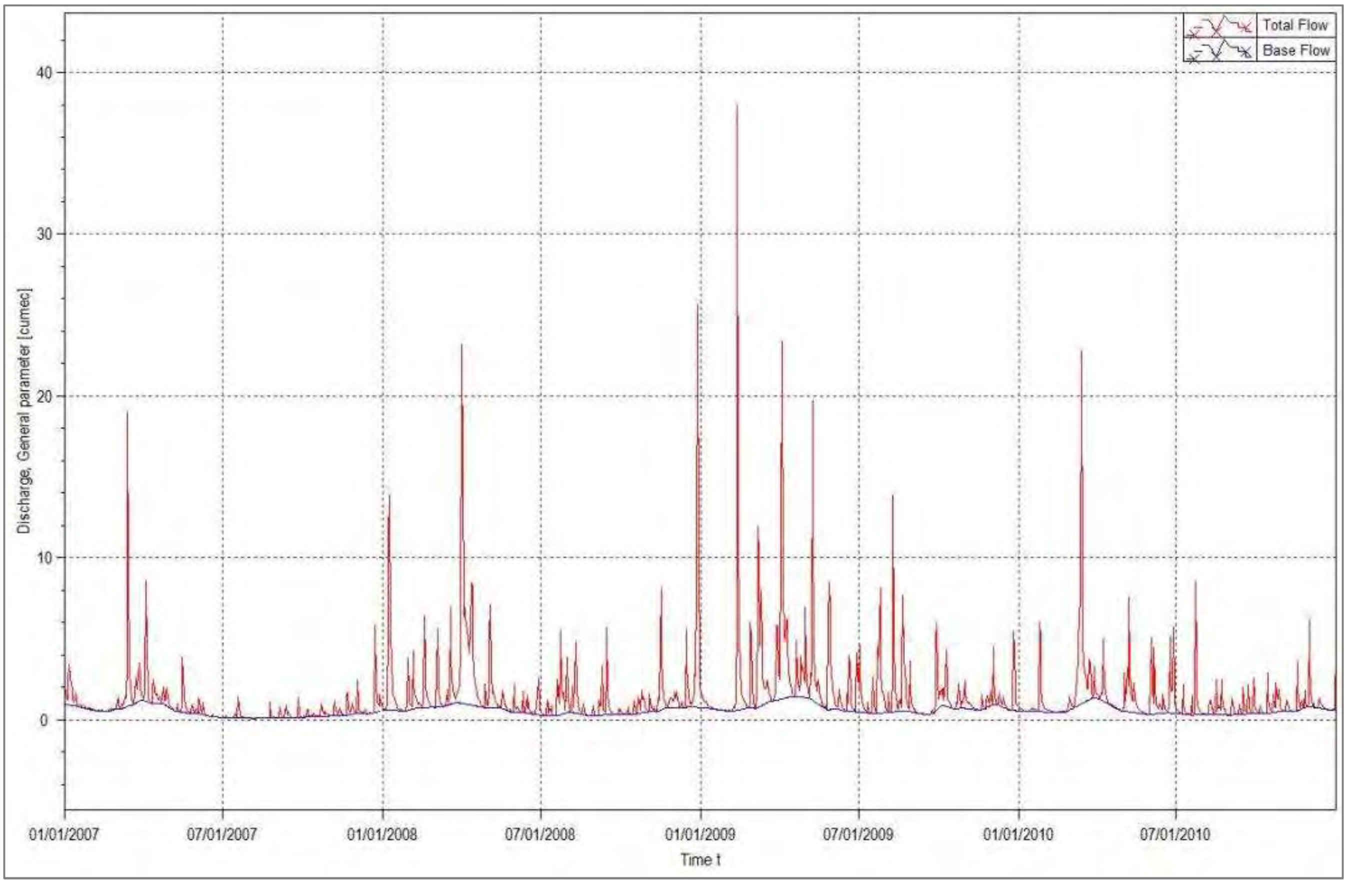


Figure 7-2: Hydrograph separation for the East Holland River using revised UKIH hydrograph separation equation.

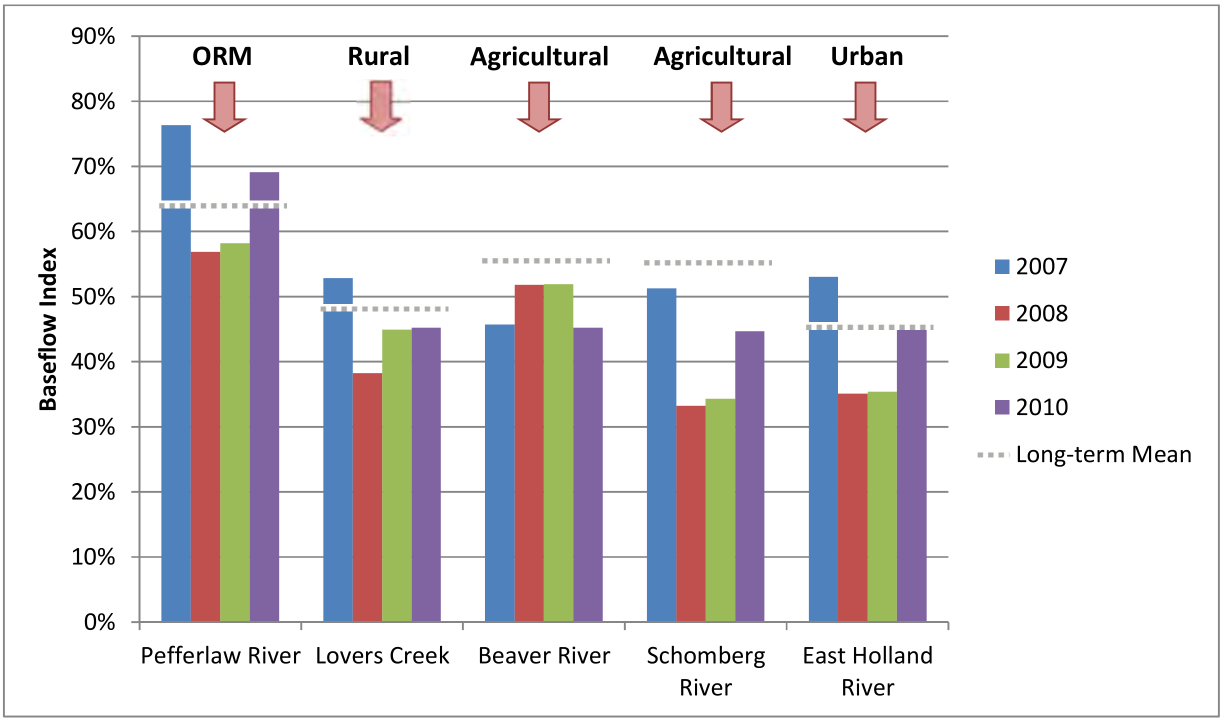


Figure 7-3: Percentage of total annual flow that is comprised of baseflow in five Lake Simcoe subwatersheds, as well as the land uses that influence baseflow contribution in the subwatersheds

The highest baseflow index was recorded in the Pefferlaw River subwatershed in 2007, when climatic conditions were very dry, which was 76.3%. The Pefferlaw River headwaters are located on the Oak Ridges Moraine, a well-documented reservoir and groundwater recharge feature in south-central Ontario. As a result of this connection with the Oak Ridges Moraine, stream flow was augmented by large inputs of groundwater, thus maintaining stream flow volumes during extended periods without precipitation. The Pefferlaw River also has the largest proportion of natural land cover (~ 42% based on Ecological Land Classification) of the five river systems analyzed, which typically contributes to higher baseflow than other land uses. During 2008 and 2009, the annual baseflow indices for Pefferlaw were much lower than in 2007 and also lower than the long-term average baseflow index with values of 56.9 and 58.2%, respectively. This is expected in years with so many large precipitation events; particularly the rain-on-snow events described above, which produce a lot of run-off due to frozen soils that do not permit infiltration and lower transpiration by vegetation. Pefferlaw River had a slightly increased baseflow in 2010, with the higher precipitation levels in 2008-09 having recharged the watershed's storage.

Lovers Creek, and the Schomberg, East Holland, and Beaver Rivers had baseflow index values of 52.8, 53.0, 51.3 and 45.7%, respectively, in 2007. Despite having similar baseflow indices in 2007, each of these systems is very different. These subwatersheds are described in the paragraphs below.

Lovers Creek has a fairly high proportion of natural cover (~35%) most of which is contained in the large wetland complex located in its headwaters. Typically, wetlands help to recharge groundwater, moderate peak flows, and augment baseflow. However, Lovers Creek hydrograph separations and baseflow indices show that a large proportion of the annual flow is generated by quick or event flow; this could be due to the steep topography and naturally straight drainage of the subwatershed, and it is also possible that the drainage canals located within the headwater wetland are preventing the wetlands from performing the functions discussed above. In 2008, the baseflow index was low due to numerous large rainfall events that quickly saturated the available storage, resulting in higher quickflow volumes. The Lovers Creek's baseflow index returned to more normal long-term values in 2009 and 2010.

The Schomberg River also drains a relatively small watershed, but also has a large proportion of agricultural land use (~60%), with drainage canals and cleared agricultural lands that can increase run-off during precipitation events. In 2007 the Schomberg River had a high baseflow index, at 51.3%, but it also had extremely low flow with an average daily minimum flow of 0.005 m^3/s or 432 m^3/day, less than one-fifth of the volume of an Olympic-sized swimming pool. During 2008 and 2009 the Schomberg River had much lower baseflow indices despite having headwater reaches located on the Oak Ridges Moraine; this could be the result of factors including agricultural drainage, subwatershed size and slope, or that the subwatershed may not receive strong groundwater discharge from the Oak Ridges Moraine. In 2010 the baseflow index was still lower than the long-term baseflow index despite a return to more typical climatic conditions.

The East Holland River has the highest level of urban land use of the five river systems analyzed, with 44% of its watershed being comprised of urban land use. Similar to the Schomberg River the East Holland had extremely low flows during the summer of 2007 with a high baseflow index that was more related to low yield than strong groundwater contribution from the Moraine. During the wet conditions of 2008 and 2009 the impervious surfaces and engineered drainage associated with urban land use produced high stormwater run-off volumes and consequently low baseflow indices of 35.1% and 35.4%, respectively. The East Holland returned to more typical flow regime in 2010 with a baseflow index (45.3%), consistent with the long-term average of 45.5%.

In 2007 the Beaver River had the lowest baseflow index of the five systems, at 45.7%. The Beaver River is a large subwatershed with a high level of storage, similar to the Pefferlaw River. The Beaver has the most agricultural land use of the five river systems analyzed, at approximately 64%. The Beaver River also contains large wetland complexes throughout the watershed (~18%) that help to moderate flow during storm events but also tend to store water during prolonged dry conditions, resulting in abnormally low flow conditions. In 2008 and 2009 baseflow index values increased but were still below the long-term average, which is expected during extremely wet years (two greatest annual discharges in back-to-back years for a 41-year record), with large rain-on-snow events that produce a lot of quickflow. In 2010 the Beaver River had a baseflow index of 45.2% which is low compared to the long-term baseflow index of 55.7%. Unlike the Pefferlaw River (a much more groundwater-dominated system, long term baseflow index = 64.2%), which had greater baseflow following the extremely wet 2008 and 2009 period, the Beaver had lower baseflow. This is likely due to the saturation of the Beaver River's surface/shallow soil storage during 2008-09, which increased quickflow during precipitation events in 2010.

TRENDS

Changing Winter and Spring Flows

Monthly average discharges were calculated for the four gauges in the Lake Simcoe watershed with the longest and most complete period of record. For each gauge, yearly seasonal average discharges were calculated and their trends were determined, as shown in Table 7-2 below. While very little change is evident in the summer and fall flow regimes, notable change is obvious in both the winter and spring flows. For each gauge the average winter discharge appears to be increasing and conversely spring discharges are decreasing. Possible causes of this apparent shift in the seasonal flow regimes include land use change, particularly increasing urban areas; increased winter salt application, which results in a greater amount of snow melt; urban heat pollution; and climate change. To further investigate the role of land use change on the shifting flow regimes that we have been seeing, this analysis was also performed on the hydrometric gauge data for a gauge near Washago. This gauge was selected because of its close proximity to Lake Simcoe, its robust period of record (97 years), and because it has undergone very little urbanization. The Washago hydrometric gauge also exhibits an increase in winter flows and consequently lower spring flows, indicating that climate change is the most likely cause of the shifting flow regime.

Most recently this shifting trend in winter flows has resulted in some of the highest winter flows being recorded on a number of rivers. In 2008 the East Holland and Schomberg Rivers observed the second greatest monthly discharge for December in their respective histories. The Beaver and Pefferlaw Rivers observed their greatest recorded December discharges; due to a combination of warmer than average daily air temperatures and 20.8 mm of rain over a four-day period on a substantial snow pack. Again in February 2009, 36.9 mm of rain fell on snow over a period of six days, which produced the second greatest winter average flow for the East Holland River gauge (almost twice the 45 year average), the third greatest winter average flow for the Schomberg River gauge, and the greatest winter flow recorded for the Beaver and Pefferlaw River in 44 and 37 years respectively. Moreover, the Beaver and Pefferlaw Rivers' average winter flows in 2009 were twice as great as their respective long-term average winter flows. As significant as the winter flows were in these two years, their removal from the period of record did not change the increasing trend in winter flows.

Extreme winter melts impact the magnitude of the following spring freshet by depleting the snow pack that would typically melt during March, a key component of the hydrologic regime for this region. An increase in the frequency of winter melts presents a number of additional problems. Winter melt events are more prone to flooding than events during ice free seasons. Ice cover breaks up as water levels increase, causing ice floes that can cause damming, resulting in streams overtopping their banks. Furthermore, because winter soils are typically frozen they are much less pervious and water cannot infiltrate and recharge groundwater stores, which are critical for augmenting stream flow during extended dry periods. As water demands are typically highest in summer, a trend of increasing winter flows and decreasing spring and summer flows may result in water shortages during the times it is needed most.

Table 7-2: Trends for winter and spring flows for four long term flow stations in the Lake Simcoe watershed, and the Washago flow station, which lies just to the north of Lake Simcoe

River flow station	Period of record (years)	Winter flow	Spring flow
East Holland River	44	↑	↓
Beaver River	41	↑	↓
Pefferlaw River	35	↑	↓
Schomberg River	35	↑	↓
Washago Gauge	97	↑	↓

Legend

↑ Increasing Trend

↓ Decreasing Trend

GROUNDWATER LEVELS

Water levels have been continuously monitored since 2003 in each of the 14 Provincial Groundwater Monitoring Network (PGMN) wells and recorded hourly. Daily water levels from 2003 to 2010 have been recently analysed and compared to climatic and seasonal trends. With the exception of four wells (Durham forest [deep well], Ballantrae [deep well], and Oro-Medonte [intermediate and deep wells]), which show influences of nearby pumping, all of the wells tend to reflect background groundwater level conditions. Long-term monitoring of baseline groundwater levels can provide insights on seasonal influences; long term trends; and issues, including drought and climate change assessments.

TRENDS

Long Term Trends

The majority of wells show consistent, long-term water levels over the entire period of record. These wells provide good baseline groundwater levels that can be used to monitor changes in climatic and seasonal conditions over the long term.

However, three of the 14 wells exhibit an upward trend over the period of record. The deep well in Durham forest shows an increase on the order of 2.5 m, the deep well at Ballantrae has increased approximately 1.5 m, and the intermediate well at Aurora has increased 0.7 m. Since the Durham and Ballantrae wells are influenced by pumping, it is unclear whether the upward trend is a result of climatic conditions or from a decrease in the rates and/or volume being pumped (groundwater levels for the Ballantrae well are shown in Figure 7-4). A longer period of record and comparison with nearby pumping rates may provide additional insights into these observed trends.

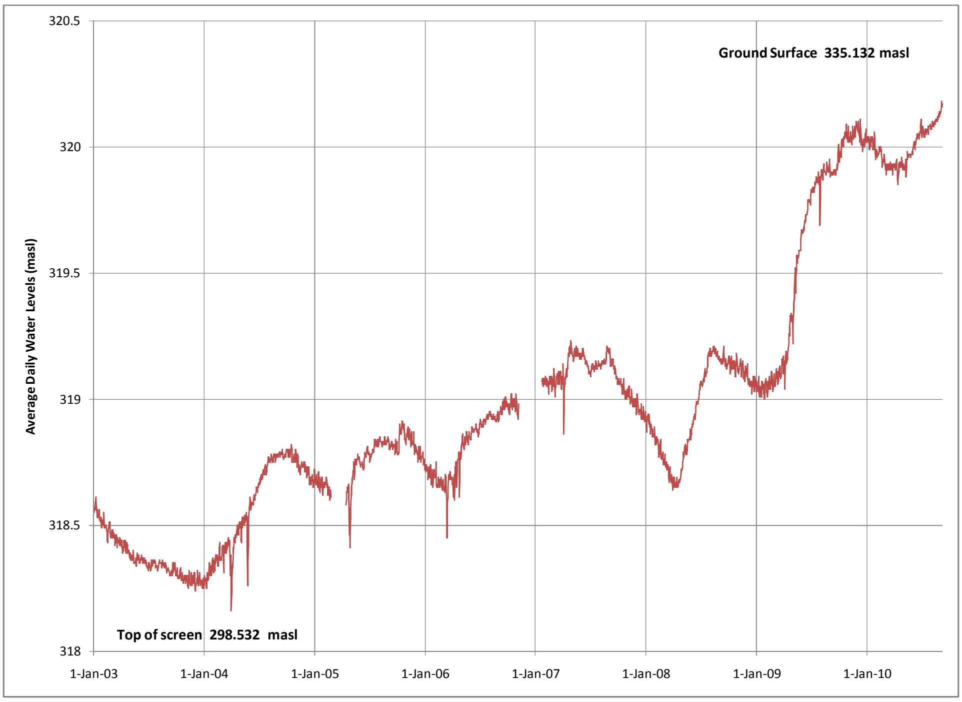


Figure 7-4: Daily groundwater levels for the Ballantrae monitoring well, which shows an upward trend of approximately 1.5 m over the period of record.

Short-Term Trends

Where long-term water level trends in a well may provide an indication of significant climatic shifts and/or local land use changes, short-term water level trends can provide insight into the sustainability of the aquifer on a seasonal basis. For example, shallow wells or wells screened in an unconfined aquifer (an aquifer that is open to receive water from the surface, with no overlying layers of low permeability) may fluctuate significantly more than deep wells during seasonal events/changes. The magnitude of water level changes within the well can provide some indication of the susceptibility of the aquifer to withstand drought and local water taking activities. These trends can also provide insight on the response of the well or aquifer to local precipitation events and whether recharge occurs after a significant delay.

The short term water level trends displayed by the wells are generally influenced by seasonal precipitation and recharge events. All wells, with the exception of those influenced by pumping (Durham forest [deep well], Ballantrae [deep well], and Oro-Medonte [intermediate and deep wells]), display seasonal water level patterns. Water levels that are influenced by nearby pumping activities may still exhibit seasonal effects; however, it is generally more difficult to isolate these trends without additional monitoring data.

In general, higher groundwater levels are observed during the spring and winter in response to snow melt and precipitation events. The lowest groundwater levels are observed during the summer and fall when precipitation is commonly at its lowest. The change in observed water levels due to seasonal fluctuations range from 0.5 m to 3 m between the highest and lowest points.

Figure 7-5 displays precipitation from the Environment Canada Black River flow station compared to daily groundwater levels for the Baldwin shallow, intermediate, and deep wells. Seasonal fluctuations are observed on the order of 1 to 2 m, over the period of record. Groundwater levels peak in the winter/spring and are at their lowest during the summer/fall, which is fairly typical for wells that are influenced by seasonal recharge patterns. In comparison, precipitation peaks in the late summer, indicating that there is a lag between the time that higher levels of precipitation fall and when it seeps into groundwater stores.

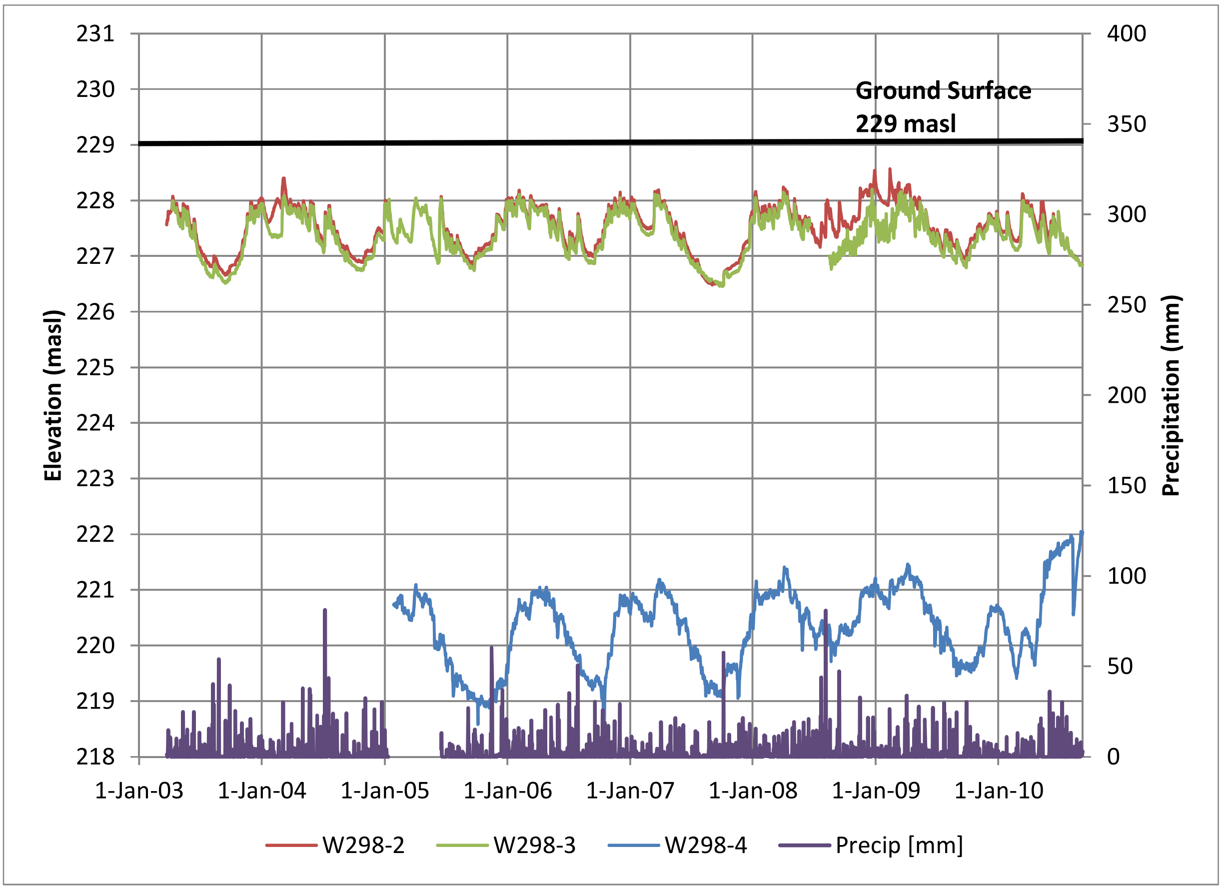


Figure 7-5: Precipitation from the Environment Canada Black River flow station compared to daily groundwater levels for the Baldwin shallow, intermediate, and deep wells (W0000298-2, W0000298-3, & W0000298-4), shows seasonal fluctuations on the order of 1 to 2 m, over the period of record.

Additional insights can be gained by monitoring multiple intervals (depths) at the same location. As seen from Figure 7-5, the shallow and intermediate wells at Baldwin show the same water levels. Although these screens are separated by more than 20 metres and some till units, the water levels indicate that the screens are located in the same water bearing zone (i.e. aquifer). The deep bedrock well (W0000298-4) displays lower water levels with the same pattern, indicating that there is a connection between the overlying sediment and the bedrock aquifer. Knowledge of this connection can be useful in undertaking groundwater modelling and mapping exercises that can be used in the management of groundwater resources.

FISH

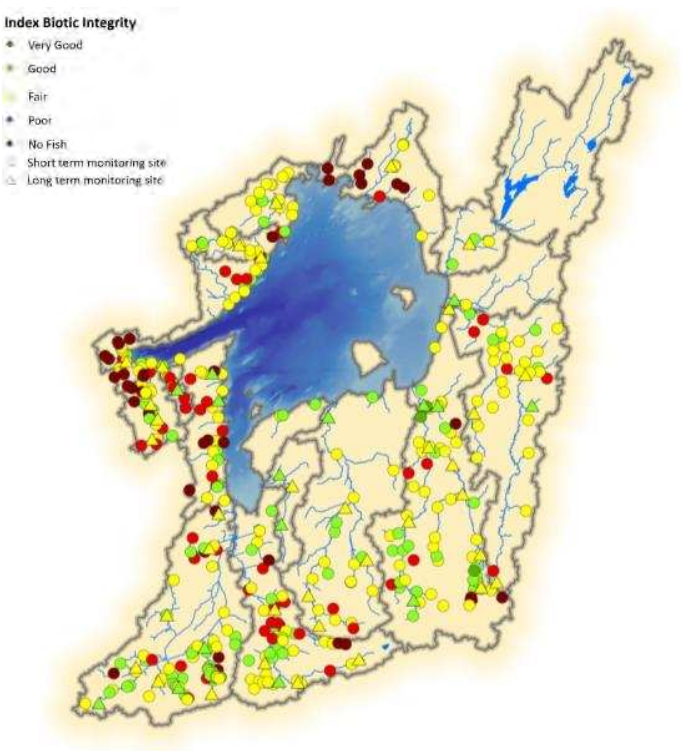


Figure 8-1: Index of biotic integrity scores at fisheries monitoring sites throughout the Lake Simcoe watershed

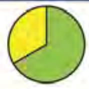
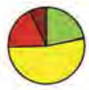
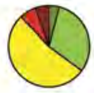
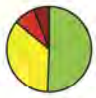
Fish are sensitive to a great number of stresses including degraded water quality, increasing temperatures, changing flow regimes, and the removal of instream or bankside habitat. While they are able to move quickly in response to a sudden change in conditions (e.g. a release of a chemical into the system) and are therefore not a good indicator of these types of issues, prolonged stresses will eventually cause a shift in the fish community from one that is sensitive and requires clean, cool water to survive to one that is more tolerant of degraded conditions. A fish Index of Biotic Integrity is used to evaluate the ecological integrity of the fish communities within the Lake Simcoe watershed. There are varying numbers of monitoring sites in each subwatershed, with the West Holland River subwatershed having the most at 85, and the Whites Creek subwatershed having the least, with only two (Figure 8-1). This needs to be taken into consideration when comparing subwatershed results.

Three monitoring sites were rated as ‘Very Good’, all located in the Pefferlaw (Uxbridge) River subwatershed. The Georgina Creeks and Maskinonge River subwatersheds share the highest percentage (67%) of ‘Good’ sites, however since they both only have three monitoring sites, these results may not be fully representative of the entire system. Nine of the 17 monitored subwatersheds had fish caught at every monitoring site; possible issues at the eight sites where no fish were captured include barriers or lack of flow.

The Barrie Creeks and Ramara Creeks subwatersheds have the lowest scores with a large percentage of sites having no fish (42% and 38%, respectively) and a small percentage of sites having a rating of “Good’ or better (13% and 15%, respectively). Results for each subwatershed are summarized in Table 8-1

LSRCA electrofishing crew collecting fisheries samples

Table 8-1: Proportion of sites with each Index of Biotic Integrity rating in each Lake Simcoe subwatershed

Subwatershed	% of sites per rating	# of Sites	Subwatershed	% of sites per rating	# of Sites
Barrie Creeks		24	Maskinonge River		3
Beaver River		36	Oro Creeks North		20
Black River		24	Oro Creeks South		11
East Holland River		55	Pefferlaw/ Uxbridge		74
Georgina Creeks		3	Ramara Creeks		13
Hawkestone Creek		26	Talbot River		4
Hewitt's Creek		14	West Holland River		85
Innisfil Creeks		31	Whites Creek		2
Lovers Creek		26			

IBI Ratings

- Very Good
- Good
- Fair
- Poor
- No Fish

Trends

The trends of the 30 long term fish monitoring stations in the Lake Simcoe watershed were looked at over a 10 year period (2002-2011) to determine if there had been any significant changes. Significance was evaluated using regression analysis on the IBI scores calculated over the 10 year period. This analysis identified seven sites showing a significant trend, while the other 23 long term sites in the watershed are in various states (slight decline, slight improvement, or static) but are not showing statistically significant changes. Of the seven sites showing trends (Table 8-2), six show a declining IBI score (indicating there are fewer coldwater species, less species diversity, and/or an increase of invasive species), with only one site in the West Holland River (WH-21) subwatershed showing a significant improvement (indicating an increase in coldwater species, increased species diversity, and/or fewer invasive species).

Site WH-21, located in a well-buffered section of Pottageville Creek in the upper portion of the West Holland River subwatershed, is the site showing a significant improvement. In comparison to the 2003 and 2006 sampling season when no brook trout were captured and there was low species diversity, the 2008 and 2010 sampling seasons had several adult brook trout caught and great species diversity, resulting in a significant increase in the IBI scores.

In the Pefferlaw River subwatershed there are four sites that are showing a significant declining IBI score, all of which are in the mid to lower portions of the subwatershed. These declining scores are associated with the loss of brook trout and/or mottled sculpin over the past several years, and, at site PF1-01 in the lower reaches, due to the increasing presence of round goby (invasive) that is displacing native species.

Table 8-2: Long term fish monitoring sites showing significant trends, and causes of these trends.

Subwatershed	Site	Trend	Cause
West Holland River	WH-21	↑	New brook trout
Pefferlaw River (includes Uxbridge Brook)	PF1-01	↓	Round goby
	PF1-18	↓	
	PF1-26	↓	
	UX1-04	↓	
Beaver River	BVRV-02	↓	Loss of diversity
East Holland River	EH-03	↓	Lack of brook trout, loss of diversity

Brook trout (*Salvelinus fontinalis*)

BENTHIC INVERTEBRATES

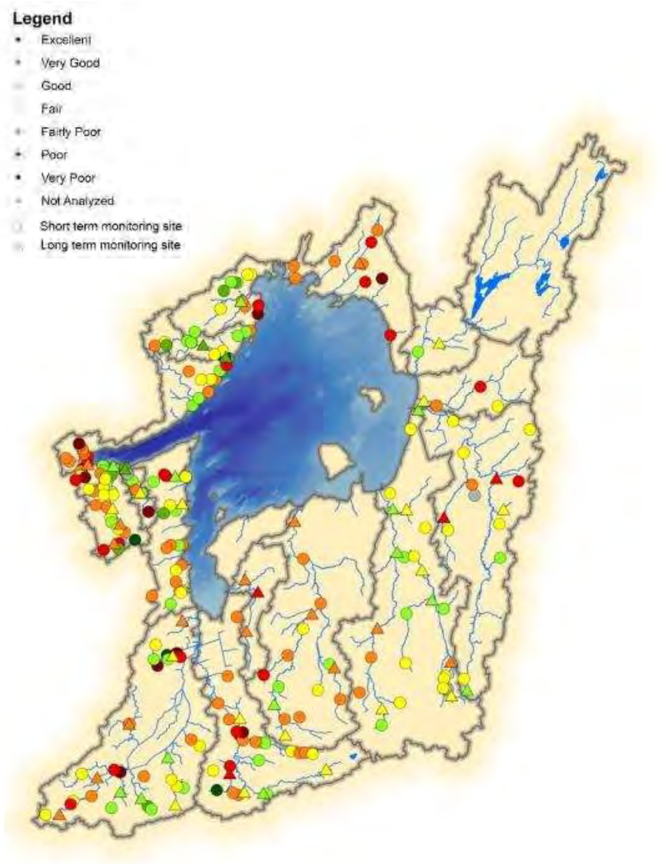


Figure 8-2: Hilsenhoff index of Biotic Integrity scores for Lake Simcoe benthic invertebrate stations

Benthic invertebrates, the aquatic insects, crustaceans, molluscs, and worms that dwell on the stream bottom, are an ideal indicator of water quality as different species have different tolerances to factors such as nutrient enrichment, dissolved solids, oxygen, and temperature. The presence or absence of a certain species can be used to help determine water quality at a given site.

Unlike fish, benthic invertebrates are not able to move quickly in response to a sudden change in conditions (e.g. a release of a chemical into the system) and are therefore a good indicator of these types of issues. Long term changes also impact benthic communities, causing them to shift from one that is sensitive and requires clean, cool water to survive, to one that is more tolerant of lower quality conditions.

The Hilsenhoff Biotic Index is used to evaluate the ecological integrity of the benthic invertebrate communities within the Lake Simcoe watershed. In total, 234 sites were monitored for benthic invertebrate species from 2002 to 2011 (Figure 8-2). However, the number of monitoring sites in each subwatershed varies, with the West Holland River subwatershed having the most with 37, and the Georgina Creeks subwatershed having the least, with no monitoring sites. This needs to be taken into consideration when comparing subwatershed results.

Both the Hawkestone Creek and the Hewitt's Creek subwatersheds have the highest percentage of 'Excellent' sites (35% and 31%, respectively). The Barrie Creeks subwatershed has the lowest rankings with 23% of its sites ranked as 'Very Poor' and no sites being ranked 'Good' or better. The results for each subwatershed are summarized in Table 8-3.

Table 8-3: Number of sites with each Hilsenhoff Biotic Index score in each Lake Simcoe subwatershed

Subwatershed	% of sites per rating	# of Sites	Subwatershed	% of sites per rating	# of Sites
Barrie Creeks		22	Maskinonge River		3
Beaver River		14	Oro Creeks North		14
Black River		16	Oro Creeks South		10
East Holland River		27	Pefferlaw/ Uxbridge		25
Georgina Creeks	N/A	0	Ramara Creeks		1
Hawkestone Creek		17	Talbot River		2
Hewitt's Creek		13	West Holland River		37
Innisfil Creeks		22	Whites Creek		4
Lovers Creek		21			

Hilsenhoff Ratings

- Excellent
- Very Good
- Good
- Fair
- Fairly Poor
- Poor
- Very Poor

Trends

The trends of the 19 long term benthic monitoring sites within the Lake Simcoe watershed were looked at over a 10-year period (2002-2011) to determine if there had been any significant changes. Significance was evaluated using regression analysis on the HBI scores calculated over the 10-year period. This analysis shows three of the 19 sites had significant long-term trends (Table 8-4), while the other 16 sites within the watershed are in various states (slight decline, slight improvement, or static) and are not showing a significant change.

Site WH-35 in the West Holland River subwatershed is located near the outlet of Kettleby Creek (a headwater tributary), with a wide buffer area in a mainly agricultural setting. The long term trend for this site indicated a significant improvement over the sampling period. The greatest change was seen between 2007 and 2009, with Hilsenhoff scores significantly decreasing (a higher quality environment reflects a lower score, while more degraded sites will have a higher Hilsenhoff score) from 4.04 to 3.67. This was a result of fewer midges (4.84% to 1.52%), which are pollution tolerant, and an increase in sensitive shredder species (from the Ephemeroptera, Plecoptera and Trichoptera – or EPT – orders; see Figure 8-3) from 67.74% to 70.45%. Site WHI1-01 in White's Creek subwatershed is also surrounded by agricultural landuses, but with little to no buffer at the outlet of White's Creek. Despite minimal riparian area, WHI-01 went from a Hilsenhoff rating of Good to Very Good between 2007 and 2009. This is a result of a decrease in midges (17.89% to 6.03%) and an increase in EPT species (27.37% to 68.10%).

The only site to show a significantly increasing Hilsenhoff score (which corresponds to declining community health) is located within the Beaver River subwatershed; Site BVRV-02 is located in Vrooman Creek in a generally marshy area with large buffer areas. Again, between the years of 2007 to 2009 there was a change in the Hilsenhoff scores from a rating of Fair to Fairly Poor. This significant decline is a result of an increase in worm species (6.45% to 21.14%) and crustacean species (4.30% to 40.54%), both of which have a higher tolerance to organic pollution and increase the Hilsenhoff scores for a poorer rating.

Table 8-4: Long term benthic invertebrate monitoring sites showing significant trends

Subwatershed	Site	Trend	Cause
West Holland River	WH-35	↑	Fewer pollution tolerant species, increase in EPT species
White's Creek	WHI1-01	↑	Fewer pollution tolerant species, increase in EPT species
Beaver River	BVRV-02	↓	Increase in pollution tolerant worm and crustacean species

A B C

Figure 8-4: Benthic invertebrate orders of note - (A) Ephemeroptera (mayfly), (B)Plecoptera (stonefly), and (C) Trichoptera (caddisfly)

TEMPERATURE

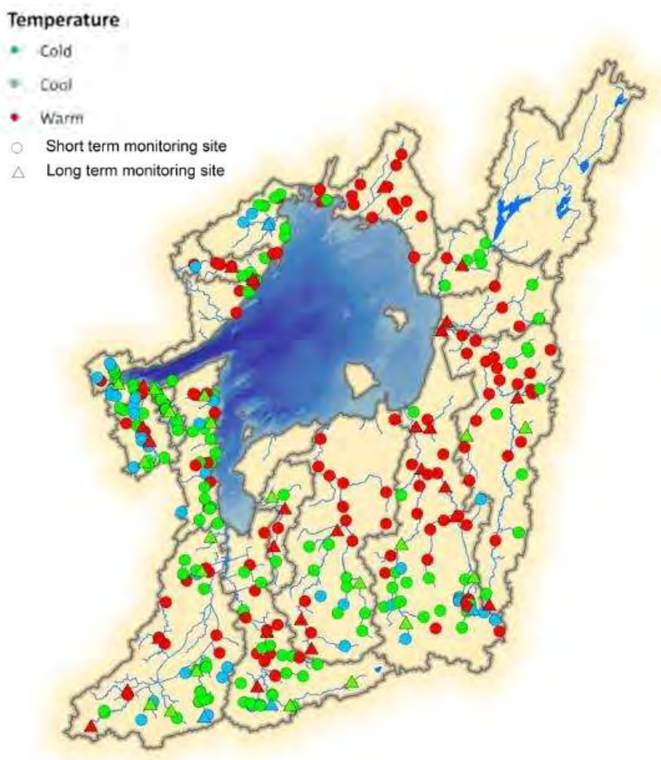


Figure 8-5: Water temperature classifications at Lake Simcoe monitoring sites

The water temperature of a system can dictate the composition of the aquatic communities, as well as determine how systems are managed. Water temperature is affected by natural conditions such as precipitation, groundwater inputs, and natural features such as wetlands. Anthropogenic alterations to watercourses and the surrounding landscape can negatively impact the water temperature of a system. For example, creating online ponds, removing stream bank vegetation, and creating impervious surfaces can all increase the water temperature in a stream, resulting in adverse effects on fish and benthic invertebrate populations.

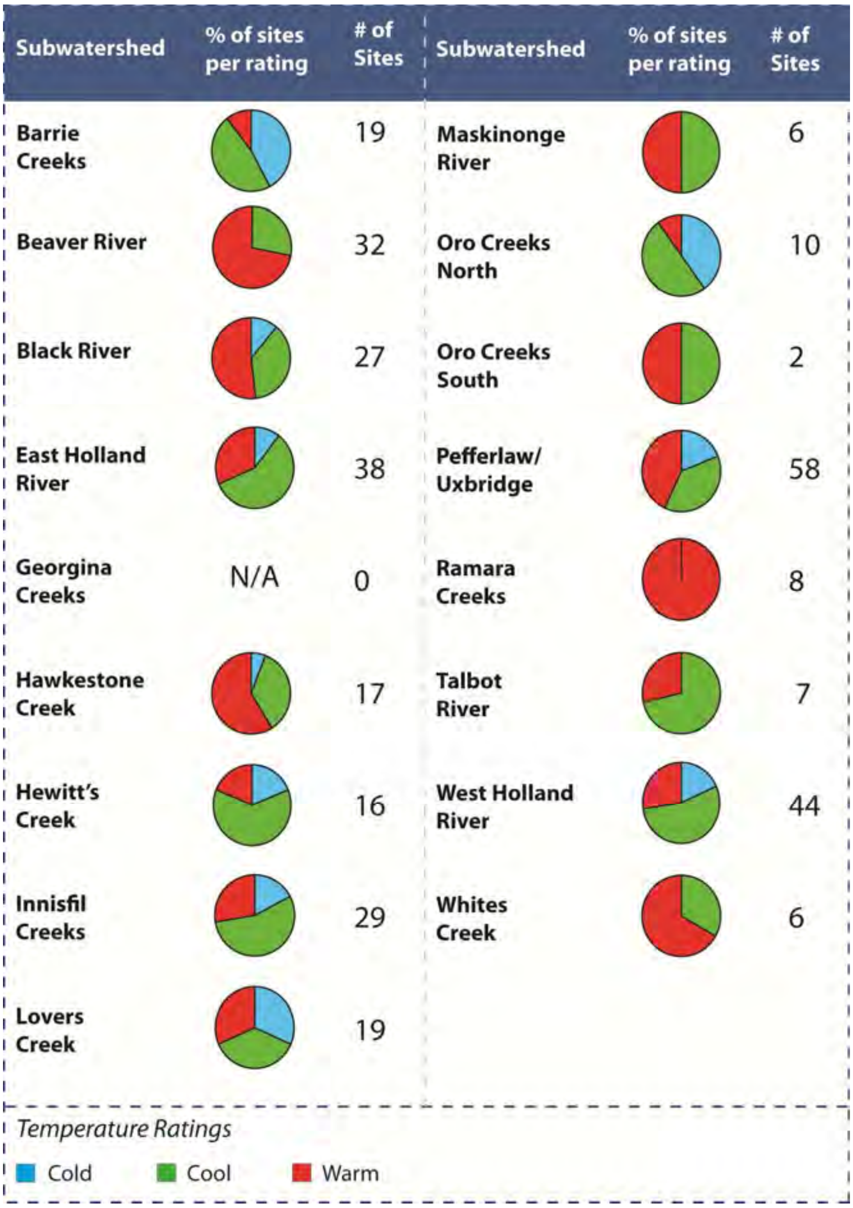
Temperature monitoring was undertaken at 338 sites within the Lake Simcoe watershed between 2003 and 2011. Of these, 53 sites recorded cold water temperatures, 151 were recorded as cool water, and 134 sites recorded warm water temperatures (Figure 8-5). It should be noted that the temperature loggers collect data at a single point and only represent the temperatures at that location (cannot be extrapolated to a reach, tributary, or watershed).

The majority of the subwatersheds with headwater streams on the Oak Ridges Moraine (Pefferlaw/Uxbridge, Black, Beaver, East Holland, and West Holland Rivers) recorded cold water temperatures in this area, mainly due to groundwater influence. Downstream of these areas, the sites tend to record warmer temperatures as the watercourses pass through wetlands, urban areas, and experience the natural warming that takes places as streams grow wider. The headwater areas in the south and west of the watershed typically have cooler systems, containing cold water fish species such as brook trout. Warmer temperatures are being seen in areas of the watershed where watercourses are being used as municipal drains and there are fewer groundwater inputs. Results are summarized in Table 8-5.

The headwaters of streams in the Oro Moraine are very similar to those on the Oak Ridges Moraine. Factors such as land use change, water taking, and the removal of bank vegetation are causing thermal degradation in the middle and lower reaches in the subwatersheds in this area. For example, Hawkestone Creek has only one of its 17 monitoring sites recording cold water temperatures, and only warm water temperatures through its middle sections.

Historically, watercourses within the Barrie Creeks subwatershed were cold water. Despite the intense urban build-up of the area, many of the creeks have remained mostly cool or cold water. The creeks in the Innisfil Creeks subwatershed were also likely cold water, supported by groundwater inputs. With the removal of streambank vegetation for agriculture and the increase in urban area, many are changing to cool and warm water systems.

Table 8-5: Proportion of sites in each subwatershed that are classified as cold, cool, and warm water



Subwatershed	% of sites per rating	# of Sites	Subwatershed	% of sites per rating	# of Sites
Barrie Creeks		19	Maskinonge River		6
Beaver River		32	Oro Creeks North		10
Black River		27	Oro Creeks South		2
East Holland River		38	Pefferlaw/ Uxbridge		58
Georgina Creeks	N/A	0	Ramara Creeks		8
Hawkestone Creek		17	Talbot River		7
Hewitt's Creek		16	West Holland River		44
Innisfil Creeks		29	Whites Creek		6
Lovers Creek		19			

Temperature Ratings

Cold Cool Warm

Trends

Trends for 36 of the long-term temperature monitoring sites within the Lake Simcoe watershed were evaluated (2003-2011). Significance was evaluated using regression analysis on the average daily maximum temperature for each year calculated over the nine year period. Results of this analysis show six of the 36 sites had significant long-term trends, while the other 30 sites within the watershed are in various states (slight increasing temperature, slightly decreasing temperature, or static) and are not showing a significant change. Of the six showing significant trends, four are exhibiting a significant increase in temperature over the nine year study period (Figure 8-6, Table 8-6). Two of these sites are located in the upstream reaches of the West Holland subwatershed (WH-24, WH-87), while the other two are in the middle and lower reaches of the Pefferlaw River subwatershed (PF1-36, UX1-04). The two sites that showed a decreasing temperature trend were in the upstream area of the East Holland River (EH-57) and at the mouth of White's Creek (WHI1-01) subwatersheds.

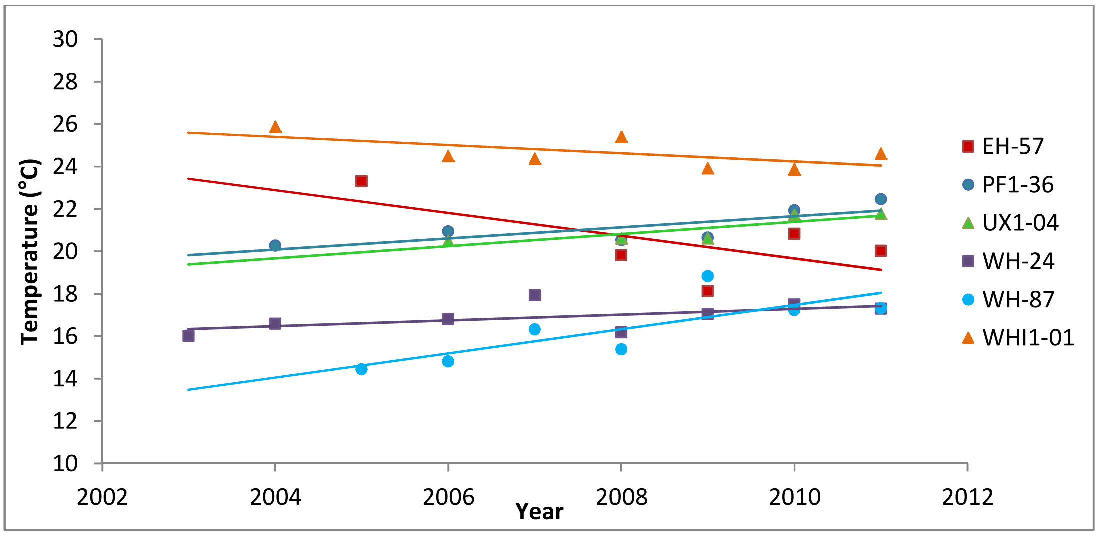
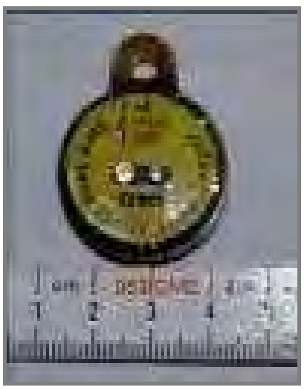


Figure 8-6: Trends in average daily maximum temperature (2003-2011).

Table 8-6: Trends in average daily maximum temperature (2003-2011).

Monitoring station	Trend (2003-2011)
PF1-36	↑
UX1-04	↑
WH-24	↑
WH-87	↑
EH-57	↓
WHI1-01	↓



Temperature Logger

DIATOMS

Diatoms (Bacillariophyceae) are single-celled algae encased in frustules of silicon dioxide that live free-floating in the water column or attached to rocks, plants, sand grains, and other substrates. As these algae have well-studied ecological optima and tolerances to most environmental variables, the species assemblages can be related to environmental conditions and used to assess and track a wide variety of changes.

As an example, Table 8-7 shows the reliability of how some key diatom-inferred environmental variables are correlated with measured water chemistry values in Lovers and Hawkestone Creeks (Figure 8-7 displays some of the diatoms found through this sampling). Diatom samples were collected along with water chemistry and benthic invertebrates from all stream habitats. After identification under a microscope, diatoms were added with water chemistry data to a “calibration set” which relates species to environmental conditions. This data set, containing information from over 115 sites in Southern Ontario, and another 1240 sites in the continental United States, was then used to infer environmental conditions at our sample sites.

Table 8-7: Comparison of diatom-inferred and measured data for key environmental indicators at Lovers and Hawkestone Creeks.

Limnological Variable	Lovers Creek		Hawkestone	
	Diatom-inferred	Measured	Diatom-inferred	Measured
pH	8.1	8.1	7.9	8.1
Temperature (^{o}C)	18.9	17.9	19.5	17.9
Dissolved oxygen (mg·L^{-1})	9.3	9.1	9.4	9.0
Total phosphorus (mg·L^{-1})	0.03	0.03	0.02	0.02
Total nitrogen (TKN) (mg·L^{-1})	0.74	0.50	0.71	0.60

Continuation of this study in future years will provide a low-cost method of tracking environmental changes in the Lake Simcoe watershed.

Figure 8-7: Photograph of diatom assemblage (mounted on a microscope slide) collected from Lovers Creek. White scale bar is 10 µm (0.01 mm) in length

INVASIVE SPECIES

The traits possessed by invasive species, including aggressive feeding, rapid growth, prolific reproduction, and the ability to tolerate and adapt to a wide range of habitat conditions, enable them to outcompete native species for food, water, sunlight, nutrients, and space. The replacement of native species with introduced affects the balance of the ecosystem, as species that relied on the native species for food, shelter, and other functions now either have to move to another area, or must utilize another source that is less desirable. Ecosystems that are already under stress are particularly vulnerable to invasion by non-native species, as the existing ecosystem is not typically robust enough to maintain viable population of native species as the invasive species becomes more established.

In the Lake Simcoe watershed, there are a total of 13 aquatic invasive species, consisting of fish (five), aquatic invertebrates (five) and aquatic plants (three), as well as two aquatic diseases (Table 8-7).

Table 8-7: Aquatic invasive species in the Lake Simcoe watershed (source: LSRCA, MNR and www.fishingsimcoe.com).

Common Name	Scientific Name	Year of first Capture
Fish		
Common carp	*Cyprinus carpo*	1896
Rainbow smelt	*Osmerus mordax*	1962
Black crappie	*Pomoxis nigromaculatus*	1987
Bluegill	*Lepomis macrochirus*	2000
Round goby	*Neogobius melanostomus*	2004
Aquatic invertebrates		
Zebra mussels	*Dreissena polymorpha*	Early 1990s
Spiny waterflea	*Bythotrephes longimanus*	1993
Quagga mussels	*Dreissena rostriformis bugensis*	2004
Rusty crayfish	*Oronectes rusticus*	2004
Eurasian amphipod	*Echinogammarus ischnus*	2005
Submergent aquatic plants		
Curly-leaf pondweed	*Potamogeton crispus*	1961-1984
Eurasian watermilfoil	*Myriophillum spicatum*	1984
Red algae	*Bangia atropurpurea*	1980
Starry Stonewort	*Nitellopsis obtusa*	2010
Aquatic diseases		
Koi Herpes Virus (KHV)		2008
Viral Hemorrhagic Septicemia (VHS)		2011

The round goby (*Neogobius melanostomus*) is the species that is currently of greatest concern in the watershed. Round gobies are native to Europe and were released into Canadian waters via ballast from international ships. They are an aggressive and fertile sculpin-like species that can out-compete native species for space and food. The round goby was first discovered in the Pefferlaw River in 2004 by an astute angler, and their presence was confirmed in June 2005 by the LSRCA and OMNR. In October 2005, efforts were made to eradicate the gobies by application of the pesticide Rotenone by licensed applicators and dead fish were removed from the system.

Round goby
Photo Credit: Gary Blight

Unfortunately, the gobies survived/rebounded and spread to the lake. In 2009, round gobies were captured at the mouths of the Black River and Beaver River, and in 2011 were captured at the mouths of Lovers Creek and Hewitt's Creek (Figure 8-8). They have also been captured in the vicinity of Georgina and Thorah Islands. LSRCA and MNR will continue to monitor the spread of this species; however, it would appear that their establishment throughout the lake and its tributaries is inevitable.

Figure 8-8: The spread of round goby around the Lake Simcoe watershed since their discovery in 2005 using LSRCA data set

Canadian Council of Ministers of the Environment (CCME). 2001. Canadian water quality guidelines for the protection of aquatic life: summary table. Updated. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Environmental Protection Act, 1999 (S.C. 1999, c. 33).

Climate Change Research Report-16 McKenney, D.W., J.H. Pedlar, K. Lawrence, P.A. Gray, S.J. Colombo and W.J. Crins. 2010. Current and Projected Future Climatic Conditions for Ecoregions and Selected Natural Heritage Areas in Ontario.

Depew D.C., Houben A.J., Ozersky T., Hecky R.E., Guildford S.J. 2011. Submerged aquatic vegetation in Cook's Bay, Lake Simcoe: assessment of changes in response to increased water transparency. J. Great Lakes Res. 37:72–82.

Eimers, M.C. and J.G. Winter. 2005. Lake Simcoe Water Quality Update 2000-2003. Lake Simcoe Environmental Management Strategy Implementation Phase III Technical Report Imp. B.20.

Environment Canada. 2013. *How Much Habitat is Enough? Third Edition*. Environment Canada, Toronto, Ontario.

Government of Ontario. 2009. Lake Simcoe Protection Plan.

Griffiths, R.W. 1999. *BioMAP: Bioassessment of Water Quality*. Published by Niagara College, Niagara-on-the-Lake, ON.

Hilsenhoff, W. L. 1998. A modification of the biotic index of organic stream pollution to remedy problems and permit its use throughout the year. The Great Lakes Entomologist Vol. 31, No. 1. 1 - 12.

Ice Watch Canada. http://www.naturewatch.ca/english/icewatch/

Mandaville, S.M. 2002. Benthic Macroinvertebrates in Freshwaters-Taxa Tolerance Values, Metrics, and Protocols. Soil & Water Conservation Society of Metro Halifax, Nova Scotia, Canada.

Ontario Ministry of the Environment. 1994. Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of the Environment.

Ontario Ministry of the Environment. 2010. Lake Simcoe Phosphorus Reduction Strategy.

Ontario Ministry of the Environment. 2011. Water Quality in Ontario 2010 Report.

Ontario Ministry of Natural Resources and Toronto and Region Conservation Authority. 2005. Humber River Fisheries Management Plan. Published by the Ontario Ministry of Natural Resources and the Toronto and Region Conservation Authority. Queens Printer for Ontario.

South Georgian Bay-Lake Simcoe Source Protection Committee. 2011. Updated Draft Assessment Report: Lakes Simcoe and Couchiching-Black River Source Protection Area Part 1.

Stanfield L. (editor). 2010. Ontario Stream Assessment Protocol. Version 8.0. Fisheries Policy Section. Ontario Ministry of Natural Resources. Peterborough, Ontario. 376 pages.

Stoneman, C.L., and M.L. Jones. 1996. Department of Fisheries and Oceans and Ontario Ministry of Natural Resources Habitat Management Series. Adapted from: A simple method to evaluate the thermal stability of trout streams. N. Amer. J. Fish Manage. In press.

Period of record for Lake Simcoe water quality stations

Station Name	Year of station initiation	Station Name	Year of station initiation
Upper Schomberg	1977	Beaver	1972
North Schomberg	1993	Whites	1994
Kettleby	1993	Talbot	1993
West Holland	1965	Ramara	2009
East Holland	1993	Bluffs	2008
Tannery	1965	Hawkestone	1993
Maskinonge	1985	Hotchkiss	2008
Mount Albert	1971	Lovers	1974
Black	1993	Hewitt’s	2008
Pefferlaw	1973	Leonards	2008
Uxbridge	2002		

For more information, or for a copy of this guide in an alternative format, please contact LSRCA at 905-895-1281.

Lake Simcoe Region
conservation authority

LAND CODE SUMMARY

There are 9 Sections in this Land Code:

Part 1: Preliminary Matters

This introduces the Land Code to the reader and defines how the document should be read. There is a description of the terms that will be used in the document, an explanation of where the authority to govern comes from, what the purpose of the Land Code is and what lands the Land Code applies to (the reserve land description).

Part 2: First Nations Legislation

This section outlines what law making power the First Nation will have out of the Land Code and the procedure for how new land laws will be created and implemented (including where they will be published and when they take effect) under the Land Code.

Part 3: Community Consultation and Approvals

This section defines how and what the process is for implementing various elements of the Land Code. For example, approving a land use plan or enacting land laws requires community approval under the conditions defined in this section. Furthermore, this section touches on the procedures for a “meeting of members”, and the ratification process and approval thresholds are for passing laws or other matters such as: i.e. development of a heritage site, amendment to the Land Code, or any other matter.

Part 4: Protection of Land

This section outlines some of the key protections the Land Code offers- and the special conditions by which the First Nation could expropriate land (only by community approval through ratification vote) and the conditions for calculating compensation, but also the rights that may not be expropriated. This section also defines the necessity for a law on heritage sites, and ensures no development or amendment can be made to the land use plan to get rid of a heritage site created under this law. Finally this section states that an agreement is necessary for the First Nation to exchange land with another party (i.e. First Nation, Province, and Federal Government) and there are conditions to be met for lands to be received (such as the need for an appointed negotiator, freedom of receiving additional compensation or land in trust, and federal commitment to add any lands to the existing reserve base).

Part 5: Accountability

This section really has to do with how the Land Code is administered by First Nation including the rules for a “conflict of interest” and the duty to report and abstain from participation in land matters where there is a conflict. Also in the context of conflict of interest this section defines the non-application of these rules for common interests, dealing with disputes and penalties.

This section also applies to how financial management, audit and financial reporting will be conducted – establishing separate lands bank accounts, signing officers, bonding, signing authorities, and the adoption of the fiscal year for operations and reporting. This section also goes into detail about the specific rules for a year to year lands budget and financial policy. The final part of this section is about financial records and the member's right to access information on year to year financial statements, audit report, the annual report on lands, and the penalties for interference or obstructing the inspection of these records by another member- and the coordination and roles responsible for creating and making these documents public (i.e. auditor and council).

Part 6: Land Administration

This section starts off by establishing the Lands Committee - it defines the composition, eligibility requirements, selection method, term of office and dealing with vacancies. This section also defines how revenue monies from lands will be handled (from fees, leases etc.), how the registration of land interests (leases, permits, licences) will be conducted and how it is captured through First Nations Land Registry System (FNLRS) and a duplicate register if directed.

Part 7: Interests in Land

This section relates more to the operation of the First Nation's lands administration and how it will address existing interests (e.g. CPs) and new land related interests (e.g. CPs or allocations). This section defines that there will need to be written documents, standards created, and that consent will be necessary to process any granting or disposing of assignments of land. This section defines the rights of CP holders and the procedure for cancelling a CP, the transfer and use of a CP, and the situation when a CP holder ceases to be a member. This section also defines the limits on mortgages and seizures, transfers upon death, and the principles for spousal property law (to be made into a Matrimonial Real Property law)

Part 8: Dispute Resolution

This section is created to address how possible disputes that could arise by any benefactor (e.g. First Nation member) of the Land Code and how the process for addressing disputes will be conducted. For example, an adjudicator would be established to resolve disputes in relation to lands unless members could come to some resolve by way of an informal resolution of disputes. The section sets out the powers for the adjudicator, adjudication procedures and decisions and the member's ability to appeal these decisions and expectations around costs.

Part 9: Other Matters

This section defines four (or more) items to address common issues such as:

1. Liability- the need for director and officers insurance for Lands Committee members,
2. Offences and enforcement- what are offences and what is the penalty,
3. Amendments to Land Code- specifically the process for amending this Land Code,
4. Commencement- defines when the actual start date will be.

Maternal And Infant Health And The Physical Environment Of First Nations And Inuit Communities:

A Summary Review

PREPARED FOR

Prairie Women's Health Centre of Excellence (PWHCE)

and the

British Columbia Centre of Excellence for Women's Health (BCCEWH)

APRIL, 2009

R. STOUT, T. DIONNE STOUT & R. HARP

INDIGENA Creative Group

British Columbia Centre of Excellence for Women's Health

PRAIRIE WOMEN'S HEALTH CENTRE OF EXCELLENCE
RESEARCH ▪ POLICY ▪ COMMUNITY

Maternal And Infant Health And The Physical Environment Of First Nations And Inuit Communities: A Summary Review

R. STOUT, T. DIONNE STOUT & R. HARP

PREPARED FOR

Prairie Women's Health Centre of Excellence (PWHCE)

and the

British Columbia Centre of Excellence for Women's Health (BCCEWH)

APRIL, 2009

Prairie Women's Health Centre of Excellence (PWHCE) and British Columbia Centre of Excellence for Women's Health (BCCEWH) support and conduct new knowledge and research on women's health, and provide policy advice, analysis and information to governments, health organizations and non-governmental organizations. They are funded by the Women's Health Contribution Program of Health Canada. The views expressed herein do not necessarily represent the official policy of PWHCE, BCCEWH or Health Canada.

The Prairie Women's Health Centre of Excellence
56 The Promenade
Winnipeg, Manitoba R3B 3H9
Telephone (204) 982-6630 Fax (204) 982-6637
pwhce@uwinnipeg.ca

B C Centre of Excellence for Women's Health
E311- 4500 Oak Street, Box 48
Vancouver, BC V6H 3N1
Telephone (604) 875 2633 Fax (604) 875 3716
bccewh@cw.bc.ca

This report is also available on our websites: www.pwhce.ca
www.bccewh.bc.ca

This is project #183 of the Prairie Women's Health Centre of Excellence

ISBN # 978-1-897250-20-4

Maternal And Infant Health And The Physical Environment Of First Nations And Inuit Communities: A Summary Review

R. STOUT, T. DIONNE STOUT & R. HARP

PREPARED FOR

Prairie Women's Health Centre of Excellence (PWHCE)

and the

British Columbia Centre of Excellence for Women's Health (BCCEWH)

APRIL, 2009

Table of Contents

Part 1 - Introduction

Methodology ... 1

Parameters and Limits ... 1

Part 2 – Findings & Analysis

Research Timeline ... 3

Database / Keyword Analysis ... 4

Research Target Groups ... 5

Aboriginal Identity & Geographic Focus ... 5

Sources / Nature of Environmental Threat ... 7

Environmental Effects ... 8

Environmental Threat Pathways ... 8

Sources of Research ... 9

Collective Synthesis: Research Clusters ... 10

Programs and Initiatives ... 22

Part 3 – Conclusions ... 27

Part 4 – Bibliography ... 29

Imagine for a moment, if you will, the emotions we now feel; shock, panic, grief, as we discover that the food – which for generations nourished us and keeps us whole physically and spiritually – is now poisoning us. You go to the supermarket for food. We go out on the land to hunt, fish, trap, and gather. The environment is our supermarket.

As we put our babies to our breasts, we feed them a noxious chemical cocktail that foreshadows neurological disorders, cancers, kidney failure, reproductive dysfunction. That Inuit mothers – far from areas where POPs are manufactured and used – have to think twice before breast feeding their infants is surely a wake-up call to the world.

- Sheila Watt Cloutier

Part 1
INTRODUCTION

First Nations and Inuit women and infants face challenging health issues in their communities where there are environmental risks. Literature examining these contexts and the processes through which health is affected is relatively limited. The objective of this review is to examine and consolidate the available literature on environmental threats to First Nations and Inuit maternal health in order to identify priorities for future research.

"There are circumstances and conditions that are unparalleled to the North…persistent organic pollutants in country foods…are all factors that complicate the delivery of maternity care programs and services."[1]

Methodology

A review of the published literature was carried out on environmental health and effects on maternal First Nations and Inuit health to assess the current body of knowledge. Information on published studies, in the 30-year period from 1978 to 2008, was obtained from primary literature through an extensive search using MEDLINE, Science Direct, JSTOR and ProQuest databases using the search terms Aboriginal, First Nations, Native American, Inuit, maternal, infant, mercury, health, contamination, environment, Canada, toxic, mining, etc.

As well, a search of national political Aboriginal organizations and NGOs, government departments, national maternal/infant health organizations, and health research institutes websites was conducted to find projects and research related to the physical environmental conditions and Aboriginal health, with particular consideration of maternal and infant health (see Appendix).

The information is compiled in an electronic database for easy reference and analysis.

Parameters and Limits

In researching information on agency websites, there were insufficient data uploaded on to sites, thus limiting knowledge on the extent of work on the subjects. Telephone

[1] Exploring Models for Quality Maternity Care in First Nations and Inuit Communities: A Preliminary Needs Assessment. Final Report of Inuit Women's Needs Assessment. National Aboriginal Health Organization (NAHO). 2006.

interviews and in person meetings would augment the findings. However, the use of databases did provide a variety and number of scientific studies.

Given the time limitations assigned to this paper, we could not generate an exhaustive listing of all available research. This is therefore a sampling of research documents drawn over a period of 12 weeks from the databases mentioned above, which represent the most widely and commonly used sources of this type of information by the science / environment / health community. The result was a total of 73 peer reviewed articles.

PART 2
FINDINGS & ANALYSIS

A considerable number of documents, 73 in all, was found on environmental impacts on First Nations and Inuit peoples' health. In particular, environmental contaminants, traditional food supply and human health effects have been a priority for some time. Closely related is the topic of climate change, which will only increase as a research area of concern over time. Resource development (mining, oil and gas, hydro-electric development), waste disposal (solid and nuclear waste), mould in housing, drinking water quality have also been occasional foci of study.

Maternal and infant health is a crucial part of the health of First Nations and Inuit communities. Women and infants face serious health issues related to environmental contamination. Traditional food security and accessibility is an issue for all Aboriginal peoples for cultural and nutritional benefits.

In reviewing the literature, consideration was given to where emphasis has taken place both in terms of group of people (First Nations vs. Inuit), geographical focus, environmental condition and the inclusion of maternal and/or infant health impacts.

Research Timeline

We begin this overview of the state of knowledge of environmental impacts on Aboriginal maternal and infant health with an examination of its chronology. Over the thirty year period beginning in 1978 and concluding in 2008, a total of 73 studies in this subject area were conducted. That is, an average of fewer than three studies per year. Although environmental research specific to Aboriginal maternal and infant health concerns started to appear more regularly by the 1990s, it was still only at the level of one or two studies a year. It was not until 1997 that scientists pursued knowledge of this sort with any frequency.

The greatest amount of research took place from 2000 through 2008, when there were a total of 45 studies, just over double the amount undertaken in the 90s when 21 studies were performed.

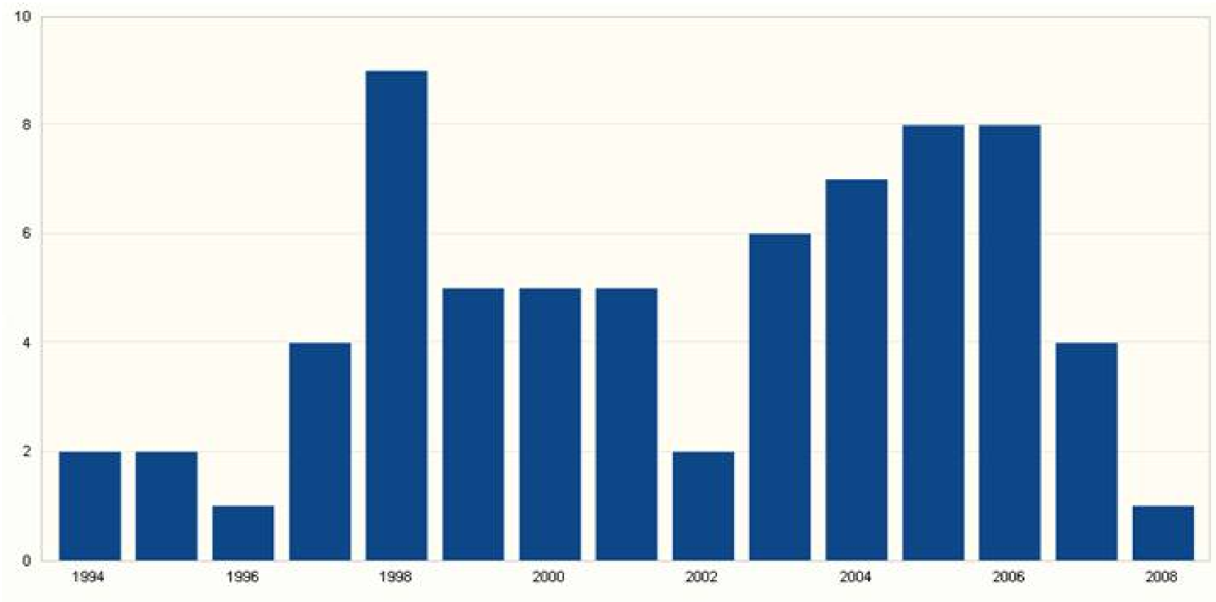


Table 1.1 Timeline, Aboriginal Maternal & Infant Environmental Research, 1994-2008

Database / Keyword Analysis

In order to systematically assess the state of knowledge concerning environmental impacts on Aboriginal maternal and infant health, this paper utilizes a database approach, consisting of strictly relevant, peer-reviewed scientific research available on the web. The recurrence of certain terms – extracted verbatim or in some limited cases inferred from the abstracts of each research paper – has led to the generation of a series of keywords. Based on their level of frequency via search queries, these keywords in turn enable one to form broader conclusions about the predominance of certain themes and topics within the body of existing research. The outcome of this quantitative exercise is complemented by a collective synthesis of the individual insights and results of each research project, making for a complete and integrated picture of the state of knowledge in this area.

Of course, many of the research papers under discussion here will often have more than one keyword turn up in a search of their abstracts, while some will have only one appear. Admittedly, the keywords can also feature degrees of unavoidable overlap. However, the goal here is not to convey some exacting statistical portrait of the research, but more simply to identify general trends, to be enriched by an integrated overview of their collective contribution to the general state of knowledge in environmental Aboriginal maternal and infant health.

Research Target Groups

In the matter of groups targeted by the existing research – *i.e.*, expectant/new mothers and infants – 45% of the research was associated with the keyword *maternal/maternity*, with *women* and *mother(s)* coming in at 36% and 10%, respectively.

KEYWORDS	# of studies	% of total
maternal/maternity	33	45%
women	26	36%
mother(s)	10	14%
infant(s)/infancy	31	42%
child/children	17	23%
pre-/peri-/neo-/post-natal	15	21%
pregnancy	12	16%
fetus/fetal	11	15%
newborn(s)	11	15%
birth	10	14%
postpartum	3	4%

Meanwhile, the keyword cluster of *infant(s)/infancy* came up 42% of the time. That result is well ahead of *child/children* at 23% and the variations of *-natal* at 21%. Generally speaking then, it may be said that, based on the above results, current environmental Aboriginal research is more or less evenly divided between maternal and infant concerns (even where that research may overlap).

Aboriginal Identity & Geographic Focus

Where studies have chosen to focus specifically on a population, *Inuit* have clearly been the dominant subject (58%) of research among Aboriginal peoples in this field, followed well behind by *First Nations* (19%) and *Métis* (12%). Perhaps it should come as no surprise then that *north/northern* also emerges as the single most researched part of the country at 41% with the related *arctic* coming in at 28%, not to mention *subarctic.*

Factor in too that two of the three First Nations that came up are northern-based (the *Cree* of James Bay and the *Dene),* and it becomes quite clear that, at this point in time, the north is the preeminent region for scientific inquiry into environmental Aboriginal maternal/infant health.

KEYWORDS	# of studies	% of total
Inuit	42	58%
First Nations	14	19%
Métis	9	12%
north/northern	30	41%
arctic	28	38%
coastal	10	14%
remote	8	11%
subarctic	4	5%
Nunavik (QC)	14	19%
NWT	12	16%
Nunavut	4	5%
Baffin Island (NU)	3	4%
James Bay (Cree)	3	4%
Ft. Albany FN (Cree)	2	3%
Cree	4	5%
Dene	7	10%
Mohawk	10	14%
Akwesasne	9	12%
Kahnawake	1	1%

Completing this picture of Canada's northern research prevalence, we see the significant recurrence of specific locations like *Nunavik* (19%) in northern Quebec and NWT (16%).

Standing out as an exception to this northern trend is the portion of research (14%) devoted to the southern-based *Mohawk* people of *Akwesasne* (12%) and *Kahnawake* (1%) concerning the environmental effects of living near the St. Lawrence River Seaway. It is obviously the case that the Mohawk are not alone among southern First Nations in facing environmental threats, representing a gap in attention that clearly needs to be addressed.

Sources / Nature of Environmental Threat

With a myriad of chemicals and compounds to deal with, many of them jointly present in a given situation, any list of environmental threats is bound to have some overlap. That said, *contaminant(s)/contamination* would seem to be the nature of the most common threats to communities under study at 62%, with polychlorinated biphenyls or *PCBs* the most specifically researched item at 51%.

KEYWORDS	# of studies	% of total
contaminant(s)/contamination	45	62%
PCBs	37	51%
mercury	25	34%
organochlorine(s)	21	29%
lead	13	18%
DDE	13	18%
metal/s	12	16%
HCB	11	15%
methylmercury	10	14%
POPs	9	12%
DDT	8	11%
waste	7	10%
mirex	7	10%
radionuclides/radioactivity	6	8%
cadmium	6	8%
selenium	6	8%
PCDDs / PCDFs	5	7%
lead	13	18%

Heavy metals showed up quite frequently in studies – from *mercury* (34%) to *lead* (18%) to *cadmium* (8%) – and were often cited together, sometimes alongside the all-purpose keyword itself, namely, *metals* (16%). Similarly, the keyword *organochlorine(s),* which came in at a strong 29%, has its own potential share of overlap with keywords like *DDT* (11%) and *mirex* (10%).

Environmental Effects

In terms of consequences for humans, some terms recurred more often than others, with various forms of the keyword *toxic* (*e.g.*, neurotoxicity, toxicant) topping the list at 30% along with *body burden* at 15%. The potential for environmental links to *diabetes* came up in a small number of cases at 4%.

KEYWORDS	# of studies	% of total
toxic	22	30%
body burden(s)	11	15%
bioaccumulation	6	8%
diabetes	3	4%

Environmental Threat Pathways

Clearly, in the field of research under examination, the main preoccupation of scientists with regard to pathways was *food* (41%), along with related variations of *diet*- (36%). Include the keywords *traditional food* (27%) and *country food* (8%) and that focus only deepens. Given that the geographic focus has been mainly northern, it makes sense that *marine* (21%), *seafood* (8%) and *fish* (32%) came up time and time again in the keyword search. That said, *mammal(s)* did figure into the picture (even if some of them are marine-based) at 14%.

KEYWORDS	# of studies	% of total
food	30	41%
diet/dietary/diets	26	36%
fish	23	32%
Traditional food	20	27%
marine	15	21%
milk	12	16%
mammal(s)	10	14%
food chain	9	12%
water	8	11%
fat	7	10%
breastfeeding	7	10%
meat	7	10%
country food	6	8%
seafood	6	8%
air	6	8%
seal	4	5%
caribou	3	4%
beluga	3	4%

All of these pathways can of course be encapsulated under the umbrella term *food chain* (12%), with infants falling in a sense at the end of that chain via the act of *breastfeeding* (10 %) and its *milk* (16 %).

Other pathways under examination included *water* (which could of course also incorporate *marine*) and *air*, which came up in 11% and 8% of the scientific research, respectively.

Sources of Research

Another potential measure of the state of scientific knowledge arguably derives from the variety of professionals who produce the research. Here, a more broadly based pool of scientists studying a subject ultimately leads to more robust science, *i.e.*, the more minds and eyes the better. After all, such thinking is what partly lies behind the whole concept of peer review. Seen in that light, a search for recurring names of researchers revealed that a significant proportion of the scientific literature concerning environmental threats to Aboriginal maternal/infant health has come from a common set of sources.

Co-Researcher	# of studies	% of total
Éric Dewailly	24	33%
Pierre Ayotte	19	26%
Gina Muckle	13	18%
Suzanne Bruneau	8	11%
Hing Man Chan	6	8%
H. V. Kuhnlein	6	8%
Edward F. Fitzgerald	5	7%
Syni-An Hwang	5	7%
Sandra W. Jacobson & Joseph L. Jacobson	5	7%
Brian Bush	4	5%
K. Cook	3	4%

Possibly worthy of note is the fact that the three most prevalent names (Dewailly, Ayotte & Muckle) have actually worked on 13 studies together as a formal research team, for 18% of the total. It would be of additional interest to look into how many of these researchers are of Aboriginal descent and/or maintain close ties to Aboriginal communities, including place of residence.

Collective Synthesis: Research Clusters

The following clusters of studies illustrate the current overall state of knowledge on environmental threats to First Nations and Inuit women and infants.

Study after study noted how Inuit consumption of relatively large amounts of seafood and marine mammals exposed them to various contaminants. Accordingly, much if not most of the research centered around the assessment and/or evaluation of the suspected links between the traditional northern diet and adverse health effects among Inuit infants and mothers. Among the various findings that make up the general pool of knowledge in this area:

- Dallaire et al. (2004) indicated that two decades of research has found neurological and immunological effects in the developing fetus and in infants exposed to either background or slightly elevated levels of persistent organic pollutants (POPs) such as PCBs

- Van Oostram et al. (2004) stated that among some circumpolar arctic populations, levels of PCBs are in the range where subtle effects on learning and the immune system have been reported

- Dallaire et al. (2004) found a possible association between prenatal exposure to organochlorines (OCs) and acute infections (e.g., upper and lower respiratory tract infections, otitis media) among a cohort of 199 Inuit infants (0-1) in Nunavik, QC

- Dallaire et al. (2004) saw a lack of association when postnatal exposure was considered

- Dallaire et al. (2006) found the incidence rates of acute otitis media (AOM) and lower respiratory tract infections (LRTIs) were positively associated with prenatal exposure to PCBs among a cohort of 343 preschool (age 0-5) Inuit children, and concluded this exposure could be responsible for a significant portion of LRTIs among these children

- However, Dallaire et al. (2006) found "no association" between prenatal PCB exposure and the incidence rate of either upper respiratory tract infections (URTIs) or hospitalization

- Dewailly et al. (2000) concluded that prenatal exposure to organochlorines like DDE, HCB and dieldrin could be a risk factor for acute otitis media among Inuit infants (0-1) from Nunavik

- Ayotte et al. (1994) stated that breastfeeding "strongly influences" a child's body burden of dioxin-like compounds until age 20 (but not after)

- As part of research about in utero organochlorine exposure among Inuit women from Kativik, QC, Dewailly et al.(1993) revealed negative associations between male height at birth and the concentration of HCB, mirex, PCBs and PCDDs/PCDFs (TEQs) in milk fat

- By contrast, Dewailly et al. (1993) observed positive associations between female birth height and PCBs/PCDDs/PCDFs (TEQs) concentration

- Adeeko et al. (2003) looked at consequences of force-feeding pregnant rats the mixture of 28 POPs found in the Inuit diet at various doses, finding no significant effects on pregnancy outcome but noting dramatic changes in the "gene expression profiles" of both maternal and fetal livers, decreasing both the numbers of genes expressed and the relative intensity of expression, which may have functional implications

- Van Oostdam et al. (2005) showed links between prenatal exposure to OCs and deficits in immune function, increases in childhood respiratory infections, and increases birth weight among infants in Nunavik

- Van Oostdam et al. (2005) showed that the developing foetus is likely to be more sensitive to the effects of OCs and metals than adults, and is the age group of greatest risk in the Arctic

- Van Oostdam et al. (1999) indicated that the developing foetus and breast-fed infant are likely to be more sensitive to the effects of OCs and metals than individual adults and are the age groups at greatest risk in the Arctic

- Exposures tend to be higher in the eastern than the western Canadian Arctic (Van Oostdam et al.: 2005)

- For the Inuit, the OCs of primary concern at this time from the point of view of exposure are chlordane, toxaphene, and PCBs (Van Oostdam et al.: 1999)

- For Dene/Métis, exposure to OCs is, in general, below a level of concern (Van Oostdam et al.: 1999)

- Consumers of traditional foods are exposed to an approximately seven-fold higher radiation dose than non-consumers of traditional foods due predominantly to the bioaccumulation of natural radionuclides in the food chain (Van Oostdam et al.: 1999)

- Muckle et al. (2001) found traditional food intake during pregnancy was unrelated to PCB body burden, which it claimed is more a function of lifetime consumption

- Muckle et al. (2001) corroborated previous findings relating marine mammal and fish consumption to increased mercury and selenium body burden

- Walker et al. (2006) recommended ongoing monitoring of populations at risk and traditional food species, as well as continued international efforts to reduce anthropogenic sources of mercury

- Mercury contamination of fish and game, blood mercury levels in excess of 200 ppb among Inuit and First, and mild symptoms of methyl mercury intoxication among FNs together constitute a “human health hazard” (Charlebois:1978)

- Hansen (1998) confirmed that the greatest source of exposure to POPs and mercury is via food of marine origin and that Greenlanders and Inuit in Canada are among the most highly exposed populations in the Arctic

Research results sometimes generated differences according to, or along, sex-related lines:

- Among the 9 Cree communities of James Bay in northern Quebec, Dumont et al. (1998) found that significantly higher levels of mercury were independently associated with male sex, increasing age and trapper status, along with a correlation between the mercury level of the head of the household and that of the spouse

- Constanze et al. (2005) revealed a continuous decline from 1994 to 2003 in the proportion of male births within the Aamjiwnaang First Nation (near Sarnia ON), a sex ratio decline associated in part with a number of environmental and occupational chemical exposures from nearby petrochemical, polymer, and chemical industrial plants in the Great Lakes/St. Clair River ‘Area of Concern’

Some studies revealed findings that ruled out certain links or associations:

- Drawing on a cohort of 454 newborns in Nunavik, Lucas et al. (2004) found no evidence of negative effects caused by their mothers’ consumption of environmentally-contaminated seafood on the newborns’ gestational age or birth weight

- Ayotte et al. (1995) found, among 499 Inuit adults, that total PCBs and dioxin-like compound concentrations were strongly correlated, had increased with age, and were greater in men than in women

Inuit have been the subject of many comparative studies, not just with Southern non-Aboriginal populations, but with the other Aboriginal groups as well. These comparisons serve to generate baselines:

- Butler Walker et al. (2006) presented “the first human tissue monitoring program covering the entire Northwest Territories and Nunavut for multiple contaminants and establishe[d] a baseline upon which future comparisons can be made”

- The geometric mean (GM) of maternal total mercury concentrations was found to be 2.6 times higher among Inuit than that of the Dene/Metis group and significantly higher than all other groups (Butler Walker et al.:2006)

- Butler Walker et al. (2006) found that 3% of Inuit women participants fell within Health Canada’s “level of concern” range for methylmercury exposure

- Butler Walker et al. (2006) found GM maternal lead was significantly higher in Dene/Metis and Inuit participants compared with the non-Aboriginal group

- AMAP found Inuit mothers from Greenland and Canada had significantly higher levels of oxychlordane, transnonachlor and mirex than Inuit mothers from Norway, Sweden, Iceland and Russia over the period 1994-97, differences that may represent regional dietary preferences or different contaminant deposition patterns across the Arctic (Van Oostdam et al.:2004)

- Butler Walker et al. (2003) established a baseline for exposure to organochlorine and metal contaminants for NWT and Nunavut mothers and newborns: 523 women from May 1994 through June 1999 generated average Inuit maternal PCB levels 3.3 times those of Dene/Metis, and 3.4 times non-Aboriginal levels, while average Inuit umbilical cord blood PCB levels were 3.3–4 fold higher than those of other ethnic groups

- Wheatley and Pardis (1996) found the overall highest levels of methylmercury exposure in Canada were tested among NWT Inuit, where the mean score of women aged 15-45 years was well into the "risk" range defined by WHO for fetal exposure. [see Kravariotis Douglas (2007) which also draws on same tests]

- Chan et al. (1995) revealed that Inuit adults and children in Qikiqtarjuaq on Baffin Island who consumed traditional foods had daily mercury intake levels much higher than the Canadian average. The average weekly intake for all age groups exceeded guidelines of the Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives and Contaminants

- In the period 1989-90, Dewailly et al. (1994) took breast milk samples from 109 Inuit women from northern Quebec whose high intake of seafood is thought to have explained the incidence of PCBs 3.5 times higher than in samples from 96 non-Aboriginal women

- Nunavik neonates were one of two cohorts Dallaire et al. (2008) assessed for the potential impact of transplacental exposure to PCBs and HCB (via seafood) on thyroid hormone (TH) concentrations, observing that OC levels were not associated with a reduction in THs, possibly because essential nutrients derived from seafood such as iodine may have prevented the negative effects of OCs on the thyroid economy during fetal development

- In examining the OC body burdens of people from the Fort Albany First Nation home to an abandoned Mid-Canada Radar Line station, Tsuji et al. (2005) found greater levels of PCBs among Fort Albany women as compared to Dene/Metis in western NWT and Inuit in central NWT; all three groups consumed low to no amounts of marine mammals

- Looking at the same community as Tsuji et al. (2005) and Tsuji et al. (2006) found elevated levels of PCBs and DDE not just among Fort Albany residents but also people from neighboring Kashechewan First Nation, who had no radar base

- However, Tsuji et al. (2006) seems to slightly contradict the earlier Tsuji et al. (2005) in reporting PCB and DDE levels in First Nation women “comparable [in] magnitude” (as opposed to greater) to those reported for Inuit women living in west/central NWT. Tsuji et al. (2006) indicated that the radar base (“Site 050”) appears to have also influenced the organochlorine body burden of people in Fort Albany through higher levels of DDT from contaminated soil surrounding the base’s buildings

Some comparisons occurred within Inuit themselves:

- Muckle et al. (1998) found the Inuit of Nunavik and the NWT exhibited the highest exposure levels to PCBs and mercury amongst all groups studied, with a portion featuring concentrations beyond the critical threshold for the appearance of neurological consequences

- Muckle et al. (1998) found variations in exposure levels resulted from the different nutritional practices of each sub-group

Simply documenting the scale and scope of contamination was also a stream of study:

- Chan et al. (1997) employed a statistical model to determine that over 50% of residents in one Arctic community had dietary exposure levels exceeding the tolerable daily intake for mercury, toxaphene and chlordane; in some cases, people had 6 times the provisional tolerable weekly intake of mercury, and over 20 times the tolerable daily intake of chlordane and toxaphene.

- Martin (2007) raised the question of whether climate change has affected the quality of raw water in brooks, lakes, rivers and potentially put Inuit in Nunavik at increased risk of gastroenteric diseases, a link yet to be established by research

- Dewailly et al. (1989) noted with surprise that blubber from arctic ringed seals contained PCDD and PCDF, even though the closest known sources were several thousands of kilometers away

- Lagueux et al. (1999) noted that most research focuses on larger doses of exposure to PCBs and PCDFs at the pre- and peri-natal stage at the expense of chronic, lower-dose exposures

Not all food sources (namely, animals) are the same when it comes to posing and thus determining risks. Nor have all animals necessarily been researched when it comes to every kind of contaminant.

- Cameron and Weis (1993) assessed the country food diet of 16 families in Sanikiluaq, NWT, to find that, of all species consumed, the fat of ringed seals and beluga had the highest concentration of DDE and total PCBs. Moreover, contaminant concentrations in local seal fat were about two times higher than Western Arctic sites, but lower than those reported from various European sites

- Dewailly et al. (1989) noted that DDT and PCB~ are the only organochlorines that have been monitored on a systematic basis in arctic marine mammals.

As for what to make of this traditional diet/contaminants correlation in everyday practice, many researchers argued that the benefits of traditional food must be weighed against the risks, as seen in the following findings and advice:

- After conducting contaminant exposure assessments in 28 indigenous communities in Canada, Chan and Receveur (2000) found mercury exposure to be “greatest among communities with high use of marine mammals as food,” yet speculated whether the decreased use of traditional food “could result in … [an] increased risk of diabetes and cardiovascular disease”

- Hansen (2000) wrote of the very difficult balancing act between the risks and benefits of country foods, as their nutritional benefits are substantial, especially compared to southern/market foods, not to mention their social, cultural, spiritual and economic benefits

- Ayotte et al. (1995) stated that dietary benefits from the sea-food based diet of 499 Nunavik Inuit still outweighed the hypothetical health risks

- Hansen (2000) recommended that consumption of traditional food continue, and noted the need for dietary advice to Arctic peoples so they can make informed choices

- Van Oostdam et al. (2005) felt, whatever the decision about country food consumption, it should involve the community and take into consideration the many aspects of socio-cultural stability, and strive for a solution that will be the most protective and least detrimental to the community

- Chan et al. (1997) counselled that assessment of health risks from the relatively high contaminant exposure must also consider the nutritional, economical, cultural, and social importance of traditional Arctic foods, and noted the absence of a "comprehensive risk management scheme" in its community of focus

- Wheatley and Paradis (1996) noted: "the need to balance the theoretical basis of the risk assessment, for different population groups and for different exposure patterns, against the potential real impact on health caused by restrictive advice on consumption of traditional foods, especially fish"

- Based on a dietary survey of 1012 Aboriginal individuals in 16 western NWT communities, Berti et al. (1998) concluded that the low health risks associated with the consumption of irradiated caribou were outweighed by the physical, social and cultural benefits derived from hunting and eating caribou

- Mos et al. (2004), conducted a survey of the coastal Sencoten (Saanich) First Nation in BC, and documented the high social and economic importance of traditional foods in their diet (encompassing at least 25 marine species), providing "an important first step in risk assessment"

- Furgal et al. (2005) indicated that, in general, the approach taken to communicating the risks of environmental contaminants in the food chain to northern Aboriginal communities has been "poor, "ad hoc" and unfocused, leading to "increased fear and confusion in [those] communities, changes in [their] dietary behaviour and traditional lifestyles… and associated impacts on their society, economy, and health," revealing the need for better "planning and evaluation… and possibly changes to the scale at which communication work is done in northern communities"

The state of knowledge sometimes improves through the discovery of new diagnostic/assessment tools, or the refinement of existing ones:

- Plusquellec et al. (2007) found that concentrations of lead (due to prenatal exposure) in cord blood samples from 169 eleven-month-old Inuit infants in northern Quebec were "significantly related" to several aspects of behavioral function, evidence of the "considerable potential" of infant behavioral assessment in helping to detect low-to-moderate associations between neurotoxicants and certain behaviors

- Muckle et al. (2001) conducted a study on infant development in Nunavik and observed that "relatively low correlations" between organochlorine and methylmercury concentrations may make it easier to identify the specific developmental deficits attributable to each toxicant

- Muckle et al. (2001) also revealed “weak correlations” between contaminants and nutrients, which could aid in documenting the “possible protective effects afforded by either n3-PUFA or selenium against neurotoxic contaminants”

- Saint-Amour et al. (2006) meanwhile found selenium and omega-3 polyunsaturated fatty acids did *not* help protect against methylmercury and PCB toxicity as once thought, when they used a measurement of pattern-reversal visual evoked potentials (VEPs)

- Ayotte et al. (2003) found that PCB concentration in any of the “biologic media” – i.e., maternal/cord plasma and breast milk – served as a good indicator of prenatal exposure to PCBs among Inuit in Nunavik

- Lagueux et al. (1999) confirmed that “CYP1A1 enzyme induction” and “DNA adducts in placental tissue” are useful biomarkers of early effects from environmental exposure to organochlorines

- Bharadwaj et al. (2006) documented the beginnings of a 1995 pilot project assessing the long term effects of fetal exposure to methylmercury in Grassy Narrows and Whitedog First Nations, based on newer and more “subtle neuropsychological development tests” given to fetally-exposed children now in secondary school

- Based on 47 Aboriginal newborns from St. Lawrence River regions, data from Fitzgerald et al. (2004) supported “a negative association” between tumor necrosis factor-alpha secretion by cord blood mononuclear cells and prenatal organochlorine exposure, a relationship which, if causal, “would suggest a role for this important proinflammatory cytokine in mediating organochlorine-induced immunotoxicity in infants” who were developmentally exposed

- The transfer of radionuclides from uranium mining operations to northern Saskatchewan Aboriginal peoples via the lichen-caribou-human food chain was the subject of study conducted by Thomas and Gates (1999), which reported that lichen concentration ratios (i.e., the plant's ability to take up a contaminant) proved “useful in predicting caribou meat concentrations” of radionuclides by relating caribou tissues to lichens or rumen (stomach) contents

- After administering the caffeine breath test (CBT) to 103 Akwesasne Mohawk adults exposed to PCBs through fish consumption, Fitzgerald et al. (2005) produced results in support of the notion that activity of the enzyme cytochrome P-450 1A2 (or CYP1A2) may be a marker of an early biological effect of PCB exposure, which could make the CBT a potentially “useful tool to monitor such effects”

Some research found a downward trend in the presence of contaminants (although no study implied the trends were necessarily permanent):

- Dallaire et al. (2003) reported “strongly significant decreasing trends” for PCBs, DDE, DDT and HCB with “no significant trends” detected for chlordanes among infants in three Nunavik communities

- Dallaire et al. (2003) also found a “significant reduction” of lead and mercury concentrations, but saw no clear linear or exponential trend

- The decreases in contaminants seen in Dallaire et al. (2003) could be due to a decrease in food contamination, changes in dietary habits, or, most likely, a combination of both.

- A retrospective analysis of Grassy Narrows and Whitedog First Nations shows a decreasing methylmercury trend in both communities according to Wheately et al. (1997)

- Among the 9 Cree communities of James Bay in northern Quebec, Dumont et al. (1998) found that the proportion of the population with mercury levels greater than 15 mg/kg declined from 14.2% in 1988 to 2.7% in 1993/94, but cautioned that the decrease may not be permanent, and does not necessarily imply the issue is definitively resolved

- Dallaire et al. (2002) showed results that prenatal exposure to persistent OCs (including PCBs, chlordanes, DDT/DDE and HCB) declined significantly between 1993 and 2000 among newborns from the Lower North Shore of the St. Lawrence River, in all age and ethnic groups, Aboriginal newborns included

- From 1992 to 1995, Fitzgerald et al. (2004) drew blood from 111 pregnant Mohawk women from Akwesasne, a reserve near three hazardous waste sites, and found a geometric mean concentration of total PCBs “similar to that in other studies of women with no unusual exposures to PCBs,” results the author(s) link to “a significant decline in local fish consumption from an annual mean of 31.3 meals a year or more prior to pregnancy to an annualized mean of 11.7 meals during pregnancy,” reportedly the result of advisories against consumption of local fish by pregnant/nursing women

- Chan et al. (1999) found that, contrary to the perception of its Mohawk residents, Kahnawake’s “fish were not particularly contaminated,” with levels of cadmium, lead, arsenic, PCBs and other chlorinated pesticides “at least 10 times lower than the guideline levels,” and although some predatory fish had higher-than-prescribed levels of mercury, average daily intakes of mercury were still below guideline levels

Looking at the state of First Nations maternal/infant health in relation to potential environmental threats, studies undertaken mostly focus on the Akwesasne Mohawk population:

- Conducted among 138 Akwesasne Mohawk Nation girls 10-16.9 years of age, Denham et al. (2005) investigated the relationship between the timing of girls' first menstrual period or menarche and their levels of exposure to DDE, HCB, PCBs, mirex, lead and mercury via substantial industrial development on the nearby St Lawrence River

- Denham et al. (2005) conducted an analysis of multichemical exposure and suggested that the odds of reaching menarche may be sensitive to relatively low levels of lead and a specific group of potentially estrogenic PCB congeners, although it urged caution in interpreting these results

- Denham et al. (2005) stated that additional investigation was warranted into whether low toxicant levels might affect reproduction and disorders of the reproductive system

- Bharadwaj (2006) offered a longitudinal overview of the "two most extensively sampled communities" in Canada, Grassy Narrows and Whitedog First Nations that were exposed to 'point source' mercury pollution in the 1970s

- Among 97 Mohawk women in Akwesasne, a reserve in the vicinity of three hazardous waste sites, Fitzgeral et al. (2004) found a reduction of PCB concentrations in their breast milk that paralleled a corresponding decrease in local fish consumption, possibly the result of advisories directing pregnant and nursing Mohawk women not to eat the fish

- Codru et al. (2007) found that "elevated serum PCBs, DDE, and HCB were positively associated with diabetes" in a cross-sectional study of 352 Mohawk adults, whereas mirex was observed to have "a negative association" with diabetes

- Newman et al. (2006) found a "significant negative relationship between PCB levels and two separate measures of long term memory" in Mohawk adolescents in Akwesasne and "a negative relationship with a measure of comprehension and knowledge"; although not large, the relationships provided "evidence of subtle negative effects of PCB exposure"

- Fitzgerald et al. (2001) found that a reduction in breast milk DDE concentrations among 97 Akwesasne Mohawk women from 1986 to 1990 paralleled a corresponding decrease in local fish consumption, which may be the result of advisories against the practice issued over the previous decade

- However, Fitzgerald et al. (2001) did find elevations in mirex concentrations in the 97 Akwesasne women's breast milk, "consistent with the fact that it is a common contaminant in the region and throughout the Lake Ontario-St. Lawrence River Basin"

- Hwang et al. (2001) found that PCB congener patterns in the breast milk of 97 Akwesasne Mohawk women who ate the most local fish more closely resembled patterns in fish caught at or close to a nearby waste site than women in the same community who ate less fish, an outcome which "demonstrates how PCBs may be 'fingerprinted' as they migrate offsite from industrial sources and ultimately result in human exposure"

- With evidence for "significant excess in incidence and prevalence of hypothyroidism" among Mohawk women 30 years of age and older due to PCB exposure, Sukdolová et al. (2000) provided an on-going study investigating long-term exposure to PCBs and acquired hypothyroidism "in order to identify the critical exposure routes and to develop and apply toxic equivalents for thyroid disease for the various PCB congeners."

Mercury and methylmercury have been long-standing areas of research, as seen in the following studies:

- Bharadwaj et al. (2006) indicated that Health Canada has collected data on Inuit and First Nations' methylmercury levels for 25 years and now has now completed a national review

- Hoover et al. (1997) used "dose-response analyses" combined with "a probabilistic exposure assessment" to conclude that methylmercury ingestion via fish caught from natural lakes and a reservoir Aboriginal people in BC "does not pose a significant risk" if eaten in reasonable quantities

- Macdonald et al. (2000) reinforced the concern that of all the metals, mercury "provokes the greatest concern," and appears to be increasing in the Arctic due to global human activities, but "are not evenly distributed nor are the pathways by which they enter and move within the Arctic well understood"

Other studies approached these issues through the more qualitative lens of attitudes:

- Hine et al. (1997), conducted a survey of four northern communities about a proposed underground nuclear waste repository in the Canadian Shield, found the strongest opposition among Aboriginal respondents, who were less trusting, had less faith in science and technology, and perceived the proposal's costs to be higher than their non-Aboriginal respondents.

A number of studies considered specific contaminants and projected their remaining life-span in the Arctic:

- Macdonald et al. (2000) reported that, despite a 1970s PCB production ban, "the Arctic presently shows little evidence of reduced PCB loadings," anticipating that reduction will ultimately take "decades"
- Macdonald et al. (2000) stated that lead loadings in the Arctic "appear presently to be decreasing due to source controls (*e.g.*, removal of [lead] from gasoline)"
- Macdonald et al. (2000) noted how drastic reductions in the production/use of the organochlorine insecticide HCH rapidly led to reductions in "atmospheric burdens," leaving only the Arctic ocean as its "major reservoir and transport agent," which will not clear itself of HCH for "decades"
- Drawing on a cohort of 314 Cree infants (9 months old) from northern Quebec, Willows and Gray-Donald (2002) observed that those infants found to have anemia or iron-deficiency anemia also had a higher mean geometric blood lead concentration than their non-anemic counterparts
- Willows and Gray-Donald (2002) also found "a significant negative correlation between blood lead and hemoglobin concentrations, and between blood lead and serum ferritin concentrations" among its northern Cree infant cohort

Certain studies attempted to address specific gaps in knowledge, in some cases piloting research questions in their area:

- Tsuji et al. (2005) noted how few data exist with respect to the human body burden of OCs in residents of communities located in close proximity to northern radar line sites, which are direct point sources of contamination
- Denham et al. (2005) claimed to be one of the few studies to examine the effects of common levels of pollutants such as lead and POPs on human sexual maturation, and the first to examine the possible effects of multiple toxicant exposures
- Based on a community-wide pilot inspection of 26 homes of asthmatic children living on the Elsipogtog Reserve (NB), Berghout et al. (2005) concluded that the range of mould damage, though "similar to that seen elsewhere in Canada," tended to "reflect more serious maintenance problems"
- Lawrence and Martin (2001) suggested that substandard housing is a major contributor to poor health among BC First Nations because of bacteria, moulds and dust mites fostered by humid, damp living conditions, a situation which puts, among others, the very young at particular risk for diseases like asthma

Where to go forward from here was also the subject of some studies, including some indications of best practices:

- Hansen (1998) recommended that priority be given to establishing protocols for the control of POPs and heavy metals under the Convention on Long Range Transboundary Air Pollution
- Furgal et al. (2006) reviewed experiences from two projects in Arctic Inuit communities where a multi-stakeholder, participatory framework for assessment best supported the necessary analysis, understanding, and enhancement of community capabilities to respond and adapt to local health impacts of climate change
- Suppiah et al. (2004) outlined a BC First Nations approach to solid waste management meant to provide remote communities with sustainable alternatives to waste dumping and incineration, such as the integration of collection services for multiple communities, education in appropriate disposal options, and waste reduction
- Mailman et al. (2006) reviewed the pros and cons of various strategies to lower methyl mercury concentrations in hydroelectric reservoirs, ranging from better site selection to intensive fishing, the addition of different elements (*e.g.*, selenium, lime, phosphorus) to the burning or removal of trees; but whichever of the many possibilities are chosen, the authors believe the "most promising strategy will be one that is agreeable to all affected people"
- Noël et al. (1998) recalled how community involvement in a mercury information program for James Bay Cree had been "essential to its success," as member-identified needs led to such tools as trilingual (French, English and Cree) brochures and posters, a radio message, and individual and group meetings

Programs and Initiatives

There are a number of research, policy and advocacy programs and initiatives working on contaminants and the environment, nationally and internationally. The table below is a sampling of governmental, non-governmental and research-based organizations in Canada whose focus is to understand, document, and exchange knowledge related to contaminants, the environment and Aboriginal health. Although many of the organizations listed below speak at times to the impacts of environmental threats on the health of First Nations and Inuit women and infants within their work, none have a specific gender-based or child-centered mandate as such.

A list of projects (the Appendix) found when this manuscript was developed, can be downloaded from http://www.pwhce.ca/maternalInfantHealth_Environment.htm or requested from PWHCE or BCCEWH.

PROGRAM	**Northern Contaminants Program – Indian and Northern Affairs Canada (NCP-INAC)** **http://www.ainc-inac.gc.ca/nth/ct/ncp/index-eng.asp**
MANDATE	Addresses human exposure to contaminants in wildlife species that are important to the traditional diets of Northern Aboriginal peoples
FOCUS AREAS	✔ Human health research ✔ Environmental monitoring and research ✔ Education and communication ✔ National/regional coordination and Aboriginal partnerships

PROGRAM	**Northern Contaminated Sites Program – Indian and Northern Affairs (NCSP-INAC)** **http://www.ainc-inac.gc.ca/nth/ct/ncsp/index-eng.asp**
MANDATE	Focuses on the clean up and remediation of a number of contaminated sites in the North
FOCUS AREAS	✔ Ensuring the protection of human health and safety, and the environment by remediating contaminated sites while supporting employment and training of Northerners ✔ Providing northern regional economic development programming ✔ Working with territorial governments to transfer province-like responsibilities for the management of land and resources

PROGRAM	**National First Nations Environmental Contaminants Program – First Nations and Inuit Health Branch/Assembly of First Nations/First Nations University of Canada (NFNECP-FNIHB/AFN/FNUniv)** **http://www.afn.ca/article.asp?id=2396**
MANDATE	Assess the extent of environmental contaminant exposure and the potential for associated risk to the health and well being of First Nations in Canada
FOCUS AREAS	✔ Supports innovative research on environmental and health impacts from contaminants in First Nations communities ✔ National, regional and local components

PROGRAM	**Environmental Health Program - First Nations and Inuit Health Branch (EHP-FNIHB)** **http://www.hc-sc.gc.ca/fniah-spnia/pubs/aborig-autoch/2007_compendium/2_2_environ-milieu-eng.php**
MANDATE	Community-based program to protect and improve First Nations (on-reserve and south of 60) health through the reduction of health risks, injuries or deaths. Strives to create and maintain healthy and safe community environments through the investigation of potential environmental health related outbreaks
FOCUS AREAS	✔ Drinking water and sewage ✔ Food Safety ✔ Facilities health inspections ✔ Housing ✔ Transportation of dangerous goods ✔ West Nile Virus

PROGRAM	**Environmental Research - First Nations and Inuit Health Branch (ER-FNIHB)** **http://www.hc-sc.gc.ca/fniah-spnia/pubs/aborig-autoch/2007_compendium/2_2_environ-milieu-eng.php**
MANDATE	Carries out laboratory and field studies, research, monitoring and surveillance; and predictive modeling efforts, in the context of risks posed by environmental contaminants (chemical, biological and radiological) to the First Nations and Inuit peoples and the balancing of health protection measures including remediation with traditional knowledge and the broader determinants of health
FOCUS AREAS	✔ Provide scientific research into concerns expressed by First Nations and Inuit communities regarding human health and environmental linkages. ✔ Provide laboratory and statistical services with respect to scientific research and monitoring. ✔ Monitor and assess scientific developments in the field of the environment's impact on human health at local, national and international levels. ✔ Improve environmental health risk awareness and community human resources capacity through community research and monitoring projects

PROGRAM	**Centre for Indigenous Environmental Resources – CIER** **http://www.cier.ca**
MANDATE	Established in 1994 by a group of First Nation Chiefs from across Canada, CIER is a national, First Nation-directed environmental non-profit organization. Supports First Nations in identifying threats to the health of their environment, develop sustainable resource use solutions, and promote restoration and protection.
FOCUS AREAS	✓ Climate change ✓ Sustainable communities ✓ Conserving Biodiversity ✓ Protection of Lands and Water

PROGRAM	**Manitoba Environmental Contaminants Pathfinder – CIER** **http://www.cier.ca/**
MANDATE	To help First Nations write community-led, environmental contaminants research proposals.
FOCUS AREAS	Help First Nations: ✓ Identify environmental contaminant concerns and issues ✓ Identify potential project ideas ✓ Assist with RFNECP proposal submissions for 2008 – 2009 ✓ Assist with RFNECP proposal submissions for 2009 – 2010

PROGRAM	**Manitoba Regional First Nations Environmental Contaminants Program - FNIHB** **http://www.cier.ca/WorkArea/downloadasset.aspx?id=1228**
MANDATE	Funding program to help First Nations develop community-based projects that explore the link between human health and environmental contaminants.
FOCUS AREAS	✓ Exposure: Assessment of First Nations peoples' exposure to environmental Contaminants (assessing concentrations of contaminants in food sources (game, fish, plants) or through human tissue sampling. ✓ Risk Management: Assessment of environmental trends of human exposure to contaminants and identifying risk management strategies (developing eating guidelines for game, fish, or plants or other risk management strategies) ✓ Effects: Research impacts of environmental contaminants on human health and wellbeing (assessing direct health impacts or social, cultural, and economic impacts of known environmental contaminants and results on health).

PROGRAM	**Centre for Indigenous Peoples' Nutrition and Environment – CINE (McGill University)** **http://www.cier.ca/**
MANDATE	An independent, multi-disciplinary research and education resource for Indigenous Peoples, CINE was created to meet demand expressed by Aboriginal Peoples for participatory research and education to address their concerns about the integrity of their traditional food systems.
FOCUS AREAS	✔ **Social sciences:** determination of traditional and market food selection in relation to environment and culture. The various social forces contributing to changing dietary patterns and nutritional health are also examined. ✔ **Laboratory sciences:** determination of nutrient and contaminant content in traditional food systems, wildlife, humans, and ecosystems. ✔ **Data analyses:** determination of extent of food use in relation to nutrient and contaminant levels to address questions of holistic human nutrition and health, and benefit/risk evaluations.

PROGRAM	**Network Environments for Aboriginal Health Research (NEAHRs) – Canadian Institutes of Health Research (CIHR)/ and Institute of Aboriginal People's Health (IAPH)** **http://www.cihr-irsc.gc.ca/e/27071.html**
MANDATE	Established in 2007, NEAHRs Collaboration between seven regional centres (NEARBC/Alberta ACADRE Network/Centre for Aboriginal Health Research/Indigenous Health Research Development Program/Atlantic Aboriginal Health Research Program/Indigenous Peoples' Health Research Centre/Nasivvik Centre for Inuit Health and Changing Environments and 2 national centres; Anisnawbe Kekendazone – CIET and the National Network for Aboriginal Mental Health Research.
FOCUS AREAS	✔ Explore critical Aboriginal health issues ✔ Develop network of centres across Canada responsible for developing the next generation of aboriginal health researchers ✔ Focused research efforts on determinants of health in Aboriginal communities

PART 3
CONCLUSIONS

Preliminary recommendations include conducting further research to be undertaken on the physical environmental risks for maternal and infant health. More research is considered necessary on southern Aboriginal peoples and First Nations communities, with an urgent need to better understand the impacts that environmental contaminants have on First Nations and Inuit women and children. As well as adding to the body of knowledge on environmental threats to First Nations and Inuit communities, further examining these issues will provide valuable information for health and environmental policy decision-makers and program development in Canada and facilitate the direction of resources and actions to the necessary areas of environmental research and work.

The following areas are in need of greater research as to how they specifically act to affect the health of First Nations and Inuit women and their infant children.

Environmental contaminants: Aboriginal people have expressed concern in continuing to eat traditional foods due to the biomagnification in the food chain and offering breast milk to their infants because of the fear of contamination. Studies have investigated prenatal exposure to mercury, polychlorinated biphenyls and organochlorines and levels of toxins in breast milk and umbilical cord blood samples. The research pays most attention to maternal and infant health.

Resource Development, including mining and hydro-electricity: Methyl mercury, lead, arsenic contamination are some of the toxins that are affecting water, marine and terrestrial plants and animals and of course humans in nearby communities.

Waste Disposal, including nuclear waste: National Dialogue on Nuclear Waste Disposal between the five national Aboriginal political organizations and the Nuclear Waste Management Organization (NWMO), monitored by Natural Resources Canada, took place over a period of three years (2003-2005) to develop a long-term management of nuclear waste. Solid waste disposal has also been contested where large urban centres are close to Aboriginal communities. Contamination of drinking water and soil is a great concern for communities.

Climate Change: There has been substantial focus on climate change and its impact on Aboriginal peoples and research is continuing to expand. Most studies and work have centered attention on the North for obvious reasons. The Center for Indigenous Environmental Resources (CIER) is currently conducting work on climate change and communities south of 60.

Household Mould: Canada Mortgage and Housing Corporation, Indian and Northern Affairs Canada and Health Canada have jointly issued a publication on mould in First Nations housing and its prevention and treatment. Research has focused on asthma in children in particular, and recent news has warned about mould’s negative impacts on pregnant women and infants.

Drinking water quality: Many Aboriginal communities live with a boil water advisory. One program recently developed was the 2003 Indian and Northern Affairs Canada and Health Canada First Nations Water Management Strategy (FNWMS) which is to reduce drinking water health risk in Aboriginal communities and involves communities to play a part in keeping the water clean.

PART 4
BIBLIOGRAPHY

Adeeko, Adedayo, Daming Li, Josée Doucet, Gerard M. Cooke, Jacquetta M. Trasler, Bernard Robaire, and Barbara F. Hales (2003) Gestational Exposure to Persistent Organic Pollutants: Maternal Liver Residues, Pregnancy Outcome, and Effects on Hepatic Gene Expression Profiles in the Dam and Fetus, Toxicological Sciences, Volume 72, pp. 242-252.

Ayotte, P., G. Muckle, JL. Jacobson, SW. Jacobson, E. Dewailly (2003) Assessment of Pre- and Postnatal Exposure to Polychlorinated Biphenyls: Lessons from the Inuit Cohort Study, Environmental Health Perspectives, Volume 3, pp.1253-1258.

Ayotte, P., E. Dewailly, J.J. Ryan, S. Bruneau, G. Lebel (1995) PCBs and dioxin-like compounds in plasma of adult Inuit living in Nunavik (Arctic Quebec), Chemosphere, Volume 34, pp.1459-1468.

Ayotte, P., G. Carrier, E. Dewailly (1994) Health risk assessment for Inuit newborns exposed to dioxin-like compounds through breast feeding, Chemosphere, Volume 32, pp. 531-542.

Berghout, Joanne, J. David Miller, Roger Mazerolle, Len O'Neill, Craig Wakelin, Barbara Mackinnon, Kenneth Maybee, Darlene Augustine, Carol Ann Levi, Charlie Levi, Terry Levi, Barbara Milliea (2005) Indoor environmental quality in homes of asthmatic children on the Elsipogtog Reserve (NB), Canada, International Journal of Circumpolar Health, Volume 64, pp.77-85.

Berti, P.R., O. Receveur, H.M. Chan, H.V. Kuhnlein (1998) Dietary exposure to chemical contaminants from traditional food among adult Dene/Métis in the western Northwest Territories, Canada, Environmental Research, Volume 76, pp.131-142.

Berti, P.R. H.M. Chan, O. Receveur, C.R. MacDonald, H.V. Kuhnlein (1998) Population exposure to radioactivity from consumption of caribou among the Dene/Métis of Denendeh (western Northwest Territories, Canada), Journal of Exposure Analysis and Environmental Epidemiology, Apr-Jun, Volume 8, No. 2, pp.145-58.

Bharadwaj, Lalita , Suzie Nilson, Ian Judd-Henrey, Gene Ouellette, Laura Parenteau, Ceal Tournier, Daryl Watson, Darcy Bear, Gilbert Ledoux, Austin Bear (2006) Waste disposal in First Nations communities: The issues and steps toward the future, Journal of Environmental Health, Volume 68, pp. 35-9.

Bilrha, H., R. Roy, B. Moreau, M. Belles-Isles, E. Dewailly, P. Ayotte (2003) In vitro activation of cord blood mononuclear cells and cytokine production in a remote coastal population exposed to organochlorines and methyl mercury, Environmental Health Perspectives Volume 111, pp,1952-1957.

Butler Walker, Jody, Jan Houseman, Laura Seddon, Ed McMullen, Karen Tofflemire, Carole Mills, Andre Corriveau, Jean-Philippe Weber, Alain LeBlanc, Mike Walker, Shawn G. Donaldson, Jay Van Oostdam (2006) Maternal and umbilical cord blood levels of mercury, lead, cadmium, and essential trace elements in Arctic Canada, Environmental Research Volume100 pp. 295–318.

Butler Walker, Jody, Laura Seddon, Ed McMullen, Jan Houseman, Karen Tofflemire, Andre Corriveau, Jean-Phillipe Weber, Carole Mills, Samuel Smith, Jay Van Oostdam (2003) Organochlorine levels in maternal and umbilical cord blood plasma in Arctic Canada, The Science of the Total Environment Volume 302, pp. 27–52.

Cameron, M., I.M. Weis (1993) Organochlorine contaminants in the country food diet of the Belcher Island Inuit, Northwest Territories, Canada, Arctic, Volume 46, pp. 42-48.

Chan, H M, and Olivier Receveur (2000) Mercury in the traditional diet of indigenous peoples in Canada, Environmental Pollution, Volume 110, pp.1-2.

Chan, H M, Trifonopoulos, M, Ing, A; Receveur, O, Johnson, E (1999) Consumption of freshwater fish in Kahnawake: risks and benefits, Environmental Research, Feb, Volume 80:S213-S222.

Chan, H M, P.R. Berti, O. Receveur, H.V. Kuhnlein (1997) Evaluation of the population distribution of dietary contaminant exposure in an Arctic population using Monte Carlo statistics, Environmental Health Perspectives, Volume105, pp.316-321.

Chan, H M, C. Kim, K. Khoday, O. Receveur, H.V. Kuhnlein (1995) Assessment of dietary exposure to trace metals in Baffin Inuit food, Environmental Health Perspectives, Volume 103, pp. 740-746.

Charlebois, Clarence T. (1978) High Mercury levels in Indians and Inuit (Eskimos) in Canada, Ambio, Vol. 7, No. 5/6, Toxics and Their Control: A Special Issue, pp. 204-210.

Dallaire, Renée, Eric Dewailly, Pierre Ayotte, Gina Muckle, Claire Laliberté, Suzanne Bruneau (2008) Effects of prenatal exposure to organochlorines on thyroid hormone status in newborns from two remote coastal regions in Quebec, Canada, Environmental Research, in press.

Dallaire, Frédéric, Éric Dewailly, Carole Vézina, Gina Muckle, Jean-Philippe Weber, Suzanne Bruneau, and Pierre Ayotte (2006) Effect of Prenatal Exposure to Polychlorinated Biphenyls on Incidence of Acute Respiratory Infections in Preschool Inuit Children, Environmental Health Perspectives, Volume 114, pp.1301–1305.

Dallaire, Frédéric, Éric Dewailly, Gina Muckle, Carole Vézina, Sandra W. Jacobson, Joseph L. Jacobson, and Pierre Ayotte, (2004) Acute Infections and Environmental Exposure to Organochlorines in Inuit Infants from Nunavik, in Environmental Health Perspectives, Volume 112, pp. 1359–1364.

Dallaire, Frédéric, Éric Dewailly, Gina Muckle, and Pierre Ayotte (2003) Time Trends of Persistent Organic Pollutants and Heavy Metals in Umbilical Cord Blood of Inuit Infants Born in Nunavik (Québec, Canada) between 1994 and 2001, Environmental Health Perspectives Volume 111, pp.1660–1664.

Dallaire, Frédéric, Éric Dewailly, Claire Laliberté, Gina Muckle, and Pierre Ayotte (2002) Temporal Trends of Organochlorine Concentrations in Umbilical Cord Blood of Newborns from the Lower North Shore of the St. Lawrence River (Québec, Canada), Environmental Health Perspectives, Volume 110, pp.835–838.

Denham, Melinda, Lawrence M. Schell, Glenn Deane, Mia V. Gallo, Julia Ravenscroft, Anthony P. DeCaprio and the Akwesasne Task Force on the Environment (2005) Relationship of Lead, Mercury, Mirex, Dichlorodiphenyldichloroethylene Hexachlorobenzene, and Polychlorinated Biphenyls to Timing of Menarche Among Akwesasne Mohawk Girls, Pediatrics Volume 115;e127-e134.

Dewailly, Eric , Pierre Ayotte, Suzanne Bruneau, Suzanne Gingras, Marthe Belles-Isles, and Raynald Roy (2000) Susceptibility to Infections and Immune Status in Inuit Infants Exposed to Organochlorines, Environmental Health Perspectives, Volume 108, pp.205-211.

Dewailly, E., J.J. Ryan, C. Laliberte, S. Bruneau, J.P. Weber, S. Gingras, G. Carrier (1994) Exposure of remote maritime populations to coplanar PCBs, Environmental Health Perspectives, SUPPL. 102.

Dewailly, E., S. Bruneau, P. Ayotte, C. Laliberté, S. Gingras, D. Bélanger and L. Ferron (1993) Health status at birth of inuit newborn prenatally exposed to organochlorines, Chemosphere, Volume 27, Issues 1-3, pp. 359-366.

Dewailly, E., A. Nantel, S. Bruneau, C. Laliberté, L. Ferron, S. Gingras (1992) Breast milk contamination by PCDDs, PCDFs and PCBs in Arctic Quebec: A preliminary assessment, Chemosphere, Volume 25, pp.1245-1249.

Dewailly, Eric, Albert Nantel, Jean-P. Weber, and Frangois Meyer (1989) High Levels of PCBs in Breast Milk of Inuit Women from Arctic Quebec, Bulletin of Environmental Contamination and Toxicology, Volume 43, pp. 641-646.

Duhaime, Gérard, Marcelle Chabot, Pierre Fréchette, Véronique Robichaud, Solange Proulx (2004) The impact of dietary changes among the Inuit of Nunavik (Canada): A socioeconomic assessment of possible public health recommendations dealing with food contamination, Risk analysis: An official publication of the Society for Risk Analysis, Volume 24, pp.1007-18.

Dumont, Charles, Manon Girard; François Bellavance; Francine Noël (1998) Mercury levels in the Cree population of James Bay, Quebec, from 1988 to 1993/94, Canadian Medical Association Journal, June 2, Volume 158, No.11, p.1439.

Egan, C., (1998) Points of view: Inuit women's perceptions of pollution, International Journal of Circumpolar Health, Volume 57, pp. 550-4.

Fitzgerald, Edward F; Hwang, Syni-An; Lambert, George; Gomez, Marta; Tarbell, Alice (2005) PCB exposure and in vivo CYP1A2 activity among Native Americans, Environmental Health Perspectives, Volume 113, No. 3, pp.272-7.

Fitzgerald, Edward F; Hwang, Syni-An; Langguth, Karyn; Cayo, Michael; Yang, Bao-Zhu; Bush, Brian; Worswick, Priscilla; Lauzon, Trudy (2004) Fish consumption and other environmental exposures and their associations with serum PCB concentrations among Mohawk women at Akwesasne, Environmental Research, Volume 94, No.2, pp.160-70.

Fitzgerald, E F; Hwang, S A; Deres, D A; Bush, B; Cook, K; Worswick, P (2001) The association between local fish consumption and DDE, mirex, and HCB concentrations in the breast milk of Mohawk women at Akwesasne, Journal of Exposure Analysis and Environmental Epidemiology, Sep-Oct, Volume11, No. 5, pp.381-8.

Fitzgerald E.F, Hwang S., Bush B., Cook K., Worswick P. (1998) Fish consumption and breast milk PCB concentrations among Mohawk women at Akwesasne, American Journal of Epidemiology, Volume 148, No. 2, pp. 164-172.

Furgal, Christopher and Jacinthe Seguin (2006) Climate Change, Health, and Vulnerability in Canadian Northern Aboriginal Communities, Environmental Health Perspectives, Volume 114, pp.1964–1970.

Furgal, C.M., S. Powell, H. Myers (2005) Digesting the Message about Contaminants and Country Foods in the Canadian North: A Review and Recommendations for Future Research and Action, Arctic, Volume 58, pp.103–114.

Hansen, Jens C. (2000) Environmental contaminants and human health in the Arctic, Toxicology Letters Volumes 112–113, pp. 119–125

Hansen, J .C. (1998) The human health programme under AMAP. AMAP Human Health Group. Arctic Monitoring and Assessment Program, International Journal of Circumpolar Health, Volume 57, pp.280-91.

Hine, D.W., C. Summers, M. Prystupa, A. McKenzie-Richer (1997) Public opposition to a proposed nuclear waste repository in Canada: An investigation of cultural and economic effects, Risk Analysis, Volume17, pp.293-302.

Hoover, S., R. Hill, T. Watson (1997) Estimating risks from exposure to methylmercury: Application to first nations people in Canada, Water, Air, & Soil Pollution, Volume 97, pp.107-118.

Hwang, S A; Yang, B Z; Fitzgerald, E F; Bush, B; Cook, K. (2001) Fingerprinting PCB patterns among Mohawk women, Journal of Exposure Analysis and Environmental Epidemiology, May-Jun, Volume 11, No. 3, pp.184-92.

Kravariotis Douglas, Vasiliki (2007) Converging epistemologies: critical issues in Canadian Inuit childbirth and pregnancy, Alaska Medicine, Volume 49, pp. 209-14.

Kwiatkowski, R., and M.H. Sadar (1999) Comparative analysis of aboriginal approach vs. modern methodologies as applied in assessing human health impacts of uranium mining in Canada, Meeting of the International Association for Impact Assessment, Glasgow, Scotland (UK), 15-19 Jun 1999. (World Meeting Number 992 5075).

Lagueux, Jean, Daria Pereg, Pierre Ayotte, Eric Dewailly and Guy G. Poiriera (1999) Cytochrome P450 CYP1A1 Enzyme Activity and DNA Adducts in Placenta of Women Environmentally Exposed to Organochlorines, Environmental Research, Volume 80(4), pp. 369-82.

Lawrence, R., and D. Martin (2001) Moulds, moisture and microbial contamination of First Nations housing in British Columbia, Canada, International Journal of Circumpolar Health, Volume 60, pp.150-6.

Lucas, Michel, Éric Dewailly, Gina Muckle, Pierre Ayotte, Suzanne Bruneau, Suzanne Gingras, Marc Rhainds, and Bruce J. Holub (2004) Gestational Age and Birth Weight in Relation to n-3 Fatty Acids Among Inuit (Canada), Lipids Volume 39, pp. 617–626.

Mackenzie, Constanze A., Ada Lockridge, and Margaret Keith (2005) Declining Sex Ratio in a First Nation Community, Environmental Health Perspectives, Volume 113, pp.1295–1298.

Martin, Daniel, Diane Bélanger, Pierre Gosselin, Josée Brazeau, Chris Furgal and Serge Déry (2007) Drinking Water and Potential Threats to Human Health in Nunavik: Adaptation Strategies under Climate Change Conditions, Arctic, Volume 60, pp.195-202.

Macdonald, R. W., L. A. Barrie, T. F. Bidleman, M. L. Diamond, D. J. Gregor, R. G. Semkin, W. M. J. Strachan, Y. F. Li, F. Wania, M. Alaee, L. B. Alexeeva, S. M. Backus, R. Bailey, J. M. Bewers, C. Gobeil, C. J. Halsall, T. Harner, J. T. Hoff, L. M. M. Jantunen, W. L. Lockhart, et al. (2000) Contaminants in the Canadian Arctic: 5 years of progress in understanding sources, occurrence and pathways, The Science of The Total Environment, Volume 254, pp.93-234.

Mailman, Mariah, Lisa Stepnuk, Nazim Cicek, R.A. (Drew) Bodaly 2006) Strategies to lower methyl mercury concentrations in hydroelectric reservoirs and lakes: A review, Science of The Total Environment, Volume 368, pp.224-235.

Mos, Lizzy, Janel Jack, Donna Cullon, Laurie Montour, Carl Alleyne, Peter S Ross (2004) The importance of marine foods to a near-urban first nation community in coastal British Columbia, Canada: toward a risk-benefit assessment, Journal of Toxicology and Environmental Health, Volume 67, pp.791-808.

Muckle, Gina, Pierre Ayotte, Eric Dewailly, Sandra W. Jacobson, and Joseph L. Jacobson (2001) Determinants of Polychlorinated Biphenyls and Methylmercury Exposure in Inuit Women of Childbearing Age, Environmental Health Perspectives Volume109, pp. 957-963.

Muckle, Gina, Pierre Ayotte, Éric Dewailly, Sandra W. Jacobson, and Joseph L. Jacobson (2001) Prenatal Exposure of the Northern Québec Inuit Infants to Environmental, Environmental Health Perspectives Volume 109, pp.1291–1299.

Muckle, G., E. Dewailly, P. Ayotte (1998) Prenatal exposure of Canadian children to polychlorinated biphenyls and mercury, Canadian journal of public health. Revue canadienne de sante publique, Volume 89 Suppl 1:S20-5, 22-7.

Muir, Derek C.G., Russel G. Shearer, Jay Van Oostdam, Shawn G. Donaldson, Chris Furgal (2005) Contaminants in Canadian arctic biota and implications for human health: Conclusions and knowledge gaps, Science of the Total Environment, 351-352: 539-546.

Neculai, Codru, Schymura, Maria J; Negoita, Serban; Akwesasne Task Force on Environment; Rej, Robert; Carpenter, David O (2007) Diabetes in relation to serum levels of polychlorinated biphenyls and chlorinated pesticides in adult Native Americans, Environmental Health Perspectives, Volume 115, No.10. pp.442-7.

Newman, Joan, Aucompaugh, Amy G; Schell, Lawrence MView; Denham, Melinda; DeCaprio, Anthony P; Gallo, Mia V; Ravenscroft, Julia; Kao, Chin-Cheng; Hanover, MaryEllen Rougas; David, Dawn; Jacobs, Agnes M; Tarbell, Alice M; Worswick, Priscilla; Akwesasne Task Force on the Environment (2006) PCBs and cognitive functioning of Mohawk adolescents, Neurotoxicology and Teratology, Jul-Aug, Volume 28, No.4, pp.439-45.

Noël, F; Rondeau, E; Sbeghen, J. (1998) Communication of risks: organization of a methylmercury campaign in the Cree communities of James Bay, Northern Quebec, Canada, International Journal of Circumpolar Health, 1998, Volume 57 Suppl 1, pp.591-5.

Plusquellec, P., G. Muckle, E. Dewailly, P. Ayotte, S.W. Jacobson, J.L. Jacobson (2007) The relation of low-level prenatal lead exposure to behavioral indicators of attention in Inuit infants in Arctic Quebec, Neurotoxicology and Teratology, Volume 29, pp.527-537.

Saint-Amour, Dave, Marie-Sylvie Roy, Célyne Bastien, Pierre Ayotte, Eric Dewailly, Christine Després, Suzanne Gingras, Gina Muckle (2006) Alterations of visual evoked potentials in preschool Inuit children exposed to methylmercury and polychlorinated biphenyls from a marine diet, NeuroToxicology Volume 27, pp. 567–578.

Sukdolová, V; Negoita, S; Hubicki, L; DeCaprio, A; Carpenter, D O (2000) The assessment of risk to acquired hypothyroidism from exposure to PCBs: a study among Akwesasne Mohawk women, Central European Journal of Public Health, Aug, Volume 8, No. 3, pp.167-8.

Suppiah, A., B. Maguir, R. Weisner (2004) Facilitation of Environmental Decision Making by a Remote Coastal First Nation Community, 2003 Georgia Basin/Puget Sound Resarch Conference Proceedings [np].

Thomas, P.A. and T.E. Gates (1999) Radionuclides in the lichen-caribou-human food chain near uranium mining operations in northern Saskatchewan, Canada, Environmental Health Perspectives, Volume 107, pp.527-537.

Tsuji, L.J.S., B.C. Wainman, I.D. Martin, J.P. Weber, C. Sutherland, E. Nieboer (2006) Abandoned Mid-Canada Radar Line sites in the Western James region of Northern Ontario, Canada: A source of organochlorines for First Nations people?, Science of the Total Environment, Volume 360, pp.452-466.

Tsuji, L.J.S., B.C. Wainman, I.D. Martin, J.P. Weber, C. Sutherland, J.R. Elliott, E. Nieboer (2005) The Mid-Canada Radar Line and First Nations' People of the James Bay Region, Canada: An evaluation using log-linear contingency modelling to analyze organochlorine frequency data, Journal of Environmental Monitoring, Volume 7, pp.888-898.

Van Oostdam, J., S.G. Donaldson, M. Feeley, D. Arnold, P. Ayotte, G. Bondy, L. Chan, E . Dewaily, C.M. Furgal, H. Kuhnlein, E. Loring, G. Muckle, E. Myles, O. Receveur, B. Tracy, U. Gill, S. Kalhok(2005) Human health implications of environmental contaminants in Arctic Canada: A review, Science of the Total Environment Volumes 351–352, pp. 165–246.

Van Oostdam, J.C., E. Dewailly, A. Gilman, J.C. Hansen, J.O. Odland, V. Chashchin, J.Berner, J.Butler -Walker, B.J.Lagerkvist, K.Olafsdottir, L.Soininen, P.Bjerregard, V.Klopov, J.P.Weber (2004) Circumpolar maternal blood contaminant survey, 1994–1997 organochlorine compounds, Science of the Total Environment, Volume 330, pp. 55-70.

Van Oostdam, J., A. Gilman, E. Dewailly, P. Usher, B. Wheatley, H. Kuhnlein, S. Neve, J. Walker, B. Tracy, M. Feeley , V. Jerome, B. Kwavnick (1999) Human health implications of environmental contaminants in Arctic Canada: a review, The Science of the Total Environment 230,1:82.

Wheatley, B., S. Paradis (1998) Northern exposure: further analysis of the results of the Canadian aboriginal methylmercury program, International Journal of Circumpolar Health, Volume 57, pp.586-90.

Wheatley, B., Paradis, S, Lassonde, M, Giguere, M-F, Tanguay, S. (1997) Exposure patterns and long term sequelae on adults and children in two Canadian indigenous communities exposed to methylmercury, Water, Air, & Soil Pollution Volume 97, No. 1-2, pp. 63-73.

Wheatley, B., S. Paradis (1996) Balancing human exposure, risk and reality: Questions raised by the Canadian Aboriginal Methylmercury Program, Neurotoxicology, Volume17, pp. 241-250.

Willows, Noreen D., and Katherine Gray-Donald (2002) Blood lead concentrations and iron deficiency in Canadian aboriginal infants, The Science of the Total Environment, Volume 289, pp.255-260.

THE UNIVERSITY OF CALGARY

Municipal State of the Environment Reporting in Canada

by

Jacqueline van Staalduinen

A Master's Degree Project
submitted to the Faculty of Environmental Design
in partial fulfillment of the requirements for the degree of
Master of Environmental Design (Planning)

Faculty of Environmental Design

Calgary, Alberta

June, 1997

0-612-26761-X

ABSTRACT

MUNICIPAL STATE OF THE ENVIRONMENT REPORTING IN CANADA

Jacqueline van Staalduinen

Supervisor: Dixon Thompson

June, 1997

Prepared in partial fulfillment of the requirements of the M.E.Des. Degree in the Faculty of Environmental Design, The University of Calgary, Calgary, Alberta, Canada

State of the Environment Reporting (SOER) is one of the emerging tools used by policy makers as part of the environmental management of the public sector. SOERs can be used by non-profits, the general public, private industry, and public employees to build awareness of the importance of environmental components on the efficiency of operations in the municipality.

The purpose of this project is to examine the current status of SOERs in Canadian cities and recommend a comprehensive planning process to develop an effective SOER program for municipalities. A critical review of eight current municipal SOERs is conducted to examine the differences and similarities between reports. The City of Calgary is the case study used to critique the planning process involved in determining a terms of reference for a SOER.

The final chapter outlines a comprehensive planning process for municipalities to follow to develop a SOER program. A number of recommendations are made for future SOERs. Ensure a complete buy-in from all stakeholders. Environmental issues must take an equal stand to economic and social issues. Include active public participation in the SOER program. Establish an independent agency to create standardized reporting method for municipalities and monitor its usage. Finally, create a common set of indicators which is used by all municipalities.

State of the environment reporting provides a forum to report on the state of our environment. This MDP provides a literature review, examines current Canadian municipal SOERs and makes recommendations for the continuous improvement of the process used at the municipal level.

Key Words: state of the environment reporting, environmental reporting, environmental management, environmental indicators, sustainable development, municipalities, municipal organizational structures

ACKNOWLEDGMENTS

I would like to thank my committee members for all their advice, encouragement, and enthusiasm for my Masters Degree Project. My supervisor, Dr. Dixon Thompson, for introducing me to Environmental Management Studies, and for inspiring me to incorporate environmental studies into my planning education. Thanks to Professor Theresa Baxter for her constant support and insight, as both a teacher and friend. To Dr. Dianne Draper, thanks for her professional contribution and her dedication to academic aspirations.

I would like to thank Kim Leach, City of Calgary, for giving me the opportunity to work with her, learn from her, and debate with her. Thank you Kim.

I would like to thank both Mr. Bill Porochnuk and Marino Vardabasso for their patience and infinite knowledge and advice throughout my three years in the faculty. They are both an invaluable asset to the faculty and students.

Lastly, I would like to thank my family;

My parents, Connie and Casey,
My grandparents, Jacob and Cora,
Cora, Greg, Tony, Alex, and Connor,
Jo-Ann, Dan, Debra and Jason,
Helena, Armin, and Mathew,
Bart, Cathy, and Andrew.

I am who I am because of them. The source of my strength and perseverance stems from the core of my family.

TABLE OF CONTENTS

ABSTRACT ii

ACKNOWLEDGMENTS iii

TABLE OF CONTENTS iv

LIST OF FIGURES viii

LIST OF TABLES viii

1.0 INTRODUCTION 1

1.10 Context of State of the Environment Reporting 1
1.11 Environmental Statistical Publications 1
1.12 Sustainability Reporting 2
1.13 Quality of Life Reporting 2
1.14 Environmental Management Systems 2
1.15 Environmental Audits 3
1.16 SOERs as a tool for the environmental management of municipalities 3

1.20 MDP Rationale 4

1.30 Purpose of MDP 5

1.40 Methodology 5
1.41 Phase 1: Literature Review 6
1.42 Phase 2: Report Collection and Examination 7
1.43 Phase 3: Key Informant Interviews 7
1.44 Phase 4: Case Study: City of Calgary SOER Process 8
1.45 Phase 5: Recommendations for a Comprehensive SOER Planning Process 8

1.50 Limitations of Research 9

1.60 MDP Outline 9
Chapter One: Introduction 9
Chapter Two: Historical Overview 10
Chapter Three: Canadian Municipal SOER 10
Chapter Four: The Calgary Terms Of Reference Process 10
Chapter Five: Recommendations 10

2.0 HISTORICAL OVERVIEW 11

2.1 Origins of State of the Environment Reporting 11

2.2 International, Federal, Provincial, Corporate, and Municipal State of the Environment Reports 13
2.21 International SOER Initiatives 13
2.22 Canada's SOER 15
2.23 Provincial SOERs 16
2.24 Municipal SOERs 17

THEORY, SCOPE AND ORGANIZATION OF MUNICIPAL SOERS 20

2.3 The Driving Forces 20

2.4 Purpose 21

2.5 Scope 23

2.6 Target Audience 23

2.7 Form 23

2.8 Structure and Content 24
Organizational Frameworks 24
Spatial Frameworks 27

2.9A Pressure-State-Response Model (PSR) 28

2.9B Environmental Indicators 30
2.9B1 Reference Points for Indicators 31
2.9B2 Criteria 31

2.9C Summary 32

CURRENT STATUS OF CANADIAN MUNICIPAL SOERS 34

3.10 Methodology 34

3.2 Terms of Reference 35
3.21 Vision 37
3.22 Purpose 37
3.23 Objective 39
3.24 Target Audiences 39
3.25 Scope 40

3.3 Structure and Content 40
3.31 Organizational Frameworks 40
3.32 Spatial Frameworks 42
3.33 Process 42

3.4 Indicator Analysis 48
3.41 Total Indicators 50
3.42 Indicator Categories 50

3.5 Public Participation 52
Timeline 54

3.6 Summary 55

THE CITY OF CALGARY TERMS OF REFERENCE PROCESS 57

4.1 Organizational Structure 58

4.2 Scope of the Project 62

4.3 Indicators 63

4.4 Public Participation 64

4.5 Summary 65

RECOMMENDATIONS 67

Recommendation One 67
Issue: No standard form of conducting SOERs at the municipal level. 67
Recommendation: Model for municipal SOER process 67
Phase One: Preparatory Information Gathering 68
Phase Two: SOER process 68
Phase Three: Preparation of SOER 68
Phase Four: Approval Process 68
Phase Five: Review, Monitor and Marketing 68
PHASE ONE: Preparatory Information Gathering 69
PHASE TWO: SOER process 69
PHASE THREE: Preparation of SOER: Phase 4: Approval Process: Phase 5: Review, Monitor, and Market 73

Recommendation Two 73
Issue: Barriers to municipal SOERs 73
Recommendation 74

Recommendation Three 75
Issue: Type and amount of public participation 75
Recommendation 75

Recommendation Four 75
Issue: Lack of Interdisciplinary Teamwork 75
Recommendation 75

Recommendation Five 76
Issue: Lack of Stakeholder Buy-in 76
Recommendation 76

Recommendation Six 76
Issue: Appropriate Use of Target Audiences 76
Recommendation 76

Recommendation Seven 77
Issue: Creation of a common set of selection criteria 77
Recommendations 77

Recommendation Eight 77
Issue: Common set of Indicators 77
Recommendation 78

Recommendation Nine 78
Issue: Lack of consistent, valid reporting for municipal SOERs in Canada 78
Recommendations 78

Recommendation Ten 78
Issue: Lack of Accurate Data 78
Recommendations 79

Recommendation Eleven 79
Issue: Use of the PSR model at the municipal level 79
Recommendation 79

Summary 80

REFERENCES 81

PERSONAL COMMUNICATION 88

APPENDIX ONE 90

Municipal State of the Environment Report 91

City of Vancouver 91

City of Kelowna 93

City of Ottawa 95

City of Burnaby 97

City of Toronto 100

Region of Peel 102

City of Regina 104

Regional Municipality of Waterloo 106

APPENDIX TWO 108

INTERVIEW QUESTIONS 109

APPENDIX THREE 115

RESPONDENTS TO QUESTIONNAIRE 116

LIST OF FIGURES

FIGURE 1.1: INTEGRATION OF ENVIRONMENTAL MANAGEMENT TOOLS 4
FIGURE 3.1: ORGANIZATIONAL STRUCTURE FOR LOWER TIER JURISDICTION 44
CITY OF OTTAWA 44
FIGURE 3.2 : CITY OF OTTAWA REPORTING PROCESS 45
FIGURE 3.3: THE ORGANIZATIONAL STRUCTURE OF THE CITY OF BURNABY 46
FIGURE 3.4: CITY OF BURNABY REPORTING PROCESS 47
FIGURE 4.1: CITY OF CALGARY ENVIRONMENTAL MANAGEMENT SYSTEM RESPONSIBILITY STRUCTURE59
FIGURE 4.2: THE CITY OF CALGARY REPORTING PROCESS 61

LIST OF TABLES

TABLE 2.1: COMPLETED SOERS IN CANADA 18
TABLE 2.2: PENDING SOERS 19
TABLE 2.3: PRESSURE-STATE-RESPONSE MODEL 29
TABLE 3.1: SUMMARY OF THE VISION, PURPOSE, SCOPE, AND TARGET AUDIENCES FOR CANADIAN ....
SOERS 36
TABLE 3.2: SUMMARY OF SIMILARITIES IN SOER FRAMEWORKS 41
TABLE 3.3: INDICATOR CATEGORIES 49
TABLE 3.4: NUMBER OF CITY SOER INDICATORS IN INDICATOR CATEGORIES 51
TABLE 3.5: PUBLIC INVOLVEMENT MEANS 53
TABLE 3.6: TIME & PERSON HOURS 54
FIGURE 5.1: PERFORMANCE MEASUREMENT INDICATOR PROJECTS CURRENTLY UNDERWAY AT THE ......
CITY OF CALGARY 70

CHAPTER ONE

1.0 INTRODUCTION

> *Our society is shaped by countless decisions made by individuals, business, government, and other organizations. In turn, the flow of energy, resource materials, labour, and waste set in motion by decisions determines the impact of our actions on the natural world and, ultimately, on our health and well-being. Environmental challenges exist because of demands we impose on the environment that are not taken into account in the decision making process.(Regina,1994, 7)*

In the last decade, local governments in Canada have been under considerable pressure to become more customer orientated and have faced increased pressure to prevent major environmental degradation through residential and commercial development. Municipalities have been developing their approaches to sustainable development in a variety of ways. State of the environment reporting (SOER) is "the systematic acquisition, analysis and presentation of information on environmental conditions and trends" (Sheehy, 1989, 1). SOERs are a tool used by policy makers to provide a general picture of the environmental conditions and trends from which progress, or lack thereof, in dealing with environmental issues can be determined.

1.10 Context of State of the Environment Reporting

In order to understand the context of SOE reporting, it is important to distinguish it from other types of similar environmental reports at the municipal level. There are a number of reports that either incorporate or overlap with SOERs.

1.11 Environmental Statistical Publications

SOERs contain substantial explanatory text, analysis, and qualitative data. Statistical publications have little or no analysis or discussion of the data presented and are largely numerical in nature. Scientists' need for detailed environmental statistics is obvious and these statistical publications satisfy that need (Parker, 1992).

Several international government agencies publish reports of environmental indicators including the Organization for Economic Co-operation and Development (OECD) and the United Nations Environment Protection Programme (Maclaren, 1996). Environmental data is also compiled for specific purposes by hospitals, universities, research organizations, industry, and government departments. For the most part, however, these data are not available to the public either because they are confidential or because there is no system in place to make potential users aware that the data exist, or any available mechanism to access the data (Maclaren, 1996). The Region of Peel, Ontario, and the City of Abbotsford, BC both produced reports on environmental indicators which can be used for state of the environment reporting and are currently available.

1.12 Sustainability Reporting

The task force of the Canadian Council of Ministers of the Environment defines sustainable development reporting as comprising..."SOER, economic and social reporting, and integrates these three streams of information" (CCME, 1992, 8).

A Sustainability report includes a range of information about environmental, economic, and social conditions and policies in the local community. Policy makers use this information to make judgements about whether the community is making progress toward sustainability. The report is also used to educate individuals about sustainability trends and to evaluate how their own actions may improve sustainability (Cambell & Maclaren, 1995). SOER information overlaps or may be used as part of an Urban Sustainability Report. The City of Calgary has a Sustainable Suburbs report which outlines goals, objectives and an action plan for future sustainable growth in the city. Many of the sustainable indicators used are taken from the pending SOER.

1.13 Quality of Life Reporting

Quality of Life (QOL) reports focus on the urban quality of life measuring such things as...

> *an individual's happiness and satisfaction with life and environment including needs and desires, aspirations, lifestyle preferences and other tangible and intangible factors which determine their overall well-being (Cambell & Maclaren, 1995,8).*

This report type requires a massive public participation element. Most of the indicators used are subjective and qualitative. The City of Burnaby's SOER is similar to this type of report due to its emphasis on public input. Most of the environmental indicators and initiatives stem from public concerns or perceptions.

1.14 Environmental Management Systems

An environmental management system (EMS) is part of the management system in place for corporations in both the private and public sectors. It is used to "formulate and implement environmental policies and to make decisions"(Thompson, 1995, 15) and to have "consistent and systematic control of procedures and operations, products or services which can have a significant impact on the environment." (Thompson, 1995, p.15)

State of the environment reporting or environmental reporting is a tool used as a bench mark to show trends in time for an environmental manager working within or developing an EMS. Many cities are in the process of considering developing an environmental management system. Most major corporations, especially in the natural resource industry have an EMS and some are submitting annual environmental reports in the same manner as financial reports.

1.15 Environmental Audits

Environmental Audits are...

> *regular, systematic reviews of. ..[an] Environmental Management System, compliance with laws and regulations, conformance to policies and development of an action plan to deal with deficiencies (Thompson, 1995, 14)*

Municipal government environmental audits cover some of the same material as SOE reports but with a much narrower focus. They tend to focus on a particular geographical area such as a port or industrial area. The audit includes a description of the natural area, distribution and severity of pollution problems, as well as recommendations for environmental remediation and future protection of the site (Cambell & Maclaren, 1995).

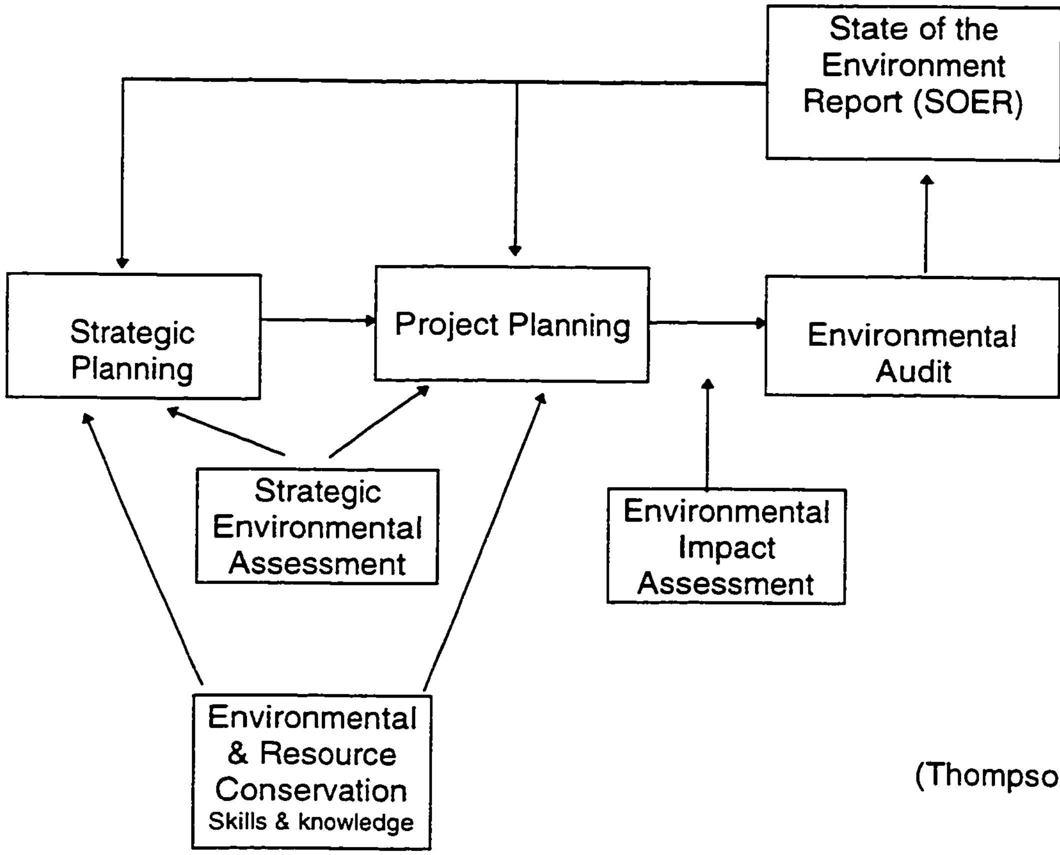
1.16 SOERs as a tool for the environmental management of municipalities

As illustrated in Figure 1.1, a SOER is part of the collection of environmental management tools. A state of the environment report provides the information which other tools can use. All of these tools help in dealing with the driving forces causing changes in environmental management, allow institutions to anticipate and avoid problems, and assist with analysis and reporting of performance and day-to-day management (Thompson, 1995).

A brainstorming session should take place to establish all of the external and internal driving forces for having an SOER. Some examples of driving forces may be public pressure; compliance with regulations; employees; cost savings; and council liability. These driving forces will establish the need for a SOER when presented to decision makers.

These reports and others like them contribute to policy making and action plans at the municipal level. How one can co-ordinate or compile these reports for a more comprehensive view of the state of the city, is the question. SOERs should be a very specific record of trends for the state of the natural environment and its indicators used to develop an ecological perspective to environmental management of Canadian cities.

Figure 1.1: Integration of environmental management tools



(Thompson, 1995)

1.20 MDP Rationale

Although state of the environment reporting (SOER) is done at the international level (i.e. OECD), the national level, and among the majority of the provinces, there are only about a dozen Canadian municipalities that have developed a comprehensive SOER program.

SOER programs are defined as management tools for the "systematic acquisition, analysis and presentation of information on environmental conditions and trends within a defined area or on a specific resource or medium" (Environment Canada, 1989, 10). They are used as a "municipal management tool designed to monitor and increase awareness of the current status, changes, and trends in the conditions of the local environment" (Environment Canada, 1995, 4). SOERs can be used by non-profit organizations, the general public, private industry, and public employees to access information about environmental issues of concern or contention.

There is evidence of growing concern about the private and public sector conducting business in a sustainable manner. In order to maintain a certain quality of life, there must be more proactive rather than reactive conduct through our interaction with the environment. There is an old saying 'until you know where you are, you can not tell where you are going'. Environmental reporting in the private sector, and public sector state of the environment reporting, are environmental management tools planners use to establish where the city is in terms of its environmental condition. Then and only then, can cities predict or be proactive in where they are going.

1.30 Purpose of MDP

The purpose of this Master's Degree Project is to examine the current status of SOERs done in Canadian cities to date and recommend a comprehensive planning process to develop effective state of the environment reporting for municipalities.

The main objectives for the MDP are:

1. Conduct a comparative description of 8 of the current Canadian Municipal state of the environment reporting programs.
2. As a case study, discuss the process the City of Calgary went through to develop the SOER terms of reference.
3. Produce a potential comprehensive planning process for municipalities to follow to develop a State of the Environment Reporting Process.

1.40 Methodology

The research project involved five key phases:

Phase 1: Literature Review;

Phase 2: Municipal SOERs collection and examination;

Phase 3: Key informant interviews;

Phase 4: Case study: process procedure of the State of the Environment Reporting system for the City of Calgary;

Phase 5: Recommendations for a comprehensive planning process to develop SOERs.

1.41 Phase 1: Literature Review

The first phase of the research project was a comprehensive literature review. This phase provided the contextual and theoretical background for the research. The purposes of the literature review were to: familiarize the researcher with the current status of state of the environment reporting in Canada; help formulate a process for critical analysis of the collected reports; identify information gaps in the literature that may be filled by this research.

A number of sources were used to conduct the literature review search.

- City of Calgary: Office for the Environment Resource Section, Library Services & Archives
- University of British Columbia: Main Library, Electronic Database Searches
- University of Calgary: McKimmie Library, Dobis on-line catalogue system & NOMADS government document index , Faculty of Environmental Design Resource Centre
- City of Vancouver: Regional Library, Electronic Database
- World Wide Web Internet System
- Canadian Municipal Environment Directory (1995)

Key word searches included:
State of the Environment Reporting, Environmental Reporting, Environmental Management, Environmental Indicators, Sustainable Indicators, Sustainable Development, Municipal Organizational Structures.

Literature research was conducted to look for the different elements of SOERs such as criteria for indicators, indicators (sustainable, environmental), and organizational and spatial frameworks used in state of the environment reporting. A literature review was also conducted on the historical overview of state of the environment reporting starting with such basic documents as the Stockholm Declaration on Sustainable Development (1972), and the Brundtland Report (1987).

Both national and provincial state of the environment reports, facts sheets, and annual reports were collected for review. These reports were vital to the literature review because they provided a methodology sample and data which influenced the scope and structure of municipal reports. A number of sources listed various municipalities which were in the process of doing a state of the environment report or had completed a final report.

1.42 Phase 2: Report Collection and Examination

Municipal governments produce a massive number of reports from each of their departments. In regards to state of the environment reports, the title of the report could vary or be part of a larger report such as the state of the city report. For example, Ottawa had a state of the environment reporting system, but did not have an overview report. Instead, the intention of the program was to produce a number of smaller reports, the first being Land and Water.

For the purpose of this research, eight municipal reports were collected for analysis. Each report was examined for its purpose, target audience, scope, indicators, and overall presentation. The results are summarized in appendix one and analyzed in chapter three.

The cities of Burnaby, Regina, and Ottawa were chosen to conduct key informant interviews. These three cities were chosen because the reports were representative of the wide spectrum of state of the environment reporting in Canadian municipalities. The Burnaby SOER was at one end of the spectrum with a focus on public consultation and participation. This city's report was qualitative and used very few indicators. Regina was in the middle of the spectrum, using an independent advisory committee to develop the SOER. The Ottawa report was at the other end of the spectrum, developing a SOER program which included a number of reports on specific topics. The influence of the Ottawa reports was much more politically focused. The purpose of these interviews was to examine the political organizational structure and the SOER process which was not represented in the final reports. These key informant interviews provided the author with a more holistic view of the process involved in the development of a state of the environment report.

1.43 Phase 3: Key Informant Interviews

Both formal and informal interviews were conducted between March 1996 and April 1997, to gather information for this MDP. Unstructured interviews were conducted with a dozen or so, professionals from The City of Calgary during the author's involvement in developing the terms of reference for the Calgary SOER. In this role, the author had the opportunity to discuss issues incorporated in state of the environment reporting with individuals from Environment Canada, the Province of Alberta, other municipalities, and the private sector. Due to the fact that most of these discussions were informal, the names and positions of those interviewed are not listed in the appendix. However, those individuals with whom the author had more extensive discussions are listed in appendix 3. From the collection of reports, three individuals from the cities of Ottawa, ON, Regina, SK, and Burnaby, BC were chosen to provide insight into the process involved in completing an

SOER. The purpose of the interviews was to gather impressions from professionals who had an active and on-going involvement with the process. A questionnaire (appendix 2) was developed and distributed to the project manager of each city SOER.

The questions asked generated discussion under the following topics:

1. The organizational structure of the local government;
2. amount and type of public participation in the SOER process;
3. scope of the project;
4. indicators and the criteria used to establish indicators and;
5. barriers encountered in the development of municipal SOERs.

The questionnaire was used as an informal guide to lead discussion in the key informant interviews. The respondents provided a more in-depth perspective of the SOER process for each of the cities. The respondents are listed in appendix 3.

1.44 Phase 4: Case Study: City of Calgary SOER Process

A situational analysis of a specific municipality was an important objective for this Master's Degree Project. To walk through the planning process from the beginning was critical for the author to understand the process and barriers which are encountered. The City of Calgary was selected for a number of reasons:

1. The researcher was doing a practicum with the Office for the Environment and was involved first hand in the SOER process;
2. Proximity to the researcher;
3. Primary research material available first hand;
4. First city in Alberta to establish a reporting process.

The municipal decision making structure and the planning process for the City of Calgary were examined. An implementation plan was illustrated in chapter five for The City of Calgary. This plan includes the SOER process, the development of a terms of reference, and an action plan. The case study demonstrated the steps involved in developing a comprehensive SOER for any Canadian City.

1.45 Phase 5: Recommendations for a Comprehensive SOER Planning Process

Based on the critical analysis of current municipal SOERs and this author's examination of the planning process for the City of Calgary, a planning process checklist was prepared which will guide a municipality through the planning process, to the terms of reference and an eventual final SOER. Recommendations were given regarding the strengths and weaknesses of municipal SOERs, and possible areas for further research.

1.50 Limitations of Research

There were a number of limitations or barriers in conducting the research for this Master's Degree Project. State of the environment reporting is a fairly new topic at the international and national levels. Few municipalities in Canada have conducted an SOER and for those that have, there is very little commonality between them. Therefore, the available literature is limited and had to be pieced together.

The list of municipalities which were conducting state of the environment reports found in the literature, was not accurate. A total of over twenty municipalities in Canada were contacted to acquire information on their reporting process. A number of cities which were thought to have had a SOER program, did not. It is also possible that a number of cities which are not listed in this report, may be in the process of doing a SOER or have completed a final report.

One of the major gaps in state of the environment reporting is a lack of consistency of reporting methods between municipalities. Due to the lack of consistency in reporting methods currently, the author could not rely on what exists to critically analyze a planning process. Therefore, one of the objectives for this MDP was to develop a step by step comprehensive planning process for state of the environment reporting for municipalities.

There was also a limitation on the number and type of key informant interviews conducted. Due to time, financial constraints, and the scope of the project, the key informant interviews were limited to three individuals who were directly involved in their municipal SOER. There were no members of the general public, private sector, or council members involved in the consultation process who were interviewed.

1.60 MDP Outline

Chapter One: Introduction

Chapter one is an introduction to the Master's Degree Project. The chapter includes the context of SOERs, MDP rationale, the purpose, and the objectives of the overall MDP. The methodology used for the MDP, the limitations of the research and the MDP outline are also covered in the introduction.

Chapter Two: Historical Overview

The purpose of chapter two is to give the reader a better understanding of the history of SOERs and their context at the municipal level. This chapter documents the origin of state of the environment reporting at the international, national, provincial and municipal levels. The chapter then expands in detail the theory, scope and organization of municipal SOERs.

Chapter Three: Canadian Municipal SOER

The purpose of chapter three is to review the current status of Canadian Municipal state of the environment reporting. The chapter includes a cross section of completed municipal SOERs analyzed for content and scope. Comparative description of Canadian municipal SOERs is conducted through a variety of techniques including figures, tables and key informant interviews to compare different municipal techniques. The organizational structure of municipal government and the planning process is analyzed as a significant influence on the structure and content of three city SOERs.

Chapter Four: The Calgary Terms Of Reference Process

The purpose of chapter four is to outline the process the City of Calgary has used to develop terms of reference for its SOER. The City went through a number of steps in developing a SOER terms of reference. The chapter outlines Calgary's civic organizational structure and the process used to develop the terms of reference for the report.

Chapter Five: Recommendations

This chapter reflects upon some of the benefits and shortcomings of current practices in state of the environment reporting at the municipal level. There are recommendations for a common procedure to develop a comprehensive planning process of state of the environment reporting for municipalities as well as on the barriers to SOER programs and recommendations for future research.

This chapter states recommendations for a common procedure to develop a comprehensive planning process for SOE reporting for municipalities. The recommendations are based on a critical analysis of the three completed Canadian municipal SOE reports and the Calgary proposal, in which development the researcher has played an active role.

Chapter Two

The purpose of chapter 2 is to establish a foundation for state of the environment reporting. This chapter documents the origin of state of the environment reporting at the international, national, provincial and municipal levels. The author expands in detail on the theory, scope and organization of municipal SOERs to provide the reader with a theoretical background for the SOER process at the municipal level. This chapter provides information for the reader to develop a basic understanding of state of the environment reporting which is necessary to judge the worth of the following chapters.

2.0 HISTORICAL OVERVIEW

2.1 Origins of State of the Environment Reporting

At the landmark United Nations Conference on the Human Environment in Stockholm in June, 1972, the Stockholm Declaration on sustainable development was issued (Region of Waterloo, 1991). In the final report of the 1987 World Commission on Environment and Development "Our Common Future", sustainable development has been memorably defined as:

> *development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (WCED, 1987, 43)*

The state of the environment and the rate at which it is changing is of fundamental importance to the sustainability of society as we know it. Both the Stockholm Declaration and the Brundtland Report appreciate that there are inherent limits to the ability of the physical environment to sustain human populations. The reports also emphasize that the actions of today have cumulative effects on our environment for future generations. In the last two decades, planners and policy makers have begun to develop tools which allow economic growth while monitoring and limiting human activity impact on the environment. State of the environment reporting is one of these tools.

The World Commission called upon all nations of the world to integrate sustainable development into their goals and action plans. Regular public reporting on the state of the environment is necessary for the private sector, all levels of govemments, non-profit organizations and institutions, and the general public to be aware of changes and trends in the condition of their environment (Environment Canada, 1994).

A state of the environment report enables policy analysts and decision makers to assess where they stand, in relation to their overall environmental goals and, where necessary, to redesign policy and action plans in accordance with changing circumstances and perceived problems (Pocock, l981). Essentially, the aim of preparing an SOER is to assess the impact of development processes on the environment over time (Elkin, 1990).

Although most countries had environmental data collected for individual departments, prior to the 1960s, SOERs were virtually non-existent. (Sheehy, 1989) The United States is considered one of the pioneers of State of the Environment Reporting. The 1970 U.S. National Environmental Protection Act required the Council on Environmental Quality to produce annual statements on the quality of the national environment as a whole (Elkin, 1990; Pocock, 1981). It was the first country to mandate co-ordination of individual sources of environmental statistical data into a single comprehensive report (Pocock, 1981, Cambell & Maclaren, 1995). It was not until the late 1970 that national state of the environment reports became widely produced. Since that time, there has been an increasing awareness of the need for SOERs at every level of government and in the private and non-profit sectors.

Most corporations began reporting on their environmental performance as part of their annual financial report. Recently though, more high profile sectors such as chemical and natural resources have begun publishing stand alone environmental annual reports (Elkington, 1993). Environmental reporting continues to grow as an essential part of an organization's environmental management system. (Schipperus, 1995)

Public sector SOERs document both the state of the environment in the jurisdiction of the city as well as the City as a corporation. Environmental reports have the same principles as an SOER but describe how the private sector affects the environment and mitigation methods. Corporations are conscious that they are accountable and must begin displaying proof of responsive environmental stewardship. The Canadian Chamber of Commerce defines an environmental report

> *as a comprehensive document itemizing environmental performance and the environmental protection activities of a firm. It is similar to industry-wide financial reporting practices but for environmental measures instead (Canadian Chamber of Commerce, 1992, 29).*

The content of environmental reporting can range from broad policy statements to detailed indices of performance. Currently there is no explicit obligation either in North America or in Europe for wide scale public reporting on private sector environmental performance (Schipperus, 1995). Although there are some environmental disclosure and reporting requirements as a result of environmental laws and regulations, the majority of examples of environmental reports are the result of voluntary disclosure initiated by the reporting entity (Gray, 1993).

The Canadian Environmental Protection Act (CEPA) addresses air, water, waste, and hazardous chemicals legislation (CEPA, 1985). The Federal government established national air quality objectives, emission standards, and principles for water resource management. However, Provinces have responsibility for implementation of the regulatory programs for individual environmental media (Schipperus, 1995). A general call to report on environmental performance includes the United Nations, Agenda 21, International Chamber of Commerce, Canadian Chemical Producer's Association (Responsible Care), and the Mining Association of Canada. (Schipperus, 1995). Along with the general call to report, many new guidelines and initiatives have emerged such as the Public Environmental Responsibility Initiative, Coalition for Environmental Responsible Economies, and the European Chemical Industry Council (Schipperus, 1995).

A successful SOE reporting program relies on partnerships with international organizations, other federal departments and agencies, provinces and territories, and non-governmental organizations (Sheehy, 1989). These partnerships allow information produced to be correlated and used effectively at all levels of government, the private and non-profit sectors.

2.2 International, Federal, Provincial, Corporate, and Municipal State of the Environment Reports

2.21 International SOER Initiatives

The United Nations 1972 Conference in Stockholm on the Human Environment revealed that not one country had maintained a comprehensive set of statistics on the quality of its environment. When many of those same delegates convened in Rio de Janeiro for the June 1992 UN Conference on Environment and Development, 70 out of 167 member countries tabled a national environmental report (Parker, 1992). The United Nations Environment Program (UNEP) released The World Environment, 1972-1982 in 1982 which reviewed the global environmental situation for the ten years after the Stockholm conference on Human Environment (Holdgate et.al., 1982, Sheehy, 1989).

An international state of the environment report is a summary of the environmental conditions and effects a particular international organization (i.e.EEC) and its members have on the environment. Each international organization influences its members to develop and maintain a regular reporting program at the international level to create valid data to assess the state of our global environment.

In 1979, the Organization for Economic Co-operation and Development (OECD) produced its first international SOER. In the same year, Environment Ministers of the OECD countries recommended that each member country periodically publish an SOER (Sheehy, 1989). The OECD report describes the state of the environment in the OECD's 23 member countries, and is considered one of the most detailed and comprehensive international SOERs currently in existence (Maclaren, 1996). The second report produced by the OECD in 1985, indicated that 16 out of the 25 countries in the OECD had drawn up at least one similar report (Sheehy, 1989, Elkin, 1990).

Another example of an international SOER is the annual State of the World report released by the Worldwatch Institute, a non-governmental organization. The European Economic Community (EEC) issued their first SOER in 1979 and the United Kingdom's first state of the environment report was issued in 1980.

Although there has been tremendous progress in international reporting on the state of our environment, there are still a number of shortcomings that must be considered. One of the most predominant shortcoming is the fact that

> *a standard for international reporting on environmental data does not yet exist...[therefore] there is no central set of national environmental statistics comparable to those available for development, trade, and population studies (Parker, 1992, 43).*

SOERs are abstracted from a huge mass of reports and data, which do not include all environmental information for a particular region. SOERs give policy makers the opportunities to improve the environment and to set priorities. Parker (1992) lists the UNCED's guidelines for the national reports which include:

- A description of development trends across the country's economic sectors;
- A description and evaluation of natural resources and environmental trends;
- Identification of the key environmental and natural resource problems;

- A comprehensive description of the last two decades of environmental and developmental policy;
- A listing and evaluation of programs undertaken for environmental protection;
- A description of the impact of external factors, such as trade and international economic relations on the national environment.

These guidelines for national reports were used by a number of countries in the formulation of their first state of the environment report.

There are a number of driving forces behind establishing state of the environment reporting at the national level. Presently, the environmental administration of many countries such as China, Russia, Brazil, and Indonesia publish regular SOERs. Members of the United Nations and the OECD have been requested to produce such reports. In some developing countries, SOERs often represent the main source of information on the environment, while in others, it allows the environmental records of government to be open to public scrutiny which causes hesitation to report. In India, Italy and Malaysia, non-governmental organizations (NGOs) produce their own SOERs in addition to the governments' official reports. Such duplication may indicate a certain amount of public distrust of officially produced reports (Parker, 1992). The Netherlands have taken SOE reporting a step further by trying to integrate the nation's multiple national policies into a cohesive environmental plan (Selman, 1994).

2.22 Canada's SOER

In response to the World Commission (WCED), the National Round Table on Environment and the Economy was created in Canada in 1986. Federal and Provincial Environmental Ministers, business executives, environmentalists and academics came together to make recommendations on actions needed to move Canada towards sustainable development. In 1986, a collaboration between Environment Canada and Statistics Canada, produced Canada's first SOER (Environment Canada, 1994). The SOER for Canada discusses ecotones and ecosystems, land use changes, contaminants in the environment, and health issues, and it does so using a wide variety of data to illustrate conditions and trends (AEPB, 1994.b.). In 1988, Canada established a formal SOE reporting program, under the direction of Environment Canada and Statistics Canada, with a commitment to deliver environmental information to the public through a number of tools, including an énvironmental indicators program (Environment Canada, 1991b, Cambell & Maclaren, 1995). In 1992, the first state of Canada's environment was released which identified the key national environmental conditions, trends, the linkage and impacts between human activities and environmental changes

(Environment Canada, 1994). This report addressed the proactive actions of Canadian citizen environmental concerns.

Environment Canada SOE Directorate, Indicator Branch, is in charge of developing a comprehensive national set of environmental indicators that gives a representative profile of the state of the environment and helps measure progress towards the goals of sustainability (Environment Canada, 1991). These common indicators can then be used in provincial and municipal reports in order to estimate common links and trends. The State of the Environment Directorate on the internet (http//www.doe.ca) has been established through the Environment Conservation Service of Environment Canada and offers a number of publications, general information, and communication links for further information and future action plans.

2.23 Provincial SOERs

Provincial SOERs provide the public with a convenient and reliable source for all the facts, with a minimum of interpretation. The general purpose for Provincial SOERs is to: identify established or developing environmental trends; identify potential issues or problems; and to compare or rate the province to other provinces. Working together with individuals, the private sector, and municipalities, a provincial SOER should provide useful information for policy and program decisions and their evaluation.

Environment Canada (Atlantic Region) published SOERs for the Atlantic provinces in 1980, 1986, and 1991, 1993 (Schipperus, 1995, Elkin, 1990). Quebec was the first individual province to publish an SOER in 1987, and again in 1992. Manitoba produced a report in 1991 and 1993, Saskatchewan in 1991,1992, and 1995, British Columbia in 1993 (Schipperus, 1995). BC Ministry of Environment, Lands, and Parks has produce a SOER for the Fraser River Basin (Environment Canada, 1992, Cambell & Maclaren, 1996).

The Alberta Round Table on the Environment and Economy composed of 24 appointed members formulated our provincial vision of sustainable development.

> *Alberta, a member of the global community, is a leader in sustainable development, ensuring a healthy environment, a healthy economy, and a high quality of life in the present and the future (Ensuring Prosperity, 1992, 10).*

Alberta's first comprehensive report was published in 1994. In addition to the comprehensive reports, a smaller report is published annually which deals with a specific topic about Alberta's environment such as waste management (AEPB, 1995). The next comprehensive Alberta

SOER will be published in the year 1999. It will look at how things have changed since the 1994 report (AEPB, 1994.b.).

The effects of the state of our environment start with the individual, and progress through industry, the municipality, province, federal, and finally the world community. How we measure these effects, how we present them, and how we respond to them starts with state of the environment reporting.

2.24 Municipal SOERs

Municipal SOERs appeared relatively early in the history of SOE reporting, with Seattle, Washington producing the first regional SOER in 1976 (Pocock, 1981, Elkin, 1990). Although Tokyo, Japan and South Yorkshire City Council in the UK produced SOERs shortly after (in 1978), the early reports did not establish a strong momentum for municipal SOE reporting world-wide and only a few reports appeared over the next decade (Pocock, 1981).

The 1992 Earth Summit in Rio has triggered many responses to the monitoring and management of the environment. A focus was put on local authorities to implement Local Agenda 21 which states:

> *the integration of development and environment at all levels of political and economic decision-making is essential to ensure sustainability (United Nations, 1993, 17).*

> *A priority in urban areas should be to clean up and maintain an environment that does not impair human health while at the same time not impeding development (United Nations, 1993, 22).*

State of the Environment Reports are integral to the local Agenda 21 process to create baseline information for environmental monitoring, increasing awareness, and influencing policy and action plans for sustainable development (Parker, 1992). Local authorities are ideally placed to provide both leadership and support for the community's efforts to attain more sustainable approaches to living (Ham, 1994).

At one time or another, local authorities have been responsible for many different environmental services, from the provision of water and energy to public health and open spaces. Although not all these functions remain, the core activities of environmental regulation still rest with local government (Hams, 1994). Municipal SOERs are a grassroots approach to gathering information on the state of the environment. These reports examine regional environmental conditions and use the information to influence local policy and decision making.

local authorities [are] the obvious vehicle for a comprehensive environmental protection service...the first step authorities need to take is a green audit, as a policy review...Secondly...the policy process should examine how to put together a corporate policy strategy on environmentally sound practices (Bassam, 1989, 13).

The first Canadian municipal SOER was produced for the Regional Municipality of Waterloo in 1987 by a Ph.D. student at the University of Waterloo, T.C. Elkin. (Cambell & Maclaren, 1995) The first city-produced SOER was in 1988 by the City of Toronto. Although State of the Environment reports have been less common at the municipal level, where they have been undertaken the emphasis has been toward the consideration of environmental conditions within the planning context (Pocock, 1981).

In Canada, there are a number of municipalities that have either completed their first State of the Environment Report or are considering SOER as an option. From a survey done by Cambell & Maclaren (1995), as well as my own research, the following cities have completed an SOER (see Table 2.1):

Table 2.1: Completed SOERs in Canada

Completed SOERs	Date
Toronto, Ontario	1988, 1994
Region of Hamilton-Wentworth, Ontario	1990
Region of Ottawa-Carleton, Ontario	1991
Waterloo, Ontario	1991
Burnaby, British Columbia	1993
Vancouver, British Columbia	1993
Regina, Saskatchewan	1994
Kingston, Ontario	1994
Ottawa, Ontario	1994
Region of Peel, Ontario	1995

Those cities that are considering doing a state of the environment report or have already completed the terms of reference and are in the process of writing the report are listed by Cambell and Maclaren (1995) and my own research (see Table 2.2):

Table 2.2: Pending SOERs

Pending SOERs
Kelowna, British Columbia
Richmond, British Columbia
Calgary, Alberta
Canmore, Alberta
London, Ontario
North York, Ontario
Oakville, Ontario
Saint Eustache, Ontario

THEORY, SCOPE AND ORGANIZATION OF MUNICIPAL SOERS

Economic growth and new technology have given society both the technical ability to destroy the quality of the environment and the wisdom and desire to preserve it (Elkin 1990, 54).

In the last decade, society has become increasingly aware of the need to manage our environment. However, it is easier and more accurate to tell where we are going if we know where we are. State of the environment reporting is a tool used in environmental management to provide the information on where we were, where we are right now, what the trends are, and give us the information necessary to develop an action plan for the future.

In developing a terms of reference for state of the environment reporting, one must ask the question "Why would a municipality want to do an SOER? There are a number of both external and internal driving forces which illustrate the need for this reporting system.

2.3 The Driving Forces

Driving forces are outside factors which force people to change their approach to environmental management. According to the KPMG Environmental Services' Canadian Environmental Management Survey, the top five factors influencing municipalities to take action on environmental issues are:

- 95% Compliance with regulations
- 76% Public pressure
- 57% Employee initiatives
- 48% Cost savings
- 33% Board of Directors' liability

Compliance with Regulations

At the international, federal and provincial levels of government, a number of environmental regulations have been implemented to monitor both the private and public sectors. Municipal governments are performing the role and responsibilities of a large corporation in the way that they do business. There are scarce resources and fierce competition to attract clean industry.

Public Pressure

Growing public awareness and concern for the environment has started to put pressure on local government to report on the state of the local environment. The general public is concerned about accessing information on how the city as a corporation is performing, as well as information on how the municipality is doing compared to other cities in environmental concerns such as recycling, waste management, and water consumption.

Employees

Increased public awareness and concern for the environment has led to individual employee initiatives in the workplace. Employees are demanding changes in the workplace which include initiatives such as recycling, new purchasing guidelines, and waste reduction.

Cost Savings

There are a number of ways in which a corporation can save money through environmental initiatives. Simple solutions in reuse, reduce, recycle concepts can save the municipal corporation waste disposal costs. Another simple solution is using products with minimal packaging and using environmentally friendly suppliers and supplies.

Board of Director's Liability

In private industry there have been both fines and jail sentences for members of a board of directors who can not prove due diligence to a court of law. Members of the board of directors for Bata Shoes were found guilty in a court of law of not providing all of the necessary and available resources to avoid environmental damage. Public sector senior managers and municipal council, who can not prove due diligence for an environmental offence are also open to criminal charges. This is a significant driving force for directors to take action to maintain a conscientious level of environmental proprietorship.

Along with these common driving forces, individual municipalities have a number of internal factors which influence the scope and content of their state of the environment report. These factors are defined in the purpose of the state of the environment report.

2.4 Purpose

The first step to municipal state of the environment reporting is to establish the purpose of the report. The purpose of an SOER takes into account the external driving forces which establish a need to have such a report. There are a number of roles a SOE report can play in the municipal structure.

Public Information and Education Tool

The majority of municipalities undertaking state of the environment reporting indicate the purpose of this activity is to enhance public awareness of the quality of the local environment. People at the grassroots level are becoming increasingly active in environmental issues and they are seeking more information on the local environment. SOERs can provide environmental information to fulfill the public's right to know (OECD, 1991; Pocock, 1981, Elkin, 1990). It can be used as a powerful education tool recommending priorities for action by public authorities for the public, politicians, and the administration of the municipality, as well as play a key role in helping a community understand environmental change.

Improve Decision Making

State of the environment reporting enables policy makers to take stock of where they stand in relation to their overall environmental goals and, where necessary, to redesign policy in accordance with changing circumstances and perceived problems (Pocock, 1981). State of the environment reporting at the municipal level provides a continuing appraisal of the relevance and effectiveness of existing environmental protection policies. SOERs can be used as a background document which enables decision makers to establish priorities, make informed decisions based on up-to-date information and allocate scarce resources appropriately. The report ensures or encourages the inclusion of environmental considerations in the decision-making context (Elkin, 1990). The SOER is an integral part of the 'action cycle' of environmental policy evaluating policies, management programs and initiatives (Pocock, 1981).

Implement Local Environmental Initiatives

Many municipalities have environmental policies and plans that have no attached action plan. However, if a municipality does not have any information on the current status of the environment within its jurisdiction, it is difficult for planners to prioritise and implement environmental initiatives or action plans. An SOER is not an end in itself, but must be seen as a tool to be used effectively by policy makers to implement an environmental action plan containing achievable goals, which are regularly reviewed to ensure their implementation. The SOE report measures the impacts of policy decisions on the local environment and provides a forum to create scenarios and a strategy for improvement (Elkin, 1990).

Accountability and Comparison

The documentation of the state of the local environment creates a means of accountability for a municipality. The report can be used to demonstrate areas that need improvement and highlight exceptional areas. As SOERs become more common and a standard reporting system is put in place, the report can be used as a basis for comparison with other municipal SOE reports.

2.5 Scope

Although there is a clear definition of SOERs as a "systematic acquisition, analysis and presentation of information on environmental conditions and trends within a defined area or on a specific resource or medium" (Environment Canada, 1989, p.1), it is left up to the discretion of the individual municipality to determine the scope of the term 'environment'. While some municipalities use SOER to report on the biophysical factors in the city region, it is common for SOERs to encompass the social, economic and cultural factors as they impact on or are affected by the biophysical environment. SOERs can vary in scope from highly technical to predominantly conceptual. The first step in understanding a SOE is to break down the process into manageable and measurable components (Ham, 1994).

2.6 Target Audience

The target audience is the stakeholder for whom the report is addressed. Selman (1994) describes the three stakeholder groups for environmental information. The public's interests in environmental information includes active partnership, informed, measurable individual behavior, ecological literacy, and effective use of information. The scientist must have reliable, comprehensive, respected data which is relevant to tasks. Decision makers are the third group Selman mentions and describes their requirements for information as informed basis on which to communicate and act; sound guidance on which to target expenditures. Producing a report which will satisfy the public, scientists, and decision makers is a difficult task. The first volume of a report should be an overview report, aimed at the general public (Parker & Hope, 1992). If scientists and decision makers would like more information, a second volume could be published, or a reference guide for further information.

2.7 Form

An SOE report must be a clear, well defined, summary of the state of the local environment so that it can be read and interpreted by the target audience without compromising its scientific validity. Those compiling the report must be careful of their interpretation of the statistical information into a meaningful indicator for the public or target audience. The information provided should reflect a meaningful measure and test of environmental policies in place. Some of the questions which are assessed include; who initiates the reporting? who is responsible? who collects and compiles the data? who presents it to council? and what form of public participation is used?

2.8 Structure and Content

A major concern in municipal SOE reporting is the lack of a common structure and content used for comparison with other municipalities. Sheehy (1989) provided a number of different types of organizational and spatial frameworks which are used both independently and in combination with other frameworks in the structure and format of municipal SOERs. Organizational frameworks include:

- Issues framework;
- Resource Sector framework;
- Environmental Media framework;
- Environmental Process framework;
- Combination framework.

The Spatial frameworks which Sheehy (1989) determined are:

- Jurisdictional frameworks;
- Environmental Component frameworks;
- Ecosystem frameworks;
- Combination Spatial frameworks.

Organizational Frameworks

Organizational frameworks govern the type of subject matter and data that are presented in the SOER document and the manner in which it is organized (Cambell & Maclaren, 1996). The organizational framework must reflect the complex, dynamic nature of the ecosystem and make effective use of available data. Most environmental data are usually collected to serve administrative needs to manage resources and regulate resource uses. The organizational framework must reflect the type of state of the environment report and the available data information.

Issues Framework

The purpose of the issues framework is to select and report on environmental problems or controversies such as waste disposal, air pollution, and excess noise and highlights important problems. Reichert and Ragetlie (1991) describe an Issues Framework as most appropriate under the following conditions:

- to highlight one or more environmental problems;
- when information is available for a particular concern;
- when data are available in a variety of formats;
- to increase public awareness of emerging, large scale or environmentally significant issues.

Ottawa, Burnaby, and Regina use an issues framework to illustrate data in a variety of formats. For example, Regina highlights the amount of solid waste generation as an environmental concern. The issue of waste management in Regina has generated information in a number of formats. The report illustrates three different indicators for solid waste generation, offers a city strategy, city initiatives, and opportunities for residents and businesses to increase public awareness and participation in waste reduction strategies.

Resource Sector Framework

A resource sector framework reports on conditions and trends of natural resources. The most common resource sectors used are agriculture, fisheries, forestry, mining, oil and gas. Reichert and Ragetlie (1991) describe this framework as:

- to show how humans use environmental resources;
- to take advantage of common data from agriculture, fisheries, forestry, and mining;
- to target resource agencies and industry audience.

The Region of Waterloo's (1991) state of the environment report is a good example of a resource sector framework. Chapter five is titled land resources, and covers agriculture, aggregated resources, wetlands, environmentally sensitive policy areas, and forestry. One measure recorded for forestry is the total forested land, 1891, 1896, 1981 for the Waterloo County Region (Waterloo, 1991). This indicator is taken from common data collected for the forestry sector.

Environmental Media Framework:

This organizational framework describes the condition of the environmental media. The broad topics of environmental media include the atmosphere, water, land, flora and fauna. Reichert and Ragetlie (1991) describe an environmental media framework as appropriate;

- to use environmental baseline and monitoring data from public agencies;
- when the target audience includes members of the public seeking information about land, air and water.

Reports from the cities of Vancouver, Toronto, and Kelowna are all good examples of the use of an environmental media framework. For example, in the 1995 SOER for Vancouver, chapter two is entitled State of the Air. This chapter includes discussion on air pollution, ambient air quality, indoor air quality, current status of air in the city, and the issues and choices available to decision makers and the general public. A number of indicators such as emission trends, contaminant levels, and road vehicles causing air pollution are among the indicators used to examine the state of the air.

Environmental Process Framework:

This framework concentrates on ecological relationships, recognizing that human activities stress the environment and that the ecosystem changes in response to these stresses. For example, vehicle exhaust causes air pollution which affects human health. In response, government passes an air emissions testing policy. Reichert and Ragetlie (1991) describe an Environmental Process Framework as appropriate:

- to illustrate dynamics of the ecosystem;
- to demonstrate temporal and spatial association;
- to target knowledgeable interest groups and informed public;
- to support large financial commitments for environmental protection.

The Region of Peel and the City of Toronto State of the Environment Reports are good examples of Environmental Process Frameworks. In the Region of Peel SOER, there is a section on motor vehicle emissions as stressers on air quality. Indicators used to measure this stress on air quality are vehicle emissions in Peel, factors affecting vehicle emissions, maintenance habits, and driving tendencies.

Combination Approach Framework

Frequently, a SOER uses a number of organizational frameworks, in combination, or for different sections of the report. A Combination Approach Framework is appropriate to meet different objectives for environmental issues as well as to accommodate different types of data. The Regina SOER is a good example of a combination organizational framework. This city report uses Environmental Media, Environmental Issues, and the Pressure-State-Response model to meet the objectives outlined for the report. The table of contents includes chapters on the state of the biophysical and socio-economic environment as well as the future. Each chapter has sections which include issues, indicators, city strategy, city initiatives and public opportunities.

Spatial Frameworks

There are a number of spatial frameworks utilized in a SOE report. The most common spatial frameworks at the municipal level are the jurisdictional or administrative frameworks.

Jurisdictional or Administrative Frameworks:

Statistical information or data are collected for a specific geographical area under a certain jurisdictional or administrative framework such as census divisions. Reichert and Ragetlie (1991) recommend using this spatial framework:

- to compare or highlight environmental conditions within particular jurisdictions;
- for a lay audience which relates to political boundaries and is not familiar with an ecosystem framework.

Both Vancouver and Regina state of the environment reports use only a jurisdictional spatial framework.

Environmental Component Framework:

The information is presented in specific geographical units determined by environmental factors. Examples include watersheds, vegetation or climatic zones, and soil units. Currently there are no examples of this spatial framework in the SOERs that have been examined.

Ecosystem Frameworks

Information is presented for geographic units which contain distinctive sets of abiotic and biotic features that are ecologically interrelated. Reichert and Ragetlie (1991) recommend using this spatial framework to:

- display and analyze cross-sectoral themes and interrelationships;
- develop information systems tailored to the ecosystem concept.

Currently there are no examples of this spatial framework in the SOERs that have been examined.

Combination Approach Framework

Comprehensive SOE reports often use more than one spatial framework and in some cases two or more spatial frameworks are combined into a composite spatial framework. This framework may consist of the best elements of each of the existing frameworks or could be modified from one or more spatial frameworks.

There are a number of advantages and disadvantages to the different types of organizational and spatial frameworks. In choosing the types of frameworks for any particular SOER, Sheehy (1989) identifies a number of factors that should be considered prior to choosing a framework.

Readability is the ability of a particular framework to contribute to the reader's understanding of the state of their environment.

The audience will influence the type of framework that is used. Is the report aimed at the general pubic in order to educate them on broad topics or aimed at scientists?

The goals and objectives of the report stem from the driving forces and purpose of the report. Is the framework highlighting a particular issue, reflecting ecosystem dynamics or showing the effects of stresses on the environment?

Both the organizational and spatial frameworks will influence the format and structure of the report, and how it should be set up.

The types of information available for reporting will influence the type of framework chosen. Environmental data gathering systems determine the framework.

Each framework will demonstrate or illustrate the social-environmental relationship differently depending on the integration of social and environmental factors.

Each framework forms a different level of depth or scientific information available in the report which will effect how comprehensive the report will be.

The budget or amount of resources available will determine the detail and format of the report and therefore the framework used in the documentation.

2.9A Pressure-State-Response Model (PSR)

The underlying concept for this model is that human activities affect environmental conditions, which in turn affect economic, health, and social conditions. Society may respond with preventative or regulatory measures to reduce the stress of human activities on environmental conditions (Environment Canada Workshop, 1995). The Organization for Economic Co-operation and Development (OECD) created the PSR Model as an organizational framework to group indicators for SOERs (Stephenson & Thompson, 1996). The PSR model used by the OECD (1993) is based on a concept of causality where human activities exert pressures on the environment and change its quality and quantity of natural resources. Society's response to these changes is through environmental, general economic and sectoral policies (Schipperus, 1995).

Table 2.3: Pressure-State-Response Model

ISSUE	PRESSURE	STATE	RESPONSE
Waste	Generation of Municipal waste	Accumulation to date	Expenditure on collection & treatment recycling rates
Water quantity	Consumption rate	Accessibility to population	water efficiency measures
Marine Resources	Land use changes	Threatened, extinct species	Protected Areas as % threatened
Forest Resources	Land use changes	Area, Volume, Distribution	Input/output ratios, Main users; Recycling rates
Air quality	Air emissions	carbon monoxide ppm	# of trips per household

(Note: information in part by World Resource Institute, 1995, research by author, 1997)

Table 2.3 is an example of the types of indicators used in the PSR model. Each issue has three different types of indicators to demonstrate the different factors which affect the issue. This framework provides a vehicle for answering the following four simple questions that lie at the heart of SOE reporting. (Environment Canada 1991b):

What is happening in the environment?

Why is it happening?

Why is it significant?

What are we doing about it?

The PSR Model is useful for identifying and addressing issues of cumulative effects of human activities on ecosystems. Human activities are seen to act as stressers that affect environmental conditions which in turn affect economic, health, and social conditions. The Pressure component identifies human activities which cause stress on the environment. The state of the environment indicates the characteristic conditions and health of the natural environment. A response describes the nature and performance of government or corporate programs/policies designed to improve the environmental conditions by remediating sources of environmental stress (Maclaren, 1996). Policy responses can alleviate the stressers or modify environmental conditions directly through restoration or clean-up programs (Maclaren, 1996).

The Region of Waterloo and the City of Regina both use this model loosely. The report for Waterloo is divided into the environmental past, present and future. An example of PSR indicators is land use. In the 'Present' section for Waterloo, land use has a 'state type' indicator of farm *versus* non-farm. The 'pressure indicator' on the land can be illustrated through the indicator total farmland. The response to the pressure and state of land use, farm *versus* non-farm is provided in the recommendations for future management of farm land.

Canada's national state of the environment report uses this model. A major problem with the Canadian approach is the pressure-state-response model requires a new geographical framework for data collection, based primarily on ecological boundaries rather than jurisdictional boundaries.

2.9B Environmental Indicators

"Environmental indicators are measures of certain aspects of our environment that we monitor to describe and interpret changes in the environment" (AEPB, 1994C, 1). Indicators help identify trends in the condition of our environment and allow government, private industry, non-governmental organizations and individuals to recognize environmental problems and act to correct them (AEPB, 1994C, Schipperus, 1995). Indicators provide an early warning of potential problems, and can alert an authority to its needs to resolve or manage them. They also show trends on the extent to which human activity is causing stress to specific environmental resources to be monitored. "Indicators found to be appropriate for a given point in time may change as policy perspective and public values evolve" (Maclaren, 1996,19). Instead of trying to find the perfect set of indicators at the municipal level, a model should be used for indicator identification and identification of criteria by which metrics and indicators will be selected or rejected (Stephenson & Thompson, 1996).

Currently, Canada leads the field both nationally and locally in environmental indicator research (Ham, 1994). The Federal Government of Canada has developed a set of environmental indicators of environmental quality. Through a special project team, the Federal Government is continuing work on the development of broad environmental indices for Canada (AEPB, 1994B, Schipperus, 1995).

Local authorities have always collected, stored, analyzed, and manipulated environmental data, however, until recently, this data was collected for specific purposes and facilities in individual departments

(Ham, 1994). Currently, there is no common set of indicators used for Canadian municipalities (Cambell & Maclaren, 1995). This is due mainly to the fact that indicators are dependent on the availability of data. Each municipality collects data in different departments for different uses and there is little consistency from city to city. As yet there is no widely accepted set of indicators of the quality of the urban environment (Canadian Urban Institute, 1991, Cambell & Maclaren, 1996).

2.9B1 Reference Points for Indicators

Reference points for indicators are an important aspect of municipal SOERs. There must be appropriate reference points for municipal indicators which include provincial/national means, policy targets, regulations, time trends, intra-community comparisons and inter-community comparisons (Maclaren, 1996).

Maclaren has divided indicators into three main types. Individual indicators measure the level of a single variable of interest. For instance, if the issue is energy consumption, a single indicator may be the consumption of energy. Representative indicators reflect the behavior of a large number of variables. The amount of recycling is a representative indicator of a large number of variables such as recycling of glass, paper, and plastic. Composite indicators aggregate a number of variables into a single quantity or index. Quality of life index is an example of a composite indicator. A number of variables are taken into consideration and compiled into a single measure of the quality of life in a municipality.

2.9B2 Criteria

A number of indicator selection criteria have been identified in order to target specific types of information. The most common selection criteria for indicators are taken from a variety of sources which include Maclaren (1996), Environment Canada Workshop (1996), the Pembina Institute (1996), Hamilton (1994), Stephenson & Thompson (1996):

- Consistent with identified environmental objectives - relevance to stated goals;
- represent the issue of concern;
- relevant to target audience information requirements;
- measurable;
- unambiguous - Can they be interpreted in more than one way;
- data accessible and available in a consistent format over time;
- cost effective to collect;
- theoretical soundness, scientifically valid, credible and verifiable;

- comparable with indicators used in other jurisdictions;
- comparable with baseline conditions, objectives, targets, standards, guidelines and regulations;
- accuracy of data;
- understandability of data for audience;
- attractive to the media;
- able to provide an early warning of potential changes.

Selection criteria for indicators determine the type and number of indicators used. Though most of the criteria is considered important, key informants from the cities of Regina and Ottawa both rank the top three criteria as:

- data accessible and available in a consistent format over time;
- represent the issue of concern;
- relevant to target audience information requirements.

Environment Canada SOE Directorate, Indicator Branch, is developing a comprehensive national set of environmental indicators that gives a representative profile of the SOE and helps measure progress towards the goals of sustainability (Environment Canada, 1991). A group of municipalities has made application to Environment Canada and ICURR to begin a study on developing a common set of indicators for municipalities so that cities can start comparing themselves to other municipalities (McDonald, pers.com., 1996). Through a common set of criteria, reference points, and national indicators, individual municipalities can eventually begin referring to a common set of municipal indicators.

2.9C Summary

The purpose of chapter 2 is to provide background information on state of the environment reporting. When a municipality is discussing whether or not to do a SOER, chapter 2 provides the information that decision makers need to understand where SOERs originated, who is doing them, and the differences between the various types of SOERs.

State of the environment reports were initiated at the International level and encouraged by organizations such as OECD to be done nationally. The Canadian Federal Government submitted Canada's first SOER in 1986. Individual provinces began conducting SOERs in the 1980s and the first municipal SOER was produced for the Regional Municipality of Waterloo in 1987. Presently, over a dozen municipalities have reported on the state of their environment and many more are considering the process.

There are a number of reports at the municipal level of government which are similar to SOERs. It is important to determine the distinction between these reports in order to determine the objectives and scope of a state of the environment report. To do this, the municipality should consider the driving forces for doing the report, the purpose of the report, the scope, target audience, form, structure, and content. Once these issues have been formulated into terms of reference, environmental indicators must be chosen.

Now that the theoretical framework for municipal state of the environment reporting has been discussed, chapter three will examine the current status of Canadian municipal SOERs and the differences and similarities in each city's methodology.

Chapter Three

CURRENT STATUS OF CANADIAN MUNICIPAL SOERS

The purpose of chapter 3 is to review the current status of Canadian Municipal state of the environment reporting programs. The chapter includes a cross section of completed municipal SOERs analyzed for content and scope. Comparative description of Canadian municipal SOERs is conducted through a variety of techniques including Figures, Tables and key informant interviews, to compare different municipal techniques. The organizational structure of municipal government and the planning process is analyzed as a significant influence on the structure and content of each city SOER.

Such comparative analysis of eight of the current Canadian municipal state of the environment reports in chapter 3 satisfies the first objective of my master's degree project.

3.10 Methodology

In Canada, there are a number of municipalities that have either completed their first state of the environment report or are considering SOER as an option. For the purposes of this MDP, eight Canadian municipal SOERs from Kelowna, Peel, Toronto, Ottawa, Burnaby, Vancouver, Regina, and Waterloo were examined in depth.

In reviewing the various state of the environment reports, information was taken from key informant interviews and the actual written documents. The approach used was to take the role of an informed member of the general public, looking for answers to particular questions about the state of the environment in a region, and the process involved in getting that information. The critical review of each report consisted of asking a series of questions pertaining to:

Vision Statement

Did the document provide a vision statement for the state of the environment report? Did the City have a vision for the urban environment?

Purpose

What was the purpose of writing a State of the Environment Report? Was it a product of the Vision statement or other driving forces?

Objectives

What specific actions would fulfill the Vision and Purpose of the SOER? What were particular issues that the SOER would address?

Target Audience

Who is the report written for? Who are the primary and secondary audiences?

Scope

How broad was the scope of the report? Did the document report on the biophysical aspects only or was it broader in its intent to cover social and economic issues as well.

Indicators

How many indicators were used? What type of indicators were used? What were the criteria for developing a set of functional indicators?

Public Participation

What was the form of public participation? At what point in the process were they involved?

This chapter is used to compare the report summaries found in the appendix one. A large summary table was produced and examined in detail to formulate the differences and similarities between the various reports. From this large table, the following tables were established for an overview of the reports. Each table feature the most significant details of the SOERs for comparison. In some cases, information was not available for a critical review. For instance, there are gaps in the table regarding criteria used to identify indicators for Ottawa. Information gaps were left blank in the table and recommendations will be made to correct these gaps.

Key informant interviews were conducted for three cities to present the wide spectrum of reporting methods used in Canadian municipalities. Chapter 1 outlines the methodology used to conduct these interviews.

3.2 Terms of Reference

Table 3.1 is used to index each city's vision, purpose, scope, and target audiences for the state of the environment reports in review. In the process of developing terms of reference for a SOER, there are a number of issues to be addressed such as who the report is for, what the goals for the report are, and how much detailed information will be in the report. Table 3.1 provides a summary of the issues addressed to formulate terms of reference .

Table 3.1: Summary of the Vision, Purpose, Scope, and Target Audiences for Canadian SOERs

CITY	VISION	PURPOSE	OBJECTIVE	SCOPE	TARGET AUDIENCES
VANCOUVER 1995	create & maintain a sustainable community	PLANNING guide the development of a practical City environmental agenda	provide environmental baseline public report card	biophysical socio-economic as it effects biophysical	general public decision makers administration
KELOWNA 1995 PRELIMINARY DATA REPORT	ensure preservation of the environment.	INDEX/OVERVIEW tool for environment. planning & policy implementation	provide environmental baseline	biophysical	general public decision makers administration
OTTAWA 1993 LAND & WATER	establish ecological approach to manage environment.	PLANNING/INDEX raise awareness, to show change in envir. describe City programs & initiatives	monitor environment outline ecological approach	biophysical socio-economic	general public decision makers administration
BURNABY 1993	ensure ecological sustainable dev't & balance between economic. & environment.	PLANNING improve decision making identify envir. issues public awareness	set environmental. goals & objectives. for city provide environmental baseline	biophysical	general public decision makers administration
TORONTO 1994	anticipate & mitigate environment. impacts of growth & change	DATA provide overview for EMS for City improve decision making public awareness	provide environmental baseline identify environmental issues	biophysical socio-economic	administration decision makers board of health general public
REGION OF PEEL 1995	create ecological approach to future planning	INDEX monitoring mechanism assess envir. policies	report past & present airborne pollutants	biophysical socio-economic as it effects biophysical	administration decision makers general public
REGINA 1994	create an urban community within limits of the environment	INDEX/PLANNING public awareness protect, manage natural & built envir.	provide environment baseline initiate envir. activities	biophysical socio-economic	general pubic decision makers administration
REGION OF WATERLOO 1991	preserve, enhance, manage the natural environment.	INDEX shape future policy guide corp. decisions public awareness	provide environment baseline	biophysical socio-economic as it effects biophysical	decision makers administration general pubic

(Note: target audience is in order of priority stated in each report)

3.21 Vision

As discussed previously in chapter 2, municipalities are taking a more prominent role in developing environmental consciousness. The Brundtland Report and Agenda 21 are two such documents which are encouraging municipalities to report and improve the state of the environment at the grassroots level. Sustainable development has become the buzz word for including indicators for the environment as well as social and economic indicators of health and prosperity of the community. The municipality needs a vision for the future of both the natural and built environment.

Table 3.1 illustrates the common vision among all of the municipalities researched. The most common theme for a city vision is *to create and maintain a sustainable community*. Vancouver, Regina, Toronto, and Burnaby demonstrate an emphasis on equality of environment, social, and economic factors. The vision statements for Waterloo and Kelowna focus purely on the biophysical environment. The City of Ottawa and the Region of Peel both concentrate the vision of the city on *the establishment of an ecological approach to future planning*. An ecological approach can be interpreted as considering all factors which influence the state of the biophysical environment including social and economic influences.

If a municipality uses the SOER for planning the future of the city, an ecological approach, using the Pressure-State-Response (PSR) model would be appropriate. The PSR model provides policy makers with the ability to analyze what the state of the environment is, the pressure that human intervention is making on it, and how decision makers can respond. Although the vision for each city is to create a sustainable city, simply reporting on the state of the natural environment or including social and economic factors, is not an effective model to achieve steps toward their vision.

3.22 Purpose

In the development of the scope of a SOER program, city staff must determine the type of report which it would like to produce. Using Reichert and Ragetlie's (1991) indicators categories from <u>State of the Environment Reporting Background Notes</u> , the researcher categorized each of the reports into a particular type, or a combination of types of the following four report types.

Data Report

The data report is a collection and compilation of available data for various parameters within each environmental sector. The interpretation of this data is generally limited to the identification of trends and variability between sites. Toronto's 1994 SOER is an example of a data report. Using different sets of scientific data, the report is compiled and presented specifically for scientists or a user-specific target audience. The lay person would not understand or find this report completely useful.

Index Report

The index report uses a number of indices to evaluate environmental quality. The state of individual components of the environment can be assessed by using biophysical indices which describe the quantity and quality of environmental assets. Two examples of this type of report is the Region of Peel and the Region of Waterloo. Both of these municipal reports use a number of indices to describe the condition of the natural environment in their region. An index report is easier to understand because of the indices showing trends and measures. This type of presentation is effective for a target audience using the information for policy and action plans.

Overview Report

An overview report presents key data with a summary statement on the condition of the major components of the environment. It does not provide a detailed interpretation of either the quantitative or qualitative data. The focus is on synthesizing available information and providing a general discussion of issues based on available reports and comments of resource managers. The Kelowna preliminary data report is an example of a combination of an index and overview report. Kelowna gives a number of indices of various data on environmental conditions. The report provides a clear presentation of key data along with a summary statement of the condition of this particular component of the environment.

The key informant from the City of Regina described it's first report in 1994 as an overview report. The purpose of the report was to give a general picture of the conditions of major components of the environment for the city. Their next report, though, is considered a follow-up report and will include more indicators and quantitative data. This report will be a data report using the information formed from the 1994 overview report.

Planning Report

The planning report is the most common type of report used solely or in combination with other types of report formats. Planning reports are oriented toward management recommendations and actions. These reports give management a sense of which environmental issues are priorities for policy and action plans. Burnaby and Vancouver are two examples of cities that employ a typical planning report. The target audience for both is the general public. Using a limited number of indicators, these reports focus on city initiatives and programs which will monitor and manage environmental issues of priority. The key informant interviewed from the City of Burnaby described the Burnaby SOER as a planning report presenting management recommendations and actions, a report which will give direction to policy makers.

In Table 3.1, under the purpose column, each city lists a number of factors which have influenced the purpose for their city's reporting process. These factors were found in each of the written reports. Along with these factors, the author assigned each city under a category outlined by Reichert and Ragetlie.

Although each city's vision may be quite similar, the purpose for doing a State of the Environment report tends to vary. To *increase public awareness* of the state of the environment in the municipality is a common purpose for several reports as well as to *raise public awareness of current strategies and initiatives* that are undertaken by the municipality. A SOER may also be a tool for environmental management at the municipal level. It is common for an SOER to make evident the current status of a city's environment and where the city needs to make improvements.

3.23 Objective

Almost every city uses their state of the environment report to provide an environmental baseline for future indices and analysis. SOERs are the first type of comprehensive report which combines a number of individual indicators to provide a holistic view of the state of the environment within the jurisdiction of the municipality. The SOER can be used as a baseline indicator of where the city is, where the city's weak areas are, and what goals the city should strive for. Another objective of most reports is the idea of the SOER as a public report card. With increased pressure from the general public to improve human interaction with the physical environment, the SOER can provide the public with a summary of the impacts and mitigation procedures the municipality as a corporation are taking, on the environment. Without an SOER, the public would have to go to different sources to find out any specific piece of information.

3.24 Target Audiences

The presentation of a report, the language used and the type and number of visual tools are determined by the target audience. A primary target audience for almost all of the municipal reports is the general public. Toronto, the Region of Peel, and Waterloo state in their reports that their primary audiences are decision makers and the civic administration. These reports are more technical, comprehensive, and include a large number of indicators. They are meant to be working documents which are not easily understood by the average citizen. For those cities who focus their reports for the general public, such as the City of Burnaby report, tend to read more easily and include a number of visual tools.

3.25 Scope

There are basically three different scopes present in the analysis of these municipal reports. The first type of scope is biophysical. Both Kelowna and Burnaby have only indicators which are based on the biophysical environment. The second type of report is biophysical with social and economic indicators used only when influencing the biophysical environment. Vancouver and the Region of Peel use this second type of report. An example of this second reporting type is the number of car trips per household. By determining the number of car trips per household, the impact of our actions on the environment may be demonstrated. The third type of scope is to define the environment as including the biophysical, the social, and economic. Regina and Waterloo use this third type of scope for their reports. The interpretation of a sustainable community concludes that all three aspects influence our environment.

The scope of an SOER is an important element. After developing a vision, purpose, objectives and target audience, a municipality must determine the scope of the project to complete the terms of reference for the report.

3.3 Structure and Content

Table 3.2 illustrates the structural framework used for each of the reports as well as the parties involved in the SOER compilation. The table provides a summary of the similarities in the structure of the state of the environment reports.

The structure and content of the SOER is determined by the scope of the project, the goals and objectives, and the target audience. All of these factors must be determined before the structure and content are formed. Table 3.2 provides a summary of city organizational and spatial frameworks. The table also identifies the departments in the civic structure which were involved in the SOER process.

3.31 Organizational Frameworks

The organizational framework is developed from looking at the scope of the project and the terms of reference. There are a number of frameworks available which are referred to in chapter 2. Almost every city used a combination framework which involved two or more types of organizational frameworks described in the previous chapter. *Environmental Media* is the most common organizational framework used.

Table 3.2: Summary of Similarities in SOER frameworks

CITY	ORGANIZATIONAL FRAMEWORK	SPATIAL FRAMEWORK	DEPARTMENTS INVOLVED IN PROCESS
VANCOUVER 1995	• Environmental Media • Environmental Issues	• Jurisdictional Boundaries	• Special Office for the Environment • Special Focus Group • Interdepartmental Committee on the Environment.
KELOWNA 1995 PRELIMINARY DATA REPORT	• Environmental Media	• Jurisdictional Boundaries	• Environment Section of Works & Utilities Department.
OTTAWA 1993 LAND & WATER	• Environmental Issues • Pressure-State-Response	• Jurisdictional Boundaries • Ecosystem approach	• Department of Engineering and Works • Advisory Working Group
BURNABY 1993	• Environmental Media • Environmental Issues	• Jurisdictional Boundaries	• Environment & Waste Committee • Public workshops
TORONTO 1994	• Environmental Media • Environmental Process • Environmental Issues	• Jurisdictional Boundaries	• SOER Task Force chaired by Dept. of Public Health
REGION OF PEEL 1995	• Environmental Process	• Ecosystem approach	• Planning Department • Regional Planning & Health Department
REGINA 1994	• Environment Media • Environment Issues • Pressure-State-Response	• Jurisdictional Boundaries	• Environment & Infrastructure Directorate • Urban Environment Advisory
REGION OF WATERLOO 1991	• Resource Sector • Environmental Process	• Jurisdictional Boundaries	• Planning & Dev't Department

To break up individual chapters into the essential elements of Land, Water, Air, and Biota is a natural process when describing the state of the environment. Ottawa and Peel were the only Cities that did not include an environmental media framework directly.

The City of Ottawa is unique in its reporting system. While most SOE reports give an overview of the environment as a whole, Ottawa has decided to treat state of the environment reporting as a monitoring tool. The Pressure-State-Response model is used at the Federal and

Provincial levels and is demonstrated in both Ottawa and Regina SOERs. The City of Ottawa reported on land and water only in this report, using specifically an issues based framework. In future reporting, other elements such as air, and waste management will be addressed using the same framework model.

The Region of Peel uses an environmental process framework which concentrates on the ecological relationships, recognizing that human activities stress the environment and that the ecosystem changes in response to these stresses. Using this type of organizational framework provides a challenge for the Region of Peel to establish a set of indicators which can effectively describe the ecological relationship between human activity and the environment.

3.32 Spatial Frameworks

Spatial frameworks are used differently at each level of government. At the municipal level, jurisdictional boundaries are a logical spatial framework to use to establish a set of indicators which provides a measure of the state of the environment within the city which is easier for the general pubic to understand and for the civic administration to design policies and programs for the municipality. However, in the natural environment, there are no jurisdictional boundaries. Therefore an ecosystem framework through which information is presented for geographic units is more natural.

The Region of Peel uses an ecosystem framework. This framework is difficult for the policy makers to use in developing policy and planning objectives for their particular jurisdiction because there are no particular index measuring factors within their jurisdiction. Ottawa, on the other hand, uses the ecosystem framework in combination with the jurisdictional boundaries framework. This combination works well because different boundaries are used for different issues and indicators. It gives the reader a broader concept of the state of the environment at the regional level and still allows policy makers to use the information in forming policy and action plans.

3.33 Process

The political structure of a municipality dictates who is involved in the reporting, who compiles the report, as well as who is accountable and responsible for the SOER. Reports can vary greatly by the simple fact that in each city a different department is responsible and accountable. The health, engineering, and planning departments will each have a very different perspective on how to report, what to report, and what indicators to use. Local government organizational structure was discussed during the key informant interviews. Ottawa and Burnaby offer two varying local government organizational structures which dictate the roles, responsibility, and accountability for their state of the environment reporting programs.

Ottawa

The City of Ottawa is under two jurisdictions, a two-tiered system in which there is a City Council and a Regional Council. The upper tier (regional government) has responsibility over a number of services of a regional nature such as public transit, major roads, and services which generate significant economies of scale such as sewage treatment and water purification. The lower tier government services the needs of the community such as parks and recreation (Kerraghan & Siegal, 1987). At the lower tier, the organization is similar to Regina with a Council-CAO model (Hercz, pers.com., 1997). Ottawa conducted the SOER at the lower tier level.

Figure 3.1 illustrates the organizational structure for the lower tier government for the City of Ottawa. The Environmental Management Branch, which is conducting the state of the environment program for the City of Ottawa, is at the bottom of the diagram. One can interpret the chain of responsibility and accountability for this program as a complicated process. The EMB reports to Engineering & Works. Engineering & Works report to the Chier Administrative Officer (CAO). The CAO reports to Council. City Council consults the Technical Advisory Committee on matters regarding the SOER.

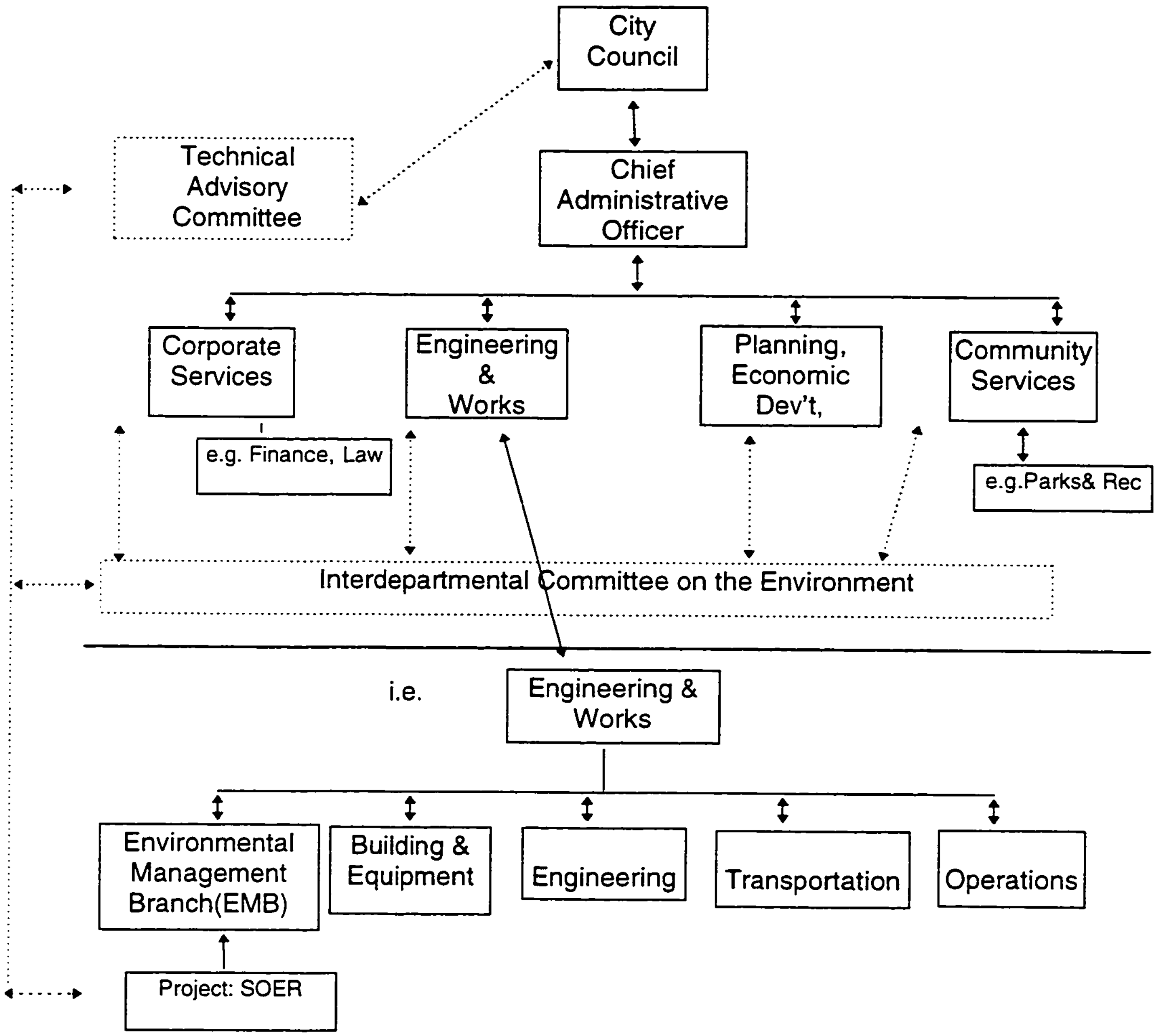
Figure 3.2 provides an outline of the reporting process involved in the SOER process for the City of Ottawa. Both the organizational structure and the reporting process indicate the complexity of reporting at the municipal level.

The Environmental Management Branch (EMB) within the Engineering department, Technical Advisory Committee (TAC), and the Interdepartmental Committee on the Environment (ICE) worked together to instigate a State of the Environment Reporting Program. The public was also consulted.

In 1991-1993 the SOER program was an EMB initiative based on a need identified by the public/community. Preparation was supported by City Council, and the TAC . The recreation and planning department (community services), the environmental management branch of the engineering department and the TAC were the main contributors to the report.

Figure 3.1: Organizational Structure for Lower Tier Jurisdiction

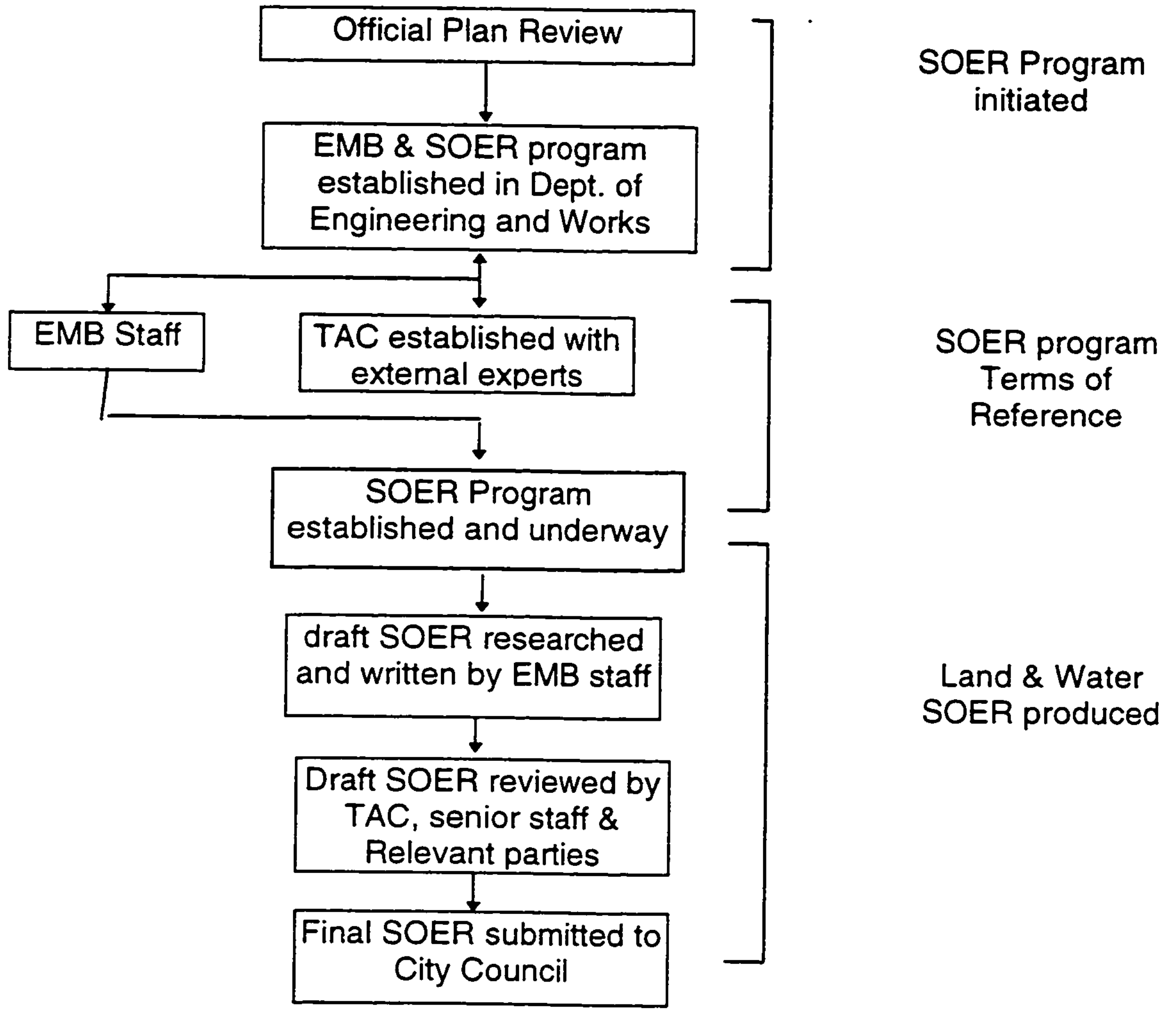
City of Ottawa



--- Advisory capacity
___ Accountability structure

(Hercz. pers.comm.. 1997)

Figure 3.2 : City of Ottawa Reporting Process



EMB = Environmental Management Branch
TAC = Technical Advisory Committee

(Cambell & Maclaren, 1995, Hercz, pers.comm., 1997)

Burnaby

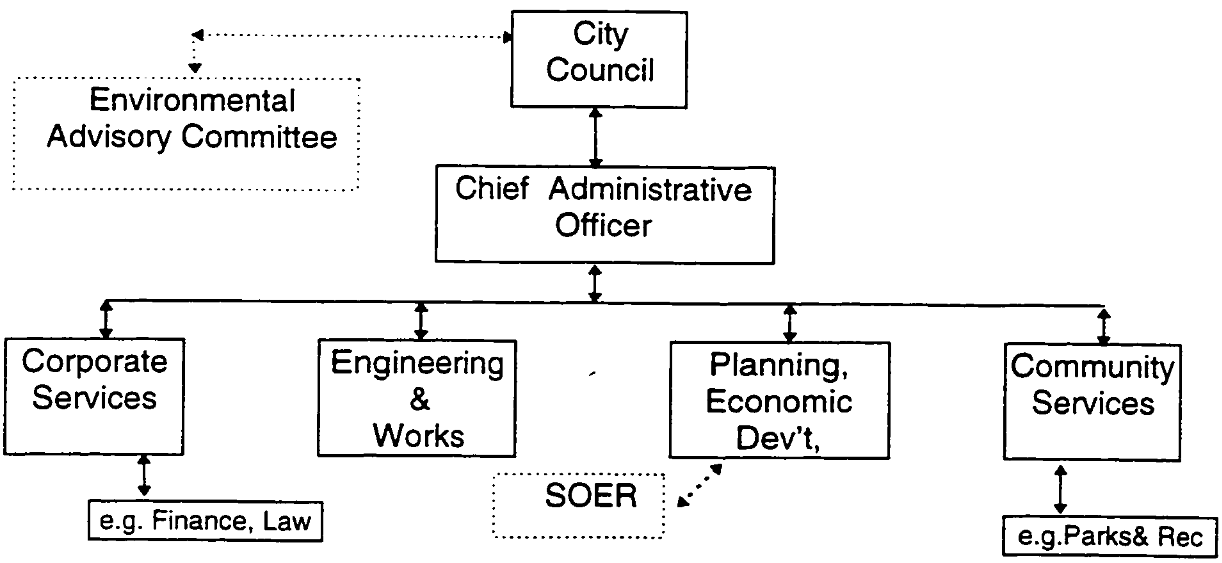
The City of Burnaby is also part of a two tiered organizational structure. The Greater Vancouver Regional District (GVRD) was designed as a mechanism for the joint provision of municipal services such as air pollution control, regional parks, and garbage disposal (Higgins, 1996). However in Burnaby's case, little or no decision-making power has been lost to the upper tier. The GVRD is basically an advisory board for the lower mainland (Luksun, 1997).

Figure 3.3 illustrates the lower tier organizational structure for the City of Burnaby. This figure demonstrates the responsiblity and accountability structure for the city. Figure 3.4 illustrates the actual reporting process conducted for the City of Burnaby. City Council initiated the state of the environment program and assigned it to the Environmental Advisory Committee (EAC) which is made up of 3 citizens at large, 1 member of the business community, and 3 council members.

The EAC formed a subcommittee made up of the 4 citizens and 1 council member to oversee the writing of the report. Assisted by the planning department, environmental planner, the EAC committee wrote the report, made recommendations and presented the document to council. Ultimate responsibility for the final SOER was with Council.

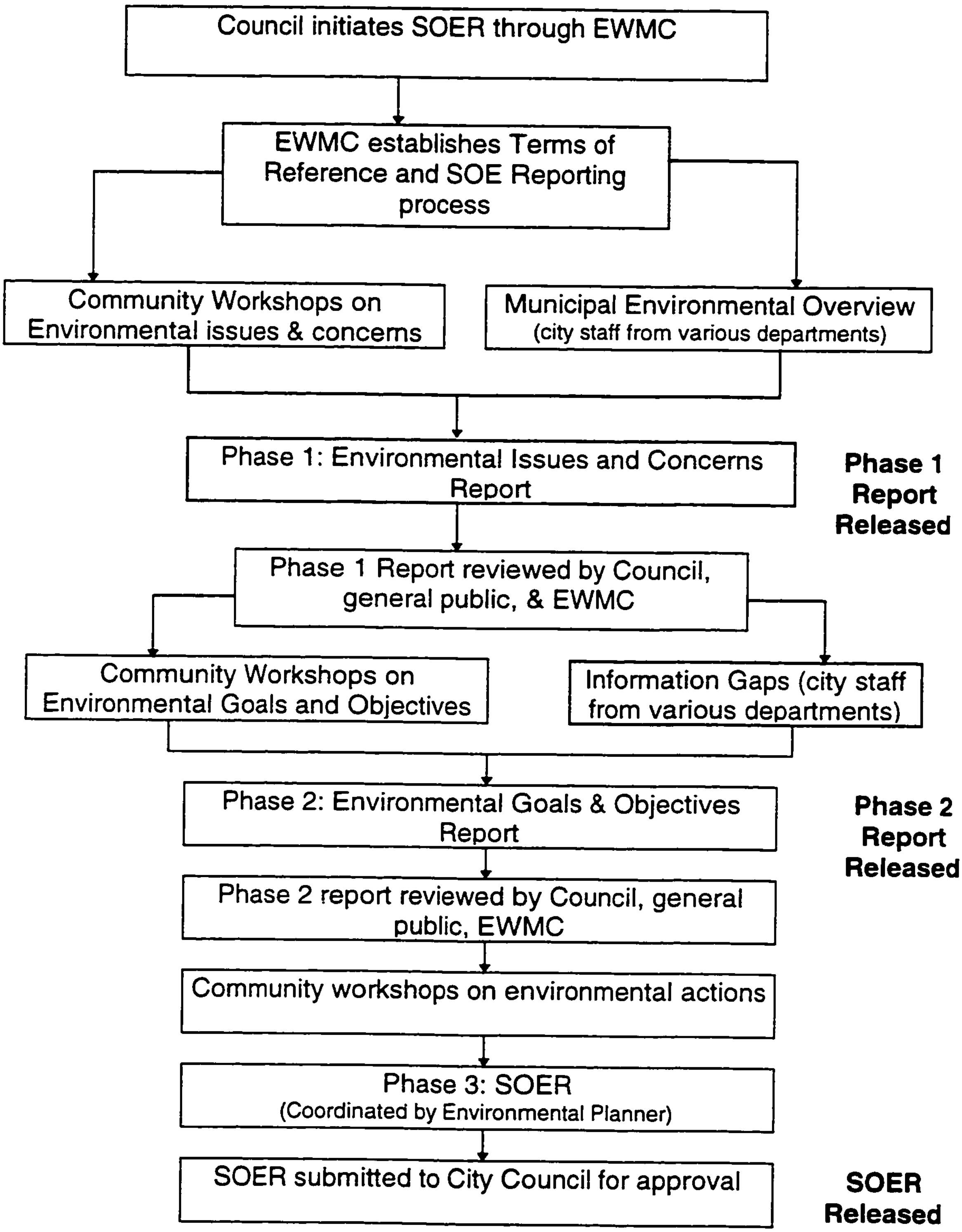
The Environmental planner in the planning department was essentially the project manager who compiled the report. The departments of planning, engineering, public health, parks and recreation, and the purchasing department all contributed data and expertise for the report.

Figure 3.3: The Organizational Structure of the City of Burnaby



(Luksun, per.com., 1997)

Figure 3.4: City of Burnaby Reporting Process



(Cambell & Maclaren, 1995, Luksun, pers.com.,)

EWMC = Environmental and Waste Management Committee

3.4 Indicator Analysis

Environmental indicators are a major issue in SOERs. The amount and type of indicators vary in each report based on the criteria used to select the indicators, the scope of their report, the target audience, the budget, and time constraints. Indicators are used as a measure of how well a city is doing in terms of the environment within the jurisdiction of the city. Although a number of indicators may be used, the final report may not include all of them. The final report may merely be a summary of the indicators, compiling the data into indices, and paraphrasing the state of the environment within the jurisdiction of the city.

The information in Table 3.3 is taken from each of the final state of the environment reports examined for this study. As noted in chapter 2, there are a number of criteria that a city can use to establish a set of indicators for their SOER. However, it is assumed that there may have been criteria used for indicator selection which were not mentioned in the final report. For example, this study did not find any mention of the criteria for the City of Ottawa, 1993 Land & Water Report. There is, however, a background report listing the criteria used to select indicators which was used.

Each city used different types of indicators to evaluate the state of the environment within their jurisdiction. As a result, it was difficult to compare or compile the indicators into a single table. By putting the indicators into categories, it was easier to formulate a table which allows for comparison between report indicators. For each of the reports, the indicators which are illustrated were broken down into a number of categories. These categories and descriptions were noted from (1991) State of the Environment Reporting Background Notes prepared by Reichert, Waterloo Region and Ragetlie from the Hamilton-Wentworth Region (Reichert & Ragetlie, 1991). Please note that there may be a number of indicators which were not used in the final SOER report for any particular city. Those indicators may be listed in a separate report such as the Region of Peel, (1993) Inventory of Key Environmental Indicators Report 3 of 4, or some indicators may have been used to create indices but not actually listed in the final report. The indicators found in the final reports were categorized as follows:

Table 3.3: Indicator Categories

Agents of Environmental Change

1. Human Activities
   - e.g. waste generation by sector/type (emissions, discharges, spills)
     restructuring (wetland drainage, land and habitat conversion)
     harvesting (fish catches, wildlife harvest, tree harvest),
     agricultural yield, depletion of non-renewable resources
     (mineral, fuel production)

2. Natural Processes
   - e.g. major events (floods, storms)
     major fluctuations (erosion rates, river and lake levels, droughts)

Environmental Conditions

3. Environmental Assets/Quantity
   - e.g. water resources, land resources
     forests (supply quantity and age statistics)
     fisheries, wildlife (population and location)
     nonrenewable resources (location)

4. Environmental Quality
   - e.g. air, water, food (levels and trends)
     soil (organic matter content, salinization, acidity)
     wildlife populations (changes, diversity, endangered species)
     landscape (land conversions of classes of soil, etc.)

Human Well-Being

5. Human Health and Exposure
   - e.g. toxic substance analysis in tissues
6. Quality of Life
   - e.g. park space per person, leisure time, perceptions or values of citizens
7. Socio-Economic Data
   - e.g. crime statistics, poverty statistics, employment data

(Note: taken in part from Reichert & Ragetlie, 1991)

3.41 Total Indicators

The number of indicators used in a report was dependent on a number of factors such as the scope of the report, target audience, and the criteria used to select the indicators. As noted in Cambell & Maclaren (1995), there is a significant range in the number of indicators used for the eight municipalities that they examined. In this researcher's examination of the final reports, Table 3.4, the number and type of indicators varied significantly.

As presented in Table 3.4, Toronto has the greatest number of indicators. This is not surprising if one looks at the target audience for the report and the type of indicators which were chosen. Toronto has a very technical report which has city administration and decision makers as its primary audience. When one is reporting to a specific audience, the content and presentation of a report is specific to that audience. The type of indicators used were very technical, quantitative, specific types of indicators.

Vancouver and Burnaby have the smallest number of indicators. Both of these reports had a large amount of public participation in the SOER process. As a result, a number of the priorities, initiatives, and objectives were qualitative and not easily measurable with specific indicators. The primary target audience for both of these reports was the general public. Therefore, the report had to be readable and understandable by the average citizen. Indicators were selected that would be useful and comprehensible to the general public.

Through the examination of the reports and discussion with the key informants, the author tried to establish which indicators would likely be used in future reports. Cambell & Maclaren (1995), and MacDonald (1996) state that for reports that have been done a second time, there is little or no consistency of indicators. If one takes into consideration the continuous improvement model, this is not necessarily a bad thing. However, the point of the SOER program is to measure trends in the environmental indicators. If different indicators are being used with each new report, establishing trends is impossible.

3.42 Indicator Categories

The indicator categories developed by Reichert and Ragetlie (1991) are used to group specific types of indicators into categories. This method allows cities to compare the type and number of indicators used by other cities when developing their own.

Table 3.4: Number of City SOER Indicators in Indicator Categories

City	Selection Criteria	Human Activity	Natural Process	Environment Quantity	Environment Quality	Human Health	Quality of Life	Socio-Economic
Vancouver 1995	Access to data Accuracy of data Usefulness of data	5	0	1	4	1	1	0
Kelowna 1995 Preliminary Report	access to data understandable data data sensitive to change reliable data Scientifically valid	12	1	8	10	2	3	0
Ottawa 1993 Land & Water		13	0	5	17	3	5	1
Burnaby 1993	Easily obtained data understandable data	14	0	3	3	4	4	1
Toronto 1994		90	0	64	11	12	2	11
Region of Peel 1995	Scientifically Valid Relevant data Available data Sufficient Data	25	0	19	3	4	1	0
Regina 1994	Available data	15	0	7	4	7	3	12
Region of Waterloo 1991	Available data	30	0	13	14	5	0	7

Note: each number represents the number of indicators found in the final report under that particular category

Human Activity indicator category generally had the greatest number of indicators in each of the State of the Environment Reports presented. The only exception to this is the City of Ottawa SOER, which had more *Environmental Quality* indicators than *Human Activity Indicators.*

The author concludes that the reason the *Human Activities* category had the most number of indicators is because it dealt with human interaction with or influence on the environment. These indicators report how humans are influencing the environment and are easy for individuals to understand and mitigate.

The *Natural Process* category had been used by only one city SOER. Kelowna used this category to demonstrate a major fluctuation in lake levels. This category has probably not been used because the purpose of a report is to demonstrate trends in the environment. Major events such as floods or major fluctuations such as droughts, may not be a priority for cities to measure over a long period of time.

Three cities, Vancouver, Kelowna, and Peel did not have *Socio-economic* indicators in their report while Ottawa and Burnaby only had one indicator. This demonstrates that many cities have a biophysical focus which includes socio-economic, as it effects the biophysical.

Environment Quantity and Quality, Human Health, and Quality of Life indicator categories all maintained a consistent number of indicators.

In conclusion, Table 3.4 demonstrates a number of differences in indicators used by each municipality. As stated by Cambell & Maclaren (1995), there is currently not a set of common indicators visible for comparison between municipalities in Canada who have reported on the state of the environment.

3.5 Public Participation

In this time of economic cutbacks, both the Federal and Provincial governments are devolving more responsibilities to local or municipal governments. Therefore, grassroots participation and input is becoming more common practice. As well, grassroots environmental groups are putting public pressure on cities to address these concerns.

The amount and type of public involvement in the SOER process is dependent on the scope of the project, the target audience, and the timeline and person hours available for the report. Table 3.5 is a summary table of information obtained from the key informant interviews with Burnaby, Ottawa, and Regina. This table is an example of the range of public involvement means for state of the environment reporting.

Table 3.5: Public Involvement Means

Means of Involvement	Regina	Ottawa	Burnaby
Citizen Advisory Committee	X	X	X
Round Tables			X
Open Houses			X
Experts		X	X

(note: information taken from questionnaire, appendix two)

The City of Burnaby's reporting process, illustrated in Figure 3.4, demonstrates a significant public participation process from the onset of phase one of the reporting process. The reporting program was established with the general public as the target audience. The scope, content, and indicators were all formed from public participation workshops. The City of Burnaby's report was qualitative in nature, a planning report expressing the major areas of concern of its citizens.

For the City of Regina, the Regina Urban Environment Advisory Committee were the only form of public participation. RUEAC felt that because they were selected as public representatives to the city, the committee would act as an information tool for the public. The key informant for Regina stated that the committee felt that no other forms of public participation were necessary.

Similar to Regina, the City of Ottawa's advisory committee made up of experts, community representatives, staff, and politicians were involved in the City of Ottawa's SOER process. Similar to Regina, the key informant for Ottawa indicated that the City used the Advisory committee as the only means of public participation during the process, with the exception of a few experts being consulted.

Although each city claims to have some type of public participation, at what point in the process will make a significant difference in the final production of the report. If the public is involved from the beginning of the process in the form of workshops or focus groups, the scope, content and structure will be significantly different than a report which involved the public only in an advisory capacity and only after the draft report was already complete.

Timeline

For a city to determine if it is feasible to do an SOER, it is useful information to know how much time and person hours are involved in producing a final report.

Time includes both months and person hours. How many people were involved in developing an approach, completing the Terms of Reference and the first draft of the SOER is different in each city. Table 3.6 is a summary table of discussion with key informants from the cities of Burnaby, Ottawa, and Regina. The purpose of the information in this Table is to give those who are considering doing a SOER an idea of the time and person hours involved in the process.

Table 3.6: Time & Person Hours

City	First Draft	Total Person Hours	Produce Final Report
Regina	12-18 months	.5-1 persons 100%	14 months
Ottawa	12-18 months	1-2 persons 60% 3-4 persons 20%	6-12 months
Burnaby	18 months	8-10 persons 50%	less than 6 months

(note: information taken from key informant interviews)

Although each city took the same amount of time to produce the first draft report, there was a significant difference in the number of people involved in the process. There are a number of factors which influence this process.

- Public participation takes a great deal of time.
- Number of people working on the project
- The scope of the project.

3.6 Summary

The state of the environment has become an important movement at the international, national, and provincial level. In the last ten years, municipalities have become part of this movement. Municipalities in Canada are beginning to report on a number of aspects of the natural environment. What type of report, what information they provide, and what indicators they use is still quite different from city to city. As more and more responsibilities are given to grassroots groups and local government, there becomes a greater need to communicate and standardize processes for issues regarding the environment.

Currently there is no standardized methodology for doing a municipal state of the environment report. From a literature review and personal research, almost a dozen cities have been noted as performing a state of the environment report. There may be a number of other cities which do similar or the same reports which have not been represented in this study. However, from the reports that were examined, chapter 3 outlines a summary of the differences and similarities between the final reports.

Table 3.1 summarizes the city vision, purpose, objective, scope and target audience for each of the state of the environment final reports. The purpose of the table is to provide the reader with a summary of the varying aspects of a terms of reference and how they differ between cities.

Table 3.2 provides a summary of information on the structure and content of individual SOERs. The organizational and spatial frameworks used by each city are similar but used in different combinations to accommodate particular aspects of their terms of reference. The process used to conduct the SOER for each city was dependent on the civic political structure, the dynamics of individual departments, and individuals who instigated the initiative.

The organizational structure of municipal government is a significant factor to consider in the development of a terms of reference for a state of the environment report. The author has provided two city organizational structure examples, Burnaby and Ottawa, to establish what a city organizational structure is and how it affects the reporting process, responsibility and accountability of the individuals involved in the SOER process.

Environmental Indicators are the substance of an SOER. Sustainable indicators are being studied extensively to provide some type of common criteria, set of indicators, and monitoring mechanisms which can be used to compare environments between cities. As of yet, there are no common set of indicators which can be used at the municipal level. Therefore, an attempt was made to categorize the indicators in order to compare them at a more general level. Table 3.4 is a summary of indicators used in the SOER program by each of the cities. They were divided into categories provided by Reichert & Ragetlie, in an attempt to provide a comparative description.

From the key informant interviews, public participation and timeline information was provided to give the reader an idea of factors not included in the final state of the environment report but essential for the process. Public participation is not a high priority for a number of SOERs examined for this study. With the City of Burnaby report, the public participation process created a number of qualitative goals. In order to make measures of progress easy to identify, there should be a rewording of the goals. The most common form of public participation is the participation of an environmental advisory committee. As the key informant from Ottawa stated, budget and time constraints were the major barriers for a more extensive public participation process.

The following chapter is a case study of the City of Calgary state of the environment program. The author has participated in the program since its initiation in March, 1996. Following chapter 3, which examined the current status of SOERs in Canadian municipalities, chapter 4 will take the reader through a case study of a city's process from the beginning through to the development of the terms of reference.

CHAPTER 4

An increasing number of municipalities across North America are using SOERs as an integral component or tool for their environmental management systems (EMS). However, as examined in chapters 2 and 3, very few municipal SOERs have common qualities. As a result, a process is needed which can be used by municipalities to develop a terms of reference and a SOER reporting program which offers some compatibility for municipal state of the environment reporting in Canada. Currently, the City of Calgary is in the process of creating a SOER. The purpose of chapter four is to outline the process the City of Calgary has used to complete a terms of reference for its future SOER. This chapter outlines Calgary's civic organizational structure and the process used to develop the terms of reference for the report.

THE CITY OF CALGARY TERMS OF REFERENCE PROCESS

The City of Calgary's Environmental Policy, Principles, and Goals, approved by Council in 1994 notes that the city will...

> *implement a system to regularly monitor and report on The City's environmental performance.*

In 1996, the City of Calgary's Environmental Advisory Committee (EAC) recognized the need for a reporting process which provided baseline data to use for developing and prioritizing actions on environmental issues. As a result, the Environmental Advisory Committee directed the Office for the Environment to examine the feasibility of doing a state of the environment reporting program for the City of Calgary. The SOER was seen by the EAC as a way of fulfilling the policies and objectives outlined in Council's Strategic Plan (1990), Environmental Objectives (1990), and the Environmental Policy, Principles and Goals (1994). The 1996 background report to the EAC from the Office for the Environment was established and included a three phase timeline to the completion of Calgary's first State of the Environment Report.

Phase one included the development of the Environmental Policy, Principles and Goals in 1994, and a background report which addressed the driving forces for doing an SOER, an overview of what other municipalities are doing, and the development of the purpose, goals and objectives for the City of Calgary's SOER, completed in the summer of 1996. Phase 2, presented to the Standing Policy Committee on Operations and the Environment (O&E) in January, 1997, included the scope for the project and the completed SOER terms of reference. Included in the terms of reference were selection criteria for indicators, established to determine what indicators would be used to measure the objectives set out in the SOER. Phase three, beginning in the Spring of 1997, involves the actual collection and compilation of the data into a final SOER, projected for completion by December, 1997.

The background report for the EAC establishes the rationale, costs and benefits of the SOER and makes methodology recommendations for a particular framework (City of Calgary, 1996d.). This report constitutes the second component of the SOER process and includes an historical overview of state of the environment reports at the international, national, provincial, and municipal levels of government. The background report includes a synopsis of the nature and function of the SOER and why it is used by municipalities and other levels of government in Canada. This report also discusses how state of the environment reporting could be useful for the City of Calgary and the issues that needed to be addressed to begin the development of a SOER.

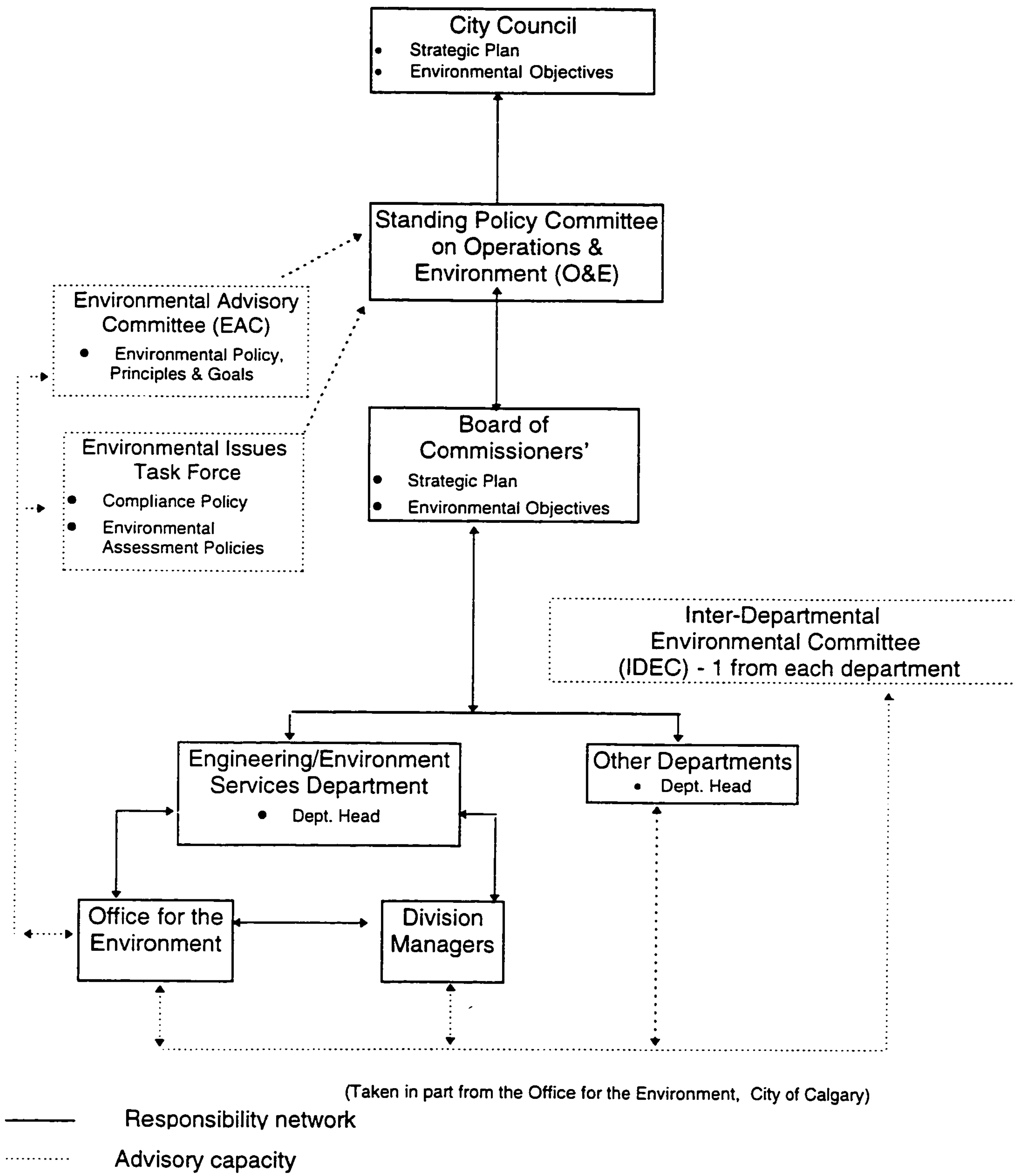
4.1 Organizational Structure

Similarly to Regina, the City of Calgary is a unicity. In terms of the administrative structure, the City of Calgary follows the Council-Commissioner model which has a multi-member board of commissioners rather than a single commissioner or city manager. The appointed commissioners function as a small executive body interposed between the legislating council and the administration departments. On the following page, Figure 4.1 illustrates the organizational structure for the environmental management system for the City of Calgary.

This figure illustrates both the organization for the environmental management system for the City of Calgary and lists a number of the policy documents which were created by different authorities in the structure. City Council was responsible for developing Calgary's Strategic Plan and, through an implementation committee (appointed by Council), the environmental objectives. The implementation committee is now called the Environmental Issues Task Force.

Standing Policy Committees are strictly advisory in their administrative role (Baxter, pers.com., 1997). The Standing Policy Committee on Operations & Environment composed of Council members and senior administration, as resource people, advises on specific issues related to corporate operations and the environment.

Figure 4.1 City of Calgary Environmental Management System Responsibility Structure



(Taken in part from the Office for the Environment, City of Calgary)

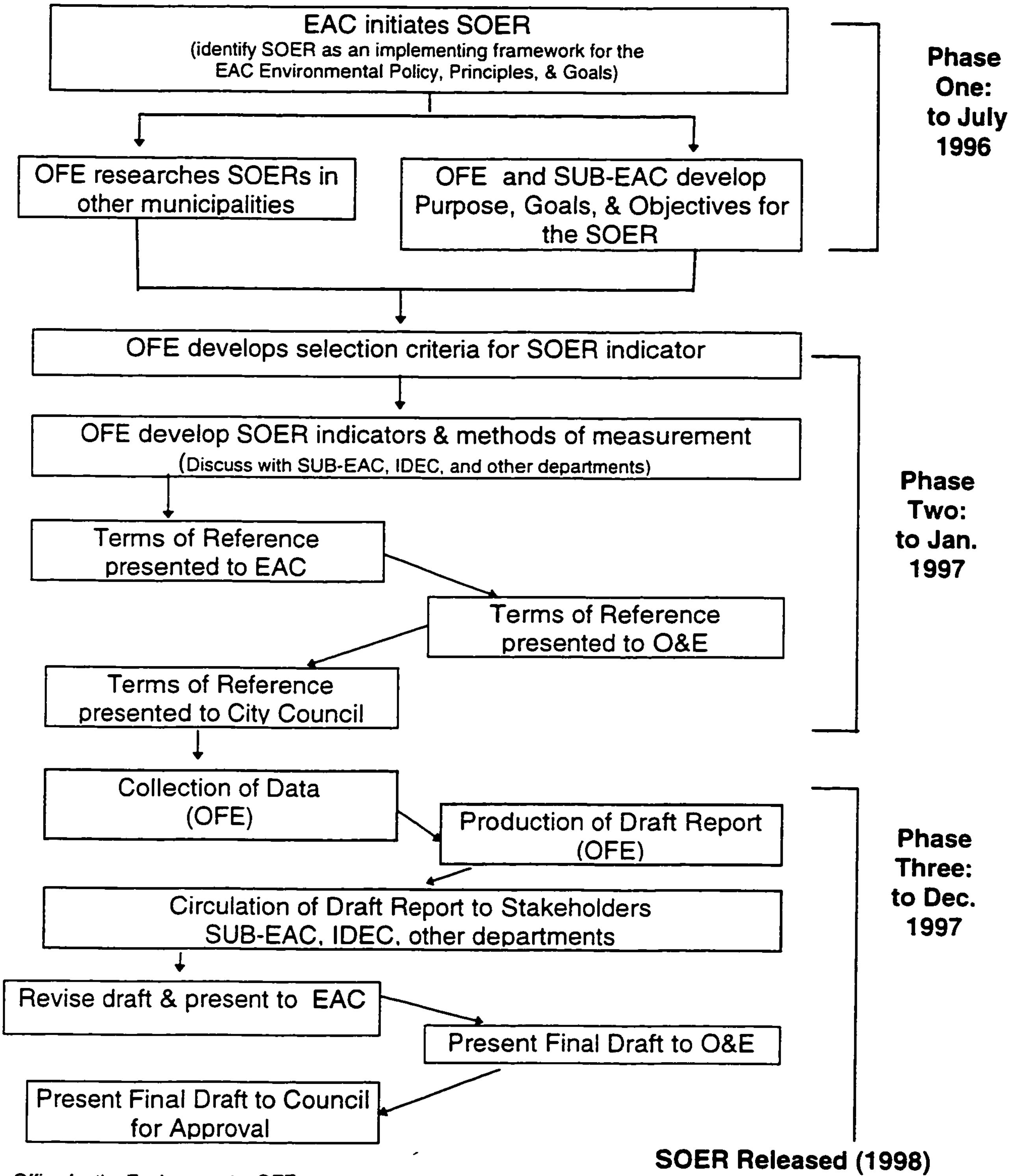
The Implementation Committee for Environmental Objectives (which was dismantled 1993, in favour of the Environmental Issues Task Force) created the Environmental Advisory Committee with the specific responsibility to establish an Environmental Policy, Principles and Goals for the City of Calgary. The EAC is a public advisory committee to council. The committee is composed of council members, senior administrative staff, and citizens who represent a number of key interest groups in the city. The EAC is composed of different groups and agencies such as the Board of Education, the Chamber of Commerce, Post-Secondary Education Institutions, and the Federation of Calgary Communities (City of Calgary, 1996). The Environmental Issues Task Force was created to prepare compliance and environmental assessment policies.

The role of the Office for the Environment is to create a communication link with all the different civic groups that have functions that affect the environment (City of Calgary, 1990) Along with the Inter-Departmental Environment Committee (IDEC), the Office for the Environment attempts to facilitate the environmental issues and work presented in each department. IDEC membership is made up of departments that have a key operating, regulatory and enforcement functions which affects the environment and is administered by the Office for the Environment (Bilkhu, 1996).

For the SOER process, Figure 4.2 illustrates who is accountable and responsible for the production and monitoring of the SOER program. This figure illustrates the hierarchy of responsibility for the City of Calgary SOER through each of its phases. The Office for the Environment is responsible for preparing and presenting the report. The office collects information from each department through the IDEC correspondent or through direct contact with the appropriate staff. The Office for the Environment takes direction from the EAC and the EAC SOER sub-committee. The EAC approves the SOER and is presented to O&E as an EAC report. If O&E approves the report then it is sent to Council. City Council is the ultimate approving authority and therefore carries the ultimate responsibility to the public. The organizational structure of the City of Calgary profiles who is responsible for the SOER and who is accountable.

As illustrated in Figures 4.1 and 4.2, there is a specific approval process (through which the state of the environment report must filter) that closely matches the organizational structure of the City. There must be due process in order to achieve checks and balances for local politics. However, in the case of a report on the state of the local environment, it should require that the facts are presented without the political influence of local government.

Figure 4.2: The City of Calgary Reporting Process



(The City of Calgary, 1996)

Office for the Environment = OFE
Environmental Advisory Committee = EAC
Sub-committee of the EAC = SUB-EAC
Inter-departmental Environmental Committee = IDEC
SPC on Operations and the Environment = O&E

The information provided in a SOER should reflect what is going on in the local environment, both good and bad, and what the City, businesses, and local citizens can do to improve the circumstances. The current reporting structure for Calgary leaves the city susceptible to a biased, public relations document. A good example of an unbiased reporting program is in the Regina case. The organizational structure involved a voluntary board, the Regina Urban Environment Advisory Council (RUEAC), which acted independently of Council. RUEAC is responsible for the SOER and Council can only use the information but can not ask for revisions to the final document. This avoids any influence on the content of the report. In Calgary, the EAC is a public advisory committee to council and is accountable to City Council who is in turn the final approving authority. The organizational structure for the Calgary SOER creates a situation which allows political will to influence the process.

4.2 Scope of the Project

Calgary City Council's 1990 Strategic Plan marks the need for action on specific aspects of the environment, including reduction of air contaminants, planting more trees, improving water and air quality, noise abatement, cleanup of contaminated sites and energy conservation. Although the City has made considerable progress in improving the performance of these aspects, there was no systematic method of reporting measured progress.

The City's 1994 Environmental Policy, Principles and Goals established an EMS Framework for the City Corporation as well as the citizens of Calgary and was a driving force, phase one, for the implementation of the SOER program. Phase one of a SOER requires that a statement of Environmental Policy, Principles and Goals be established before developing the scope and terms of reference. In Burnaby, the process of developing an environmental policy, principles and goals entailed a long public participation process which made phase one an entire program in itself. Phase one took very little time to complete for Calgary because the EAC had established its Environmental Policy in 1994. The City began researching SOERs, other City policies, and established how a SOER would create an effective method to measure progress towards this policy.

Along with these two initiatives, other driving forces included the Alberta Vision for Sustainable Development, the dismantling of the Regional Planning Commission, the new Municipal Government Act, Sustainable Suburbs and the Calgary Transportation Plan (GoPlan) (City of Calgary, 1996a). It was necessary to consider all of these documents to avoid duplication of information. Having considered these driving forces, the EAC SOER Sub-committee recommended that a biophysical, technical focus be used for the SOER (Leach, pers.com., 1996). Socio-economic indicators were covered in the Sustainable Suburbs and GoPlan reporting process. To avoid duplication of biophysical indicators in these reports, communication between project managers allowed for biophysical indicators to be used in a number of reports. In the SOER, however, the biophysical indicators were much more extensive in content and context (Leach, pers.com., 1996).

The data or indicators for the SOER were drawn from a number of internal and external sources for the City including the Bow River Water Quality Council, River Valleys Committee, Calgary Health Services and the Alberta Environmental Protection Office (City of Calgary, 1996a). The SOER will consolidate existing information in a manner that highlights trends and stresses on the biophysical environment. It will not be within the scope of the project to create new indicator measurements and management procedures (Leach, pers.com., 1996).

The primary audiences for the City of Calgary SOER are decision makers and the civic administration. The purpose of the SOER is to provide baseline information for better decision making and the development of goals and policies set by the city. For this purpose, the information requirements are for more technical, biophysical indicators. The secondary audience is the general public because that is who Council is responsible to and the information presented in the report affects the well being of the public. The indicators used are purely biophysical, with social, economic, and health indicators used only in their effect on the environment.

The scope of the project is based also on budget, person hours available and the fact that it is Calgary's first SOER report. Because SOERs are a new process being conducted at the municipal level, the City would like to maintain a smaller scope which can develop in a continuous improvement model for future reports in the program (Reynolds, pers.com., 1996).

4.3 Indicators

In Phase one, the 1996 background report to EAC examined a number of municipal SOERs for the type and number of indicators used in their reports. Cambell & Maclaren (1995) provided a summary of how many indicators were used by each municipality, what type of indicators were used, and a categorized list of a variety of indicators. As discussed in earlier chapters, there is no common set of indicators between reports and they vary in type and number of indicators used in each municipal report. Calgary's choice of indicators was no exception.

The Office for the Environment started with developing a set of indicators which cover each of the principles and goals in the Environmental Policy. The parameters are air quality, water quality and quantity, solid waste management, land use, pesticides, open space, natural areas, energy, noise, and environmental education (Calgary, 1996a). These parameters were similar to those used in other reports. Environmental education as an issue was unique to Calgary, although aspects of education were addressed in other reports such as the Burnaby SOER.

Possible selection criteria for indicators, listed in chapter two, used by other municipal SOERs, were assessed. Calgary took these criteria into consideration when the selection criteria were determined for their report. From these, Calgary listed the top three criteria for choosing indicators for their SOER as: consistent with the report's objectives; target audience; and the data's relevance and measurability (Leach, pers.com., 1997).

The Office for the Environment consulted with the Inter-departmental Environmental Committee and various city staff to determine what indicators were available to address the parameters set by the report and meet the criteria set for establishing indicators. A preliminary list of indicators was presented to the EAC SOER sub-committee. The sub-committee debated over the list and narrowed the indicators to a useful, practical number of 32 indicators for the terms of reference.

The process of developing a set of useful indicators was a difficult one. The City of Calgary examined what indicators other cities used, examined the needs and parameters for the city, set appropriate selection criteria and researched what information was already collected for the jurisdictional boundary of Calgary. Cities collect data for different purposes and currently cities are not prepared to develop new indicators due to lack of funds, lack of personnel, and the fact that developing indicators is currently not within the scope of state of the environment reporting.

4.4 Public Participation

As previously discussed, public participation has become an important aspect of the planning process in recent years. The contribution of the public in policy making and action plans has become an integral part of the process. However, public participation methods employ a significant amount of time and effort by city staff, with inconsistent results. Administration will look at what the purpose is for public participation, and what is the right method of consultation to achieve effective participation. The first question to ask in this process is who are the primary target audiences?

Through personal communication with the Office for the Environment and observation at EAC and EAC sub-committee meetings, the following information on the public participation process for the Calgary SOER was obtained. In Calgary, the primary target audiences for Calgary's State of the Environment Report are City Council and the civic administration. The secondary target audience is the general public. The EAC decision to focus the report towards the administration and council was justified as such. The administration and council are responsible for creating action plans which will satisfy the goals, principles and objectives they established, which will guide the city to sustainable development and urban environment. Therefore, a more technical document is required to satisfy these needs. The EAC recognized that the public is a target audience as well. The report is meant to be an information based tool for individuals to get the information necessary for their needs.

After the presentation of the background report to the EAC, discussion was generated regarding the amount and type of public consultation. As a committee, the EAC concluded the following. Stakeholders (including the public) will be consulted throughout the process via the Environmental Advisory Committee and associated consultation mechanisms such as personal communication and open houses. Both the administration and the EAC felt that there was clear representation of the general public on the EAC to validate adequate public participation. The final draft will be approved by the EAC which is representative of the public. Open houses will be held to present the SOER to the public. Although this approach to public participation is presented by other city SOERs, the author would disagree that this is adequate representation. Most of the individuals on the EAC are experts in their field and would not likely represent the average citizen in the City of Calgary.

4.5 Summary

Chapter four documents a first hand account of the process the City of Calgary went through in the development of their terms of reference for their first state of the environment report. The purpose of chapter four is to give an example of an actual municipal process of developing an SOER. A number of issues of concern were explored which will be used in recommending a standard process for determining a terms of reference for a municipal SOER.

The organizational structure of the city was a significant factor in developing a terms of reference. The structure determines who is responsible and accountable for the SOER. In this particular organizational structure, the EAC presented the terms of reference which included the target audience, the scope of the project, budget and the timeline, to O&E, and then, to council. This approval process established Council as being ultimately responsible for the SOER. Therefore, there is a risk of turning the SOER into a public relations document in terms of presenting only positive information.

The scope of the project for Calgary was determined by a number of goals and objectives set out by established documents. To determine a scope of an SOER, a city must assess other city reports. To avoid duplication, these other reports will help develop the goals, objectives, and the scope of the SOER.

Environmental indicator selection is one of the most difficult issues to resolve in SOERs. The type, amount, and accuracy of indicators presented will have a significant influence on the validity and usefulness of the reporting process. The selection of indicators is the most time consuming aspect of the report as well. The selection of indicators for the City of Calgary was based on a standard set of criteria which guided the type, accuracy, and amount of data collected.

Environmental information and action plans have become a significant topic for the general public and concern is growing. Public participation is a valuable, significant process which should be considered and accessed in environmental reporting. Full and meaningful participation by the public is absent in the Calgary SOER. The public participation process takes time and money that is currently not available for state of the environment reporting so the EAC was used as representative of the public.

The following chapter outlines a number of recommendations for the future of municipal state of the environment reporting in Canada. These recommendations are a result of the study of the current status of municipal state of the environment reporting in Canada and the experience the author had working with the Office for the Environment in phase one of the SOER process for the City of Calgary.

Chapter 5

This chapter reflects upon some of the benefits and shortcomings of current practices in state of the environment reporting at the municipal level discussed in previous chapters. Recommendations in this chapter revolve around the current process used for SOERs, barriers to SOER programs, and recommendations for future research.

RECOMMENDATIONS

Based on the critical analysis of current municipal SOERs and the examination of the case study of the City of Calgary planning process to develop a SOER terms of reference, the following recommendations are given regarding the benefits and shortcomings of the SOERs, and the possible areas for future research.

Recommendation One

Issue: No standard form of conducting SOERs at the municipal level.

As determined in previous chapters, there is a wide spectrum of municipal state of the environment reports. If Canadian municipalities would like to compare themselves to other cities or work together as a country to increase environmental consciousness, SOERs in Canadian municipalities must have some type of standard. Currently there is no standard form of conducting SOERs at the municipal level.

Recommendation: Model for municipal SOER process

If a municipality is considering establishing a SOER program, the following recommendations or model summarized in Table 5.1 will guide them through the process. The table is a summary of recommendations that will be detailed in this chapter. This table could be used for future research on the development of a standard form for conducting SOERs at the municipal level.

Table 5.1: Steps for preparing a municipal state of the environment report

Phase One: Preparatory Information Gathering

- *Step 1: Develop an environmental policy, goals, and objectives statement, with the involvement of all relevant stakeholders;*
- *Step 2: Review other city reports (in progress or complete) for areas of possible duplication;*

Phase Two: SOER process

- *Step 3: Develop a SOER purpose, goals, and objectives for municipality;*
- *Step 4: Establish the scope of the project.*
- *Step 5: Develop selection criteria for indicators;*
- *Step 6: Select appropriate indicators;*
- *Step 7: Complete and present the terms of reference to approving authority.*

Phase Three: Preparation of SOER

- *Step 8: Collection and compilation of data;*
- *Step 9: Production of draft SOER;*
- *Step 10: Review and consultation with stakeholders;*
- *Step 11: Revision of report;*

Phase Four: Approval Process

- *Step 12: Submit to approving authority;*
- *Step 13: Production and print of report;*
- *Step 14: Distribution to stakeholders.*

Phase Five: Review, Monitor and Marketing

- *Step 15: Time line set for regular monitoring ;*
- *Step 16: Review process;*
- *Step 17: Marketing the report.*

This checklist is meant as a general guide to establishing a state of the environment reporting process for a municipality. How much time, person hours, and money it takes to do the report is relative to the scope of the project and the amount of public participation undertaken. Following is a more detailed explanation of the steps to developing the terms of reference which will establish whether or not an SOER is practical, feasible, and useful for any particular municipality. Table 5.1 is based on a continuous improvement model in which the process is cyclical.

PHASE ONE: Preparatory Information Gathering

Step 1: Develop an Environmental Policy, Goals, and Objectives Statement

If a municipality has not prepared a environmental policy and objectives, this is the first step to establishing a SOER process. The environmental policy must have complete buy-in by all of its stakeholders and include a solid public participation process. This first step is crucial to the development of an environmental management system for the municipality as well as to assure the success of the SOER. The development of environmental goals, objectives and policies is a time consuming process in itself.

Step 2: Review other city reports in progress or complete for possible areas of duplication.

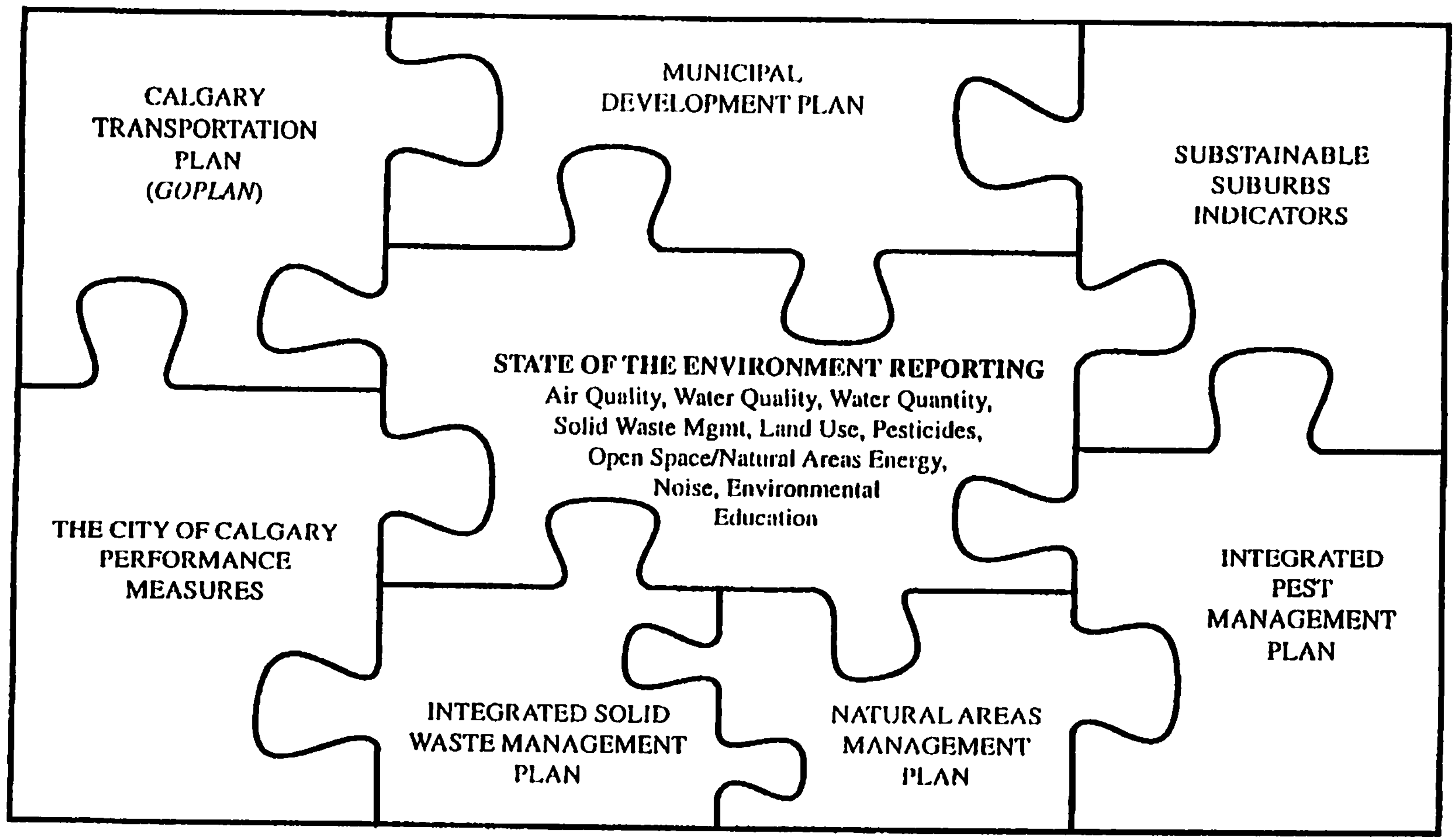
Other city reports should be examined to see where the SOER fits into the organization. To avoid duplication, all city reports should be reviewed (by the party responsible for the SOER compilation) which are in progress or completed. This process will also help establish the scope of the SOER to complement rather than duplicate other city documents being used. Figure 5.1 is an example of step 2 for the City of Calgary. This figure demonstrates how and where the SOER program fits into other programs under the Municipal Development Plan for the City of Calgary.

PHASE TWO: SOER process

Step 3: Develop a municipal SOER purpose, goals and objectives

The next step is to develop the purpose, goals, and specific objectives for municipal SOER. The purpose establishes a broad, somewhat idealistic vision for the state of the environment which is sometimes called mission, vision or philosophy statement. From this purpose, a set of goals and objectives are used to achieve this purpose. The goals, drawn from the purpose of the SOER, should be broad in nature, but state specific directions the report should establish in its reporting

Figure 5.1 Performance Measurement Indicator Projects Currently Underway at The City of Calgary



(City of Calgary, 1996)

program. The objectives are created from the goals and outline measurable actions. Examples of objectives may be to describe all of the current city environmental initiatives, to improve the waste management facilities, or simply plant more trees.

Step 4: Establish the scope of the SOER

The scope of the project is a key element of the SOER. All the previous steps lead up to the development of the scope. The scope of the project provides both organizational and spatial frameworks for the written report.

Most SOERs have used a combination organizational framework which includes the issues that need to be addressed taken from the environmental policy, goals and objectives. Environmental media is the most popular organizational framework which includes air, water, land, and biota. It is possible to divide each category into more specific issues such as water quality, quantity, and waste. Some categories which do not fit within this framework are energy, waste management, and corporate services. Environmental media categories would be appropriate as chapter headings addressing specific issues or special interests taken from the environmental policy under each category, or chapter heading. For example, if the media 'air' is a chapter heading, issues such as air pollution, indoor air quality and global warming can be addressed under this chapter heading. Each issue can used to create a city strategy and action plan, as well as create opportunities for residents and the private sector to participate.

For reporting at the municipal level, it is practical to use the jurisdictional spatial framework. The public can understand circumstances better if they can relate to them. If a purely ecosystem framework is used, the boundaries are not visible and cannot be put into perspective easily by most members of the public. Ideally, an ecosystem spatial framework is the most accurate measure; however, data are difficult to find for an entire ecosystem without jurisdictional boundaries. A combination spatial framework which includes both jurisdictional and ecosystem measures is preferable.

Used at both the international, national, and provincial levels, the Pressure-State-Response Model provides a viable organizational framework at the municipal level. Currently only two cities are using the PSR model in its partial form. The key informant interviews with both Regina and Ottawa indicated a reluctance to use the PSR model in full due to the lack of available, reliable data and a lack of monetary commitment.

As part of the scope of the project, there must be some indication as to who will be taking responsibility for the SOER, collecting information, writing the report, and monitoring the information it provides.

Step 5: Selection criteria for indicators

Indicators make up the substantial portion of the SOER. It is important to select indicators which will provide significant, valuable, useful information to the target audiences. Therefore, establishing selection criteria indicators is especially important. Chapter three lists a long set of possible indicator criteria used by municipalities. Respondents from the key informant interviews indicated the top three criteria as being:

1. Accessible and available in a consistent format;
2. represent issues of concern;
3. relevant to target audience's information requirements.

As each step builds on those preceding it, the municipality must assess who the target audience is, what the budget is, and what the scope of the project is, in order to prioritize the data. Once the selection criteria for indicators are set, collecting data becomes easier.

Step 6: Identify the indicators

The number and type of indicators are dependent on the criteria used to select them. A number of external agencies such as NGOs, other government agencies and the private sector may be able to provide suitable indicator information. Internally, each municipal department should have or develop information regarding data collection they have for their own purposes. It is not difficult to find suitable indicators.

Step: 7: Complete terms of reference and present to approving authority

For Council to approve the terms of reference for the SOER, a checklist of items should be included. This checklist should include:

- Purpose (vision, mission, philosophy statement);
- goals;
- objectives;
- scope;
- selection criteria for indicators;
- target audiences;
- indicators;
- method or process for doing SOER;
- roles and responsibilities;
- resources;

- results;
- budget including person hours;
- timeline.

PHASE THREE: Preparation of SOER; Phase 4: Approval Process; Phase 5: Review, Monitor, and Market

The process undertaken in phases 3, 4, and 5 is cyclical, and continuously improving through phase 5. Monitoring the activities of the indicators and an action plan are necessary to provide the opportunity for policy makers to review the content of the report and make improvements for the next report. The importance of monitoring and reviewing the SOER program cannot be stressed enough. Currently, there is a lack of consistent monitoring and reporting. The environment is in an evolving state and different issues may be more or less significant at different periods of time. Without continuous improvement, reporting on particular issues may become insignificant.

Step 17, marketing the report is a significant step in completing a successful SOER. In order for the public to utilize the report, there must be a sense of awareness and support for the report. Marketing the report to its stakeholders provides the report with the impetus to create action plans and continuous improvement for the report. Too many reports at the municipal level not marketed properly are not used by the stakeholders due to lack of awareness.

Recommendation Two

Issue: Barriers to municipal SOERs

State of the Environment Reporting is one of the emerging tools used by the public sector as part of the environmental management. However, many barriers remain in conducting and improving the process of reporting at all levels of government, including the municipal level in Canada.

In conducting a SOER process, there are a number of barriers which municipalities must overcome. Cambell and Maclaren (1995) list the types and severity of barriers which were found by the respondents in their survey of over 40 municipalities.

- limited staff resources;
- limited funds available;

- staff not knowledgeable about databases or information systems;
- overall methodology for SOERs is not well developed;
- municipal environmental indicators are not well developed;
- some required data does not exist;
- data exist but departments reluctant to cooperate in sharing data;
- data exist but not in appropriate spatial units;
- data exist but not consistently over time;
- lack of a local environmental strategy.

Recommendation

In the key informant interviews conducted by the author a number of these barriers were discussed. The key informant from Regina discussed the problem of keeping the planning process a realistic, honest report card with out political influence. There is an effort to keep the process apolitical and give credit where credit is due, and criticism where criticism is needed.

The key informant from Ottawa discussed four main barriers to reporting for the City of Ottawa.

- lack of corporate commitment or recognition of its value;
- the significant amount of time commitment and individual commitment to the process;
- the lack of available, measurable, valuable data;
- public involvement is still not on the corporate agenda of most cities;

Due to the current fiscal crises, municipal governments reduce their responsibilities, not add to them. Both Regina and Ottawa respondents admit to the fact that barriers will always be present in one form or another for reporting on the state of the environment. Stakeholders involved in the SOER process should be aware of all the barriers and try to reduce or eliminate those over which they have some control. Individuals working on the report should recognize and plan for the constraints that the other barriers, which they cannot control, impose upon the report that they will prepare and the processes that they will have to use. If the process is standardized and recognized as valid and productive, these barriers may be easier to mitigate.

Recommendation Three

Issue: Type and amount of public participation

There has been a significant shift in the approach to municipal policy making in the last decade. With more and more responsibility being placed on local authorities, public input has become a valued commodity. The use of public participation has resulted in a more comprehensive approach to planning. In municipal SOERs, with the exception of Burnaby, public participation has been limited to an environmental advisory committee of mostly professionals, administration and council. The type and amount of public participation will influence the scope and content of the report. This issue has created a significant amount of debate for municipal SOERs.

Recommendation

It would be appropriate and advantageous to have more appropriate, active forms of public participation in the SOER program. Public participation would be most valuable in the visioning process of the SOER. In phase 1, the public would make a valuable contribution in developing an environmental policy, principles and goals, define the issues of concern, and develop a policy and goals for the municipality to work with. The actual selection of criteria for indicators, data collection, and drawing up the report could be done internally. In phase four and five, the public can then review the draft report and provide input on the scope and content of the report. A more consistent form of public participation for the SOER process would improve the credibility of the report and its potential for implementation.

Recommendation Four

Issue: Lack of Interdisciplinary Teamwork

Interdisciplinary team work between departments is a difficult issue to address. State of the environment reporting is a collection of data from a number of varying departments on particular environmental issues affecting both the municipality as a whole and the municipality as a corporation. As discussed informally with City of Calgary employees, currently, each department acts almost as a separate entity. Reports are made without consideration to duplication with other departments and it is sometimes difficult to exchange information.

Recommendation

There must be both co-operation and buy-in by all stakeholders in order for the collection and management of data to maintain consistency and accuracy. At the City of Calgary, the Interdepartmental

Environment Committee is the link for the Office for the Environment to discuss other department initiatives and collect information. This committee is a significant contribution to the much needed interdisciplinary teamwork needed for the Calgary SOER and can be used as an example for other municipal SOERs.

Recommendation Five

Issue: Lack of Stakeholder Buy-in

Environmental issues are still lacking a sense of buy-in from many stakeholder groups at the municipal level. Environmental issues are being addressed for their visible physical effects on our own personal health, safety and leisure. The lack of stakeholder buy-in is due to a lack of education, awareness, and the pressure on a city to act.

Recommendation

With increased efforts at the municipal level to actively promote a vision towards sustainability, environmental issues and state of the environment reporting should begin to take an equal stand to other municipal issues. With increased pressure and acknowledgment at the international and national levels, local stakeholders will be pressured to act on these issues. Marketing the report is a significant aspect in creating stakeholder buy-in. Appropriate marketing of the report will increase the knowledge level of environmental issues and create a sense of awareness of municipal actions. Through marketing, stakeholders will take a greater interest in participating in the monitoring and action plans following the State of the Environment Report.

Recommendation Six

Issue: Appropriate Use of Target Audiences

The purpose, scope, and terms of reference of a SOER are determined by the target audiences. The general public is the most common target audience used in municipal reports across Canada. However, the primary target audiences for SOE reports in Canada are local politicians and staff of local agencies, in that much of the decision making power to improve environmental quality lies here (Cambell & Maclaren, 1995). It is difficult to create a single written report that is valuable for scientists, administration, decision makers, and the general public.

Recommendation

The first volume of a report should be an overview report, aimed at the general public.(Parker & Hope, 1992) If scientists and decision makers would like more information, a second volume could be published, or a reference guide for further information. If the report and its data are available in non-print forms (i.e. on a website or CD ROM), it may be easier to serve several different, important audiences. This electronic basis will also make it significantly easier to produce different reports for different audiences.

Recommendation Seven

Issue: Creation of a common set of selection criteria

Currently, the Federal government is developing a national set of environmental indicators which will satisfy some of the indicator needs for municipalities. However, if a municipality is to follow a continuous improvement process of state of the environment reporting, issues of focus will change. If a common set of indicators is used, the flexibility to change and grow will be jeopardized.

Recommendations

A common set of selection criteria for developing environmental indicators would be a significant step towards standardized SOERs at the municipal level. There are two recommendations which can be made. First, a national organization such as the Canadian Standards Association, should develop a common model including selection criteria to establish indicators (i.e. PSR Model) which is specific to municipalities and can be used by all municipalities. Partnering with municipal governments to develop a standard methodology, the Canadian Standards Association could provide a credible model for SOERs. From this model, common indicators will eventually develop.

The second recommendation is to have the Federal and Provincial governments establish an environmental indicator program which uses this model, and include indicators measurable at the municipal level.

Recommendation Eight

Issue: Common set of Indicators

To deem a report useful for comparison with other municipalities, many practitioners are expressing the need for a set of common indicators. Municipalities tend to use what information is available and has already been collected. Respondents from the key informant interviews indicate that they were not prepared to develop a set of new indicators to use as baseline data. However, having 'availability of data' as a main selection criteria will influence how an issue is addressed and presented. Currently the federal government is working on a set of indicators for the country. How applicable these indicators will be for municipalities is questionable.

Recommendation

This is where the federal and provincial governments should take a leading role. The two levels of government should concentrate their efforts on developing a common process model which includes the development of selection criteria. If municipalities follow the same model, a common set of indicators will eventually follow. Although it is valuable to form an indicator program which could provide data to municipalities to use as a basis for comparison of environmental stewardship between municipalities, a common process model should be the first step.

Recommendation Nine

Issue: Lack of consistent, valid reporting for municipal SOERs in Canada

One of the main problems is the lack of consistent, valid reporting on the actual state of the environment. Currently most municipalities document individual components separately. Municipalities need to recognize and report on the linkages between the biophysical components and provide information and indicators on the actual ecosystem as a whole.

Recommendations

A standard organizational framework should be implemented by the Federal government for all municipal SOERs, in order to begin benchmarking between internal reports. If there were a standardized method of writing SOERs to allow for (bench marked) comparison between cities, it would validate SOERs. For example, information gaps found in Table 3.1, Chapter 3, indicate that some SOERs did not provide information considered essential information. Perhaps an independent agency able to standardize, coordinate, and audit SOERs at all levels would provide a more useful document. An example of this is industry regulation. ISO 14,000 provides a framework and a license which ensures the public of a certain standard of conduct. This can be taken a step further with a section on environmental reporting.

Recommendation Ten

Issue: Lack of Accurate Data

Currently, there are major information gaps in our knowledge of the impacts of human activity on the environment at the municipal level.

The intrinsic complexity associated with environmental issues means it is difficult to understand all the feasible actions available for reducing impacts on the environment. The lack of accurate data collection at the municipal level has left decision makers to make less informed decisions about the health and welfare of our communities. The lack of a reliable and accurate statistical data base from which to deduce environmental trends is a significant problem. The amount of environmental statistics is pale in comparison to the amount of economic statistics which implies that there is a level of resistance in the civil service and by other public administration to address environmental issues (Parker & Hope, 1992).

Recommendations

The purpose of state of the environment reporting is to establish a base line environmental data source for reporting on the effects of decision making on our environment. With the increase of awareness of the significance of environmental issues by the general public, the private sector, and the public sector, there will be an increase in the type and accuracy of data pertaining to the biophysical environment. A gap analysis would help show where lack of data posed a problem, which would be solved if the appropriate agency were required to fill the gap for the next report.

Recommendation Eleven

Issue: Use of the PSR model at the municipal level

Currently SOERs portray a significant amount of information on the *pressure* of human activities (transportation, agriculture and industry) on the environment, as well as information on the *state* of the environment and of natural resources (air, water, land and living resources). However, there is very little information on *response* indicators by economic and environmental agents (administrations, households, enterprises).

Recommendation

The Federal and most of the Provincial SOERs are using the PSR model. This model is a topic for future research to study how it can be applied at the municipal level. Future municipal SOERs could use the Pressure-State-Response model for its ability to provide information for action plans. However available data, time, and budget are all major concerns at the municipal level to use this model. A gap analysis would be useful at the municipal level to establish where lack of data posed a problem, which would be solved if the appropriate agency were required to fill the gap for the next report. This would provide municipalities with the information necessary to use the PSR model for SOERs.

Summary

The purpose of doing this Masters Degree Project is to begin to develop a process on which a municipality can model its SOER. There are a number of factors which contribute or influence the scope, structure and content of an SOER. This MDP provides sufficient historical background about municipal state of the environment reporting, and can provide guidance for a municipality to comprehend and complete a successful environmental reporting program.

By following these steps and recommendations, perhaps municipalities can begin to provide compatible, comparable data among cities. In order to 'think globally, act locally', individuals, businesses and government organizations need to know where we are currently with respect to the environment. A state of the environment report provides a forum for an environmental action plan. By providing municipal reports which have comparable, consistent data reflecting trends, Canadians can begin the process of repairing our ecosystem city by city.

REFERENCES

AACIP. (1996.) "Municipal Environmental Assessment: A Land use Planning Tool." A discussion paper prepared by the Alberta Association, Canadian Institute of Planners. April, 1996.

Alberta Environment Protection Branch. (1996.) State of the Environment Annual Report: Waste Management. Provincial Government of Alberta.

(1995) 1995 S.O.E. Report Highlights Waste Management in Alberta,

(!996) News Release, April 18, 1996.

(1994a.) Alberta's State of the Environment Comprehensive Report., Provincial Government of Alberta.

(1994b.) "State of the Environment Reporting - Some History, and a Preview of the Future." Alberta's State of the Environment Fact Sheet No.3, Fall 1994, ISSN1198-3264.

(1994c.) "What are Environmental Indicators?", Alberta's State of the Environment Fact Sheet No. 2, Summer 1994, ISSN 1198-3264.

Alberta Government, (1995). Measuring Up: First Annual Report by the Government of Alberta June, 1995.

Azzone, Giovanni, & G. Noci, (1996.) "Defining Environmental Performance Indicators: An Integrated Framework"., Business Strategy and the Environment, Vol. 5, p.69-80, John Wiley and Sons Ltd. and ERP Environment.

Bassam, Steve. (1989) "The Greening of Local Government" Municipal Journal, May 1989 p.13-15

Bilkhu, Jagdev. (1996.) Incorporating Environmental management and Restructuring in Municipal Government. Master's Degree Project, Faculty of Environmental Design, University of Calgary, Calgary, Alberta.

Bow River Water Quality Council, (1993.) State of the River Report, July 1993 AGRA Ltd.

(1991.) "The Bow River: Preserving our Lifeline" November 1991

Brown, Bill, (1996.) Town of Canmore SOER Preface, Town of Canmore Planning and Building Department.

Brundtland, Gro Harlem, et al.,(1987) Our Common Future: World Commission on Environment and Development. Oxford: Oxford University Press.

City of Burnaby, (1993.) State of the Environment Report for Burnaby, Environment and Waste Management Committee. September.

City of Calgary (1996a.) State of the Environment Reporting, Environmental Advisory Committee Report to the S.P.C. on Operations and Environment, December 02.

(1996b.) Performance Measures for the City of Calgary: A Progress Report, January 1996

(1996c.) Guidelines for Implementing The Environmental Regulatory Compliance Policy

(1996d.) Background Report on Municipal State of the Environment Report. Report to EAC. June 1996

(1994a.) Environmental Regulatory Compliance Policy, prepared by the Task Force on Environmental Issues.

(1994b.) The City of Calgary: Environmental Policy, Principles & Goals, prepared by The Environmental Advisory Council.

(1990.) Charting Calgary's Future...Council's Strategic Plan, prepared by City Council.

Cambell, Monica. And Virginia Maclaren. (1995.) Municipal State of the Environment Reporting in Canada: Current Status and Future Needs. Occasional Paper Series No.6, Environment Canada, Ottawa.

Canadian Institute of Canadian Accountants, (1994.) Reporting on Environmental Performance. Toronto.

Canadian Chamber of Commerce, (1992.) A Guideline on Corporate Environmental Reporting. Toronto, ON. CCC.

CEPA, (1985.) Canadian Environmental Protection Act. R.S.C. 1985, C.16 4th Supplement. Section 7.

Dilks, David. Ed. (1996.) Measuring Urban Sustainability, Canadian Indicators Workshop June 19-21, 1995 Workshop Proceedings. Prepared for the State of the Environment Directorate, Environment Canada, Centre for Futures Studies in Housing and Living Environments, Canada Mortgage and Housing Corporation, January

Elkin, T.J. (1990.) "State of the Environment Reports and National Conservation Strategies: The Linkage", Alternatives Vol.16 no.4/vol.17 No.1, p.52-60.

Elkington, John & Nick Robins., (1993.) "The Corporate Environmental Report: A Necessary Condition for the Implementation of Industry's Voluntary Codes of Conduct on Environment and Sustainable Development." SustainAbility

Environment Canada, (1994.) State of the Environment Reporting Newsletter No. 12, November.

(1993a.) From the Mountains to the Sea: A Journey in Environmental Citizenship Minister of Supply & Services, Canada.

(1993b.) State of the Environment Report for British Columbia. Ministry of Environment Lands and Parks. Victoria.

(1991.) A State of the Environment Report: A Report on Canada's Progress Towards a National Set of Environmental Indicators. SOER No.91-1, January, 1991.

(1990.) "A State of the Environment Report: Canadian Perspectives on Air Pollution." SOE Report No. 90-1

(1989.) Towards an SOE Reporting Action Plan: Opportunities to 1993. Technical Report No. 3. State of the Environment Branch.

Environment Council of Alberta, (1995.) Ensuring Prosperity: Implementing Sustainable Development. The Report of the Future Environmental Directions for Alberta Task Force, March, 1995.

Fact Sheet No. 3, (1994a.) "State of the Environment Reporting: Some History, and a Preview of the Future."

Fact Sheet No.2, (1994b.) "What are Environmental Indicators?" Alberta's State of the Environment Fact Sheet ISSN 1198-3264, Summer, 1994.

Federation of Canadian Municipalities, (1995.) Municipal Government Actions for a Sustainable Environment: A Compendium of Initiatives, Contacts, and Documents, Canadian Urban Research on the Environment.

Gray, Rob. (1993.) Accounting for the Environment. Prepared for he Chartered Association of Certified Accountants. Chapman Publishing Company, London, England.

Ham, Tony, M. Jacobs, R. Levett, H. Lusser, J.Morphet, & D. Taylor. (1994.) Greening Your Local Authority, Longman Group Ltd., Great Britain.

Region of Hamilton-Wentworth, (1994.) State of the Environment Report, 1994 Update. Planning and Development Department, August,

Higgins, Donald. (1986.) Local and Urban Politics in Canada, Toronto: Gage Educational Publishing Company.

Hope, Chris. & J. Parker. (1992.) "The State of the Environment: A Survey of Reports from Around the World", Environment, January/February 1992, Vol. 34, No. 1. p.17-45.

City of Kelowna, (1995.) State of the Environment Preliminary Data Report, George York, Ed., Department of Water Works, November 24, 1995.

Kerraghan, K. & D. Siegel. (1987.) Public Administration in Canada , Queen's Printer, Toronto, p.587-602

Kerr, A. (1995.) National Environmental Indicator Series, Environment Canada, Indicators Branch, State of the Environment Department, December 1995

KPMG. (1995.) The 1994 KPMG Canadian Environmental Management Survey. KPMG Environmental Management Services Inc., Toronto, Ontario.

Maclaren, Virginia. (1996.) “Urban Sustainability Reporting” Journal of the American Planning Association, Vol. 62, No.2 p. 184-202.

(1996.) Developing Indicators of Urban Sustainability: A Focus on the Canadian Experience., CMHC, ICURR, & Environment Canada.

O'Connor, John. (1996) "Toward Environmentally Sustainable Development: Measuring Progress." " A Sustainable World: Defining and Measuring Sustainable Development, IUCN - The World Conservation Union Publication, Sacramento, U.S.A, p. 87-172.

City of Ottawa, (1993.) Land & Water: Background Report on State of the Environment Reporting Program. Ottawa Environmental Management Branch, Department of Engineering and Works.

Regional Municipality of Peel, (1995.) State of the Environment: Atmosphere Report, December, 1 of 3.

(1993.) "Inventory of Key Environmental Indicators", Environmental Planning Policy Study Report 3 of 4.

Perks, William. & J. Bilkhu, D.Thompson. (1996.) The Integration of Environmental Assessments and Municipal Planning. ICURR Publications. Toronto, Ontario.

Pocock, Dr. R.L. (1981.) "Describing the State of the Environment at the Urban Scale" Local Government and Environmental Planning and Control. University of Aston in Birmingham, Gower Publishing Company Limited., England. p. 93-109.

Province of Alberta, (1995.) Measuring Up: First Annual Report by The Government of Alberta, June 1995.

Province of Saskatchewan, (1991.) Saskatchewan State of the Environment Report. Saskatchewan.

City of Regina, (1994a.) State of the Environment Report, Regina Urban Environment Advisory Council.

(1994b.) "Regina - Planning for a Sustainable Community" Environmental Forum. Regina Urban Environment Advisory Council's Second Annual Citizen's Environmental Forum, Regina Saskatchewan, November 18, 1994.

Regional Municipality of Waterloo, (1991.) State of the Environment Report, Final Report. Department of Planning and Development, December,.

Reichert, Clark, & N. Ragetlie. (1991) State of the Environment Reporting Background Notes., December 3, 1991, Prepared for the Regions of Waterloo and Hamilton-Wentworth, Ontario, Canada.

Rodenburg, Eric. (1995.) "Monitoring for Sustainability" A Sustainable World: Defining and Measuring Sustainable Development, IUCN - The World Conservation Union Publication, Sacramento, U.S.A, p. 77-86.

Schipperus, Adrienne Lynne. (1995.) Environmental Reporting. Masters Degree Project, Faculty of Environmental Design, University of Calgary, Calgary, Alberta.

Selman, Paul. 1995. "Systematic Environmental Reporting and Planning: Some Lessons from Canada".Journal of Environmental Planning and Management, Vol.37, No. 4

(1994.) Environmental Planning The Conservation and Development of Biophysical Resources, Paul Chapman Publishing Ltd. p. 1-24.

Sheehy, G. (1989.) Organizational and Spatial Frameworks for State of theEnvironment Reporting., Strategies and Scientific Methods SOE Reporting Branch, Canadian Wildlife Service, Conservation and Protection Environment Canada.

Stephenson, M.L., & D. Thompson. (1996.) "Environmental Performance Indicators: Development at the Industry Group Level". Paper presented at International Conference on Health, Safety & Environment in New Orleans, Louisiana, 9-12 June, 1996.

Stuetz, George, & J.D. Woodruffe, (1996.) "Measuring and Reporting Environmental Performance: The Use of Objectives, Targets and EPIs in Corporate Reporting, Executive Summary". Woodruffe Associates Inc. January, 1996.

Tindal, C.R. Tindal, S. Nobes. (1990.) Local Government in Canada, 3rd Edition,Toronto: McGraw-Hill Ryerson Ltd.

Thompson, Dixon. (1995.) "Curing Institutional Alzheimer's: Tools for More Effective and Efficient Environmental Planning" Plan Canada. Canadian Institute of Planners Nov. 1995, Vol.35, No.6.

City of Toronto, (1993.) State of the Environment Baseline Report. Prepared by P.R.W. Kendall for the Environment Protection Office, Department of Public Health, City of Toronto. November,.

(1988.) Toronto: State of the Environment., Prepared by A.S. Macpherson, Medical Officer of Health for the Department of Public Health, May, 1988.

City of Vancouver, (1995.) State of the Environment Report. Special office for the Environment.

United Nations. (1993.) The Global Partnership for Environment and Development: A Guide to Agenda 21, Post Rio Edition. United Nations. New York 1993, p.3-38.

World Resources Institute. (1996.) Corporate Environmental Performance Indicators: A Benchmark Survey of Business Decision Makers. , Tellus Institute, Boston, MA.

(1995.) Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development. May, 1995.

PERSONAL COMMUNICATION

Bilkhu, Mr. Jagdev., personal communication. Discussion with Mr. Bilkhu took place between September 1996 and April 1997. Mr. Bilkhu is a graduate of the Faculty of Environmental Design. His Master's Degree Project was titled "Incorporating Environmental Management and Restructuring in Municipal Government" with the City of Calgary as a case study.

Baxter, Ms. Theresa., personal communication. Discussion with Ms. Baxter took place between September 1994 and May 1997. Ms. Baxter is a Professor of Planning at the Faculty of Environmental Design, University of Calgary, phone: (403) 220-7741.

Draper, Dr. Dianne., personal communication. Discussion with Dr. Draper took place between September 1996 and May 1997. Dr. Draper is a Professor of Geography at the Faculty of Environmental Design, University of Calgary, and a member of the Environmental Advisory Committee, City of Calgary, phone: (403) 289-7728.

Fong, Ms. Siu., personal communication. Discussion with Ms. Fong took place between March 1997 and April 1997. Ms. Fong is a Research consultant with Pubic Health, Environmental Protection Office, City of Toronto, phone: (416) 392-6788.

Hercz, Ms. Anna., personal communication. Discussion with Ms. Hercz took place between March 1997 and April 1997. Ms. Hercz is the Senior Policy Analyst, Environmental Management Branch, Department of Engineering and Works, City of Ottawa, phone: (613) 244-5300 ext:3824.

Leach, Ms. Kimberly, personal communication. Discussions with Ms. Leach took place between March 1996 and March 1997. Ms. Leach is an Environmental specialist in the Office for the Environment, Engineering and Environmental Services Department, City of Calgary, phone: (403) 268-5670

Luksun, Mr. Basil., personal communication. Discussion with Mr. Luksun took place between March 1997 and April 1997. Mr. Luksun is the Senior Environmental Planner, Long Range Planning, City of Burnaby, phone: (604) 294-7420.

McDonald, Mr. Paul, personal communication. Discussion with Mr. McDonald took place in March 1996. Mr. McDonald is the Coordinator, Environmental Management Branch, Department of Engineering and Works, City of Ottawa, phone: (613) 244-5300 ext:3221.

Reynolds, Mr. Dave, personal communication. Discussion with Mr. Reynolds took place between March 1996 and March 1997. Mr. Reynolds is the Environmental Services Coordinator, Office for the Environment, Engineering & Environmental Services Department, City of Calgary, phone: (403) 268-8050

Schommer, Mr. Joe, personal communication. Discussion with Mr. Schommer took place between March 1997 and April 1997. Mr. Schommer is a Senior Planner with the Planning Department, City of Regina, phone:(306) 787-5847.

Szdan, Mr. Terry, personal communication. Discussion with Mr. Szdan took place in April, 1996. Mr. Szdan is a Project Manager for State of the Environment Reporting for Alberta, phone: (403) 427-2326.

Thompson, Dr. Dixon, personal communication. Discussion with Dr. Thompson took place between March 1996 and May 1997. Material from his course EVDS 747 (Environmental Management) and EVDS Golf Course Course and his research in Environmental Management tools contributed to this Master's Degree Project. He is a Professor of Environmental Science in the Faculty of Environmental Design, The University of Calgary, Calgary, Alberta. Phone (403) 220-3625.

Zsomber, Mr. Ed, personal communication. Discussion with Mr. Zsomber took place in March 1997. Mr. Zsomber is the former Senior Director, Environment & Infrastructure, City Managers Office, City of Regina and is currently with Saskatoon Transportation, phone (306) 787-5847.

APPENDIX ONE

Municipal State of the Environment Report

Reports for the following municipalities were obtained for a content analysis

Vancouver, BC 1993
Burnaby, BC 1993
Kelowna, BC, 1996
Regina, SK, 1996
Toronto, ON 1994
Waterloo, ON, 1991
Hamilton-Wentworth, ON, 1990
Region of Peel, ON, 1994
Ottawa, ON, 1994

City of Vancouver

Vision

Create and maintain a sustainable community

Purpose

PLANNING REPORT
To guide the development of a practical environmental agenda for the City of Vancouver.

Objective

- Provide an environmental baseline which will help decision makers set priorities for action and guide decision making.
- Provide the public with a report card, a list of indicators on different aspects of the environment by which they may guide their actions.

Target Audience

The primary target audience is the general public. It is hoped that this report will create a greater interest in environmental issues and generate issue initiatives. The other two target audiences are City decision makers and City departments.

Scope

The City of Vancouver concentrated on using purely the biophysical components of the environment and only applied social and economic factors as they impacted the biophysical components directly. The reason being is that the CITY PLAN was covering the social aspects of the

Sustainable Community. Both economic and social environmental considerations are taken in account, only when they directly effect the biophysical environment.

The Special Office for the Environment determined the Scope of the report based on other completed municipal SOERs, Federal and Provincial SOERs, and other City initiatives. This document covers the areas that are not covered in other reports done in the city. There is no discussion of the interrelationship with other reports, or processes. This would include the use of an Environmental Management System to implement, monitor, etc. changes and to provide further update reports. In Vancouver's quest as a Sustainable Community, it is stated in the report as 'beginning with an SOER, ending with council adopting an environmental agenda for the City'. I would suggest that ENDS is not the right word in this case. Being based on a continuous improvement model there is no end to the SOE process!

Process:

The report was prepared by the Special Office for the Environment which includes two representatives each from the Health Department, the Engineering Department and the Permits and Licenses department of the City of Vancouver. Contributions were made from a Special Focus Group who critiques the various drafts and provided numerous recommendations. This group consisted of selected representative members of the community. An interdepartmental committee on the Environment provided considerable information for the initial draft and recommendations for ensuing drafts. This committee was in charge of collecting data, formulating particular chapters, and establishing support and participation in each department. The SOE report is used to guide the development of a practical environmental agenda for the City of Vancouver.

The process begins with the State of the Environment report and is completed with City Council adopting an environmental, sustainable agenda for the City. The important part comes in between when the public is encouraged to provide input on the current status of our environment, what they see as priorities and any solutions they might suggest.

Structure and Content

The report is divided into eight major sections in addition to the introduction and a short conclusion. State of the Air, Drinking water quality and conservation, Receiving Water Quality, State of the Land, Solid Waste Management, Dangerous goods and Hazardous wastes, City Hall as a community, Other environmental Issues (Noise, Electromagnetic Fields, Energy Utilization). Each section begins with a brief introduction of the topic area followed by a discussion of the indicators to be used, the current status of the area, a preliminary discussion of the Issues and Choices and a preliminary list of recommendations. This document is meant to be descriptive (of the current state of the environment rather than prescriptive (of the possible solutions.)

The report is structured in a combination organizational framework using both Environmental Media and an issues based framework. The spatial framework is based on the jurisdictional boundaries framework although there are some considerations of the impact of the city beyond its borders.

Each chapter contains the issue, the indicators used, the current status, and issues and choices for the future.

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	5
Natural Process	0
Environmental Assets/ Quantity	1
Environmental Quality	4
Human Health and Exposure	1
Quality of Life	1
Socio-Economic	0

In determining the type and amount of indicators to be used, there are a number of criteria which is taken into consideration. The predominant factors are availability and cost. In the case of Vancouver, no primary data collection was conducted.(Maclaren, p.72) Most of the indicators correlated with individual department's access to data, accuracy, and usefulness.

City of Kelowna

The Official Community Plan (OCP) for the City of Kelowna outlines a number of policies and objectives to ensure the preservation of the environment. The City's Strategic Plan has emphasized the environment is a priority issue

Vision

To ensure the preservation of the environment

Purpose

INDEX/OVERVIEW
Tool for environmental planning and policy implementation and integration into a more comprehensive report.

Objective

- Provide a baseline from which a more comprehensive state of the environment report can be developed.
- Provide information on the state of water, air and land in the City of Kelowna

Target Audience

The general public, decision-makers, & administration are the target audiences.

Scope

The scope of the preliminary SOER for Kelowna is purely the biophysical environment. This report provides information on the state of water, air, and land in the City of Kelowna. Although the report deals only with the physical environment, there is acknowledgment that environmental issues are not isolated form the social, economic and cultural aspects of the City's life. The report is based on solid technical data and provides information on the environmental initiatives already put in place by the City.

Process

The Preliminary Data Report for the City of Kelowna State of the Environment, was formulated by a Water Quality Technician in the Environment Section of Works and Utilities Department for the Municipality. The information for the report was gathered from current City programs and services. There is an admittedly, information gaps from the City and other sources.

Structure and Content

The structure and content of this report was formed under the premise that this report is merely to identify what information is available, where information is lacking and where more work needs to be done. The report is based on technical data and provides information on the environmental initiatives already in place. The organizational framework is environmental media. The report provides indicators on water quality, air quality, and land uses with in the Okanogan. The spatial framework is strictly jurisdiction and many of the indicators come from jurisdictional data sources.

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	12
Natural Process	1
Environmental Assets/ Quantity	8
Environmental Quality	10
Human Health and Exposure	2
Quality of Life	3
Socio-Economic	0

Keeping in mind that the report is merely preliminary to a complete State of the environmental report. The preliminary list is a first draft of potential indicators for environmental conditions in Kelowna. The criteria for the indicators included availability, historical data available, sensitivity to change, reliability, scientifically valid, and understandable. There were approximately 22 indicators used in the preliminary report.

City of Ottawa

Vision

To establish an ecological approach to monitoring, evaluating and managing environmental health

Purpose

PLANNING/INDEX

- To provide an integrated perspective for showing changes in environmental quality;
- To broaden the awareness of public and private decision makers regarding environmental issues and providing them with the information needed to see the interrelatedness of social, economic and environmental aims;
- To increase the environmental awareness of residents and encouraging them to feel responsible for contributing to the social, economic and environmental well-being of their communities.

Objectives

- To monitor and assess environmental conditions and trends, with an emphasis on learning how human and social/economic health are interconnected with the well-being of nature.

The reporting program is divided into a number of reports. The first SOE report for the program was on Land and Water.

- The objectives of this report are to set a framework and process for future monitoring and reporting on land and water in the city;

- To outline an ecological approach for state of the environment reporting on environmental conditions and trends;
- To show what the City of Ottawa is doing to maintain, protect and enhance environmental quality in relation to parks, urban forests, soil and water.

Target Audience

The target audience includes the general public, residents of the City of Ottawa, Administration, and local decision makers.

Scope

The report is based on current City programs and services for environmental management. It uses existing information to show some of the conditions and trends in the ecology of the city. It is not a full-scale and comprehensive SOE report. A primary emphasis of the report is on the current state of the environment rather than on changes that occur over time.

The report is based on a survey of existing information about the City's environment. The gathering of available information was guided by the pressure-state-response model for SOE reporting. The SOE program is based on a continuous improvement model. Each report will be examined to make improvements for the next report issued.

Process

The 1991 Official Plan policies, the City of Ottawa's Approach to Environmental Management report and the City's 1992 Environmental Agenda provide direction for the establishment of a State of the Environment Reporting program.

The report was compiled by the environmental management branch established in the Department of Engineering and Works. An Advisory Working Group represented by various levels of government, the community, local universities and many specialists who provided professional assistance and advice.

Structure and Content

The organizational framework for the first SOE report on Land and Water for the City of Ottawa is based on Environmental Issues. Ecological concerns are being addressed to various degrees by new city policies and programs, including the Urban Forest Maintenance Strategy, the naturalization Program for City Parks and the City Greenways. The report focuses on open space land and water, and on related soil quality issues.

The open space concerns in the report centre on parkland, the urban forest, natural places and city greenways.

The spatial framework is not limited to the jurisdiction of the City of Ottawa. Attention is given to both the local and regional landscape surrounding the City which provides an ecosystem framework for analysis.

The SOE reporting program being developed by the City of Ottawa will, in the long term, include a comprehensive information base and reporting capability for natural area, wildlife, the urban forest, soil quality, water quality, waste management, air quality, energy use, transportation and land use.

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	13
Natural Process	0
Environmental Assets/ Quantity	5
Environmental Quality	17
Human Health and Exposure	3
Quality of Life	5
Socio-Economic	1

The State of the Environment Reporting program for the City of Ottawa will eventually incorporate indicators for land and natural places in the city, Air quality, Energy and transportation, human health, water, Land use, Waste, and environmental policies and protection processes. These same type of measures of environmental quality are being developed for the federal SOE reporting program as well.

For the State of the Environment Report on Land and Water, indicators were selected to report
on open space and the built environment, natural places in the city, the urban forest, urban parks, the city greenways, open space management, water, and soil.

City of Burnaby

Vision

To ensure ecologically sustainable development and a balance between the environment and the economy

Purpose

PLANNING

- To respond to the variety of environmental problems - air pollution, water pollution, global warming, toxic real estate, hazardous waste, dwindling wildlife populations, too much garbage, degraded natural areas, and other environmental challenges;
- To provide a comprehensive framework for identifying and addressing environmental issues and concerns in the City;
- To ensure community participation in environmental decision-making and problem solving.

Objectives

- To develop a set of environmental goals and objectives for the city;
- To integrate an environmental action program into all City decisions and activities;
- To establish and maintain baseline environmental data fro monitoring environmental quality

Target Audience

The target audience for the SOER is the general public, its elected officials, city staff and contractors in meeting the challenges of making environmentally responsible decisions.

Scope

The Scope of the City of Burnaby SOER was focused on the biophysical environment. The scope was developed from the terms of reference, established by the Environmental and Waste Management Committee. After considerable public consultation, the scope was reinforced by public concerns and issues.

Process

Burnaby's Environmental and Waste Management Committee served as the steering committee for the SOER. The Committee developed the terms of reference for the SOER and outlined a three phase process to complete the project. Burnaby had an extensive public consultation process for the report which included a wide variety of participants.

The first phase of the project was to outline the environmental issues and concerns. Through public workshops a wide range of issues and concerns were identified. Participants included private citizens, representatives of industry, business, community groups, service clubs, educational institutions, members of City Council and city staff.

The second phase was to develop environmental goals and objectives that respond to issues and concerns identified during Phase 1.

Phase three involved the identification of environmental actions for the City of Burnaby. The environmental actions are ideas for specific actions to be taken to meet the environmental goals and objectives developed during Phase two.

Structure/Content

The structure of the Burnaby SOER was largely determined by the terms of reference, outlined by the Environment and Waste Management Committee. Using an extensive public consultation process, the structure and content of the report would emphasize community concerns and issues of public importance.

The framework for the report is a combination of environmental media and environmental issues framework. Each chapter which emphasizes either or both environmental media or issues is structured in the following manner.

A vision statement for the issue; a number of goals; an outline of various programs and initiatives within Burnaby; other programs and initiatives in the lower mainland and Canada; workshop issues and concerns; workshop ideas for action

The last chapter presented an implementation strategy and recommendations for future action. The jurisdictional boundaries for the City of Burnaby was the spatial framework for the report.

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	14
Natural Process	0
Environmental Assets/ Quantity	3
Environmental Quality	3
Human Health and Exposure	4
Quality of Life	4
Socio-Economic	1

There was a minimal amount of indicators used for the report. Those used were identified through the workshops and a literature review. They were easily obtained and available.

City of Toronto

Vision

To anticipate and mitigate the environmental impacts of growth and change.

Purpose

DATA

- Overview of the state of Toronto's environment s part of an environmental management strategy based on the implementation plan;
- Describe and assess the state of the environment.

Objectives

- To provide baseline information for the year 1988;
- Identify environmental conditions and factors that need to be monitored in order to protect, promote, or restore the urban environment.

Target Audience

The primary audience is administration and City Council. The secondary audience consists of the Board of Health, the environmental research community and members of the public.

Scope

The scope of the SOER is to report on the state of the environment for both the Corporation and the City at large. It provides a comprehensive compilation of information on environmental quality in the City at-large and considers, for the first time, environmental issues affecting the Corporation of the City of Toronto.

Process

With the adoption of the Toronto Declaration on the Environment, outlining environmental principles and objectives to guide the activities, policies and decisions of the City, a task force was formed to create an Implementation Plan based on the Declaration. The task force consists of representatives from almost every department.

The State of the Environment Baseline Report is one of eight reports that will constitute the Implementation Plan and therefore will need to be viewed in context of the policy actions and specific interventions discussed in other reports. The SOE Baseline Report was chaired by a medical officer of Health and submitted by the Department of Public Health.

Structure/Content

The 1994 SOE Report for the City of Toronto provides a comprehensive compilation of information on environmental quality in the City at-large and considers, for the first time, environmental issues affecting the Corporation of the City of Toronto. The report document s various aspects of the City's natural and built environments and use of environmental services as well as information on the Corporation's consumption and provision of environmental services.

The organizational framework is a combination framework of environmental media and environmental process framework. The City of Toronto is viewed as both the producer and the consumer of environmental services. The report documents recommendations for on-going monitoring of both environmental quality and the City's progress towards attaining a more
sustainable urban environment. The spatial framework is jurisdictional in nature.

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	30
Natural Process	0
Environmental Assets/ Quantity	64
Environmental Quality	11
Human Health and Exposure	12
Quality of Life	2
Socio-Economic	11

The preliminary indicators of environmental quality and services as well as the subsequently recommended sustainability indicators are based on research of existing documents on environmental indicators and environmental quality information in general.

In addition to background demographic and economic statistical data, indicators for air quality, water quality, and land use issues are provided and suggestions are made for on-going monitoring of both environmental quality and the City's progress towards attaining a more sustainable urban environment. Indicators of urban environmental sustainability were more difficult to obtain, largely owing to difficulties in defining the concept and to the lack of existing data on potential measures of sustainability. More pertinent and informative indicators are likely to be developed over time.

In most cases, the best recent available data have been assembled from many sources and summarized to describe current conditions in the City's air, water and land environments. As well, the report attempts to identify changing conditions and emerging trends by comparing annual indicators of certain parameters for the past five to ten years.

Region of Peel

Vision

Create an ecological approach to future urban planning which considers the interrelationship that exists between the community, the economy, and the environmental components

Purpose

INDEX

- To provide an early warning of potential environmental problems;
- Assess environmental policies and the impact of development activities on the environment;
- And facilitate the achievement of sustainable development in Peel.

Objectives (for 1st report)

To provide the past and present concentrations of regionally significant airborne pollutants in the
Peel Region.

Target Audience

The target audience is the administration and policy makers. The State of the Environment Reporting program will give both the administration and policy makers the baseline information to make proactive, informed decisions about the future of the Region. The secondary audience is the general public.

Scope

The Region of Peel's SOER is organized into three components; atmosphere, water, and land. The first report is on the Atmosphere.

The Region of Peel State of the Environment: Atmosphere Report is the first in a series of state of the environment reports to be prepared by the Region of Peel. This report provides indicators of atmospheric quality in the Region and examines the impact of selected pollutant on the natural environment and human health.

Process

In order to achieve an ecosystem approach to planning, the Regional Planning department initiated the development of an Environmental Planning Policy Study. The overall purpose of the study is to provide an environmental perspective for the Regional Official Plan that is presently being formulated and to work towards an ecosystem approach to planning.

As part of this study, a State of the Environment report is to be prepared on an annual basis providing a snapshot of Peel's natural environment.

In addition to fulfilling the need for a monitoring device in achieving an ecosystem approach to planning in Peel, the Regional Health department is required by the Province to prepare a report on local environmental risk area. Therefore, Peel's first State of the Environment Report is prepared in cooperation by the Regional Planning and Health departments.

Structure/Content

Beginning with atmosphere, each component of the SOER will be prepared and published as a separate report. Following the completion of the three reports, a highlight package will be prepared to summarize the main findings.

The organizational framework for the SOER as a whole, is an environmental process framework. Following the Vision of the Environmental Planning Policy, this framework uses an ecosystem approach that recognizes the response of the environment to human induced stresses, that looks at dynamic relationships and that illustrates the cause and effect nature of environmental conditions.(Sheehy, 1989)

An ecosystem is composed of atmosphere, land, water, living organisms, and the complex set of interactions between them. Each component plays a distinct yet significant role in a system where everything is connected to everything else. Any decisions that are made or problems that arise cannot be considered in isolation, but must be made in the overall context of the ecosystem.

The spatial framework for this SOE report is an ecosystem framework. The Ecosystem framework relies on geographic units which contain distinctive sets of abiotic and biotic features. (Sheehy, 1989)

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	25
Natural Process	0
Environmental Assets/ Quantity	19
Environmental Quality	3
Human Health and Exposure	4
Quality of Life	1
Socio-Economic	0

Indicators describing the impact of human activity on the Region's natural, biophysical features are selected to present the current environmental baseline conditions and to assess the overall health of the environment in Peel.

The indicators have been selected as scientifically valid; relevant to issues of concern; routinely available at the Region or from other agencies; and supported by sufficient data in order to show trends over time. Indicators are chosen for their ability to monitor the state of the atmosphere, water, land and living organisms.

City of Regina

Vision

Create an urban community in concert with its environment and consistent with community expectations and existing knowledge and research

Purpose

INDEX/PLANNING

To provide the public with current information about the strategies and initiatives undertaken by the City to protect and manage our natural and built environment as well as those proposed for the future.

Objectives

- To provide baseline information for decision-making purposes and to raise awareness of the varied environmental activities.
- To identify sustainable actions for individuals and businesses.

Target Audience

The Citizens of Regina are the primary audience for the Regina SOER. It is important that the community be informed of the environmental activities of the City to ensure public safety, health and well being. An informed and committed community is a prerequisite for positive change in Regina. Decision-makers and administration are the secondary audience.

Scope

In this report, the urban environment has been divided into biophysical and socio-economic sections. The biophysical environment section covers air, water, physical urban form, transportation, wildlife habitat, parks and open spaces, and waste management. The socio-economic section consists of recreation facilities and programs, protective services, heritage, housing, employment, economic diversity, disposable income, and the City of Regina's fiscal condition.

In these areas, the report outlines how the City maintains and improves both the natural and built components of our urban environment. Socio-economic information is included in this report to present a holistic picture of the current state of our urban environment.

Process

The State of the Environment Report for Regina was coordinated by the Environment and Infrastructure Directorate with extensive assistance and co-operation from many civic departments. The Regina Urban Environment Advisory Council also participated.

Structure/Content

The report reviews global, national, and provincial environmental strategies to provide a global prospective and to put Regina and its own actions and initiatives into perspective.

The report has two primary sections: The Biophysical Environment and the Socio-Economic environment. The report identifies resource utilization, management issues, environment concerns, and opportunities available to address these concerns. For each issue addressed there are a number of indicators, a City Strategy, City initiatives and future opportunities for the Citizens and Businesses of Regina.

The organizational framework for this SOER is an Environmental Media, Pressure-State-State Response model and an issues based framework. The report covers a number of varied issues in both the biophysical and socio-economic environment.

The spatial framework used is jurisdictional. All indicators given for a specific issue is based on the political boundaries of the City of Regina.

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	15
Natural Process	0
Environmental Assets/ Quantity	7
Environmental Quality	4
Human Health and Exposure	7
Quality of Life	3
Socio-Economic	12

The limited number of indicators in the report act as a baseline for future comparisons and documents. As the State of the Environment Reporting develops and matures, existing indicators will be refined and new indicators developed.

Regional Municipality of Waterloo

Vision

To preserve, enhance, manage the health of the natural environment to ensure the quality of life we would like to provide our children.

Purpose

INDEX

- To shape future policy directions in the 1991-1993 review of the Regional Official Policies plan;
- To guide future corporate decisions of the Regional Municipality of Waterloo;
- To foster in the Region's residents a consciousness that the state of the environment, whether good or bad, is the cumulative effect of our past and present actions.

Objective

To provide baseline information for future environmental initiatives

Target Audience

This report is for all levels of government, the private sector, and individuals who are required to preserve, enhance, and manage the health of the natural environment to ensure the quality of life we would like to provide for our children. The Final Report was written with the general public in mind.

Scope

The State of the Environment Report is mandated by the Terms of Reference of the Regional Ecological ad Environmental Advisory Committee. Although the Final Report is written with the general public in mind, a series of four background reports were written which provide considerably greater detail. [NOT DONE]

Process

Prepared by the Planning and Development Department for the council of the Regional Municipality of Waterloo. [EXPAND]

Structure/Content

The State of the Environment Report briefly describes the historical development and present state of the Regional environment. Part one is a series of sketches covering many millennia which shows how the Regional environment came into being. Part two deals with environmental conditions in the Region at the present time as they affect land, water, natural resources, and the fundamental ecological processes which sustain life. The concluding chapter outlines a number of recommendations aimed at helping the Regional community start down the path of Sustainable Development.

The organizational framework for the Final Report is both Environmental Media and Environmental issues based. Although the report covers Land, Water, Air, and Biota, their are a number of issues discussed that effect the Region.

The spatial boundaries are jurisdictional. Indicators are used to identify measures within the jurisdiction of the Region of Waterloo.

Indicators

In determining the number and type of indicators from the actual document, the following indicators where found.

Human Activity	30
Natural Process	0
Environmental Assets/ Quantity	13
Environmental Quality	14
Human Health and Exposure	5
Quality of Life	0
Socio-Economic	7

Indicators were presented from a number of different sources including all levels of government, i.e. Census Canada.

APPENDIX TWO

The interview should take no more than 20 minutes of your time. Your participation in this survey is completely voluntary. You are free to refuse to answer any particular question on the survey. If you have any questions about the information presented, or not included here, please feel free to ask the investigator before they proceed. The interview will be recorded for later review and kept confidential. All data will be reviewed and disposed upon publication of the document. Please take the time to read this carefully and to understand any accompanying information.

INTERVIEW QUESTIONS

STRUCTURE OF LOCAL GOVERNMENT

In order to put each city in context with its surroundings, it is necessary to establish the civic organization and how the SOER fits into this structure. A diagram or chart showing the civic organization of your municipality will be studied prior the interview.

1a) Who initiated the State of the Environment Reporting Program?

____ *Planning department*

____ *Engineering department*

____ *Environmental Advisory Committee*

____ *Interdepartmental Committee on the Environment*

____ *Water Works & Utilities department*

____ *Public Health Services*

____ *Politicians*

____ *Public*

____ *Other*________________________________

1b) Who takes responsibility for undertaking the State of the Environment Reporting Process and who is accountable?
(i.e. The Office for the Environment is in charge of the City of Calgary SOER and they report to Engineering, who reports to the commissioner, who reports to Council.)

1c) Which departments contributed to the report and what was their level of responsibility?

____*Planning department*______________*% of responsibility*

____*Engineering department*___________*% of responsibility*

____*Environmental Advisory Committee*___*% of responsibility*

____*Interdepartmental Committee on the Environment*

______*% of responsibility*

____*Water Works & Utilities department*____*% of responsibility*

____*Public Health Services*_______*% of responsibility*

____ *Other*____________________*% of responsibility*

1d) Who collected and compiled the data?

____*Planning department*

____*Engineering department*

____*Environmental Advisory Committee*

____*Interdepartmental Committee on the Environment*

____*Water Works & Utilities department*

____*Public Health Services*

____ *Other*____________________

SCOPE OF THE PROJECT

2a) What factors contributed in determining the scope of the project?

____*Target Audience*

____ *Funds*

____ *Data Availability*

____ *Vision*

2b) What type of report or combination of reports would you consider your City SOER?

____ ***A Data Report*** *in which available data is collected and compiled for each environmental sector and interpretation is limited.*

____ ***An Index Report*** *in which indicators are presented as a series of indicators evaluating environmental conditions.*

____ ***An Overview Report*** *which provides a presentation of key data and a summary statement on the conditions of the major components of the environment. It provides a limited interpretation of quantitative and qualitative data.*

____ ***A Planning Report*** *orientated towards management recommendations and actions.*

____ *Other* ______________________________

2c). How long did it take to develop an approach, complete the terms of reference and the first draft of the SOER?

____ *less than 6 months*

____ *between 6 and 12 months*

____ *between 12 and 18 months*

____ *Other* ________________

2d) How many people were involved in developing an approach, completing the terms of reference and the first draft of the SOER?

____ *1-2 person, 100% of time*

____ *3-4 persons, 100% of time*

____ *4-6 persons, 100% of time*

____ *Other* ________________

2e). How long did the approval process take for the final report?

____*less than 6 months*

____ *between 6 and 12 months*

____ *between 12 and 18 months*

____ *Other* ____________________

INDICATORS

In my analysis, I have extracted all indicators presented in the final report. However, there may be a number of indicators which are not presented in the final report but were used in the State of the Environment Reporting process. The following questions pertain to all indicators which were considered in the SOE reporting process.

3a) Please rank the criteria used to determine the indicators between 1 - 5?
1 = being the most important
5 = being the least important

____*Consistent with identified environmental objectives*

____ *Represent the issue of concern*

____ *Relevant to target audience information requirements*

____ *Sensitivity to change*

____ *Measurable*

____ *Unambiguous*

____ *Accessible and available in a consistent format over time*

____ *Scientifically valid, credible and verifiable*

____ *Responsiveness, Understandable, Accurate*

____ *Cost effective*

____ *Comparable with indicators used in other jurisdictions*

____ *Attractive to the Media*

____ *Able to provide an early warning of potential changes*

____ *Other* ____________________

3b) Of the criteria ranked above, which is the:

*Most important*____________________________

*Second most important*______________________

*Third most important*________________________

3c) Are the indicators categorized?

____ *Pressure (Human intervention)*

____ *State (Natural State of the Environment)*

____ *Response (to Pressure and State activities)*

____ *Human Activities*

____ *Environmental Assets*

____ *Environmental Quality*

____ *Human Health*

____ *Quality of Life*

____ *Other* ____________________

3c) How many indicators were examined and used in the final report?

3d) Which indicators have been most useful?

3e) Of the indicators listed above, which have been:

Most useful ____________________________

*Second most useful*______________________

Third most useful _______________________

PUBLIC INVOLVEMENT

4a) What was the means of public involvement?

_____ *Citizen Advisory Committee,*

_____ *Task Force,*

_____ *Round Table,*

_____ *Open Houses*

_____ *Experts*

_____ *Other*____________________________

4b) At what point in the process was the public involved:

_____ *From the beginning*

_____ *After the first draft was completed*

_____ *Other*____________________________

4c) How often was the public involved?

4d) Was the general public considered a driving force? Primary target audience? Involved in a monitoring and future action plan?

BARRIERS TO STATE OF THE ENVIRONMENT REPORTING

What are some of the barriers in the development of the SOER program?
(i.e. lack of common indicators, lack of consistency in reporting, purpose and scope of report, budget, indicator selection)

APPENDIX THREE

RESPONDENTS TO QUESTIONNAIRE

Hercz, Ms. Anna.

Discussions with Ms. Hercz took place between March 1997 and April 1997. Ms. Hercz is the Senior Policy Analyst, Environmental Management Branch, Department of Engineering and Works, City of Ottawa, phone: (613) 244-5300 ext:3824.

Luksun, Mr. Basil.

Discussions with Mr. Luksun took place between March 1997 and April 1997. Mr. Luksun is the Senior Environmental Planner, Long Range Planning, City of Burnaby, phone: (604) 294-7420.

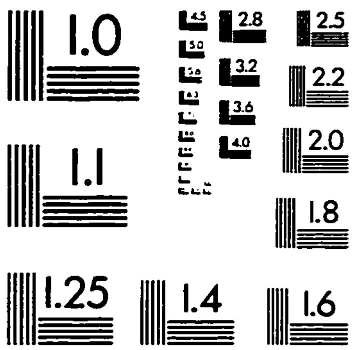
Schommer, Mr. Joe.

Discussions with Mr. Schommer took place between March 1997 and April 1997. Mr. Schommer is a Senior Planner with the Planning Department, City of Regina, phone:(306) 787-5847.

Zsomber, Mr. Ed.

Discussions with Mr. Zsomber took place in March 1997. Mr. Zsomber is the former Senior Director, Environment & Infrastructure, City Managers Office, City of Regina and is currently with Saskatoon Transportation, phone (306) 787-5847.

IMAGE EVALUATION
TEST TARGET (QA-3)



150mm

6"

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989

Putting Manitoba Peatlands on the Map

Informal Progress Report on Manitoba Climate Change Action Fund Project MCCAF 05-010, "Eastside Boreal Peatlands Carbon Monitoring"

Sampling Peatlands on the East Side of Lake Winnipeg, Poplar River First Nation Traditional Lands July 2007

In fact, Manitoba peatlands have already been mapped. Figure 1 shows the percentage of land covered by bogs and fens in Saskatchewan, Manitoba, and western Ontario. Areas north and east of Lake Winnipeg have some of the highest coverages. Figure 2 shows that the thickness of the peat deposits in Manitoba is as great as or greater than in Alberta and Saskatchewan. Figure 3 shows that Manitoba has the largest carbon storage of the three Prairie provinces.

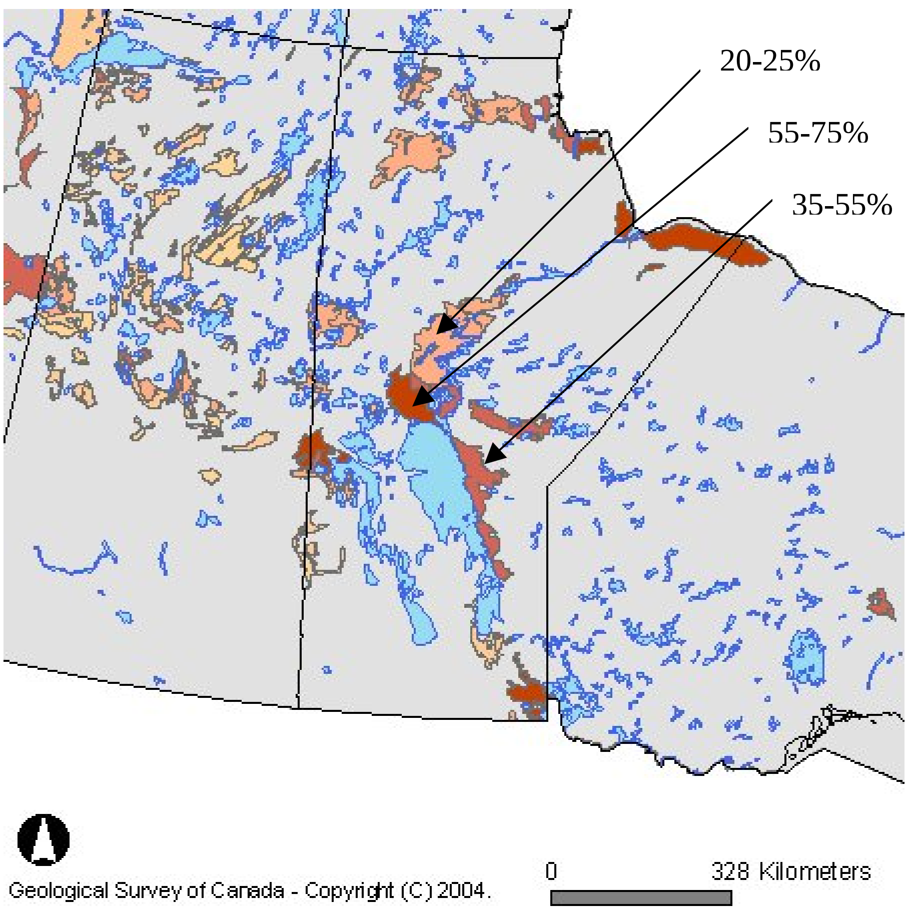


Fig. 1. Extent of land covered by bogs and fens where the orange indicates 20-25%, medium brown, 35-55%, and dark brown, 55-75%. From Natural Resources Canada Canadian Peatland Database (1).

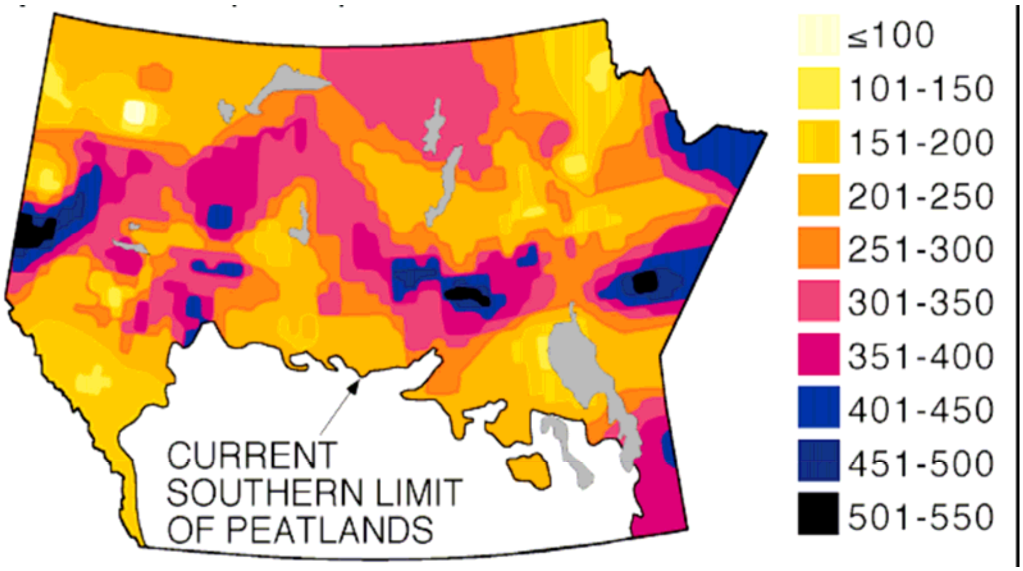


Fig. 2. Contoured maximum depth for peatlands on Alberta, Saskatchewan, and Manitoba. Values are in cm. From Vitt et al., 2000 (2).

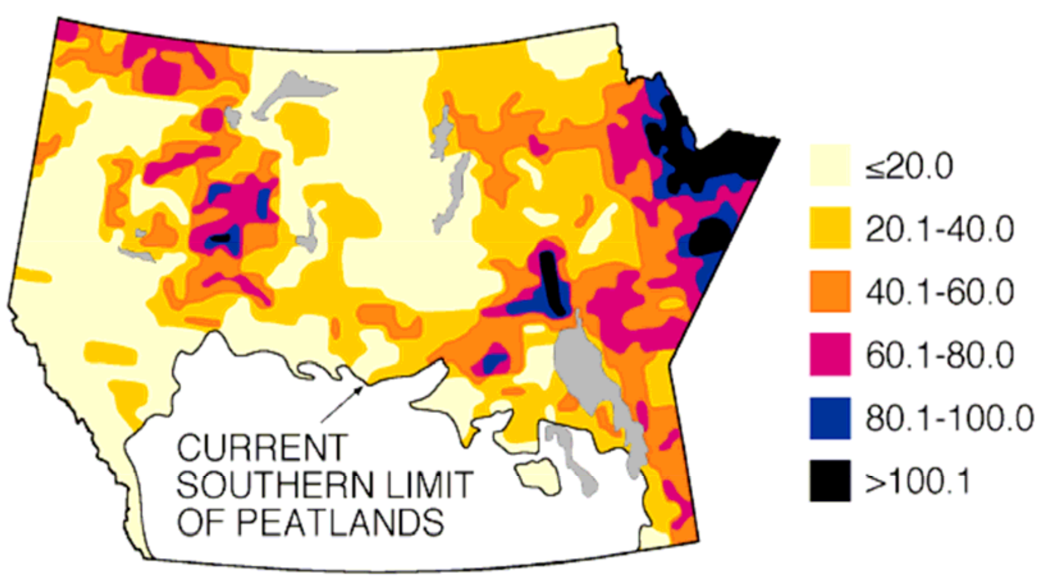


Fig. 3. Contoured current carbon storage in the surface and below-ground component of peatlands of Alberta, Saskatchewan, and Manitoba. Values are in kg/m^2. From Vitt et al., 2000 (2).

Peatlands as a Global Carbon Store

Over long periods of time, great amounts of carbon have accumulated in peatlands where biomass production has exceeded the rate of decomposition. The waterlogged conditions in bogs and fens result in lack of oxygen required for decomposition.

Peatlands cover an estimated 3% of the earth's land surface and occur world-wide, but primarily in Canada, Siberia, Europe, and the U.S. Peatlands represent a major store of the world's land-based carbon (3), exceeding the organic stores of any other terrestrial biome on Earth. They contain at least 20% of the world's soil carbon (4), an amount roughly equivalent to half of the total amount of C in the atmosphere (5). Peatlands occupy more than 4 million km^2 worldwide and store more than 550 billion tonnes of carbon (6). Thus, their fate on the globe can have tremendous impact on concentrations of greenhouse gases (GHG) in the atmosphere and oceans.

Peatlands are dominant features of the Canadian landscape, covering approximately 1.136 million km^2, or 12% of the land area. Ninety-seven per cent of the peatlands occur in the Boreal Wetland Region (64%) and Subarctic Wetland Region (33%). Associated with the large area they cover and their high organic carbon content, these peatlands contain approximately 147 billion tonnes of soil carbon, that is about 56% of the organic carbon stored in all Canadian soils (7). Unlike peat in some other parts of the world, such as Europe and Britain, peatlands in Canada are largely intact. They have not been harvested for fuel over past centuries as in Europe (see box below), and are at risk today from climate change.

Peat is a Traditional Fuel

In Europe, exploitation of peat as a fuel for domestic use began at least 1300 years ago. With the decline of native woodlands as a source of fuel, peat became the major fuel in countries such as Ireland during the 17th and 18th centuries (8). Traditionally, peat was cut by hand using a special turf-spade known as a sleán/slane. The production of hand-cut turf in Ireland reached its peak in 1926 when over six million tonnes of turf was cut. Most exploited was the deep peat in raised bogs and the extensive areas of blanket bogs.

Peat briquettes

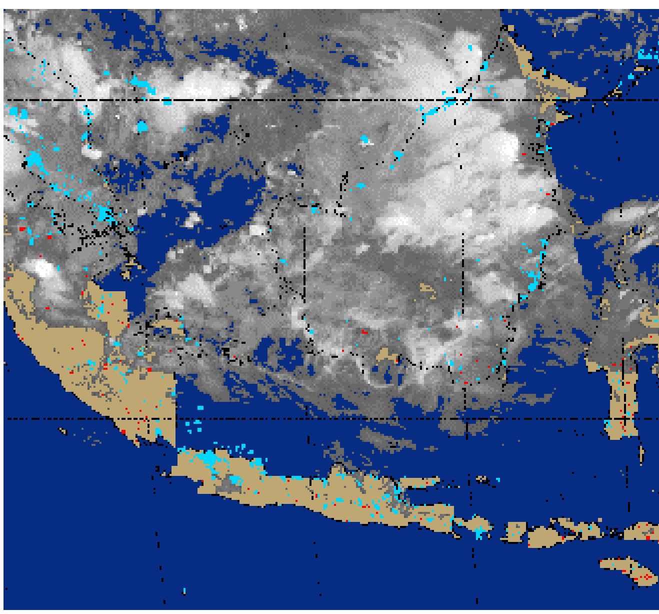
Potential Impacts of Climate Change on Canada's Peatlands

Calculations show that approximately 60% of the total area of Canadian peatlands and 51% of the organic carbon mass in all Canadian peatlands is expected to be severely to extremely severely affected by climate change (7). Northern peatlands are already responding to global warming. In Siberia, an area of frozen peat bog one million km^2 in area, the size of France and Germany combined, is melting and turning into shallow lakes (16). This is beginning to release some of the 70 billion tonnes of methane stored in the permafrost. Methane as a GHG is 23 times as potent as carbon dioxide. This melting phenomenon is also being observed on the North Slope of Alaska.

As peat warms and dries especially in the middle latitudes, there is increasing risk of wildfire. Drier peat deposits will burn longer. Smouldering fires could become virtually inextinguishable. Peatlands then become a dangerous source of emission of carbon dioxide. The most immediate hazard for local populations is the impact on regional air quality (see box below).

Fire in Peatlands is a Regional Problem

This was demonstrated clearly in 1997 in southeast Asia where peat fires, accidentally started by human activity for land clearing, burned out of control for months. This affected visibility and human health over an area of 3 million km^2 (17). The haze spread as far as the Philippines to the north, Sri Lanka to the west, and northern Australia to the south.



From (18)

From (20)

By mid-1998 the estimate of the area that had burned climbed beyond 5 million ha (12.4 million acres). The total cost is estimated at US$ 9 billion in health care and disruption of air travel and business. The crash of an Airbus a-300 plane killing all 234 people on board was attributed to the haze. In the region, coffee production declined 40 percent, while palm-oil harvests were down 30 percent after fires burned plantations and interfered with transportation. Tourism in Malaysia was seriously impacted by the haze and the government issued a ban on all media coverage of the fires (18). The 1997-1998 fires are estimated to have released between 0.81 and 2.57 billion tonnes of carbon to the atmosphere (19).

A Canadian example of the difficulty of managing even small peat fires happened in 2005 with the burning of Burns Bog (see box below).

The Lesson of Burning Burns Bog

The largest domed peat bog in North America, 4,000-ha Burns Bog in the Vancouver Lower Mainland, caught fire from an unknown cause on 11 September 2005. Despite quick and intensive response by firefighters, water bombers, and the raising of the water level in the bog, the fire was not extinguished for about 10 days. Forty firefighters were dedicated to combating the forest, and particularly, the underground peat fire. The fire grew from 20 ha in size on the first day to eventually cover over 2 sq km (200 ha) three days later.

There is a normal level of fire in peatlands and Burns Bog has burned on at least three previous occasions in the last 100 years.

The lessons are the difficulty of combating a small peat fire, despite the availability of virtually unlimited firefighting capacity, and the strong impact of this relatively small fire on air quality in the region.

Smoke from the fire extended as far south as Bellingham, Washington State, U.S., and west to central Vancouver Island across Georgia Strait. A health advisory was issued in the lower mainland for people with breathing problems and a recommendation to reduce outdoor exercising and physical activities. The smoke plume from the fire is seen below (21).

Not only carbon dioxide is emitted as peat burns, but also mercury. Recently, it is reported that peat soils underlying the northern boreal forest contain more mercury than previously thought. It is, therefore, estimated that wildfire activity in peatlands will release 15 times more mercury than had previously been expected (22).

Monitoring of Peatlands for Impacts of Climate Change

Because of their large carbon content and northern location, Canada's peatlands are vulnerable to climate change (7). Natural Resources Canada has developed a Canadian Peatland Database (9) that will provide baseline data for monitoring the effects of climate change on peatlands and its impact on the Canadian environment. Research in Canada over a number of decades provides considerable understanding of the distribution of peatlands, their geological history, biology, hydrology, and functioning, including gas exchange dynamics. Nevertheless, there is presently no widespread, geographically-representative monitoring of the response of peatlands to climate change in Canada.

Partnership to Initiate Monitoring on the East Side of Lake Winnipeg

To begin to address this gap in peatland monitoring, a unique partnership among a Manitoba First Nation community, a Manitoba environmental organization, a small private company, and a scientist from the Ontario government (Ontario Ministry of Natural Resources), with support from the Manitoba and Ontario governments, (see box below) is beginning to bring scientific attention to peatlands on the east side of Lake Winnipeg.

This project is envisioned as the first component of a larger, multi-year project, the goal of which is the establishment of boreal forest/peatlands research and monitoring sites in the pristine and largely unstudied East Side of Lake Winnipeg for the purposes of:

- applying traditional knowledge in assessing an approach to climate change study
- obtaining data on carbon sequestration, including long-term carbon accumulation rate measurements for northern peatlands, and baseline data for climate change impact monitoring
- exploring biodiversity, above and below ground
- studying fire and other natural disturbances in the boreal zone
- demonstrating innovative field and analytical technologies.

The project collected cores from four representative peatland habitats in the Poplar River Traditional Resource Area in July 2007. These will be analyzed for moisture and carbon content using near-infrared spectroscopy (NIRS).

Near-infrared spectroscopy is one of the innovative technologies to be applied to peat analysis in the context of monitoring. The technology is based on the absorption of light in the near-infrared region of the electromagnetic spectrum that has longer wavelength than visible light and shorter wavelengths than infra-red light. It analyzes samples with little sample preparation, rapidly, and cost-effectively. The NIR instrument has to be calibrated to predict each constituent in each type of sample. The feasibility of determining moisture, carbon content, and carbonate content in field-moist peat samples from fens near the shores of Lake Superior, Ontario, has been demonstrated (15).

Once calibrated, NIR instruments can be operated in remote locations by trained individuals, allowing peat monitoring to be undertaken in communities near peatlands.

Participants in the Peatland Project

Poplar River First Nation (10)
  Ray Rabliauskas - Lands Manager
  John Charles McDonald – Elder and field guide
  Alex Hudson – field guide
  Waylon Bittern - field guide
  Norway Rabliauskas - guide

Manitoba Wildlands (11)
  Gaile Whelan-Enns
  Kristin Bingeman

PDK Projects, Inc. (12)
  Diane Malley, President
  Phil Williams, Consultant and educator

Forest Research Institute (13)
Ontario Ministry of Natural Resources
  Dr. Jim McLaughlin, Forest Soils Research Scientist
  Sandra Wawryshyn, Soils and Water Project Coordinator

Manitoba Government
Climate and Green Initiatives Branch
Manitoba Energy, Science and Technology (14)
  Manitoba Climate Change Action Fund Project MCCAF 05-010, **"**Eastside Boreal Peatlands Carbon Monitoring" received by Poplar River First Nation

Fig. 4. Left to right: John Charles McDonald, Sandra Wawryshyn, Norway Rabliauskas, Kristin Bingeman, Jim McLaughlin, Waylon Bittern, Alex Hudson

Sampling Peat on the Poplar River Traditional Lands, July 2007

Sampling Gear

Peat was sampled using the Russian Peat Borer, a side-filling core sampler (23). The core tube is about 50 cm long with an inside diameter of 5 cm and a volume of 500 mL. The sampler is operated by manually inserting the bottom point of the sampler into the peat to the desired depth (Fig. 5A). A cover plate covers the open side of the empty semi-circular core tube. When the sampler is at the desired depth, the turning handle is manually turned 180° clockwise allowing the sharpened edge of the core tube to cut longitudinally through the peat, isolating a semicircular core. The sampler is retrieved (Fig. 5B). The core tube is turned counterclockwise (Fig. 5C) allowing the core to be collected, placed in a plastic bag, and labeled.

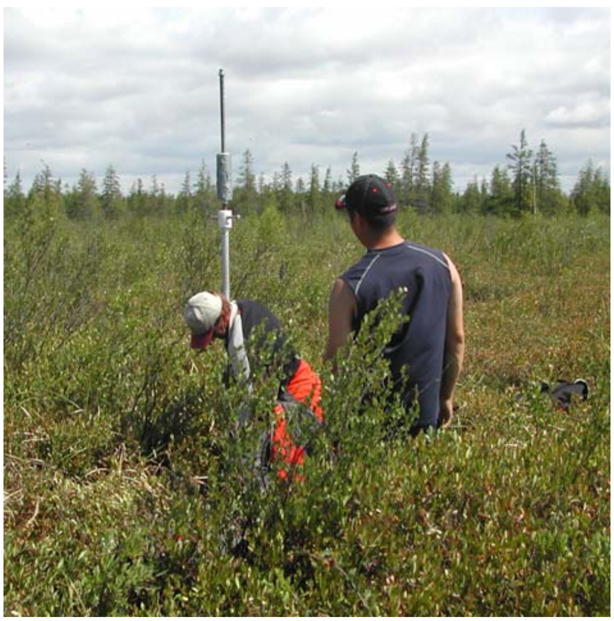


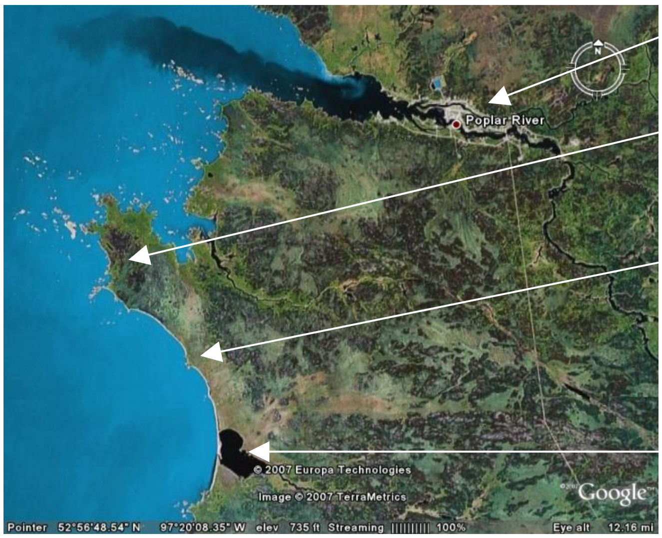
Fig. 5A. The core sampler is inserted into the peat

Fig. 5B. The core sampler is retrieved.

Fig. 5C. Peat core

Site 1

The position of all sites and precise sampling locations within them were recorded as GPS coordinates. Site 1 was reached by boat by traveling on Lake Winnipeg about 15 km from Poplar River, past Poplar Point, to Point A on Fig. 6. Site 1 was close to Point A (Fig. 6), and reached by traversing the beach ridge and a natural canal (Fig. 7) on the land side of the beach ridge. Site 1 ranged from open bog to shrub bog to poor fen with birch and tamarack. Peat was sampled to a depth of 250 cm at this site.



Poplar River Reserve

Poplar Point

Point A

Marchand
Lake

Fig. 6. Satellite photo of Lake Winnipeg from Poplar River to Marchand Lake. From Google Earth

Fig. 7. View towards Site 1 from the land side of beach ridge showing natural canal

Site 2

Site 2 was reached by boat by traveling north from Site 1, rounding Poplar Point and entering the river indicated in Fig. 8. Site 2 was accessed by canoe from a creek. The site was poor to intermediate fen. Representative vegetation is shown in Fig. 9. The deepest peat sampled was at 205 cm. Below this depth at one location the substrate was silt.

Fig. 8. Site 2 was along the river shown by the white arrow. The river is situated between Poplar River and Poplar Point. From Google Earth

Fig. 9. Site 2 vegetation

Site 3

Site 3 was reached by boat by traveling up the Poplar River with a portage around rapids. The site was a spruce forest swath (Fig. 10). Maximum depth of peat sampled was 110 cm.

Fig. 10. Sampling at site 3

Site 4

This site was spruce bog reached by boat from a channel within the Poplar River Reserve. This channel reached the Black River winter road and thereafter travel was on foot. Two locations were inland about 1-2 km along the road (Fig. 11, 12). The maximum depth of peat sampled was 200 cm.

Fig. 11. Winter road to Site 4

Fig. 12. Vegetation at Site 4

Next Steps in the MCCAF Project

A total of 62 cores were collected from the five sampling sites on the Poplar River Traditional Lands in July 2007. The cores were brought to the laboratory and frozen. They will be subdivided into sections of 10 to 20 cm in length. Each section will comprise a sample that will be scanned in an NIR instrument in the field-moist state, dried, ground and scanned again in the dry state. The moisture content of all of the samples will be determined. At least 100 of the samples will be analysed for total organic carbon, and possibly for carbonate. Calibrations will be developed for moisture, organic carbon, and possibly carbonate.

Transfer of knowledge of near-infrared technology for peat analysis to the Poplar River community will be initiated as part of this project.

Acknowledgements

Figure 6 and 8 were obtained from Google Earth version 4.1. Figures 4, 5, 7, and 9 to 12 are the property of Diane Malley.

References

1. Natural Resources Canada. Peatlands of Canada. http://tsdmaps.gsc.nrcan.gc.ca/website/_peatland/peatland_e.htm
2. Vitt, D.H., L.A. Halsey, I.E. Bauer, and C. Campbell. 2000. Spatial and temporal trends in carbon storage of peatlands of continental western Canada through the Holocene. Can. J. Earth Sci. 37: 683-693.
3. Gorham, E. 1991. Northern peatlands: Role in the carbon cycle and probable responses to climatic warming. Ecological Applications 1(2): 182-195.
4. Post, W.M., W.R. Emanuel, P.J. Zinke, and A.G. Stangenberger. 1982. Soil carbon pools and world life zones. Nature 298: 156-159.
5. Houghton, J.T., G.J. Jenkins, and J.J. Ephraums. 1990. Climate Change: The IPCC Scientific Assessment. Cambridge University Press, New York.
6. International Mire Conservation Group. http://www.imcg.net/gpd/gpd_intro.pdf
7. Tarnocai, C. 2006. The effect of climate change on carbon in Canadian peatlands. Global and Planetary Change 53(4): 222-232.
8. Environment and Heritage Service, Belfast, Ireland, http://www.peatlandsni.gov.uk/history/fuel.htm
9. Natural Resources Canada. Geological Survey of Canada. Climate Change. Canadian Peatland Database. http://gsc.nrcan.gc.ca/climate/peatland_e.php
10. Poplar River First Nation, http://www.poplarriverfirstnation.ca/
11. Manitoba Wildlands, http://manitobawildlands.org/
12. PDK Projects, Inc., www.pdkprojects.com, http://www.pdkprojects.com/innovation/wetlands.html
13. Ontario Ministry of Natural Resources, Ontario Forest Research Institute. http://ofri.mnr.gov.on.ca/

14. Government of Manitoba. Climate and Green Initiatives. http://www.gov.mb.ca/est/climate/index.html
15. Malley, D.F., P. Williams, J McLaughlin and T. Atkinson. 2007. Rapid analysis of moisture, organic matter and carbonate in peat cores from Northern Ontario by near-infrared spectroscopy. Proceedings 50th Annual Meeting of the Manitoba Soil Science Society, Winnipeg, 8-9 February, 10 pp.
16. Pearce, F. 2005. Climate warming as Siberia melts. New Scientist 2512:12. 11 August
17. Wikipedia. 1997 Southeast Asian haze. http://en.wikipedia.org/wiki/1997_Southeast_Asian_haze
18. Mongabay.com (undated). The Asian forest fires of 1997-1998. http://rainforests.mongabay.com/08indo_fires.htm
19. Page, S.A., F. Siegert, J.O. Rieley, H-D. V. Boehm, A. Jaya and S. Limin. 2002. The amount of carbon from peat and forest fires in Indonesia during 1997. Letters to Nature. Nature 420, 7 November, p 61-65.
20. Rincon, P. 2005. Asian peat fires add to warming. http://news.bbc.co.uk/2/hi/science/nature/4208564.stm
21. Millage, K. 2005. B.C. bog smoke wafts over county. The Bellingham Herald. Wed. Sept 14.
22. Turetsky, M.R., J. W. Harden, H.R. Friedli, M. Flannigan, N. Payne, J. Crock, and L. Radke. 2006. Wildfires threaten mercury stocks in northern soils. Geophysical Research Letters, Vol. 33. L16403, doi:10.1029/2005GL025595.
23. USEPA, United States Environmental Protection Agency. 1999. Innovative Technology Verification Report, Sediment Sampling Technology, Aquatic Research Instruments Russian Peat Borer. Office of Research and Development. Washington DC. EPA/600/R-01/010, December. xix+114 pp

Prepared by Diane F. Malley
PDK Projects, Inc.
28 September 2007

SKILLS FOR ENVIRONMENTAL COMPLIANCE INSPECTOR SAMPLE

Skills Needed for: Environmental Compliance Inspector:

1) Reading Comprehension -- Understanding written sentences and paragraphs in work related documents.

2) Speaking -- Talking to others to convey information effectively.

3) Science -- Using scientific rules and methods to solve problems.

4) Critical Thinking -- Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

5) Judgment and Decision Making -- Considering the relative costs and benefits of potential actions to choose the most appropriate one.

6) Writing -- Communicating effectively in writing as appropriate for the needs of the audience.

7) Mathematics -- Using mathematics to solve problems.

8) Active Listening -- Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

9) Complex Problem Solving -- Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

10) Systems Analysis -- Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.

11) Systems Evaluation -- Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.

12) Monitoring -- Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

2011

Report of the

Commissioner of the Environment and Sustainable Development

DECEMBER

Chapter 5
A Study of Environmental Monitoring

Office of the Auditor General of Canada

The December 2011 Report of the Commissioner of the Environment and Sustainable Development comprises The Commissioner's Perspective, Main Points—Chapters 1 to 5, an appendix, and six chapters. The main table of contents for the Report is found at the end of this publication.

The Report is available on our website at www.oag-bvg.gc.ca.

For copies of the Report or other Office of the Auditor General publications, contact

Office of the Auditor General of Canada
240 Sparks Street, Stop 1047D
Ottawa, Ontario
K1A 0G6

Telephone: 613-952-0213, ext. 5000, or 1-888-761-5953
Fax: 613-943-5485
Hearing impaired only TTY: 613-954-8042
Email: distribution@oag-bvg.gc.ca

Ce document est également publié en français.

Cat. No. FA1-2/2011-2-5E-PDF
ISBN 978-1-100-19541-4
ISSN 1495-0782

Chapter

5

A Study of Environmental Monitoring

Table of Contents

Main Points 1

Introduction 3

Focus of the study 3

Observations 5

How is information from environmental monitoring used? 5

Monitoring is essential for making well-informed decisions about the environment and how it will affect Canadians 5

The federal government relies on environmental monitoring for crucial management information 6

What environmental monitoring is the federal government doing? 8

Legislation and international agreements require Canada to monitor the environment 9

Current federal monitoring systems track many aspects of the environment 10

What contributes to a successful monitoring system? 13

Successful monitoring systems share similar traits 13

Monitoring systems can present different challenges, depending on their purpose, nature, and size 15

Coordination helps ensure that monitoring objectives are appropriate and the right partners are involved 15

Building in quality at every step will yield sound results 17

Good internal and external reporting provides information that will be useful and used 18

Efficient use of resources helps monitoring systems meet their objectives 19

What questions could parliamentarians ask about environmental monitoring? 22

Conclusion 24

About the Study 26

Appendix

Inventory of federal environmental monitoring systems 28

A Study of Environmental Monitoring

Main Points

What we examined

The federal government collects information about what is going on in the environment to help Canadians make decisions every day. It monitors many different aspects of the environment, including solar flares, weather, air quality, migratory birds, fish, insects that carry human diseases, forests, water quality and quantity, changes in permafrost, and the ecology of national parks.

We conducted this study to develop an inventory of systems the federal government uses in monitoring the state of the environment; to identify the challenges associated with environmental monitoring; and to highlight good environmental monitoring practices. Together these serve as a basis for criteria for future audits of environmental monitoring conducted by the federal government.

We studied the environmental monitoring systems of several federal departments and agencies with responsibilities related to the environment. We interviewed expert officials from those organizations and from other jurisdictions, and reviewed the relevant literature. This included past observations and recommendations by our office; however, we did not follow up to determine what progress had been made.

This document is not an audit report. For this reason, our observations should not be seen as an assessment of the federal government's current practices or performance with respect to environmental monitoring. Because this is a study, it is descriptive and does not include recommendations.

Work for this chapter was completed on 31 July 2011.

Why it's important

Environmental monitoring is critical to knowing whether the quality of our environment is getting better or worse. Information gathered through environmental monitoring is important to many different decision makers, inside and outside the federal government. With the results of monitoring, the federal government can make informed decisions about how the environment will affect Canadians and how Canadians are affecting the environment. Outside the federal government, the information is used by many people, such as municipal engineers to design flood control systems or public health experts to design effective policies. Timely and effective responses to environmental emergencies, such as spills, are impossible without adequate information. Farmers, hunters, foresters, and fishers all need to know what is happening to the natural resources they rely on.

The Canadian federal government shares responsibilities for environmental monitoring with businesses, local governments, provincial and territorial governments, and other national governments. Based on a Statistics Canada survey of federal science activities, we estimate that the federal government spends more than $500 million each year on different environmental monitoring activities and assigns more than 2,500 people to these activities.

What we found

- Environmental monitoring generates the critical information that is essential for the federal government to provide sound stewardship of the environment. The government uses the information to assess the current state of the environment, to predict the future environment, and to develop sound strategies for adapting to environmental change. For example, daily weather forecasts rely on a complex set of linked environmental monitoring systems.
- Environmental monitoring systems are most successful when they are well coordinated with other systems, when the right partners participate, when quality is built in from the beginning, when reports are designed to be useful, and when resources are used efficiently. For example, some monitoring systems rely heavily on expensive tools and equipment, such as satellites or scientific research vessels, that need to be managed carefully with respect to their long-term benefits and costs.
- Well-managed environmental monitoring systems can provide a basis for Parliament to hold departments and agencies accountable for their environmental stewardship.

Introduction

RADARSAT2 satellite supplies information about ground conditions to several different monitoring systems.

Photo: Canadian Space Agency

5.1 Canadians benefit daily from environmental monitoring in all aspects of their lives. Canadian families rely on weather forecasts to find out whether to bring sunscreen to the beach or brace for a winter storm. Insurance companies have to make provisions for potential claims resulting from flooding on the Prairies, in Quebec, or elsewhere in the country. Arctic communities want to know whether the food they hunt has high levels of toxic chemicals, such as mercury. And fishers on all three coasts depend on the federal government for decisions about how many fish can be caught.

5.2 Statistical agencies and other organizations collect and analyze a vast array of information about the state of the Canadian economy, such as how many people are employed, what is being exported or imported, and how quickly the economy is growing. This information is supplied to individuals, businesses, investment analysts, and governmental finance departments, among others. Similarly, an **environmental monitoring system** collects information about the environment and distributes it to people who need the information to make decisions. Environmental information is obtained using a vast spectrum of approaches, ranging from radar satellites that peer through clouds, to sophisticated chemical analyzers that measure air quality, to foresters counting the number of trees of certain species and sizes at a given location.

Environmental monitoring system—A system that combines the processes of obtaining, assembling, synthesizing, and reporting repeated and systematic measurements or observations of environmental characteristics.

5.3 The Government of Canada shares responsibilities for environmental monitoring with businesses, local governments, provincial and territorial governments, and other national governments. Based on a Statistics Canada survey of federal science activities, we estimated that every year, the federal government spends more than $500 million on environmental monitoring activities and assigns more than 2,500 people to these activities.

Environment Canada laboratory technicians process water samples to assess water quality.

Photo: Environment Canada

Focus of the study

5.4 Because environmental monitoring plays a central role in the everyday lives of Canadians and the way Canada's resources are managed, we decided to provide Parliament with a description of these monitoring activities. Our specific objectives for this study were to document the key challenges associated with environmental monitoring, to describe the active Canadian federal monitoring systems, and to highlight good monitoring practices in other jurisdictions. In addition, this study serves as a basis for future audits of monitoring systems and for questions that members of Parliament might wish to ask about such systems.

5.5 We looked at the monitoring activities of the 11 main federal departments and agencies that have environmental monitoring responsibilities:

- Aboriginal Affairs and Northern Development Canada
- Agriculture and Agri-Food Canada
- Canadian Food Inspection Agency
- Canadian Space Agency
- Environment Canada
- Fisheries and Oceans Canada
- Health Canada
- Natural Resources Canada
- Parks Canada
- Public Health Agency of Canada
- Statistics Canada

Based on this examination, we prepared an inventory of national monitoring systems that assess the state of the environment. More details are given in the Appendix.

5.6 This document is not an audit report. For this reason our observations should not be seen as an assessment of the federal government's current practices or performance with respect to environmental monitoring. Because this is a study, it is descriptive and does not include recommendations.

5.7 At the same time as this study, we conducted an audit of how environmental scientific activities are managed at Environment Canada and how these activities support decision making (Chapter 2 of this report, Environmental Science). Scientific research complements monitoring as another source of information, providing a foundation for good environmental management.

5.8 More details about the study objectives, scope, and approach are in **About the Study** at the end of this chapter.

Observations

How is information from environmental monitoring used?

5.9 Environmental monitoring is critical to understanding whether the quality of our environment is getting better or worse. Information gathered through environmental monitoring is important to many decision makers, outside and inside the federal government.

Monitoring is essential for making well-informed decisions about the environment and how it will affect Canadians

5.10 Outside the federal government, many people and organizations use the results of environmental monitoring to manage the environment and the way Canadians interact with it:

- **Health professionals.** Public health officials are concerned about short-term environmental impacts, such as poor air quality and the need to issue smog advisories. They are also concerned about long-term health effects, such as the presence of toxic substances in the environment and human bodies.
- **Planners.** Municipal engineers responsible for designing flood control systems need to know the maximum height to which water levels could rise. When they set premiums, insurance companies need accurate information about current and future environmental risks. If they lack sound information, they pay a real financial cost.
- **Emergency responders.** When an earthquake or a major industrial accident occurs, it is vital to know without delay exactly where it occurred and how severe it is; armed with accurate and timely information, responders can deliver rapid and targeted assistance. Magnetic disturbances caused by solar flares induce electric currents in long conductors, such as power lines and pipelines, and can lead to power system outages or pipeline corrosion. Monitoring information can help emergency managers predict and respond to such events.
- **Resource managers.** Farmers need to know the short-term weather—for example, to help them decide when to harvest their crops. They also rely on information about long-term climate trends—for example, when deciding how to respond to declining water supplies. Mining companies in the North need to know whether changes in permafrost and the extent of sea ice will affect their access to resources.

- **Industries.** Wind power developers need reliable information about wind patterns and bird migration routes to plan their facilities. Major industries need to monitor their own environmental effects to ensure that they comply with regulations. For example, the National Pollutant Release Inventory requires many businesses in Canada to measure and report how much pollution they release into the environment from their facilities.

The federal government relies on environmental monitoring for crucial management information

5.11 Within the federal government, environmental monitoring generates information that is essential for several core management functions.

5.12 **Designing environmental management programs.** Environmental monitoring describes the starting point against which targets can be set and progress evaluated. One key step in developing an environmental management program is assessing the current state of the environment. For example, in 2010, the federal, provincial, and territorial governments worked together to produce a report on the status and trends in Canada's ecosystems. Exhibit 5.1 summarizes some of the conclusions in that report, entitled *Canadian Biodiversity: Ecosystem Status and Trends 2010*. This report highlights the key areas of concern.

Exhibit 5.1 Canadian governments have assessed the status and trends of Canada's major ecosystems

Forests—Some are healthy and not changing; some are showing signs of stress and are deteriorating.

Grasslands—These ecosystems are impaired and deteriorating.

Wetlands—These ecosystems are showing signs of stress and are deteriorating.

Lakes and rivers—These ecosystems are showing signs of stress and are deteriorating.

Coastal ecosystems—Some are healthy and some are showing signs of stress, but all are deteriorating.

Marine ecosystems—Some marine mammal populations are healthy and are recovering rapidly; other parts of the ecosystems, including commercial fisheries, are impaired and deteriorating rapidly.

Ice ecosystems—These ecosystems are impaired and deteriorating rapidly.

Source: Summarized from *Canadian Biodiversity: Ecosystem Status and Trends 2010*

5.13 A second key step in designing programs is deciding which actions to pursue. Environmental monitoring results provide a basis for designing models that can be used to predict the future consequences of management actions. The predictions could be of the weather tomorrow, the climate in 40 years, or the amount of fish that can be harvested sustainably given population projections. Monitoring results are also used to check and improve the model predictions over time. These kinds of predictive tools can then be used to compare alternative management actions.

5.14 **Allocating resources efficiently.** Knowing where the problems are makes it possible to target management action efficiently. For example, moose population monitoring done by Parks Canada identified areas of high population density and forest damage, and helped direct corrective action.

5.15 **Assessing the environmental effects of past and present projects.** When projects are assessed under the *Canadian Environmental Assessment Act* for their possible environmental effects, follow-up programs may be required to determine whether the observed effects are consistent with the predictions and whether actions to mitigate the possible effects are working as planned. Such monitoring programs are put in place for about 5 percent of environmental assessments. The environmental effects are typically restricted to a single location; however, when the effects of more than one project are combined, as in the case of the oil sands region of northern Alberta, project planners may need to consider the cumulative effects of the different projects (Chapter 2 of the 2011 October Report of the Commissioner of the Environment and Sustainable Development, Assessing Cumulative Environmental Effects of Oil Sands Projects). In the case of contaminated sites related to completed or abandoned projects, such as mines, continuing attention may be required if pollutants are being released into the environment.

5.16 **Evaluating compliance with environmental regulations.** Environmental monitoring produces the information to evaluate performance in relation to regulations. For example, ground-level ozone—a component of smog—increased from 1980 to 2009 in southern Ontario. By comparing smog levels with regulatory limits, authorities can make decisions about how they should respond to protect public health and environmental quality. Compliance monitoring is based on specific regulations and a situation in which non-compliance may result in enforcement action. (Chapter 3 in this report, Enforcing the *Canadian Environmental Protection Act, 1999,* presents the results of an audit of how Environment Canada enforces the Act.) Industry and the federal government may share the responsibilities for compliance monitoring. Statistics Canada has estimated that Canadian industries spent $329 million on environmental monitoring in 2008, out of a total of about $9.1 billion that they spent on all aspects of environmental protection.

5.17 Monitoring also provides a way of determining whether regulations and enforcement actions are working as expected. If the regulations are being followed but the state of the environment is not improving as planned, changes may be needed to the regulatory approach.

5.18 **Promptly identifying problems.** Environmental monitoring may also produce information about emergencies that require an immediate response, as well as processes that take longer to unfold. For example, federal managers may need to act very quickly in response to a disease in wildlife that threatens domestic animals or that potentially affects the food supply for Canadians. Long-term changes in glaciers in the Rocky Mountains with the related consequences for irrigation supplies will demand a different approach.

5.19 **Complementing scientific research.** Environmental monitoring is closely tied to scientific research. Research can identify and describe the cause-effect relationships that underlie monitoring programs. For example, when managers of a monitoring program choose particular types of water pollutants for measurement, the decision is based on the research documenting the effects of those pollutants on aquatic plants and animals. Researchers can also help design the equipment and methods that allow monitoring programs to ask new questions or obtain more accurate results. In turn, unexpected results from monitoring can trigger new research.

What environmental monitoring is the federal government doing?

5.20 Canada's environment is affected by many influences whose origins are beyond our borders. For example, the far-reaching effects of hurricanes that start in the middle of the Atlantic Ocean demonstrate that Canada's weather is part of a global system. The migratory ducks shot by hunters on the Prairies may have crossed several national borders before reaching their destinations in Canada. And the toxic substances that accumulate in Canada's Arctic come from all over the planet.

5.21 The federal government is directly involved in environmental monitoring for several reasons:

- the need to negotiate with other countries and jointly manage the global environment;
- the need for coordination and consistency within Canada;
- the constitutional division of powers; and
- the federal government's exclusive responsibilities in certain areas, such as oceans and federal lands. Among the lands controlled by the federal government are national parks and national park reserves, which cover 30.3 million hectares (about 3 percent of Canada's land area).

Legislation and international agreements require Canada to monitor the environment

5.22 Several federal laws require environmental monitoring, either directly or indirectly. One example is the *Canadian Environmental Protection Act*, which requires the Minister of the Environment to monitor the state of the environment and to report on the results periodically. The approach to meeting this requirement has evolved (Exhibit 5.2). As a second example, the *Canada National Parks Act* requires Parks Canada to report every two years on the ecological integrity of all 42 national parks. The ecological integrity monitoring programs of Parks Canada are designed to support this requirement as well as its legal obligation to perform management planning. In all, over 13 federal laws entail direct or indirect requirements to monitor the environment. In addition, some land claim agreements have required monitoring programs.

5.23 Agreements with other countries may also lead to monitoring requirements for the federal government. For example, the Great Lakes Water Quality Agreement with the United States includes a requirement for a "coordinated surveillance and monitoring program in the Great Lakes System." The program is intended to

- assess compliance with pollution control requirements,
- track progress on the agreement's objectives,
- provide information for determining how the Great Lakes have responded to control measures, and
- identify emerging problems.

Exhibit 5.2 Reporting on the state of the environment has evolved since 1986

Canada has a long tradition of reporting on the state of the environment, based on its monitoring programs. The first comprehensive national report was prepared as a joint effort between Environment Canada and Statistics Canada in 1986. It covered a wide range of topics, from forest ecosystems to contaminants in the environment. Larger and more detailed reports were prepared in 1991 and 1996. Environment Canada then shifted to a different approach using a mix of publications and resources.

In 2004, Environment Canada began working with Health Canada and Statistics Canada on a new set of indicators: the Canadian Environmental Sustainability Indicators. Annual reports were prepared from 2005 to 2008, giving details on air quality, water quality, and greenhouse gas emissions. Since then, the set of indicators has been expanded to include measures of air pollutant emissions, water pollution, water levels, protected areas, and risks to the health or survival of wildlife species. There are plans to expand the set further, notably to support the new Federal Sustainable Development Strategy.

In parallel, Statistics Canada has continued to produce its core compilation of environmental statistics and analysis, entitled *Human Activity and the Environment.* The first issue was released in 1978 and the second appeared with the first state of the environment report in 1986. The compilation now appears annually, with the latest issue released in June 2011. This publication combines analysis of the results of environmental monitoring with the socio-economic information Statistics Canada collects through a variety of surveys and other instruments.

The federal government has led other state of the environment reporting efforts that are more narrowly focused—for example, covering the state of the Great Lakes or national parks, agri-environmental indicators, the status of ecosystems, and (since 1992) the relationships between human health and the environment. The government has contributed as well to several international reports, such as those by the Commission for Environmental Cooperation of North America. In addition, several provinces and territories have prepared state of the environment reports and indicators.

5.24 As a member of the World Meteorological Organization, Canada has obligations to collect and share weather, water quantity, and climate information with the global community. Of the almost 100 international environmental agreements Canada has signed, more than 33 create monitoring requirements for the federal government. In some cases, international agreements have led to standards or protocols for conducting monitoring to ensure country-to-country compatibility. For example, standards and protocols have been put in place for measuring acid precipitation, stratospheric ozone, persistent organic pollutants, and water quality.

Current federal monitoring systems track many aspects of the environment

5.25 To give Parliament a clearer picture of the environmental monitoring conducted by the federal government, we have prepared an inventory of federal monitoring systems. During the study, we did not identify any other recent government-wide attempts to summarize Canada's environmental monitoring. Other recent inventories of federal monitoring systems have been limited in scope: they focused on the mandate of a single department (such as Fisheries and Oceans Canada) or a specific region (such as northern Canada). The Appendix presents a summary of our approach and the inventory.

5.26 We identified 94 monitoring systems or clusters of monitoring systems in our inventory. As explained in the Appendix, in some cases we had to combine monitoring systems to avoid a list that would be unwieldy and of limited use to Parliament. The combined systems are listed under the following components of the environment: water, plants and animals, and other (Exhibit 5.3). The monitoring systems for plants and animals outnumber those for other components; this is partly because of the federal government's responsibilities for migratory birds and fisheries, as well as the diversity of species in this component. Note that there are several ways we could have grouped monitoring systems, given the similarities and links between them.

Exhibit 5.3 Levels of monitoring vary depending on the component of the environment

Environmental component	Number of monitoring systems*
Air and atmosphere	20
Water	19
Soil and landforms	3
Contaminants in several components	4
Plants and animals	32
Ecosystem processes	3
Human population	6
Other	7

* In some cases, monitoring systems are clusters of systems.

5.27 Environment Canada has the widest range and largest number of monitoring systems of any department or agency (Exhibit 5.4). This reflects its responsibilities, including for monitoring weather, air and water; managing toxic substances; and tracking bird populations. Fisheries and Oceans Canada monitors fisheries as part of its mandate to manage fisheries resources. Other departments and agencies have different roles. For example, the Canadian Space Agency does not directly manage monitoring systems, but it contributes data in support of many of the systems in the inventory managed by other departments.

Exhibit 5.4 The number of monitoring systems varies across departments and agencies

Department or agency	Number of monitoring systems*
Aboriginal Affairs and Northern Development Canada	2
Agriculture and Agri-Food Canada	5
Canadian Food Inspection Agency	4
Environment Canada	41
Fisheries and Oceans Canada	25
Health Canada	6
Natural Resources Canada	9
Parks Canada	1
Public Health Agency of Canada	6
Statistics Canada	1

* In some cases, monitoring systems are clusters of systems. Where there is no single lead department, we have included all key departments.

5.28 Based on information from departments and agencies, we estimated that 55 percent of the monitoring systems were based directly on federal legislation. Systems without a direct legislative basis may still contribute to meeting departmental mandates. For example, while not directly required by legislation, measuring contaminants in bird eggs has helped to

- set regulatory priorities for toxic substances,
- assess the success of the resultant management actions, and
- meet international agreements.

5.29 The monitoring systems we looked at use a vast range of approaches and methods, depending on what they measure. For example, we asked departments and agencies about the number of monitoring stations in each system. We were told that the system for tracking water flows and levels in Canada's lakes and rivers has approximately 2,117 stations. In contrast, a network of 16 stations measures ultraviolet (UV) radiation; the resulting data is used for calculating the UV index featured in daily weather forecasts across the country.

5.30 The monitoring systems also vary widely in age, with some systems going back many decades. For example, agricultural research stations have collected soil samples for over 100 years; they can now supply answers to questions that had not been posed when the samples were first collected. Some of the more recently introduced monitoring systems represent new technologies, new scientific perspectives, or emerging requirements. For instance, satellite-based monitoring coordinated through the Canadian Space Agency and the Canadian Centre for Remote Sensing (part of Natural Resources Canada) is generating a wealth of information about the Canadian landscape and how it is changing.

5.31 Our past audits of federal monitoring systems found some gaps, such as the more limited coverage of Arctic regions compared to southern Canada. Northern monitoring poses logistical and financial challenges because of the distances and harsh environment. Other assessments have noted that some components of the environment are still poorly understood, and are not monitored regularly or at all; they include insects and some groups of marine species. Monitoring systems in other countries show similar limitations. A recent report by NatureServe Canada, a non-profit conservation organization, commented on the lack of a central repository for information about the geographic range of Canada's plants and animals. Such gaps highlight the trade-offs managers must make between the value of environmental information and the cost and effort required to obtain it.

What contributes to a successful monitoring system?

5.32 One of the goals of this study is to identify the characteristics of a successful and effective monitoring system. To do this, we first describe the key features of a well-managed monitoring system, and then identify the main challenges and how they can be met. We also consider some practices in other jurisdictions that might be applicable to the Canadian federal context.

Successful monitoring systems share similar traits

5.33 Despite the wide range of monitoring systems in use, we observed that well-managed systems share similar features. We reviewed the literature and consulted with departments and agencies. On the basis of what we learned, we were able to identify eight features that, in our view, represent good practices for designing and putting in place a monitoring system (Exhibit 5.5).

5.34 Before implementing a specific monitoring system, we observed that it is critical to have a coordinated and strategic vision of

- what needs to be monitored,
- how the different monitoring systems fit together,

- how the information will be reported, and
- how the monitoring results will be used.

Having a strategic vision means understanding the requirements based on departmental mandates and agreements with other jurisdictions. It includes determining which organizations will be involved and what their responsibilities will be, so that there will be no gaps or overlaps. The vision can also spell out how long monitoring systems should be in place and how they should change depending on the results obtained. It can specify the common methods and standards to be used so that results from different systems can be compared and integrated. For example, the vision could specify the use of a common set of geographic boundaries.

Exhibit 5.5 Well-managed monitoring systems share certain features

Features
1. Design The design addresses the objectives of the monitoring system, what will be monitored, how the data will be used, what indicators will be prepared, and how stakeholders will be involved. The geographic and temporal details have been determined—for example, frequency, timing, location, and density of monitoring stations.
2. Implementation The parties responsible for each aspect of the system have been identified and have received the necessary training. The methods and sampling strategies have been tested and documented. Contingency plans are in place to respond to problems.
3. Data collection Procedures and practices to obtain the data are established and applied. The samples and data records are documented and archived.
4. Quality control The methods are consistently applied, following guidelines and standards. Other quality controls are in place to maintain the integrity of the data sets.
5. Synthesis and analysis of the data The data are converted into summary forms, such as maps or graphs. Indicators are calculated and used to compare results to those for other times and locations, using statistically sound methods.
6. Internal reporting and communication The results are communicated within the organizations responsible for monitoring. The data are available internally with a description of their properties and their limitations.
7. External reporting and communication The results are communicated to external audiences (the public, Parliament, or international bodies, such as the secretariats responsible for international agreements). Specialized users have access to detailed monitoring results.
8. Audit and review of the system Audits or evaluations of the monitoring system are conducted to assess whether it is achieving its objectives, and to identify opportunities for improvements.

5.35 Well-designed monitoring programs can help reduce the costs associated with environmental management by identifying where the real problems are and enabling governments to target resources effectively. For example, the United Kingdom reduced the amount of data it needed to collect through its air quality monitoring network. It recognized that modelling could provide adequate estimates of air quality, even if not all stations were operated or if they did not collect information on all possible air pollutants. Modelling is increasingly recognized as a complement to on-the-ground monitoring.

Monitoring systems can present different challenges, depending on their purpose, nature, and size

5.36 Monitoring systems pose general management challenges in areas such as coordination and governance, coverage, comparability, timeliness, data quality, accessibility, and effective reporting. Our past audit work has documented several instances of deficiencies in these areas. For example, in 2009, we observed that Fisheries and Oceans Canada did not systematically monitor fish habitat.

5.37 Other challenges emerge specifically from features of the Canadian federal context, such as the division of responsibilities within and between federal, provincial, and territorial levels of government. To reduce costs and avoid duplication, governments often jointly establish and operate monitoring systems—for instance, applying principles such as those developed by the **Canadian Council of Ministers of the Environment**. This collaboration requires establishing the appropriate arrangements, both formal and informal. Still other kinds of challenges may depend on the nature of the monitoring system. For example, federal departments have set up some information collection programs that rely on direct observations by Canadian citizens. The programs may reduce costs but increase requirements for quality control.

Canadian Council of Ministers of the Environment—The Canadian Council of Ministers of the Environment is comprised of the environment ministers from the federal, provincial, and territorial governments. These 14 ministers normally meet at least once a year to discuss national environmental priorities and determine work to be carried out under the auspices of the Council.

Coordination helps ensure that monitoring objectives are appropriate and the right partners are involved

5.38 Environmental managers in some countries (such as Sweden, Australia, and Finland) have observed that coordination contributes to effective environmental monitoring and helps provide a more complete picture of the state of the environment. The challenge is finding the best way to integrate environmental monitoring into the systems and practices of environmental management. The key aspects include

- setting environmental objectives,

- clarifying roles and responsibilities, and
- setting a strategic direction.

5.39 **Setting environmental objectives.** Monitoring systems can be more accurately targeted when they are based on national environmental objectives. In Sweden, for example, a set of 16 national objectives has been translated into regional and local objectives. Intermediate targets are now associated with the objectives, and monitoring systems are used for tracking progress toward those targets. Negotiations to achieve these kinds of objectives may be more difficult where different jurisdictions share responsibilities for environmental management, as they do in the United States, Canada, and the European Union.

5.40 **Clarifying roles and responsibilities.** In previous audits of monitoring programs, we identified the need for the federal government to formally coordinate priorities and activities among its departments and among the different levels of government, such as provinces, territories, and local governments. Coordination among different organizations can reduce duplication, identify gaps, and help ensure nationally consistent approaches. The coordination is particularly important because federal departments and agencies rely on other parties to contribute to their monitoring programs in about 93 percent of the systems included in our inventory.

5.41 The federal government also needs to coordinate with the governments of other countries in regions such as the Arctic and the Great Lakes, and in dealing with resources such as the fish stocks that move into and out of Canada’s exclusive economic zone. For meteorological measurements, the World Meteorological Organization is leading the development of a global “network of networks.” Other national and international agencies are promoting a Global Earth Observation System of Systems to improve the tools available for monitoring different aspects of the environment, including monitoring from space.

5.42 Within the federal government, monitoring responsibilities need to align with the different environmental components so that departments can coordinate their efforts rather than work against each other. For example, do water quantity monitoring programs fit best with programs for rainfall monitoring or programs for water quality monitoring? Who monitors the intertidal zone at the boundary between terrestrial and marine ecosystems? Should fisheries biologists focus on monitoring fish populations or the many facets of the

Ecosystem approach—An approach to environmental management that considers all aspects of an ecosystem—air, water, plants, animals, humans and their interactions—when addressing critical environmental issues. This approach also takes into account the social and economic factors relevant to ecosystem health and recovery.

Source: Environment Canada

ecosystem in which those fish live? Both Environment Canada and Fisheries and Oceans Canada have adopted the **ecosystem approach**, which leads to a broader view of environmental management, and which could help answer these kinds of questions.

5.43 **Setting a strategic direction.** When defining strategies, one needs to set priorities. Priority setting involves identifying the most important monitoring systems, determining where additional resources are most needed, and reallocating resources to higher-priority needs. It also involves identifying the data gaps that need to be filled to inform decision makers about the most important environmental risks and trends. An example of priority setting is Australia's National Plan for Environmental Information, put in place in 2010. It is intended to coordinate and set priorities for the way the Australian government as a whole collects, manages, and uses environmental information. The Canadian Environmental Sustainability Indicators initiative is intended to play a similar role in Canada (Exhibit 5.2).

5.44 One of the challenges in setting a strategic direction is deciding how to split monitoring efforts between well-understood current issues and new issues. An example of the latter would be the emerging effects of climate change in the Arctic, a matter that requires coordination between circumpolar countries. Throughout our study, we observed repeatedly the value of long-term and consistent information collection.

Building in quality at every step will yield sound results

5.45 Statistics Canada and other national and international statistical agencies have identified the features of high-quality statistical information (Exhibit 5.6). The same characteristics may be applied to environmental monitoring systems. As Statistics Canada notes, there may be trade-offs between different features. In addition, the resources available will affect how much and what kind of quality can be achieved by the monitoring system.

5.46 When sound statistical methods are used to design monitoring systems and analyze data, the resulting reports will be much more credible, especially in the case of controversial matters. For instance, the monitoring programs for the environmental effects of oil sands mining in northern Alberta are undergoing revision, partly to enhance their statistical credibility.

Exhibit 5.6 Statistics Canada has summarized the characteristics of high-quality information

Relevance
The information sheds light on the issues of most importance to users.

Accuracy
The information correctly describes the phenomena it was designed to measure. Accuracy can be measured by the extent of errors in the estimates.

Timeliness
The information is available as soon as practical after the period to which it refers. More timely information may mean that it is less accurate.

Accessibility
The information is easy to obtain, the public is made aware of it, the format is suitable, and the cost is reasonable.

Ease of interpretation
Supplementary information is available to help in interpreting and using the information appropriately. This additional information normally covers the underlying concepts, variables, and classifications; the methods of data collection and processing; and the accuracy of the statistical information.

Coherence
The information can be combined with other related information collected at other times within a shared analytical framework. The use of standard concepts, classifications, and common methods promotes coherence.

Source: Adapted from Statistics Canada

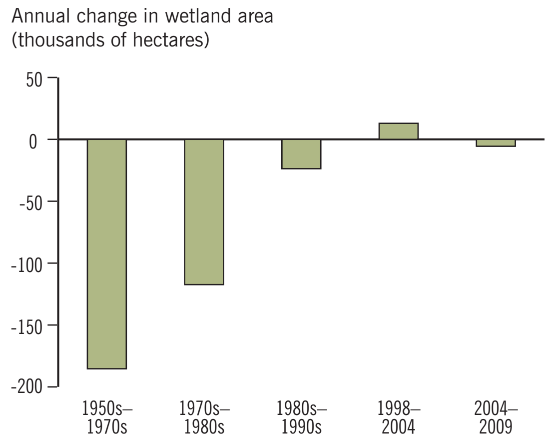
5.47 Managers can use a variety of approaches to build quality into a monitoring system, depending on the kinds of activities required. For example, certification of laboratories or use of International Organization for Standardization (ISO) standards can result in procedures and frameworks that provide quality assurance in specific areas.

5.48 The wetland monitoring program set up by the US Fish and Wildlife Service has produced several rounds of measurements and estimates documenting gradually slowing losses of wetlands (Exhibit 5.7). Professional statisticians and biologists were involved in the design of the program and later as independent reviewers. A similar approach could be used to measure land use changes in other contexts.

Good internal and external reporting provides information that will be useful and used

5.49 One of the key challenges in preparing reports on the results of monitoring systems is making the link back to environmental indicators, if they exist, and from there to national environmental objectives. These links will help internal and external users understand the implications for environmental management and performance.

Exhibit 5.7 A sound statistical design underlies the estimates of wetland trends in the United States



Note: Time frames are approximate.

Source: US Fish and Wildlife Service

5.50 In general, it is a good practice to make the results of monitoring systems widely available, provided that the information is accompanied by documentation to allow the results to be interpreted properly. Sometimes managers may need to limit access to sensitive information. For example, information about the location of endangered plants is sometimes restricted to prevent damage to the plants and their habitat.

5.51 The US Geological Survey has created a tool for communicating water quality and water quantity information to the public. The data from sensors around the country is posted on the Internet within a few hours of being collected. Inside and outside the Geological Survey, users can look at current results or can check earlier data to examine seasonal trends. This means, for example, that users can see how heavy rainstorms affect river levels and sediment in the water. Similar tools may be particularly useful to those responsible for responding to extreme weather events.

Efficient use of resources helps monitoring systems meet their objectives

5.52 **Managing assets.** Some monitoring systems rely heavily on expensive equipment, such as satellites, radar stations, or scientific research vessels. These assets need to be managed with careful attention to their **life-cycle costs**, the risks associated with using the equipment, and the benefits that may ensue. For example, in the transition from one type of research instrument to another, or from one satellite to its replacements, it is important to ensure continuity and comparability in the data collected. Equipment management and

Life-cycle costs—Costs of managing a monitoring system throughout its planning and use. Assessing total life-cycle costs involves taking a broad and long-term view by recognizing all of the costs, as far as practicable, associated with meeting a requirement. Generally, life-cycle costs are divided into four broad categories:

- planning costs, including administrative and other costs;
- acquisition costs, including administrative and design/production costs associated with the goods or services in question;
- operating and use costs, including introduction and contingency costs, and prediction of useful life; and
- disposal costs.

Source: Public Works and Government Services Canada maintenance is also a concern with new and complex technologies such as DNA-based sampling programs, real-time monitors, and remote autonomous vehicles for underwater measurements.

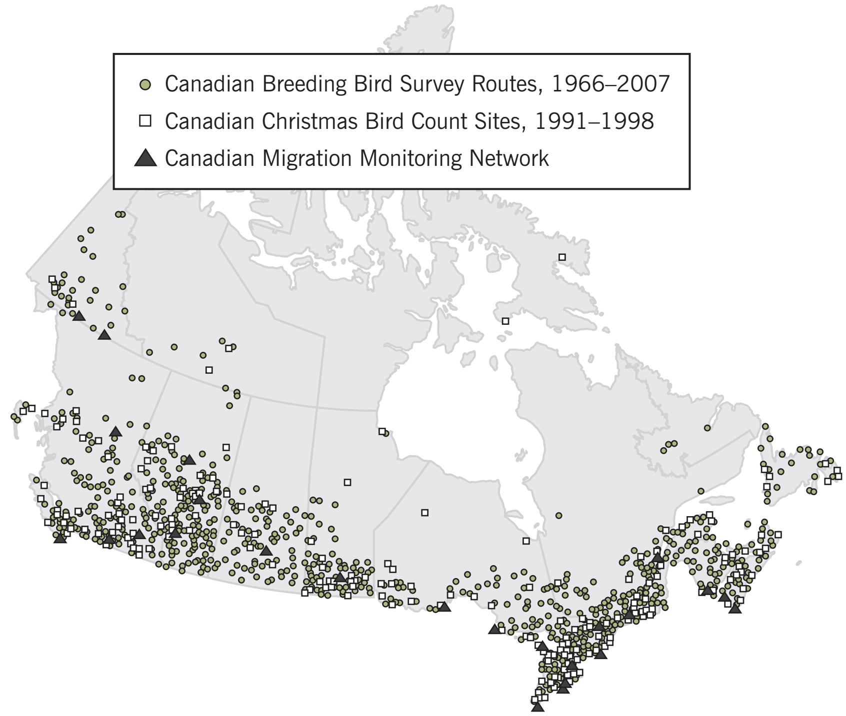
5.53 The main asset for many monitoring systems is the accumulated data and samples. Managing these kinds of information assets poses similar challenges as managing physical assets. In addition, proper documentation and archiving are necessary so that information can continue to be accessed and used for examining long-term trends. These procedures are especially important with the vast quantities of data flowing from automated data sensors, such as satellites. In the case of biological samples, specialized taxonomic expertise may be required to maintain the material and make accurate comparisons with new samples. Sometimes formal arrangements may be needed to address issues of ownership and control of the data.

5.54 **Managing human resources.** The people involved in environmental monitoring may be highly specialized experts or local volunteers. For example, to measure biodiversity along the Nova Scotia coast, volunteers collected samples from the coastal area as part of the Natural Geography In Shore Areas program, part of the international Census of Marine Life.

5.55 What is the best mix of people to deliver a monitoring program and what training should they receive? Sweden, the United Kingdom, and other countries are using citizen volunteers to monitor features of the environment, such as water quality or animal populations. Experts train the volunteers, guide them during the sampling, and perform quality control of the results. The European Environment Agency has put in place Eye On Earth, a system that combines continuous automated reports on air quality across Europe with the qualitative ratings provided by citizens near the monitoring stations. The model of combined systems, with citizens directly involved in monitoring, could be applied to similar situations in Canada.

5.56 A challenge common to Canada, Australia, and the United States is the uneven geographic distribution of the human population. The distribution affects monitoring programs that rely on human observers—for instance, programs that use volunteer birders to record the trends in population size of bird species (Exhibit 5.8). To compensate for the uneven sampling effort, the programs may have to bear the expense of using professional biologists and arranging transportation and supplies for them.

Exhibit 5.8 Observations of bird populations are concentrated in southern Canada



Note: The Christmas Bird Count is not funded or managed by Environment Canada, but is included because it complements the other observation networks.

Source: Canadian Wildlife Service, Environment Canada

Traditional ecological knowledge—A cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living things (including humans) with one another and their environment. It includes the knowledge of elders, current land users, and other community members. Traditional knowledge is an attribute of societies with historical continuity in resource use practices.

Source: Aboriginal Affairs and Northern Development Canada

5.57 Some managers have used **traditional ecological knowledge** to complement scientific monitoring. This may offer opportunities to expand the capacity and legitimacy of the monitoring system. Nevertheless, it is important to ensure internal consistency, repeatability, and independence. Traditional knowledge has been used, for example, in the Northwest Territories to track the cumulative effects of development projects there.

5.58 **Managing financial resources.** The federal government allocates substantial resources to collect information about the environment and to supply it to Canadians (paragraph 5.3). Monitoring programs require continuity of funding to be able to supply reliable and consistent data, and support detection of long-term trends. The government is only one of the sources of funding for monitoring activities. Examples of other sources include:

- Canada receives money from the United States to monitor migratory birds.
- Cost-sharing agreements with the provinces fund the water quantity monitoring program.

- The fishing industry provides financial support for some of the marine environment monitoring conducted by Fisheries and Oceans Canada.

With external funding, it is particularly important to ensure continuity, control the coordination costs, and ensure independence of the results.

5.59 One way of reducing costs has been to piggyback some monitoring programs on others, taking advantage of samples that are already being collected. Fisheries and Oceans Canada has used this approach for the wide range of sampling programs being run simultaneously during scientific cruises. Environment Canada has used the same approach for tracking toxic substances under the Chemicals Management Plan. Internationally, cooperation between space agencies has helped reduce total costs.

5.60 **Using reviews, evaluations, and audits.** Analytical reviews, evaluations, and audits can help promote the efficient use of resources by comparing the intended purposes of monitoring systems with what is actually being achieved in the context of environmental management programs. For example, Environment Canada is reviewing all of its bird monitoring systems to identify needed modifications. In the United States, the Government Accountability Office audited a national set of ecological indicators. It assessed whether changes to US federal monitoring systems might affect the ability of those systems to provide the data necessary to support the indicators.

5.61 The challenges and solutions we have discussed are interrelated and cannot be treated in isolation. For instance, a statistically sound design for a monitoring system can improve the quality of the information obtained, while reducing the costs to obtain information of that quality. A sound design may also make a clearer link to environmental objectives and produce more credible final reports.

What questions could parliamentarians ask about environmental monitoring?

5.62 Parliament has a crucial role in ensuring that the environment is properly managed in Canada: it passes legislation that sets the basic ground rules for the federal government, and it oversees the government's activities. This study provides information to help members of Parliament understand the core issues related to environmental monitoring and carry out their responsibilities. Several pieces of legislation, such as the *Species at Risk Act*, assume that timely and reliable monitoring data is available to make decisions. If the data is unavailable, it may not be possible to implement the law properly. Based on the analysis in this study, we have identified several questions that members of Parliament may wish to ask when holding departments and agencies to account for their stewardship of the environment.

5.63 In terms of their legislative responsibilities, members of Parliament may wish to ask the following questions:

- What monitoring is required to report on the state of Canada's environment? Is that monitoring in place?
- What monitoring is required to determine whether environmental legislation is working as intended? Is that monitoring in place?
- What specific steps have been taken to avoid duplication or gaps when working with the provinces and territories?
- What environmental components or geographic regions are not being monitored now? What are the consequences of these gaps?

5.64 It could be particularly useful for members of Parliament to have a realistic understanding of the challenges associated with environmental monitoring systems as they consider information about federal monitoring systems and the results of audits and evaluations. In terms of their oversight responsibilities, parliamentarians may wish to ask the following questions in relation to particular monitoring systems:

- How does this monitoring system fit into the set of monitoring systems in place?
- What are the priorities for environmental monitoring? How were they established?
- Who is using the information collected by this monitoring system? How does the federal government know the information is being used for its intended purpose?
- How does the federal government ensure that reports are timely and accurate?
- Who is funding the monitoring system? What steps have been taken to ensure continuity of funding, accountability, and independence?
- Did the Office of the Auditor General of Canada or departmental internal audit groups conduct audits and evaluations of this monitoring system? Have the problems identified in their reports been successfully addressed?

Conclusion

5.65 In this study, we have summarized the main ways in which environmental monitoring systems are used, described the active Canadian federal monitoring systems, documented the key challenges associated with environmental monitoring, and highlighted good practices for monitoring in other jurisdictions.

5.66 Outside the federal government, many people and organizations use environmental monitoring results to manage the environment and the ways Canadians interact with it. They include health professionals, planners, emergency responders, resource managers, and major industries.

5.67 Within the federal government, environmental monitoring generates the information essential for

- designing environmental management programs,
- allocating resources efficiently,
- assessing the environmental effects of past and present projects,
- evaluating compliance with environmental regulations,
- promptly identifying problems, and
- complementing scientific research.

5.68 Monitoring helps determine baselines against which targets can be set and progress can be evaluated. Information from monitoring can be combined with other information to assess the current state of the environment and to predict its future state.

5.69 To give Parliament a clearer picture of the environmental monitoring conducted by the federal government, we have prepared an inventory of 94 federal monitoring systems. Among other things, the inventory shows that there are more monitoring systems for plants and animals than other components of the environment. Environment Canada has the widest range and largest number of monitoring systems of any department or agency. This is a reflection of its responsibilities, which include monitoring weather, air, and water; managing toxic substances; and tracking bird populations.

5.70 We identified some of the main challenges that managers need to meet when putting in place monitoring systems:

- coordinating, including establishing objectives and a strategic direction, and clarifying roles and responsibilities;

- building in quality at every step of monitoring;
- preparing reports that contain useful information; and
- using the available resources efficiently.

5.71 Practices from other jurisdictions suggest possible ways of meeting some of these challenges in the Canadian context. Our identification of the main challenges and good practices will serve as a basis for criteria in future audits that examine how the federal government conducts environmental monitoring.

5.72 Environmental monitoring systems are like the systems that take the pulse of our economy: they both provide information to support a very wide variety of uses. Environmental monitoring information helps us deal with questions ranging from the mundane ("Do I need to take an umbrella today?") to the globally significant ("How quickly is the Arctic ice cap melting, and how will this affect the animals and people living in the North and other parts of Canada?"). In this study, we have tried to provide Parliament with some of the essential information it needs about the role of environmental monitoring systems and the challenges the federal government faces in managing such systems.

About the Study

Objectives

The overall objective of this study is to document the key challenges associated with environmental monitoring, describe the active Canadian federal monitoring systems, and highlight good practices for monitoring in other jurisdictions.

There are four sub-objectives:

- to describe environmental monitoring and its role in environmental management;
- to prepare an inventory of active federal environmental monitoring systems and document the main properties of these systems;
- to describe the key challenges for environmental monitoring systems; and
- to identify and document good practices in responding to the key challenges, drawing on the experience of other countries and other jurisdictions in Canada.

We did not establish criteria, because this is a study, not an audit.

Scope and approach

We studied the environmental monitoring systems that have been used by the following 11 entities:

- Aboriginal Affairs and Northern Development Canada
- Agriculture and Agri-Food Canada
- Canadian Food Inspection Agency
- Canadian Space Agency
- Environment Canada
- Fisheries and Oceans Canada
- Health Canada
- Natural Resources Canada
- Parks Canada
- Public Health Agency of Canada
- Statistics Canada

Based on preliminary work, we determined that these were the main entities responsible for monitoring the state of the environment. We interviewed officials from these organizations and obtained documents describing their monitoring systems. The responsibilities for monitoring systems are shared by different parts of these departments and agencies.

We sent a questionnaire to all of the departments and agencies listed. We used the results to prepare an inventory of active federal monitoring systems that collect information related to the state of the environment. Our study focused mainly on the past two fiscal years, especially for the purpose of providing a snapshot of current monitoring systems. We also provided a brief historical perspective and drew on other information related to federal monitoring systems. The Appendix gives details of the inventory.

As part of the study, we assembled a committee of experts from the departments and agencies concerned. The committee provided valuable input and advice.

To better understand common challenges and good practices, we interviewed other Canadian and international experts, and reviewed the relevant literature. This included past observations and recommendations by the Office of the Auditor General of Canada and provincial counterparts. We did not, however, follow up on our past recommendations to determine what progress had been made.

We also interviewed officials from selected organizations in other countries. These included the

- Danish Environmental Protection Agency,
- European Environment Agency,
- Swedish Environmental Protection Agency,
- United Kingdom Department for Environment, Food and Rural Affairs,
- United Kingdom Environment Agency,
- US Environmental Protection Agency,
- US Fish and Wildlife Service, and
- US Geological Survey.

We made our selection from organizations in countries that are recognized leaders and that have legislative systems and issues relevant to Canada's. We spoke with officials of the national audit offices in each of the countries to ensure that we had a good understanding of the context for the interviews.

Period covered by the study

This study focuses on federal environmental monitoring systems that were in place during the 2009–10 or 2010–11 fiscal year. Some information from outside this period has been used as background.

Work for this chapter was substantially completed on 31 July 2011.

Study team

Principal: Bruce Sloan
Director: Peter Morrison

Amélie Beaupré-Moreau
Carolle Mathieu

For information, please contact Communications at 613-995-3708 or 1-888-761-5953 (toll-free).

Appendix Inventory of federal environmental monitoring systems

Our inventory of environmental monitoring systems lists active federal systems. By "environmental monitoring system," we mean a system that combines the processes for obtaining, assembling, synthesizing, and reporting repeated and systematic measurements or observations of environmental characteristics.

By "observations of environmental characteristics," we mean observations related to the different components of the environment: air, water, land (soil and landforms), plants and animals (including human beings), and ecosystems. We excluded human structures, such as those in the urban environment. We also excluded farmed and domestic animals. Contaminants affecting these components of the environment were taken into account when measured directly in the environment.

By "active system," we mean a system for which the entity managed the data collection in the 2009–10 or 2010–11 fiscal year. By "federal," we mean a system in which the federal government had some responsibility for ongoing operations. If the federal government simply provided funding but gave no direction, we excluded the system from this inventory.

For the purpose of this inventory, we focused on the state of the environment monitoring; we excluded compliance monitoring and monitoring related to individual projects (such as in relation to the assessment of environmental effects). This means, for example, that we excluded monitoring programs for contaminated sites. In addition, we excluded monitoring systems managed by other jurisdictions, where the federal government was only a user of the data.

The inventory focuses on national or major regional monitoring systems (for example, systems monitoring the Great Lakes). In some cases we included monitoring systems with a more restricted scope if they were part of a cluster of similar monitoring systems: that is, if the same approach was applied in different locations. We also used clusters if there were several very similar monitoring systems using the same methods. For instance, there are about 190 monitoring systems that track bird populations; we combined them into four clusters. Similarly, there are several monitoring systems that track aspects of ocean ecosystems; we grouped them by theme for each ocean. We also listed the set of monitoring systems for Canada's 42 national parks as a single monitoring system. We developed these clusters through discussion with the entities regarding the best way to present the monitoring information for our inventory. Of course there are various possible ways of grouping monitoring systems, given their similarities and the links among them.

We also restricted the inventory to systems where the federal government obtains measurements of the environment or of materials previously released into the environment (toxic substances, for example). The inventory excluded situations where the federal government used calculations from other information to estimate releases or environmental conditions. (The inventory excluded, for example, examination of the greenhouse gas emissions inventory and the National Agri-environmental Health Analysis and Reporting Program.) We also excluded samples collected only once, such as soil samples to characterize the soil in a particular location.

We used a questionnaire to obtain details about the monitoring systems in the inventory. We chose the questions to obtain basic and standard factual information about the systems. We pilot-tested the questions internally in the Office of the Auditor General of Canada and with departmental officials.

Even with the tested design of the questionnaire and the definitions of the monitoring systems to be included, several judgments were required about which systems to include and how best to represent them in the inventory. We discussed these judgments with the respondents to ensure the most consistent set of responses possible.

We entered responses to the questionnaire into a spreadsheet containing all of the information supplied. In addition, respondents provided background documents that gave further details about their monitoring programs.

We performed several checks to ensure that the inventory was as complete as possible. These included comparisons with other partial inventories and consultation with entity officials. As a final check on completeness, we asked the deputy head of each department or agency included in the study to identify any major monitoring systems that we had omitted.

The following table lists the monitoring systems (or clusters of monitoring systems) we identified through this process.

Monitoring system name and description	Lead department or agency
Air and atmosphere	
National Air Pollution Surveillance Network In collaboration with provinces and territories, provides accurate and long-term data of a uniform standard across Canada regarding key air pollutants, including ground-level ozone, particulate matter (fine particles in the atmosphere), and nitrogen oxides.	Environment Canada
Canadian Air and Precipitation Monitoring Network Studies the regional patterns and trends of atmospheric pollutants, such as acid rain, smog, particulate matter, and mercury, in both air and precipitation.	Environment Canada
Global Atmospheric Passive Sampling Network Determines spatial and temporal trends of persistent organic pollutants, identifies new chemicals in air, and helps assess long-range atmospheric transport.	Environment Canada
Integrated Atmospheric Deposition Network Monitors trends in toxic pollutants from non-point sources in the air and precipitation in the Great Lakes Basin. (Non-point sources are usually small, diffuse sources, such as runoff from agricultural land.)	Environment Canada
Intercontinental Atmospheric Transport of Anthropogenic Pollutants to the Arctic Monitors persistent organic pollutants and mercury in the Arctic air.	Environment Canada
Atmospheric Greenhouse Gas Measurement Program Identifies trends, seasonal variability, and spatial distribution of greenhouse gases and related gases in the atmosphere.	Environment Canada
Canadian Aerosol Baseline Measurements Program Tracks changes in aerosol (fine particles) composition and concentration in relation to changes in climate, anthropogenic emissions, and changes in natural sources and atmospheric transport patterns.	Environment Canada

Monitoring system name and description	Lead department or agency
AEROCAN Provides a sample of aerosols in the air column. The sample is as representative as possible of national, regional, and local variation across Canada, and contributes to the long-term record of particulate matter in the atmosphere.	Environment Canada
Canadian Operational Research Aerosol Lidar Network Monitors long-range transport of aerosols that occur naturally (for example, as a result of volcanic venting or eruptions, dust storms, forest and grassland fires) or are caused by human activities, such as the burning of fossil fuels.	Environment Canada
Canadian Ozonesonde Network Provides regular measurements of ozone concentration from ground level up to an altitude of approximately 36 kilometres.	Environment Canada
Canadian Brewer Spectrophotometer Network Monitors the recovery of the stratospheric ozone layer by measuring total column ozone, sulphur dioxide, and ultraviolet radiation in the atmosphere.	Environment Canada
Surface Weather and Climate Monitoring Network Provides real-time data to weather offices for weather warnings and forecasts, and provides a long-term record of surface climate conditions.	Environment Canada
Upper Air Network Provides a profile of the upper atmosphere, including temperature, humidity, pressure, and winds. Contributes to weather forecasts.	Environment Canada
Space-based Monitoring Network (Geostationary and Polar Orbiting Sub-networks) Provides satellite images, which are used by meteorologists to determine atmospheric, land, and ocean characteristics. Images are also used for environmental emergencies.	Environment Canada
National Radar Network Monitors precipitation, thunderstorms, and high-impact weather. Can also detect birds and insects on clear days.	Environment Canada
Aircraft Meteorological Data Relay Program Uses commercial aircraft to collect data from the upper atmosphere regarding wind, temperature, and pressure altitude.	Environment Canada
Meteorological Service of Canada—Marine Monitoring Network Provides real-time measurements of weather and the state of the sea, from coastal and Arctic regions of Canada (including the Great Lakes and other large interior lakes, such as Lake Winnipeg and Great Slave Lake). These measurements support weather predictions and contribute to marine safety.	Environment Canada
Canadian Lightning Detection Network Detects lightning activity.	Environment Canada
Drought Watch Website Provides near-real-time information about drought or excessive moisture and flood risks in agricultural areas, based on Environment Canada's meteorological data and provincial networks.	Agriculture and Agri-Food Canada

Monitoring system name and description	Lead department or agency
Comprehensive Nuclear Test-Ban Treaty Radiological Network Monitors radioactive compounds in the atmosphere to detect nuclear tests.	Health Canada
Water	
Fresh Water Quality Monitoring Program Monitors the status of water quality in Canada's rivers and lakes, as well as changes to aquatic ecosystem health.	Environment Canada
Freshwater Inventory and Surveillance of Mercury Monitors spatial and temporal trends in fish mercury concentrations across Canada to assess the effectiveness of the Clean Air Regulatory Agenda mercury emission regulations.	Environment Canada
Canadian Aquatic Biomonitoring Network Assesses freshwater quality and aquatic ecosystem conditions in Canada, using communities of large bottom-dwelling invertebrates.	Environment Canada
Acid Rain Aquatic Effects Monitoring Program Monitors water chemistry of lakes (and a few streams) to establish the current regional acidification status, trends in acidification, and causes of the trends detected.	Environment Canada
National Hydrometric Program Provides for the collection, interpretation, and dissemination of both real-time and historical surface water level and flow data.	Environment Canada
Sea and Lake Ice Monitoring Program Monitors freshwater ice and sea ice conditions to provide information on stage of development, drift, and overall extent of the ice.	Environment Canada
Iceberg Monitoring Program Monitors icebergs along Canada's east coast, south of latitude 60 degrees north.	Environment Canada
Integrated Satellite Tracking of Pollution Uses satellites to monitor the marine environment for the accidental or intentional dumping of oily waste products.	Environment Canada
Snow Cover Mapping System Maps daily snow cover over Canada and in watersheds adjacent to Canadian territory.	Natural Resources Canada
National Glacier-Climate Observing System Quantifies, and detects trends and other changes to, the mass balance and extent of Canada's land ice (glaciers and ice caps).	Natural Resources Canada
Impact of Agriculture on Water Quality Evaluates the risk of fecal pollution of water from agriculture, versus other sources, and evaluates the efficacy of agricultural management practices.	Agriculture and Agri-Food Canada
Drinking Water Monitoring System Measures the presence and levels of a variety of contaminants in raw and treated drinking water at 65 treatment plants across Canada.	Health Canada

Monitoring system name and description	Lead department or agency
Marine Environmental Quality—Atlantic Monitors marine environmental quality (including contaminants) in sediments, biota, and the water column, as well as toxic algal blooms.	Fisheries and Oceans Canada
Marine Environmental Quality—Pacific Monitors marine environmental quality (including contaminants) in sediments, biota, and the water column, as well as toxic algal blooms.	Fisheries and Oceans Canada
Freshwater Environmental Quality For a set of lakes in Ontario, conducts monitoring with a focus on ecosystem stresses, including lake acidification and eutrophication (the buildup of nutrients in a water body, leading to excessive plant growth).	Fisheries and Oceans Canada
Physical and Chemical Environment (including Greenhouse Gases)—Atlantic Measures the hydrographic, physical, and chemical state of the marine ecosystem, including waves, winds, currents, tides, sea level, ice coverage and movement, temperature, salinity, oxygen, macronutrients, and surface chlorophyll. This includes the components of the carbon cycle as well as other climate-related chemicals.	Fisheries and Oceans Canada
Physical and Chemical Environment—Pacific Measures the hydrographic, physical, and chemical state of the marine ecosystem, including waves, winds, currents, tides, sea level, ice coverage and movement, temperature, salinity, oxygen, macronutrients, and surface chlorophyll.	Fisheries and Oceans Canada
Physical and Chemical Monitoring (including Greenhouse Gases)—Arctic Measures the hydrographic, physical, and chemical state of the marine ecosystem, including waves, winds, currents, tides, sea level, ice coverage and movement, temperature, salinity, oxygen, macronutrients, surface chlorophyll, and carbon.	Fisheries and Oceans Canada
Greenhouse Gases—Pacific Measures components of the carbon cycle, as well as other climate-related chemicals.	Fisheries and Oceans Canada
Soil and landforms	
Canadian Permafrost Monitoring Network Measures permafrost temperatures and the thickness of the active layer.	Natural Resources Canada
Canadian National Seismograph Network Monitors signals from seismic sources, including earthquakes and other possible sources (for example, nuclear tests and mining blasts).	Natural Resources Canada
Ecological Long-term Plots Monitoring Determines the long-term changes in soil productivity and health, water quality, and crop productivity in response to crop production and management practices.	Agriculture and Agri-Food Canada
Contaminants in several components	
Chemicals Management Plan Monitoring and Surveillance Monitors chemical substances, including emerging chemicals of concern in air, water, sediment, and biota.	Environment Canada

Monitoring system name and description	Lead department or agency
Northern Contaminants Program Monitors concentrations of contaminants, including persistent organic pollutants and mercury, in air, wildlife, and human residents of the Canadian North.	Aboriginal Affairs and Northern Development Canada
First Nations Food Nutrition and Environment Study Monitors the health status, traditional foods consumed, contaminants in traditional foods, contaminants in drinking water, pharmaceuticals in surface water, and mercury in hair of First Nations people in Canada.	Health Canada
Colonial Water Bird Contaminant Program Monitors changes in contaminant concentrations in seabird eggs in the marine and Great Lakes environments over time.	Environment Canada
Plants and animals	
Acid Rain Biomonitoring Program Monitors the biological component of aquatic ecosystems in order to determine whether acid rain reduction efforts are sufficient to protect or enable the recovery of sensitive ecosystems across Canada.	Environment Canada
Monitoring Deforestation in Canada Produces annual deforestation area estimates for Canada. Deforestation is defined as human-induced land use change from forest to non-forest.	Natural Resources Canada
National Forest Inventory Estimates change in Canada's forest ecosystems.	Natural Resources Canada
Species at Risk Recovery Monitoring Monitors status of species at risk under the *Species at Risk Act*.	Environment Canada
Coastal Habitat Assessment and Monitoring Project Monitors marsh bird communities and their habitat in lower Great Lakes coastal wetlands.	Environment Canada
National Wildlife Area (NWA) and Migratory Bird Sanctuary (MBS) Monitoring Program Monitors, surveys, and tracks ecological integrity and species trends within NWA and MBS. Assesses habitat changes, effectiveness of NWA management prescriptions, species at risk, and bird populations.	Environment Canada
Annual Crop Inventory Identifies and maps the crops grown in agricultural fields in Canada annually.	Agriculture and Agri-Food Canada
National Crop Monitoring System Provides weekly crop condition assessments for all of Canada south of latitude 60 degrees north.	Agriculture and Agri-Food Canada
Lower Trophic Levels—Water Column—Atlantic Monitors organisms living in the water column, such as phytoplankton and zooplankton (13 different activities).	Fisheries and Oceans Canada
Lower Trophic Levels—Water Column—Pacific Monitors organisms living in the water column, such as phytoplankton and zooplankton (9 different activities).	Fisheries and Oceans Canada

Monitoring system name and description	Lead department or agency
Lower Trophic Levels—Benthos—Atlantic Monitors organisms that live on, in, or near the seabed (27 different activities). These activities exclude monitoring fish and higher organisms.	Fisheries and Oceans Canada
Lower Trophic Levels—Benthos—Pacific Monitors organisms that live on, in, or near the seabed (14 different activities). These activities exclude monitoring fish and higher organisms.	Fisheries and Oceans Canada
Higher Trophic Levels—Fish—Atlantic Monitors fish populations, including their abundance, distribution, and biological data (38 different activities).	Fisheries and Oceans Canada
Higher Trophic Levels—Fish—Pacific Monitors fish populations, including their abundance, distribution, and biological data (21 different activities).	Fisheries and Oceans Canada
Multi-Species Stock Assessment Surveys of Canadian Shrimp Fishing Areas in the Arctic Monitors northern shrimp, striped shrimp, and Greenland halibut populations to assess the effects of fisheries on these species in the Arctic. Also monitors other species, as well as water temperature and salinity.	Fisheries and Oceans Canada
Community-based Monitoring of Freshwater and Anadromous Fishes in the Western Arctic Monitors populations of several related fish species (Dolly Varden, Arctic char, and lake trout) to assess the effects of fisheries on these species.	Fisheries and Oceans Canada
Higher Trophic Levels—Marine Mammals—Atlantic Measures abundance, distribution, contaminant exposure, genetics, and diet of marine mammals in the Atlantic (19 different activities).	Fisheries and Oceans Canada
Higher Trophic Levels—Marine Mammals—Pacific Measures abundance, distribution, contaminant exposure, genetics, and diet of marine mammals in the Pacific (6 different activities).	Fisheries and Oceans Canada
Community-based Monitoring of Ice Seals—Arctic Monitors changes associated with global warming in several species of seals, including changes in age/sex structure, diet, reproduction, survival, contaminants, and disease.	Fisheries and Oceans Canada
Aquatic Animal Health—American Oyster Health Surveillance Detects new occurrences of multinucleated sphere unknown parasitic disease, which can cause oyster mortality, and monitors any emerging diseases in oysters in the Atlantic.	Fisheries and Oceans Canada
Aquatic Invasive Species—Atlantic Focuses on the early detection and monitoring of biofouling aquatic invasive species and their spread in high-risk ecosystems. Also focuses on assessing and understanding ecosystems at various stages of aquatic invasive species infestation (3 different activities).	Fisheries and Oceans Canada
Aquatic Invasive Species—Pacific Detects new aquatic invasive species, and geographical spread of existing species (3 different activities).	Fisheries and Oceans Canada

Monitoring system name and description	Lead department or agency
Aquatic Invasive Species—Central and Arctic Monitors and provides early detection of aquatic invasive species in the Great Lakes, and establishes a baseline for aquatic invasive species monitoring in the Canadian Arctic (3 different activities).	Fisheries and Oceans Canada
Canadian Shorebird Monitoring Provides information on the current population status, distribution, and trends of shorebird species in Canada, including some monitoring in Latin America (about 15 different surveys for approximately 75 species).	Environment Canada
Canadian Landbird Monitoring Provides information on the current population status, distribution, and trends of land bird species in Canada, largely relying on public volunteers (about 58 different surveys for approximately 250 species).	Environment Canada
Canadian Waterfowl Monitoring Provides information on the current population status, distribution, and trends of waterfowl species in Canada, as well as the magnitude of harvest of game species (about 80 different surveys covering approximately 50 species).	Environment Canada
Canadian Waterbird Monitoring Provides information on the current population status, distribution, and trends of waterbird species in Canada, including seabirds, inland colonial waterbirds, marsh birds, and others (about 37 different surveys for approximately 90 species).	Environment Canada
Prairie Habitat Joint Venture Habitat Monitoring Program Monitors wetland and upland status and trends in the Prairie Habitat Joint Venture area.	Environment Canada
Canadian Shellfish Sanitation Program Monitors shellfish (bivalve mollusc) harvest areas in Canada. Includes marine toxin monitoring, ongoing water quality monitoring for fecal contamination in the shellfish-growing area, and identification of pollution sources.	Canadian Food Inspection Agency with Environment Canada and Fisheries and Oceans Canada
Interagency Wild Bird Influenza Survey Detects highly pathogenic strains of avian influenza early, identifies avian influenza viruses circulating in wild bird populations, and tracks genetic changes in the viruses over years.	Canadian Food Inspection Agency
Plant Health Surveillance Monitors plant pests of quarantine significance, including invasive species.	Canadian Food Inspection Agency
Wildlife Disease Monitoring Monitors different wildlife diseases in dead and live animals: West Nile virus, Lyme disease, white nose syndrome of bats, rabies, and others. (Avian influenza is listed separately in this inventory.) Monitoring is conducted by the Canadian Cooperative Wildlife Health Centre.	Environment Canada with Canadian Food Inspection Agency, Public Health Agency of Canada, and other federal partners
Ecosystem processes	
Land Cover Time Series of Canada Uses satellite observations to provide information on land cover and land cover change at the national scale.	Natural Resources Canada

Monitoring system name and description	Lead department or agency
Fire Monitoring, Accounting and Reporting System Integrates annual burned area mapping with models of fire weather and behaviour and fire ecological effects, resulting in estimates of carbon emissions.	Natural Resources Canada
Lake Ontario Coastal Wetland Vegetation Dynamics Monitoring Monitors vegetation communities and wildlife habitat in response to a new water level regulation plan for Lake Ontario.	Environment Canada
Human population	
Canadian Integrated Program for Antimicrobial Resistance Surveillance Tracks temporal and regional trends in antimicrobial use, and antimicrobial resistance in selected species of enteric bacteria along the food chain and from human cases.	Public Health Agency of Canada
National Integrated Enteric Pathogen Surveillance Program Detects changes in trends in human enteric disease and in levels of pathogen exposure from food, animal, and water sources.	Public Health Agency of Canada
Lyme Disease Surveillance System For the information of the public and medical practitioners, identifies the geographic locations where Lyme disease is emerging.	Public Health Agency of Canada
West Nile Virus National Surveillance System Provides data for the prevention and control of West Nile virus and reduction of the disease's impact on Canadians.	Public Health Agency of Canada
First Nations Biomonitoring Initiative Monitors First Nations people living on reserves to examine their current exposure to environmental chemicals or contaminants. The Assembly of First Nations is the custodian of the data.	Health Canada
Canadian Health Measures Survey Collects key information relevant to the health of Canadians, including blood and urine samples, to test for chronic and infectious diseases, nutrition, and environmental markers.	Statistics Canada with Health Canada and the Public Health Agency of Canada
Other environmental components	
Ecological Integrity Monitoring System Monitors the ecological integrity of Canada's national parks by measuring, for each major park ecosystem, the biodiversity, ecosystem processes, and sources of stress at both local and landscape scales.	Parks Canada
Marine Protected Areas—Atlantic Monitors the status and efficacy of marine protected areas in the Atlantic.	Fisheries and Oceans Canada
Marine Protected Areas—Pacific Monitors the status and efficacy of marine protected areas in the Pacific.	Fisheries and Oceans Canada
Northwest Territories Cumulative Impact Monitoring Program Collects, analyzes, and synthesizes environmental information to provide cumulative effects information to decision makers.	Aboriginal Affairs and Northern Development Canada

Monitoring system name and description	Lead department or agency
Canadian Geomagnetic Observatory Network Monitors the Earth's magnetic field and geomagnetic disturbances caused by space weather.	Natural Resources Canada
Canadian Radiological Monitoring Network System Measures radioactivity levels in the environment locally, around major Canadian nuclear facilities, and more broadly across Canada, and collects precipitation and air samples to measure radioactive particulate matter and radioactivity doses.	Health Canada
State of the St. Lawrence Monitoring Program Monitors and reports information on water, sediment, shorelines, biological resources, and uses of the St. Lawrence River.	Environment Canada

Report of the Commissioner of the Environment and Sustainable Development—December 2011

Main Table of Contents

The Commissioner's Perspective
Main Points—Chapters 1 to 5
Appendix

Chapter 1 Transportation of Dangerous Products

Chapter 2 Environmental Science

Chapter 3 Enforcing the *Canadian Environmental Protection Act, 1999*

Chapter 4 A Study of Managing Fisheries for Sustainability

Chapter 5 A Study of Environmental Monitoring

Chapter 6 Environmental Petitions