Developing Indicators Of Urban Sustainability: A Focus On The Canadian Experience

by
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List of Acronyms

ACC	Appropriated Carrying Capacity
CCME	Canadian Council of Ministers of the Environment
CMHC	Canadian Mortgage and Housing Corporation
COMLE	Community Oriented Model of the Lived Environment
CSR	Condition-Stress-Response
EE	Environmental Elasticity
EQI	Environmental Quality Index
GDP	Gross Domestic Product
GNP	Gross National Product
GVRD	Greater Vancouver Regional District
ICURR	Intergovernmental Committee on Urban and Regional Research
ISS	Indicators for a Sustainable Society
LGMB	Local Government Management Board
NGO	Non-Governmental Organization
OECD	Organization for Economic Cooperation and Development
QOL	Quality of Life
SOE	State-of-the-Environment
UBC	University of British Columbia
UNDP	United Nations Development Program
UNCHS	United Nations Conference on Human Settlements
VVS	Villes et Villages en Santé

Foreword

On behalf of the Canada Mortgage and Housing Corporation (CMHC), Environment Canada and the Intergovernmental Committee on Urban and Regional Research (ICURR), we are pleased to present this study analysing frameworks for indicator development as well as the selection, development and analysis of urban sustainability indicators. This study, which focuses primarily on Canadian work, represents an innovative effort in establishing a methodology for the development of urban sustainability indicators that can be used at the federal, provincial and local levels.

ICURR's research on the many facets of urban sustainability has been developed under the leadership of its sponsors, the provincial and territorial ministries of Municipal Affairs and CMHC. Environment Canada, through the State of the Environment Reporting program and other branches, is actively involved in indicators research and development in a sustainability context. As a result, in addressing the methodological problems associated with measuring and reporting the sustainability of urban areas, ICURR felt that such analysis would be best pursued in partnership with Environment Canada and CMHC.

This report complements research by CMHC, Environment Canada and ICURR in the fields of quality of life indicators, environmental indicators and municipal environmental planning. Previous studies published by ICURR in the field of municipal environmental planning include: *Sustainable Urban Development in Canada: From Concept to Practice* by Virginia Maclaren (1992); *Environmental Policy Review of 15 Canadian Municipalities* by Paule Ouellet (1993) and *Ecosystem Planning for Canadian Urban Regions* by Ray Tomalty et al. (1994). Environment Canada has supported municipal state of environment reporting efforts and regularly publishes Environmental Indicators Bulletins on a wide array of environmental sustainability issues which include: urban water use, urban air quality, passenger transportation and energy consumption. CMHC's indicators research has concentrated on the quality of life domain. Developed in 1992 and pilot tested in a number of Canadian communities, the Community Oriented Model of the Lived Environment (COMLE) provides a logical approach to measuring the quality of the social, economic and natural environment of cities.

We therefore wish to acknowledge the intellectual and financial input of the federal government in enabling us to successfully complete this comprehensive and innovative study. More specifically, we wish to thank Wayne Bond of Environment Canada, State of the Environment Directorate, as well as Denys Chamberland and Dick Leong of CMHC, Centre for Future Studies in Housing and Living Environments for managing the research and reviewing interim and final reports of this study along with ICURR.

Our thanks are extended to Virginia Maclaren for identifying this area of research as important and for pursuing it with the enthusiasm and commitment that has always been characteristic of her work with us. We also acknowledge Virginia's research assistants, Sonia Labatt, Jennifer McKay and Michael Van de Vegte, for their dedication and effort throughout the course of this research.

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Preface

The concept of sustainability is starting to have a significant influence on planning and policy at the local level. Evidence of this can be found in recent research reports which have identified numerous examples of urban sustainability initiatives in Canada and the rest of North America[1]. Urban sustainability is also being adopted as one of the principal goals of official plans and other strategic plans in many Canadian communities (Maclaren 1993; Ouellet 1993). Having identified sustainability as an important goal, municipalities and other levels of government are now turning to the issue of how to measure a community's progress towards achieving this goal. In order to measure progress, we need a clearly articulated methodology for developing sustainability indicators. This report seeks to establish such a methodology. Effective indicators serve not only to monitor progress towards sustainability but can also provide information useful in a wide variety of planning activities, including:

- the formulation of recommendations for new or improved policies or programs;
- improvements to the efficiency/effectiveness of municipal services and functioning of cities;
- public education;
- the measurement of changes in urban environmental, social and economic conditions;
- the evaluation of policies and programs.

Such activities are of intense concern to urban planners and environmental officers, but they also involve a broad set of other user groups including elected officials at all levels of government, senior bureaucrats and decision-makers, citizen groups, NGOs and interest groups, the media, educators, the general public, and the private sector.

A draft version of this report was prepared for a national workshop on "Measuring Urban Sustainability: Canadian Indicators Workshop", sponsored by Environment Canada and Canada Mortgage and Housing Corporation (CMHC). The workshop was held from June 19 to 21, 1995, in Toronto and was attended by over 70 individuals representing many of the above-mentioned potential user groups. During the three-day workshop, participants discussed a range of topics related to the development of urban sustainability indicators, including: conceptual frameworks, indicator selection criteria, national indicators programs, municipal/community indicators programs, a "core" set of indicators, the indicators program underway at the United Nations Centre for Human Settlements, and future challenges and directions for indicator development.

In addition to contributing towards urban sustainability indicator development in Canada, the results of the workshop will provide a basis for Canada's input to Habitat II, the United Nations international conference on human settlements, to be held in the summer of

[1] See, for example, Roseland 1992; Maclaren 1993; Ouellet 1993; Tomalty and Pell 1994; Ontario Round Table on Environment and Economy 1995.

1996. The workshop proceedings, published jointly by Environment Canada and CMHC[2], provide additional insight into the questions that conclude this report.

This study reviews a range of indicator frameworks and selection criteria for urban sustainability indicators. The first portion of the review leads to options for a consistent methodology for identifying standardized indicators of urban sustainability. The second portion identifies a range of practical and theoretically sound indicators, based primarily on the Canadian experience, that fulfil some or all of the conditions required for sustainability indicators.

In the process of conducting the research for this study, we examined the following issues:

- the meaning of urban sustainability and goals derived from the sustainability concept;
- how the concept of urban sustainability and sustainability goals or targets can be linked to appropriate indicators;
- which indicator selection criteria are appropriate for selecting urban sustainability indicators;
- the existence of trade-offs among selection criteria, such as scientific validity versus ease of understanding;
- which indicator frameworks offer the most promise for developing sustainability indicators;
- the importance of multi-stakeholder input to the formulation of indicators;
- the identification of sample indicators that can be considered good sustainability indicators for use by municipalities and higher levels of government;
- how to operationalize "forward-looking" indicators;
- current application of urban sustainability indicators in Canada and elsewhere.

The project's research methodology consisted of four components: a literature review, personal interviews with researchers and practitioners, analysis of proposed indicator frameworks and selection criteria, and case studies. Thirty-two interviews were conducted with researchers and local practitioners working on urban sustainability reporting or related fields across Canada (see Appendix A).

[2] The proceedings, entitled "Measuring Urban Sustainability: Canadian Indicators Workshop, June 19-21, 1995, Workshop Proceedings", can be obtained, free of charge, from the State of the Environment Directorate, Environment Canada (Attention: Linda Gravel), at (819) 994-5738 (Fax) or (819) 994-9569 (Tel.) or from the Canadian Housing Information Centre, CMHC (Attention: Leslie Jones) at (613) 748-4069 (Fax) or (613) 748-2367 (Tel.).

The report itself begins with a discussion of alternative definitions of urban sustainability and then describes some of the general characteristics of indicators and indices. Following a brief investigation of the meaning of sustainability indicators, several potential sustainability indicator frameworks are examined, including those which could be adapted from the work on State-of-the-Environment (SOE) reporting, Quality of Life (QOL) reporting and Healthy City reporting. Next, more detailed attention is given to appropriate criteria for identifying sustainability indicators and to the steps to be followed in applying those criteria. A number of examples of potential sustainability indicators are then described and evaluated against the criteria. The report concludes with detailed case studies of urban sustainability reporting in three jurisdictions in North America - Seattle, Hamilton-Wentworth, and British Columbia - as well as a brief description of sustainability reporting projects underway in Richmond, British Columbia and the Fraser River Basin.

ICURR Intergovernmental Committee on Urban and Regional Research
Comité intergouvernemental de recherches urbaines et régionales CIRUR

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This report was jointly funded by the State-of-the-Environment (SOE) Directorate at Environment Canada, the Centre for Future Studies in the Housing and Living Environments, CMHC, and the Intergovernmental Committee on Urban and Regional Research (ICURR). Many individuals contributed to the preparation of this report. First of all, I am deeply grateful to Dr. Sonia Labatt, Jennifer McKay and Michael Van de Vegte for their research assistance and dedication in ensuring that the interim report was completed on time. Preparation of the graphics included in this report would not have been possible without the expert assistance of Greg Philpott and Michael Van de Vegte. Joan Campbell edited the final draft and Denise Girard helped in preparing the final report for publication.

Others whom I would like to thank include Wayne Bond, the project manager from the SOE Directorate at Environment Canada, who provided overall guidance throughout the study as well as significant input on draft versions of the interim and final reports. Denys Chamberland and Dick Leong from CMHC provided guidance on the structure of the report and reviewed, in detail, the draft interim and final reports. Other reviewers included Anne Kerr and Heather Blenkiron from the SOE Directorate, and the provincial representatives of ICURR as well as Claude Marchand. Dr. Claude Marchand from ICURR was the project's research coordinator and provided support and advice from the earliest stages of the project.

Finally, the completion of this study would not have been possible without the cooperation of the individuals listed in Appendix A, who generously provided their time during site visits and telephone interviews.

About the Author

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Dr. Maclaren was educated at Bishop's University in Lennoxville, Quebec, at the University of Ottawa and at Cornell University in Ithaca, New York. She is the author of a 1993 ICURR publication entitled "Sustainable Development in Canada: From Concept to Practice" and has co-edited two books on environmental assessment. She is currently the Associate Director of a five-year CIDA-funded project on environmental management in Vietnam and has recently completed a collaborative research project on industrial waste management in Jakarta, Indonesia

Executive Summary

The concept of sustainability is starting to have a significant influence on planning and policy at the local level. Evidence of this can be found in recent research reports which have identified numerous examples of urban sustainability initiatives in Canada and the rest of North America. Urban sustainability is also being adopted as one of the principal goals of official plans and other strategic plans in many Canadian communities. Having identified sustainability as an important goal, municipalities and other levels of government are now turning to the issue of how to measure a community's progress towards achieving this goal. One way of accomplishing this task is through the development of urban sustainability indicators. The following six-step process is proposed as a means of developing such indicators.

Step 1. Define and conceptualize the nature of urban sustainability and the urban sustainability goals for which indicators are needed. What is urban sustainability? Many different definitions of urban sustainability can be found in the academic literature and in current planning documents. A common theme of all these definitions is long term protection of the environment and the wise use of natural resources. At one end of the spectrum, some consider this to be the only theme relevant to sustainability. At the other end are those who feel that protection of the environment is a fundamental aspect of sustainability, but that it must be balanced against economic and social considerations. Not only may interpretations of the general meaning of urban sustainability differ: so may views on the specific characteristics of sustainability that should be considered when developing sustainability goals. The existence of a wide range of interpretations of urban sustainability and variability in the economic, social, and environmental circumstances of different communities mean that a set of indicators designed to measure progress towards achievement of one community's goals may not necessarily be appropriate for measuring progress in another community.

Step 2. Identify the target audience, the associated purpose for which indicators will be used, and the relative number of indicators needed. The format for presenting indicators and the number of indicators selected will vary according to whether the target audience consists of scientists, policy-makers or the general public. Professional analysts and scientists may be more interested in raw data and a highly detailed set of indicators that emphasize scientific validity and system complexity, but these may not be easily understood by the non-specialist. Policy-makers may prefer information that is directly related to policy objectives, evaluation criteria, and target values. The media and the public may be most interested in a reduced set of indicators that are easy to understand and representative of the issues of most direct concern to them.

A key question that has yet to be resolved is whether or not it is possible to develop a "core" set of urban sustainability indicators that could be used by all municipalities in a province, a country or even several countries. The search for core indicators is a search for certain fundamental indicators that are of concern to all communities, regardless of differences in their situational context or their sustainability goals. The unemployment rate and the

amount of waste generated per capita may be possible examples of core indicators. On the other hand, the amount of contaminated land in the community is an indicator which may be of considerable concern in larger communities where hazardous waste-producing industries have been or are currently present, while it may be of much less interest in smaller, rural communities which have experienced little industrial activity.

Step 3. Choose an appropriate indicator framework. A review of indicator frameworks found in the literature on urban sustainability reporting, State-of-the-Environment reporting, Healthy City reporting, Quality of Life reporting suggest that there are six general types of frameworks that can be used to develop urban sustainability indicators. These are: goal-based frameworks, issue-based frameworks, sectoral frameworks, domain-based frameworks, causal frameworks and combination frameworks. Each of the first five frameworks has its own strengths and weaknesses: a combination framework has the advantage of being able to draw on all of these strengths while downplaying the weaknesses. A hypothetical combination goal-based, causal, sectoral framework might require that all indicators be linked with urban sustainability principles, that the indicators be selected to cover a broad range of conditions, stressors and responses, and that the indicators be relevant to municipal government programs.

Step 4. Define indicator selection criteria. This study identified 12 general indicator selection criteria: scientific validity; representativeness; responsiveness; relevance to the needs of potential users; relevance to stated goals; accuracy, accessibility and availability of data; understandable by potential users; comparable to thresholds or targets; comparable with indicators developed in other jurisdictions; cost effective to collect and use; attractive to the media; and unambiguous.

Step 5. Identify a set of potential indicators and evaluate them against the selection criteria. This study reviewed 16 potential urban sustainability indicators and undertook a partial evaluation of their suitability for measuring urban sustainability, using a combination causal, goal-based, domain-based framework and the 12 general selection criteria identified in the previous step. This exercise illustrated how difficult it will likely be to find indicators that satisfy all selection criteria simultaneously. Consequently, judgements will have to be made about the relative importance of different criteria. For example, it will be necessary to decide whether scientific validity or meaningfulness to individuals in the community should be given first place in the list of selection criteria. Whether data availability limitations should exclude certain otherwise desirable indicators is also open to question. It may be necessary, in the end, to apply criteria sequentially, and to accept trade-offs among them.

Step 6. Choose a final set of indicators and test their effectiveness. The purpose of this step is to determine whether the indicators are able to measure what they were meant to measure. Data availability problems or questions about an indicator's revealed effectiveness may reduce the number of indicators in the final set and require a new round of indicator identification and evaluation. Once the final list of indicators has been tested, it is ready for use. Periodically, however, it will need to be re-evaluated, as a community's sustainability goals evolve, as better data become available, as there are advances in scientific knowledge concerning the validity of selected indicators, and as other factors change over time.

Three detailed case studies are presented in this report in order to illustrate how urban sustainability indicators were developed (or are being developed) in a variety of different contexts. The case study descriptions for the City of Seattle, the Regional Municipality of Hamilton-Wentworth, and for five cities in British Columbia examine the steps taken to develop sustainability indicators, the way in which they were presented to the intended audience, and how well they were received. A brief overview of sustainability indicator initiatives in Richmond, British Columbia and the Fraser Basin rounds out the case study analysis.

An important characteristic that distinguishes sustainability indicators from other types of indicators is the manner in which they are developed. Since sustainability is such a value-laden and context-sensitive concept, it makes sense to seek input on sustainability concerns and priorities from a broad range of stakeholders. The three case studies described above relied heavily on a multi-stakeholder decision-making process in the development of their urban sustainability indicators. In British Columbia, the provincial Round Table guided the indicator selection process. In Seattle and Hamilton-Wentworth, the entire indicator selection process was community-driven from the beginning.

A second important characteristic of sustainability indicators is their ability to integrate two or more of the economic, environmental and social aspects of sustainability into a single indicator. If they are to measure inter-generational equity, then sustainability indicators should also be forward-looking. Three types of forward-looking indicators identified in this study are trend indicators, predictive indicators and conditional indicators. A third distinguishing characteristic of sustainability indicators is their regard for the distributional properties needed to measure the concept of intra-generational equity.

In conclusion, it should be remembered that the creation of a widely accepted set of sustainability indicators cannot be accomplished overnight. Economic, social and environmental indicators have been in existence for many years and are still evolving. The development of sustainability indicators faces even greater challenges because of the complexity of the economic-environmental-social relationships that need to be portrayed, and because of the absence of a commonly understood measurement unit, comparable to monetary units commonly employed in economic indicators.

A key area of future research will be the development of examples of "good" sustainability indicators that meet as many general selection criteria as possible while satisfying the needs of a chosen conceptual framework. Although much work remains to be done, it is already evident from the theoretical, methodological and case study material examined in this report that urban sustainability indicators are likely to become an important new tool in planning for sustainability.

Chapter 1

Defining Urban Sustainability

Urban Sustainability as a Concept

In order to develop indicators of urban sustainability, it is essential, at the outset, to define what we mean by "urban sustainability". The attempt to provide a universally acceptable definition is not without its difficulties, however. The most significant stems from the fact that different communities are likely to develop slightly, or even significantly, different conceptualizations of urban sustainability, depending on their current economic, environmental and social circumstances. As a consequence, the existence of a wide range of interpretations of urban sustainability means that a set of indicators designed to measure progress towards achievement of one community's sustainability goals may not necessarily be appropriate for measuring progress in another community.

Perhaps the best way to start defining urban sustainability is to consider its opposite: lack of urban sustainability denotes a full or partial break-down in the way that an urban community functions. It is also important to distinguish between "urban sustainability" and "sustainable urban development". The meanings of the two terms are very close and they are often used interchangeably in the literature. One way of distinguishing the two, however, is to regard "sustainability" and "sustainable" as terms that describe a desirable state or set of conditions which persist over time. In contrast, the word "development" in the term "sustainable urban development" implies a process by which sustainability can be attained.

The term "urban sustainability" has recently gained in popularity over that of "sustainable urban development" because it avoids misunderstandings over the meaning of "development". Too often, "development" is confused with "growth". "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". It also has environmental and social dimensions missing in the common interpretation of sustainable urban growth.

The literature provides many definitions of urban sustainability and its related concepts. For example, Haughton and Hunter (1994a:27) highlight the importance of the urban contribution to global sustainability when they define a sustainable city as "...one in which its people and businesses continuously endeavour to improve their natural, built and cultural environments at neighbourhood and regional levels, whilst working in ways which always support the goal of global sustainable development." A slightly different perspective can be found in a report for the Canadian Environmental Advisory Council that defines sustainable urban development as "... a process of change in the built environment which fosters economic development while conserving resources and promoting the health of the individual, the community and the ecosystem (recognizing that ... the urban environment cannot be separated from the region of which it is a part)" (Richardson 1989: 14). This latter definition does not mention global sustainability, but it

does introduce the notions of resource conservation and human health as elements of sustainability. Both definitions mention the physical structures or built environment of a city (including streets, buildings and physical services), and point to the built environment as a major factor in understanding sustainability at the urban level. These two definitions also illustrate the diversity of opinions concerning the meaning of sustainability. This diversity will be examined in more detail in the following section.

Characteristics of Sustainability

The discussion of urban sustainability so far has referred to some, but by no means all, of the characteristics of sustainability that are frequently espoused in the literature and in planning reports. A number of these characteristics are listed in Figure 1. Not all of these terms have received widespread support and some terms that are used less frequently have been omitted. However, the list is a useful starting point for municipalities attempting to develop their own conceptualizations of sustainability and specific sustainability goals. Each of the listed terms will be described briefly.

Inter-generational equity

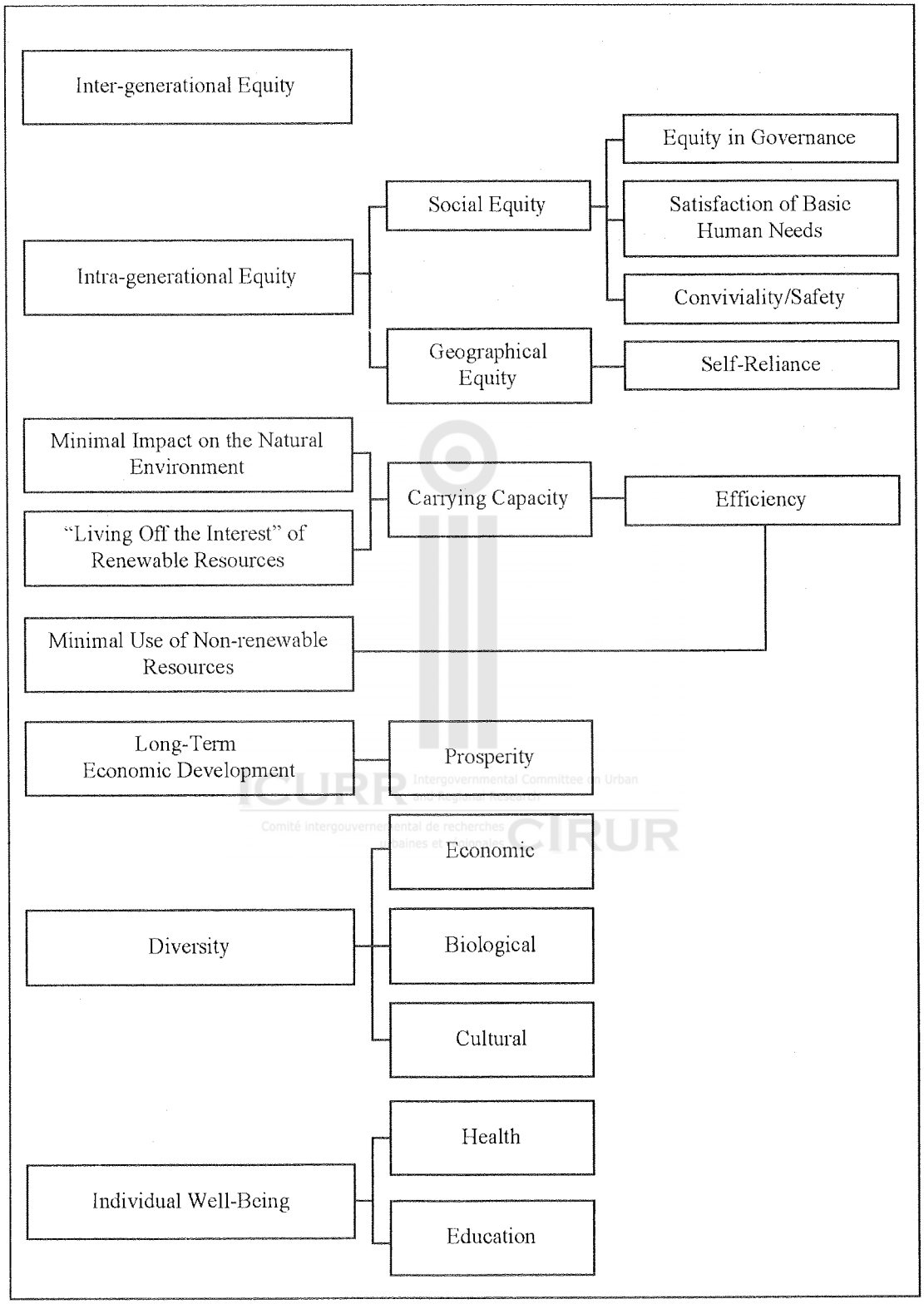
The term "sustainable development" was popularized by the World Commission on Environment and Development (1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." A foremost characteristic of this definition is the concept of inter-generational equity, which embraces the notion that the needs of future generations are as important as the needs of the current generation.

Intra-generational equity

This form of equity has two important components: social equity and geographical equity. "Social equity" refers to the fair distribution of the benefits and costs of natural resource use and environmental protection, taking account of such basic human needs as food, shelter, employment, public facilities and services. To many, social equity in the context of sustainability also means the improvement of equity in a broader sense, for example, more equitable distribution of income, and the elimination of discrimination. Two other aspects of social equity are equity in governance and conviviality. "Equity in governance" includes such concepts as self-determination and a more participatory approach to governance through community-based decision-making. "Conviviality" means that people live together harmoniously and without fear for their personal safety.

The second essential component of intra-generational equity is "geographical equity". This term was coined by Haughton and Hunter (1995) to underline the undesirability of achieving economic growth, or a higher quality of life, in one community at the expense of environmental degradation in another. They contend that this type of development is inequitable unless some form of reparation or compensation takes place between the communities. Geographical equity also implies that sustainable communities support global sustainability by minimizing their contribution to global environmental problems, such as global warming and depletion of the ozone layer. Ideally, one way that a community can minimize its contribution to geographical inequities is by increasing its capacity for self-reliance (Girardet 1990). This would involve minimizing its consumption of resource inputs from outside the community and minimizing its production of

Figure 1. Characteristics of Sustainability



waste outputs. In practice, a goal of total self-reliance may be neither realistic nor feasible. For example, Haughton and Hunter (1994b) describe how the negative environmental impacts of growing tropical fruits in greenhouses in a city with a temperate climate may in fact be greater than those of importing the fruits from their natural habitat, because greenhouses require significant physical inputs and energy during construction and after (including heating) and the application of fertilizers.

Minimal impact on the natural environment

This term implies that waste discharges of all types (including emissions to the air, water effluents, contaminants of land and biota, and the disposal of solid waste) should not exceed the assimilative capacity of the natural environment, where assimilative capacity refers to the capacity of physical, biochemical and geochemical processes in the ecosystem to decompose and render inert certain types of waste products.

"Living off the interest" of renewable resources

Similarly, sustainability means that the depletion rates for renewable resources, such as timber and fisheries, should not exceed the regenerative capacity of the natural system that produces them.

Together, these two concepts make up "carrying capacity", which has been defined as "the maximum rate of resource consumption and waste discharge that can be sustained indefinitely in a given region without progressively impairing the functional integrity and productive activity of relevant ecosystems." (Rees 1992:125)

Minimal use of non-renewable resources

By definition, consumption of non-renewable resources is unsustainable because the resources will eventually run out. Therefore, the emphasis must be on minimizing their use, using them as efficiently as possible, through reduction, reuse and recycling, and by seeking renewable resource substitutes.

Efficiency

Increased efficiency in the consumption of resources reduces the need to harvest or extract additional resources. From an urban perspective, increased efficiency in the use of land and resources can be accomplished by reducing sprawl and moving towards a more compact urban form. When the space occupied by the built environment of an urban area becomes more compact in form, economic efficiencies in the provision of public transit services increase and reliance on the automobile as a means of transportation can decrease. The debate over how to implement sustainability goals in an urban context centres in large part on the advantages and disadvantages of compact urban form. (See, for instance Breheny 1992; Paehlke 1991; Tomalty 1993).

Long-term economic development

Enduring economic vitality is an essential component of urban sustainability. This condition is also frequently described as economic "prosperity".

Diversity

Diversity in the economic, biological and cultural elements of an urban system helps to increase its ability to adapt to change, and so contributes to urban sustainability.

Individual well-being

An individual's well-being extends to his or her physical, social and mental well-being. Health and education, by developing human potential, contribute to individual well-being, which also requires the satisfaction of basic physical and economic needs.

Agreeing on a Definition

Not only is there considerable debate within the academic community, planning agencies, and other organizations over the relative importance of each of these urban sustainability characteristics; there is even disagreement on whether all of them should be included when developing sustainability goals. Almost everyone who has tried to define urban sustainability agrees that the concept points to the necessity of introducing environmental considerations to the policy debate over future patterns of urban development. Some maintain that environmental considerations should now be paramount in this debate, while others call for a more holistic approach that balances environmental, economic and social considerations, and pursues such sustainability goals as ecological integrity, economic vitality and social well-being.

Perhaps the narrowest perspective on sustainability is that favoured by Hardoy, Mitlin and Satterthwaite (1992). They argue that the economic, social and cultural interpretations of sustainability have little to do with the basic environmental focus of sustainability and may in fact conflict with it. For example, they note that economic sustainability is sometimes used to mean simply the long term economic viability of projects or programs. They submit that meeting economic, social and cultural goals must be sustainable in an ecological sense, but they question whether sustaining societies and cultures in perpetuity is either desirable or feasible, given the dynamic nature of such entities. Hardoy et al., therefore argue that sustainability should be interpreted in terms of ecological sustainability alone. According to them, sustainability means minimizing the use of non-renewable resources, minimizing impacts on the natural environment, protecting biodiversity, and using renewable resources in a sustainable manner.

Richardson (1992) offers another argument for limiting the scope of "urban sustainability". He warns that the potential utility of the concept for policy-making and analysis will be eroded if it becomes a "motherhood" statement that encompasses an unwieldy range of social, cultural, and even spiritual values. His interpretation of urban sustainability is that it encompasses the

relationships among four domains: the natural environment, economic activity in the urban milieu, the built environment, and the human environment. The emphasis on linkages among these domains is an essential characteristic of Richardson's interpretation. Another is the omission from the concept of any aspect of urbanization and urban life that is not strongly connected to the physical fabric of a city and its economic base. Richardson prefers to exclude from definitions of sustainability such issues as personal safety, the opportunity and range of choice for personal development, the opportunity for effective participation in decision-making, and the accommodation of different cultural needs and interests. He suggests that some of these concerns would be more appropriately addressed using the Healthy Community/Healthy City concept, which embraces many of the principles of urban sustainability, but places greater emphasis on community health and individual well-being.

Despite the potential pitfalls identified by Richardson (1992) and Hardoy et al. (1992), the holistic view of urban sustainability has become increasingly popular. (See, for example, Barbier 1987, D'Amour 1991, Chamberland 1994 and the British Columbia Round Table 1994). Richardson (1995:35) points out that this interpretation calls for:

> the active pursuit of modes of economic development that are not just "environmentally friendly" but which also offer the community long-term economic stability, diversity and prosperity. It means a deliberate, broadly-based, multi-faceted quest for social health and individual well-being. It means a concerted, long-term program not just to "clean up" the environment, but to conserve and enhance the community's natural assets of land, water, air and living things. All of these are essential elements of the sustainable community: because each affects the others, if any one of them is lacking, the vitality of the local human ecosystem is impaired. Furthermore, a community should not seek its own sustainability at the expense of the sustainability of other communities, including the wider community (ecosystem) to which it belongs.

The holistic perspective recognizes that trade-offs will have to be made among economic, environmental and social goals, and between present and future generations. For example, a municipality may have to trade off increased property tax revenues from a new housing development against protection of environmentally sensitive lands on which the housing was to have been constructed. At the same time, urban sustainability also means seeking development paths in which the goals are compatible with one another, rather than conflicting.

A good example of an activity where environmental and economic goals can be achieved simultaneously is industrial waste minimization. There are numerous examples showing that reducing solid and liquid industrial wastes through source reduction, reuse and recycling can result in significant economic savings for industry while limiting the impact of industrial production on the environment (e.g. Huisingh et al. 1986; Munroe et al. 1990). In urban areas, municipal governments have several tools that they can use to encourage waste minimization and thus promote sustainability. These include educational programs, technical assistance programs, sewer use by-laws for managing industrial effluents, and development controls on the approval of new industrial sites (Roseland 1992; Scanlon 1987).

Dimensions of Sustainability

It is possible to think of environmental, social and economic urban sustainability as separate concepts, each with its own definition. However, most definitions of urban sustainability contain environmental, social and economic elements. By analyzing these three concepts in turn, the remainder of this chapter will provide greater insight into what we mean by "urban sustainability".

Environmental Sustainability

Jacobs (1991:79-80) gives an example of the "environmental" or "ecological" perspective on sustainability:

> Sustainability means that the environment should be protected in such a condition and to such a degree that environmental capacities (the ability of the environment to perform its various functions) are maintained over time: at least at levels sufficient to avoid future catastrophe and at most at levels which give future generations the opportunity to enjoy an equal measure of environmental consumption.

Embodied in this definition are what Jacobs refers to as "minimum sustainability" and "maximum sustainability". Minimum sustainability means not allowing environmental degradation to occur to the point where future generations experience environmental catastrophes (such as flooding or droughts caused by global warming), while maximum sustainability means providing future generations with at least the same level of environmental consumption that current generations receive. Jacobs maintains that the principle of maximum sustainability does not oblige present generations to increase environmental capacities for future generations, but simply to ensure that they do not deteriorate beyond what they are currently. Most proponents of environmental sustainability favour the maximum as opposed to the minimum sustainability interpretation. That is, they argue that sustainability may also require improvements in environmental quality, if current conditions are already degraded (See, for example, Hardoy et al. 1992).

Social Sustainability

A narrow interpretation of "social sustainability" limits the concept to the perpetuation of existing institutions and of customary behaviours and relations (Hardoy et al. 1992). One problem with this definition, as Hardoy et al. acknowledge, is that the achievement of ecological sustainability may require fundamental changes in social structures, institutions and individual behaviour. Consequently, "social sustainability" in this sense is unlikely to be compatible with achieving ecological sustainability.

Yiftachel and Hedgcock (1993:140) attempt to avoid this problem by removing references to social institutions and customary behaviour in their definition of social urban sustainability, and

by couching it in terms similar to those used by the World Commission on Environment and Development to define sustainable development. Accordingly, a socially sustainable city is one that supports "lasting and meaningful social relations that meet the social needs of present and future generations... [and] is marked by vitality, solidarity and a common sense of place among its residents." This definition is less restrictive than the previous one, for it does not imply that social structures need remain static indefinitely, but rather that they are characterized by vitality and can evolve to meet the needs of future generations.

Broad interpretations of social sustainability also include as essential components, such concepts as the achievement of social equity, meeting basic human needs, personal development, maintaining personal health (physical, mental and psychological) and responsible citizenship (British Columbia Round Table 1993; Yiftachel and Hedgcock 1993; Chamberland 1994; Richardson 1994).

The British Columbia Round Table contends that an additional key element of social sustainability should be community self-reliance. Self-reliance in this context does not mean that communities should become isolated, however. Instead, it encourages them to develop the capacity to respond to local concerns while recognizing the goal of balancing local needs with regional, provincial, national and global sustainability goals.

Economic Sustainability

Economic sustainability implies that the local economy is both stable and diversified (Richardson 1994). Economic sustainability also means that economic activities have minimal impacts on the natural environment, and are efficient in their consumption of resources.

Economic stability can be enhanced by development of a strong local or community-based sector where local resources and local jobs meet local needs (Ekins et al. 1992; Richardson 1994). However, Haughton and Hunter (1994) caution that a complete shift to local economic self-reliance can be as damaging to economic sustainability as the absence of self-reliance, because of the global nature of the capitalist economic system and the opportunities for innovation that are associated with a more open local economy.

In concluding this discussion of urban sustainability and its component parts, it is important to note that, regardless of the perspective taken on interpreting the meaning of sustainability, whether it be a broad or a narrow one, careful consideration of the meaning of this term is the first step that should be taken by a community when attempting to identify sustainability indicators. This is because the interpretation chosen will drive the selection of indicators. There are clearly a variety of definitions that have found favour among academics and practitioners to date and the existence of so many definitions serves to highlight the value-laden qualities of sustainability. Some of the characteristics of sustainability have received universal acknowledgement, such as inter-generational equity and regard for the environmental consequences of development, while others are more controversial and may not be adopted by all communities.

Chapter 2

Indicators or Indices?

Indicators

Like sustainability itself, indicators have been defined in many different ways and from many different perspectives. This chapter will examine a few of these definitions, drawing from the literature on social indicators, economic indicators, Healthy City indicators, quality of life indicators and environmental indicators. The chapter concludes with an analysis of the difference between indicators and indices.

It is important to remember throughout this discussion that indicators are usually simplifications of complex phenomena. The term "indicator" should therefore be taken literally in the sense that it provides only an indication of conditions or problems (Whorton and Morgan 1975; Clarke and Wilson 1994). Since a single indicator will seldom be able to give the full picture, it is often useful to employ a wide range of indicators to characterize the different dimensions or aspects of a situation. Unfortunately, this requirement can conflict with the need to identify a fairly limited set of indicators for decision-making purposes, and to minimize double-counting.

A sample definition from the social indicator literature is provided by Rossi and Gilmartin (1980:xiii). They focus on the temporal nature of indicators by defining them as "repeated measurements of the same phenomena over time...the time series allow[ing] the identification of long term trends, periodic change, and fluctuations in rates of change."

In a similar vein, the Jacksonville quality of life report (Jacksonville Community Council 1992:1) describes indicators as "bits of information that reflect the status of large systems. They are a way of seeing the 'big picture' by looking at the smaller piece of it. They tell us which direction a system is going: up or down, forward or backward, getting better or worse or staying the same."

Both of these definitions emphasize the historical trend-identification properties of indicators. They are less concerned with the role that indicators can play as forward-looking instruments. In contrast, the sustainability indicator literature emphasizes the importance of this latter type of indicator, because of the need to monitor progress towards achieving inter-generational equity.

The literature on Healthy City indicators provides one of the broadest indicator interpretations. Konkin (1991:6) defines an indicator as "a summary measure, a tool for monitoring change, which carries with it a degree of implied causality. In this case, causality is the relationship between health problems and/or concerns and the societal, ecological or environmental context in which they occur or to which they can be traced."

The important aspect of this definition is that it emphasizes causal relationships. It recognizes the role of an indicator in measuring linkages between, for example, social and environmental causes and effects, which is important for sustainability.

Hodge (1995:299) offers another broad definition that contains elements not found in any of the previous definitions. He defines an indicator as "a measurable descriptor, quantitative or qualitative, of normative interest which facilitates assessment of the past, current, or future state or performance of system constituent parts, controls, and feedback loops as well as the system as a whole." This variation introduces the idea that indicators are normative in nature, and hence, that they can be used to measure progress towards or away from a desired state. In addition to the normative aspect of indicators, Hodge notes their forward-looking properties and the fact that they can be indicators of either performance or conditions.

Indices

When two or more indicators are combined together, they are known as an "index" or "composite indicator". The major advantage of the composite indicator is that it reduces a great deal of quantitative information to a single number. A key problem in creating an index is the issue of how to weight the individual indicators within the index, since this necessarily involves subjective judgements which may vary, depending on the group that performs the weighting (Carley 1981; LGMB 1994).

Another problem with indices is that their outcomes will depend on the type of aggregation method chosen. Alternative aggregation methods include taking a simple linear sum of the individual indicators, a weighted linear sum, the root-mean-square, or a variety of multiplicative forms.

Deciding how to standardize or aggregate indicators that are measured in different units is a third issue. One solution, as suggested by Opschoor and Reijnders (1991), is to define the indicators with respect to percentage achievement of a set of reference values, such as standards or targets. This procedure transforms the indicators to a unitless measurement scale and allows the indicators to be combined with other indicators into indices. In the absence of reference values, there are various other standardization techniques that can be employed (See, for example, Voogd 1983).

A fourth problem for indices is that they are less transparent than a set of disaggregated indicators, because aggregation can hide important variations in individual indicators. One way that individual variations can be hidden is through "eclipsing" (Ott 1978). Eclipsing may be present in situations where: (i) an index has been created by weighting and then summing the individual indicators; and (ii) a composite standard has been established for the index which, when exceeded, is meant to indicate that one or more of the individual indicators has exceeded its individual standard. With eclipsing, the index may remain below the composite standard even when one or more individual standards are being exceeded. This can occur when most of the individual indicators are nowhere close to exceeding their standards and they therefore compensate for the exceedances of the other indicators.

Composite indicators are most effective if it is easy to understand how they were formulated. For example, one of the most commonly used and readily understood economic composite indicators is gross national product (GNP). It is simply the dollar value of all goods and services produced by a country during a year. By contrast, one of the early environmental indices most frequently cited in Canada, Inhaber's (1974) environmental quality index (EQI), is more complex in its formulation and therefore less easily understood. A dimensionless number, it is calculated as the weighted root-mean-square of values for an air quality index, a water quality index and a land quality index.

The use of indices has been popular in the quality of life (QOL) literature. Indices have been developed to compare QOL in American metropolitan areas (Liu 1976, 1982; Todd 1977; Boyer and Savageau 1989) and in British Cities (Findlay et al. 1988a, 1988b). One of the most successful indices of QOL internationally is the United Nations Development Program's Human Development Index (UNDP 1991). This index combines indicators of income, life expectancy and literacy as a means of quantifying a country's level of development. Numerous environmental indices, most dating from the 1970's, have also been popularized. Ott (1978) is the major source from this era for information on aggregate environmental indices, air quality indices, and water quality indices.

During the 1980's, interest in environmental indices declined, largely because of the problems described above concerning composite indicators. They are now receiving renewed attention, however. For example, the Netherlands has been publishing environmental performance indices annually since 1991. The indices have attracted considerable attention from government officials, the private sector and the general public and have had a significant influence on policy-making in the country (Hammond et al. 1995). A major discrepancy between current levels for one of the indices, the Acidification Index, and a level considered to be sustainable into the future, prompted the Dutch government to set progressively stricter targets for reducing emissions of the major acidification gases measured by the index (SO_2, NO_2, NH_3).

Although the literature on indicators offers a wealth of information on how to define indicators, in a general sense, and how to differentiate indicators from indices, it says very little about sustainability indicators. The following section addresses this neglected issue by proposing several characteristics of sustainability indicators that distinguish them from other types of indicators.

Chapter 3

What is a Sustainability Indicator?

Sustainable Seattle (1993:4) defines good indicators of a sustainable community as those which "are bellwether tests of sustainability and reflect something basic and fundamental to the long term economic, social or environmental health of a community over generations." The United Kingdom's Local Government Management Board defines sustainability indicators as those which "give a measurable indication of progress towards (or away from) sustainability" (LGMB 1994:15). Both of these definitions are rather general in nature. A more specific characteristic is that sustainability indicators do not represent just a collection of environmental, economic and social indicators; they also include "integrating" indicators that illustrate the linkages among these three domains. Gosselin et al. (1991) refer to this characteristic as a sustainability indicator's "synthetic" value. Their example of an indicator that performs well on this criterion is the production of ozone-depleting gases (CFCs and other halogen gases). Depletion of the ozone layer has multiple impacts, with an increase in the incidence of skin cancer generally being considered one of the most serious. A consequence of this and other possible health impacts will be increased health care costs. There is also an inter-generational equity aspect to this indicator, because of the long atmospheric lifetimes of these gases.

Another integrating measure might be the amount of "brownfield" or idle industrial land found in an urban area. This could be considered both as an indicator of industrial activity loss and as an indicator of environmental constraint on redevelopment (if the lands are contaminated). Still another integrating measure would be the unemployment rate, since it is a measure of both economic stress and social stress. One of the integrating indicators used by Sustainable Seattle is the number of salmon returning to spawn in a representative sample of local salmon runs. This indicator is relevant for both an environmental condition (water quality) and an economic vitality condition (survival of one of the Seattle area's most important industries).

Composite indicators, which combine two or more individual indicators, can also be useful as integrative indicators. For example, the cost of recycling per tonne of waste recycled is a simple composite indicator that integrates economic and environmental considerations. As discussed earlier, the construction of more complex composite indicators faces a number of methodological problems associated with the issues of weighting, standardizing, aggregating, and eclipsing. Despite these problems, there is considerable interest in developing urban sustainability indices at the local (Regional Municipality of Hamilton-Wentworth 1994b) and international (Hammond et al. 1995) levels.

A second important characteristic of sustainability indicators is that they must be forward-looking if they are to be used in measuring progress towards achieving inter-generational equity. There are several different ways in which an indicator might be considered forward-looking. The

simplest type of forward-looking indicator would be a "trend indicator". A trend indicator describes historical trends and provides indirect information about future sustainability. For example, it is often obvious that particular paths we are now following could lead to disaster if continued into the future and are therefore not sustainable. However, Ruitenbeek (1991) points out that, because trend indicators provide only indirect information about the future, they are more useful for reactive than for proactive policy-making. This is because a review of trend indicators can signal when corrective action may be needed, but they are poor at anticipating future problems, and cannot help us to design policies that will prevent these problems from happening in the first place.

The forward-looking capabilities of trend indicators can be enhanced if they are linked to reference points that define intermediate or final steps in the move towards meeting sustainability goals. Table 1 presents several examples of reference points that can be used at the local level. The two main types of reference points are targets and thresholds. Whereas targets are levels that must be met in the future if sustainability is to be achieved, thresholds are levels that should not be exceeded. Thresholds are scientifically determined and are known as standards if they possess regulatory status. Targets can be set in a fairly arbitrary manner, by using easily recognized numbers (e.g. reduce solid waste by 50% by the year 2000), by adopting means from higher order jurisdictions (e.g. national or provincial means), or by relating the targets to social norms (e.g. the poverty level). Due to the subjective nature of targets, Hannah (1994) notes that it will probably be much more difficult to achieve consensus over targets than to identify the sustainability indicators themselves.

Table 1. Reference Points for Urban Indicators

Type of Reference Point	**Sample Indicators and Reference Point**
Provincial/National Means	· Municipal household waste production per capita compared with provincial or national means · Municipal household water consumption per capita compared with provincial or national means
Policy Targets	· Percent reduction in herbicide use compared with provincial target · Percent reduction in emission of CO_2 compared with target in local Official Plan
Regulatory	· Number of days/year that ground level ozone exceeds the federal air quality standard · Number of days/year that beaches are closed to swimming due to guideline exceedances for bacteria
Intra-community	· Percent of population living in park-deficient neighbourhoods in one quadrant of the city compared with another · Modal split (vehicle/transit use) in one part of the municipality compared with another
Inter-community	· Levels of PCBs in breast milk in one community compared with other communities · % of land covered by a historical land use inventory in one community compared with other communities

Source: Adapted from Campbell and Maclaren (1995)

The Oregon "benchmarks" are a well known application of the use of targets for reviewing government accountability. In 1991, the Oregon Progress Board released its first benchmarks

report, in which it identified 272 indicators of environmental, social and economic well-being in that state (Oregon Progress Board 1991). The Board also specified a series of targets for each indicator, to be met at regular intervals up to the year 2010. They referred to these targets as benchmarks. The indicators in the report are primarily output indicators (e.g. number of households with drinking water that does not meet government standards) rather than input indicators (e.g. expenditures on water treatment facilities) since a high level of input does not always translate into a similarly high level of output. The indicators and the benchmarks are being used to help set a broad range of program and budget priorities.

Both targets and thresholds are present in the Netherlands' national environmental policy indices. Each index has one or more policy targets set for specified future dates (e.g. the years 2000, 2010) and, in some cases, includes a longer term "sustainability level" which is a scientifically determined threshold. For example, the Eutrophication Index, which measures releases of phosphates and nitrogen compounds to the environment, has interim targets and a final policy target which is determined by the sustainability level. The sustainability level will be reached when the excessive supply of phosphates and nutrients has been reduced sufficiently such that a balance has been achieved between supply and removal from the environment of these two major contributors to eutrophication (Adriaanse 1993).

Another type of forward-looking indicator is the "predictive indicator". Predictive sustainability indicators rely on mathematical models to describe the future state and development of variables describing the environment, the economy, society or the linkages among them. Population levels and population growth are commonly used predictive indicators found in planning reports. Bratt (1991) notes that a weakness of the predictive indicator is that all predictions are inherently disputable and, therefore, the best that predictive indicators can do is to provide plausible information about future conditions. Only trend indicators provide scientifically reliable information, assuming that the data collection methods themselves were reliable.

A third type of forward-looking sustainability indicator is the "conditional indicator". Conditional indicators depend on a form of scenario development and answer the question: "If a given indicator achieves or is set at a certain level, what will the level of an associated indicator be in the future?" This type of indicator recognizes that there is considerable uncertainty in forecasting indicator values into the future, and that it is therefore better to develop a range of forecasts or predictions. The following table from the B.C. Round Table's State of Sustainability Report (1994) provides an example of a conditional indicator of urban form. The "if" indicator is future residential density. The "then" indicator is the total amount of land that will be needed to accommodate the expected urban population of British Columbia in 2021 at each of these density levels. Two different measures of the land area indicator are presented: the amount of land in hectares and the equivalent amount of land currently occupied by the City of Vancouver.

Table 2. Land Area Needed for Cities to Serve Additional British Columbia Residents in the Year 2021 at Various Residential Densities

Housing Density[1] (units per hectare)	Area Needed for Housing (hectares)	Area Needed for Other Urban Functions	Total Area Needed (hectares)	City of Vancouver Equivalents
1.4	479,000	240,000	719,000	64
2.3	290,000	145,000	435,000	38
6.5	103,000	52,000	155,000	14
9.5	70,000	35,000	105,000	9
18	37,000	19,000	56,000	5

1. From lowest to highest, these are the current densities for the City of Kelowna, the City of Cranbrook, Greater Victoria, Greater Vancouver Regional District, and the City of Vancouver.

Source: B.C. Round Table on Environment and Economy (1994)

Sustainability indicators must be able to measure not only inter-generational equity but also intra-generational equity. They should be able to take into account the distribution of conditions (social, economic, environmental) within a population or across geographic regions. Typically, spatially aggregated indicators fail to account for distributive effects. An example is GNP, which may increase even though economic conditions for many groups or different regions in the country are declining (Liverman et al. 1988). Disaggregated indicators can overcome this problem. The City of Toronto's State of the City report (Healthy City Toronto 1993) provides several good examples of indicators disaggregated by age group, gender and census tract.

Sustainability indicators should also be able to distinguish between local and non-local sources of environmental degradation, and between local and non-local environmental impacts. A downstream community may generate very little pollution and display all the characteristics of a sustainable community except for the fact that it suffers from significant upstream water pollution or upwind air pollution. The development of indicators which can identify pollution problems outside the local community's control will facilitate the formulation of appropriate policy responses to geographical inequities. Similarly, sustainability indicators should also measure the extent to which a local community contributes to environmental degradation in other communities, regions, or the world at large.

A final characteristic that distinguishes sustainability indicators from other types of indicators is the manner in which they are developed. Since sustainability is such a value-laden and context-sensitive concept, it makes sense to seek input on sustainability concerns and priorities from a broad range of stakeholders. Consequently, it is usual either to assign full responsibility for making decisions about the selection of sustainability indicators to a broadly-based, multi-stakeholder group or to consult with multiple stakeholders in some other way.

Chapter 4

Frameworks for Indicator Development

Now that the key characteristics of sustainabililty indicators have been identified, it is possible to move on to consideration of an organizational framework for developing such indicators. The first three parts of this chapter describe examples of potential frameworks drawn from several different sources. *State-of-the-Environment reporting* offers experience in developing indicators that measure conditions in the natural environment and human activities that affect environmental conditions. *Healthy City reporting* focuses on indicators of human health and healthy environments. *Quality of life reporting* is dominated by consideration of indicators of social and economic conditions in urban areas. All three types of reporting have developed frameworks that may help in the construction of a general framework for sustainability indicators.

The fourth part of this chapter highlights some of the differences between these three types of reporting and urban sustainability reporting. It then presents three examples of sustainability frameworks and develops a typology of frameworks for sustainability indicators, based on the frameworks reviewed earlier.

State-of-the-Environment Reporting

State-of-the-Environment (SOE) reporting analyzes and describes environmental conditions and trends of significance (Environment Canada 1991b). The more sophisticated SOE reports examine the factors affecting environmental conditions, including relevant environmental policies. Occasionally, SOE reports may also develop general environmental policy recommendations, but, more commonly, they restrict their recommendations to areas for future research or to data collection needs, and act as precursors to the policy-making process. This latter role is typical of municipal State-of-the-Environment reports that have been prepared as background reports to assist in official plan reviews or public health policy formulation (Campbell and Maclaren 1995).

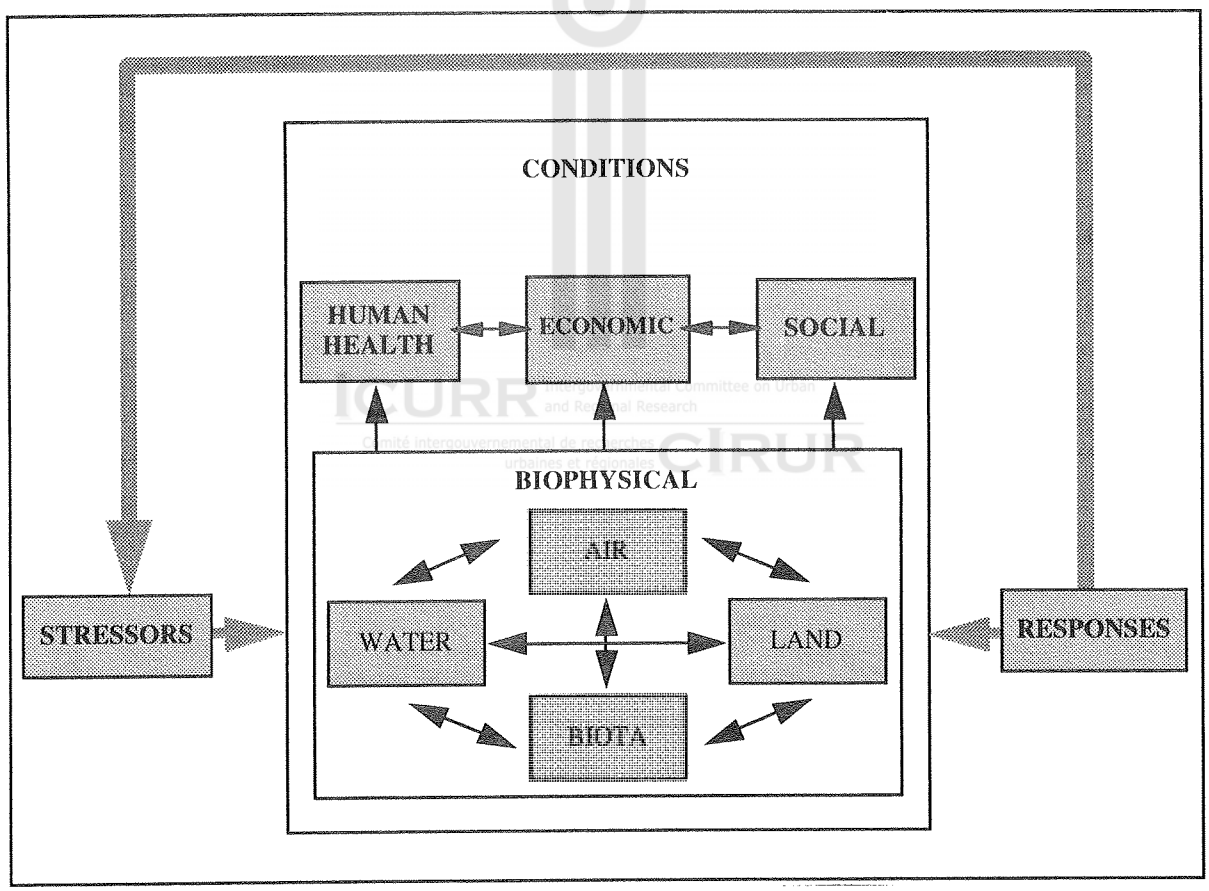
The primary focus of SOE reporting is the natural environment. Social, economic or health conditions are discussed only insofar as they relate to the biophysical environment (Campbell and Maclaren 1995). Thus, SOE reporting is not broad enough to be called sustainability reporting. This becomes clear when examining the conceptual framework that has achieved greatest support in SOE reporting. The framework is known as the condition-stress-response (CSR) framework. Several authorities in Canada have proposed and used frameworks of this type. They include the Canadian Council of Ministers of the Environment with its ecosystems-stressors-programs framework (CCME 1992), and Environment Canada with its condition-stress-management framework (Environment Canada 1991a). The framework is used in Canada's SOE report (Environment Canada 1991b) and has been used most recently at the local level by the Municipality of Metropolitan Toronto in preparing its first SOE report (Metropolitan Toronto Planning

Department 1995). The CSR 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?

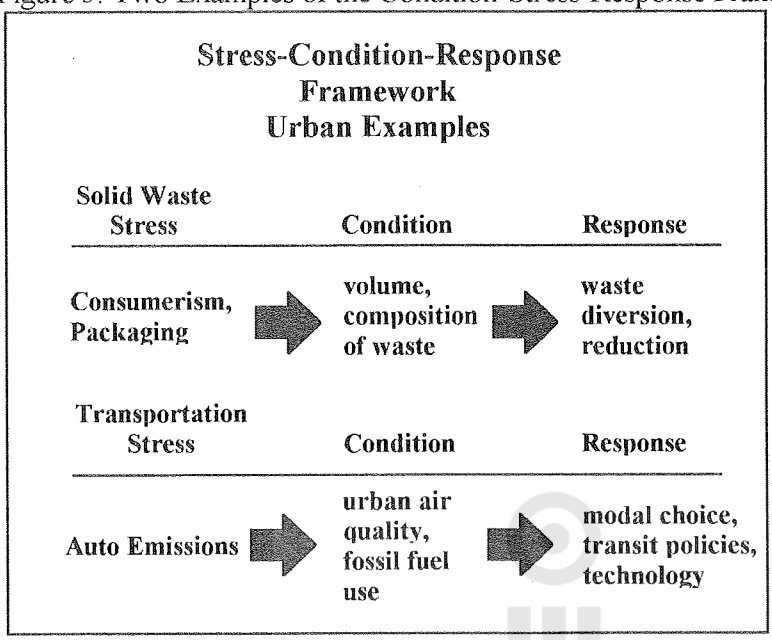
Figure 2 shows how *stressors* arising from human activities affect environmental *conditions*, which in turn impact on economic, health and social conditions. Policy *responses* can alleviate the stressors or modify environmental conditions directly through restoration or clean-up programs. Figure 3 provides two examples of how this framework can be applied to an urban area. A more detailed example of the types of linkages that can occur between human activity stressors and urban environmental conditions is shown for Metropolitan Toronto in Table 3.

Figure 2. Condition-Stress-Response Framework



Source: Campbell and Maclaren (1995)

Figure 3. Two Examples of the Condition-Stress-Response Framework



Source: State of the Environment Directorate (1994), unpublished

The CSR framework recognizes linkages among the environment, the economy and society. It therefore captures an important aspect of sustainability. The framework is limited by the fact that all stressors and responses feed into the biophysical environment. It excludes both stressors and responses that directly affect social or economic conditions. However, by its inclusion of human activities, the framework is highly effective at showing the linkage between the economy and environmental degradation.

The CSR conceptual framework is a key contribution of the SOE literature. With modifications to correct for some of its current weaknesses, it holds significant potential as a base framework for sustainability reporting. The SOE literature is less helpful in another regard. SOE reports and indicators tend to concentrate on past trends and current conditions. As a result, the SOE literature provides only limited guidance on how to develop indicators for measuring progress towards future conditions. One exception is SOE indicators which are linked to standards or targets and thus to an implied, desirable future.

Table 3. Selected Linkages Between Human Activity Stresses and Environment Conditions

CONDITIONS	STRESSES			
	Land Use Change	**Contaminant Loadings to the Land**	**Contaminant Loadings to the Air**	**Contaminant Loadings to the Water**
Soil Quality	Land use change modifies the landscape changing topography and removing topsoil. Urban development displaces the soil's potential as a renewable resource (e.g. agriculture, gardening)	Contaminant loadings to the land pollute the soil from activities such as landfilling, hazardous materials use, transport and storage	Contaminant loadings to the air pollute the soil from atmospheric deposition of pollutant-laden suspended particulates	Contaminant loadings to the water pollute ground water resources and impair soil quality.
Air Quality	Land use change influences surrounding meteorological conditions contributing to the urban heat-island effect. Land use change influences local micro-climate conditions which can intensify air quality concerns (e.g. the canyon effect along streets)	Contaminant loadings to the land pollute the air from methane gas emissions released from waste disposal sites. Contaminant loadings to the land in the form of waste generation can contribute to degraded air quality conditions as wastes are incinerated.	Contaminant loadings to the air contribute to urban smog conditions, stratospheric ozone layer depletion, and global warming.	Contaminant loadings to the water contribute pollutants to the atmosphere from the incineration of sewage sludge following waste water treatment.
Water Quality	Land use change alters natural drainage patterns and interferes with the natural hydrological cycle.	Contaminant loadings to the land pollute the water through leachate migration into ground water and surface waters.	Contaminant loadings to the air pollute the water from atmospheric deposition of pollutant-laden suspended particulates.	Contaminant loadings to the water pollute the water from storm and waste water discharges.
Natural Resources	Land use change consumes natural resources and decreases plant and animal habitat.	Contaminant loadings to the land bioaccumulate in species (e.g. pesticides) and degrade habitat.	Contaminant loadings to the air contribute to global warming and stratospheric ozone layer depletion with their associated effects impairing habitat and species.	Contaminant loadings to the water degrade aquatic habitat and present opportunities for pollutant bioaccumulation.
Human Well-Being	Land use change modifies the landscape and consumes resources interfering with ability to enjoy and appreciate the environment.	Contaminant loadings to the land affect human well-being through contact with polluted soils and ingestion of pollutants through food.	Contaminant loadings to the air affect human well-being through inhalation of pollutants.	Contaminant loadings to the water affect human well-being through contact with and ingestion of food and water.

Source: Metropolitan Toronto Planning Department (1995)

Healthy City Reporting

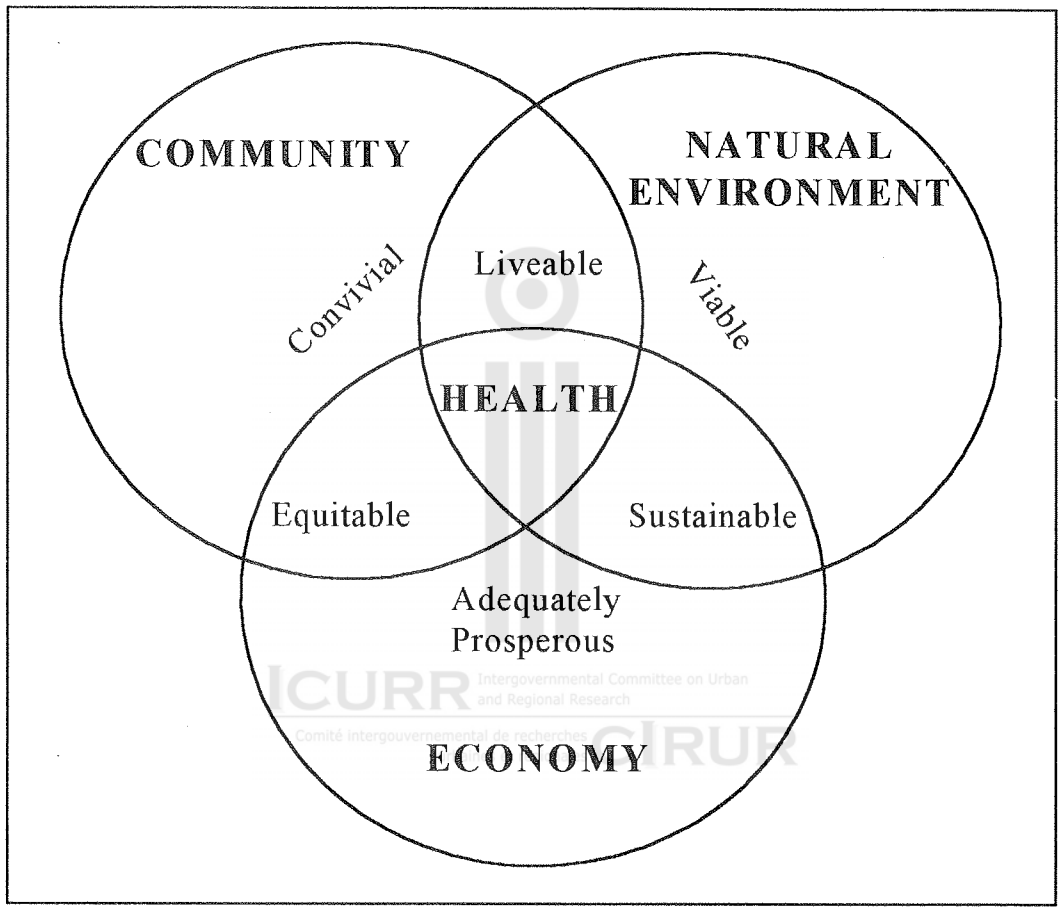
Health has been embedded in the concept of sustainable development since its inception (Labonte 1991); thus it is not surprising that there are significant similarities between a healthy city and a sustainable city. For example, Hancock's (1993) conceptual framework for a healthy city (Figure 4) emphasizes the inter-connectedness of the economy, the natural environment and the community in a manner reminiscent of the holistic elements of sustainable community concepts.

The holistic nature of the Healthy City movement is evident in the following definition of a healthy community:

> A healthy community is one in which people live in harmony with their natural and built environments. Healthy Communities are planned and developed in a way that preserves the natural environment and cultural heritage, encourages community

interaction, provides access to a range of services and leisure opportunities, provides efficient, safe traffic flow, and encourages social diversity and respect for a variety of lifestyles. (Ontario Premier's Council on Health, Well-Being and Social Justice 1993:41)

Figure 4. A Holosphere for Healthy and Sustainable Communities



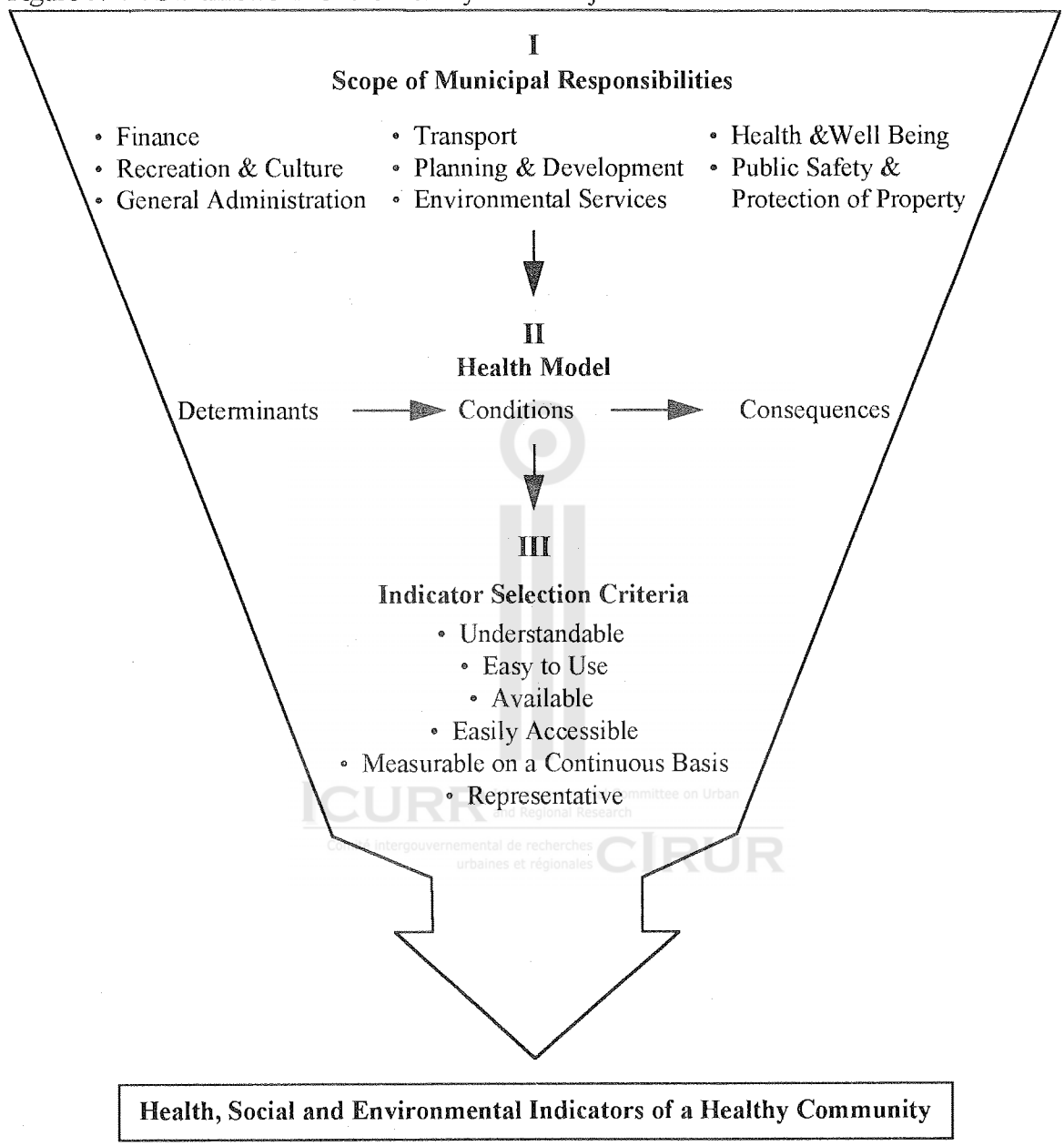
Source: Hancock (1993)

This definition contains many of the concepts that are also found in the sustainability literature. One trait that is very strong in healthy community projects and healthy community reporting is the emphasis on community-based planning. In fact, a healthy city is not just an outcome, but also a process of ongoing community involvement, consultation, and awareness.

Evidence of community-based planning is found in the "Villes et Villages en Santé" (VVS) project initiated in Quebec in 1989. This program centres around municipal decision-making on the issues of health and well-being, with the goal of evaluating the overall health of municipalities. Figure 5 outlines the framework within which health, social and environmental indicators were

selected for the VVS project. A central focus of the framework is the selection of indicators that reflect physical, social and public health conditions in the community.

Figure 5. VVS Framework for the Healthy Cities Project



Source: O'Neill and Cardinal (1992)

Table 4 presents the indicators deemed to represent the three aspects of the healthy community model in the VVS framework, that is to say, the determinants of a healthy community, as well as conditions and their consequences. Although the terminology used in describing indicator types for the VVS framework (i.e. determinants, conditions and consequences) is similar to that used in the CSR framework found in SOE reporting, there are significant differences between the two frameworks. One difference is that the VVS framework mixes policy responses (e.g. seat belts) and stressors (e.g. percentage of the population smoking more than 26 cigarettes per day) in the category labelled "determinants". A second difference is that the CSR framework combines consequences with conditions.

A fundamental principle underlying the Healthy Cities movement is that communities require information to assess their own situations and to take action (Jackson 1991). Some examples of indicators proposed for Healthy City reporting can be found in Appendix B. Many of these indicators can also be found in the City of Toronto's *State of the City* report (Healthy City Toronto 1993). This report was developed as a means of monitoring the city's progress towards achieving its Healthy City vision of environmental sustainability, social equity and economic vitality. The report is written in an easy to read, journalistic style, but, as the relatively small number and limited time span of indicators presented in Table 5 illustrates, this was accomplished at the expense of more detailed statistics on long-term trends and current health conditions.

Table 4. List of Potential Indicators for Measuring the Health of a Community

DETERMINANTS		
Lifestyle		
	Tobacco	• regulations protecting non-smokers
		• % population smoking more than 26 cigarettes per day
	Alcohol	• % population consuming more than 14 drinks per week
	Transportation	• % population not wearing seat belts
		• km bicycle paths per 1000 persons
		• km sidewalks per 1000 persons
	Physical Exercise	• % population exercising 15 minutes or more per week
Environment		
	Population	• rate of population growth
		• % population under 15, over 65, living alone
		• % population single parent families with children under 18 months
		• among all families with same age children
	Economic	• rate of unemployment
	Socio-Political	• % population dissatisfied with social aspects of the community
		• % population with no social support
	Physical	• recreational area per 1000 persons
		• times water unswimmable due to pollution
		• % treated water
		• % population recycling
		• rooming houses per 1000 persons
		• assisted housing per 1000 persons
CONDITION		
Physical Health		
	General	• % population who feel in poor health
	Accidents	• number of injured in car accidents per 1000 persons
Social Health		
	Safety	• number of crimes, fires per 1000 persons
		• existence of emergency services
Public Health		
	Food Poisoning	• number of cases of food poisoning per 1000 persons
	Vaccinations	• % children immunised under 6 months
CONSEQUENCES		
Morbidity Causes		• number of patients hospitalized due to mental illness
Mortality Causes		• number of deaths due to automobile accidents
		• number of deaths due to circulatory illness

Source: O'Neill and Cardinal (1992)

Table 5. Toronto State of the City Indicators

THEME	INDICATOR	MEASURE	TIME SPAN
Economic Life	Employment	% by sector	1992
	Unemployment	rate	1982-92 (quarterly)
	Wages relative to poverty lines	average, by sector	1992
	Low income households	incidence by census tract	1986
Environment	Nitrogen oxides	% by source	1989
	Particulates	% by source	1989
	Carbon monoxide	% by source	1989
	Volatile organic compounds	% by source	1989
	Beach postings (closures) for Western, Eastern and Island beaches	number of days/year	1986-91
	Waste generation	kg/capita/year	1988-92
	Waste landfilled	kg/capita/year	1988-92
	Waste diverted from landfill	kg/capita/year	1988-92
Community Health	Leading causes of death	number, by age group and gender	1990
	Mortality	rate by census tract	1984-88
	Deaths of homeless people	number	1987-90
Transportation	Person trips versus full time office employment	index (1975 = 1.0)	1975-89
	Travel mode	% by type	no date
Safety	Violent crimes	% by type and by gender of victim	1991
	Non-sexual assaults	% by gender of victim	
		% by location (Metro vs. City of Toronto)	1991
		% by age of victim	1991
	Sexual assaults	% by gender and by age	1991
	Charges laid in domestic violence incidents	% by source of charge (victim vs. police)	1990

Note: Only indicators that are presented in graphical or tabular form in the State of the City report have been included in the table.

Source: Healthy City Toronto (1993)

Noack and McQueen (1988) note that Healthy City reporting has been handicapped by a number of methodological problems. One of these is the lack of a theoretical base for identifying appropriate indicators and for interpreting their results. Toronto's State of the City report contains a good example of the quandary posed by this particular problem when it attempts to determine whether or not the city is a "safe" city:

> Without a better understanding of the nature and effects of violence on people's lives, we cannot say whether Toronto is becoming safer. Clearly, we need more research not only on how people's experience of violence influences their use of the city, but also on how the experience of victims affects the population as a whole. (Healthy City Toronto 1993:92)

This type of problem is not unique to Healthy City reporting. Analogous problems can be found in the literature on SOE reporting, quality of life reporting, and even in the fairly new field of sustainability reporting. The presence of similar problems in the four fields, and their conceptual proximity, suggest that some of the solutions found in one field may be transferable to the others. In fact, as noted by Tomalty et al. (1994), one of the key contributions of the Healthy City movement to sustainable urban development has been its promotion of "process" and community empowerment. These lessons have clearly had an influence on the direction being taken by urban sustainability reporting.

Quality of Life Reporting

There has been considerable debate in the literature over the definition of quality of life (QOL) (Carley 1981; Rossi and Gilmartin 1980) and the types of indicators that should be used to measure it (Rogerson et al. 1989). Most definitions of QOL include some recognition of the concepts of "well-being", "happiness" or "satisfaction". Some definitions of QOL emphasize the individual. For example, Naess (1987:14) considers an individual to be experiencing a high quality of life when that individual is "active, relates well to others, has self esteem, and a basic mood of happiness." Other definitions emphasize the relationship between the individual and community or place. The Jacksonville Community Council (1992:1) defines QOL as "a feeling of well-being or satisfaction resulting from external environments." Similarly, Cutter (1985:1) provides a geographical definition in which QOL is viewed as an objective and subjective measure of "social and environmental conditions in a place and how these conditions are experienced by the people living there."

Several definitions of QOL include some notion of "the perceived discrepancy between aspirations and achievement." (Campbell et al. 1976). An elaboration of this notion is provided by Schwab (1992:184):

> Quality of life is the difference between what should be and what is in a community - the difference between goal and appraisal states. Therefore...quality of life is defined as the measurement of the conditions of place; how these conditions are experienced and evaluated by individuals, and the relative importance of each of these to individuals.

This particular definition points to a close association between QOL and sustainability: the idea of a desirable set of conditions, as established by society, resembles the forward-looking attributes of inter-generational equity. In practice, however, most QOL studies completed to date have tended to avoid the measurement of aspirations or the "goal state", and have focused instead on the measurement of existing conditions. One possible reason for this is that relatively few QOL studies have sought a broad consensus in the community about the types of indicators and goals that should be included in the study. Many have been conducted by research organizations or national agencies that have relied totally on secondary data sources.

There is a fairly widespread agreement in the literature that two quite distinctive types of indicators are appropriate for measuring societal well-being. The first type comprises objective indicators, which measure concrete aspects of the built environment, the natural environment, economy and the social domain. The second type is the subjective indicator, which is an evaluative statement of an individual's sense of well-being or satisfaction with a certain aspect of life. Thus, a measure of people's attitude toward crime in the neighbourhood is a subjective indicator, while the number of burglaries or assaults that have occurred in the same neighbourhood represents an objective indicator (Rossi and Gilmartin 1980). Unlike objective indicators, which usually rely on secondary sources for data, subjective indicators require attitudinal data derived from personal interviews or surveys.

One reason for the neglect in the use of subjective indicators in assessing QOL has been the lack of available data. For example, in an ambitious investigation of QOL in 243 U.S. metropolitan areas in the 1970's, Liu (1976) based his choice of indicators on a well-developed theoretical model that defines QOL as the output of a production function containing two variables: physical input variables, which are objectively measurable, and psychological input variables, which are subjective in nature but not interpersonally comparable. Despite the importance of psychological variables in his theoretical model, he specifically excluded consideration of a subjective evaluation of QOL when applying the model, on the grounds that psychological inputs are difficult to measure and require expensive attitude surveys for collection. More recently, in a study conducted for the Centre for Future Studies in Housing and Living Environments at Canada Mortgage and Housing Corporation (CMHC), Murdie, Rhyne and Bates (1992) excluded subjective indicators from their model of QOL for similar reasons. However, they note the serious limitations imposed on their model when subjective indicators are excluded, and suggest how the process for operationalizing the model could be modified for municipalities that have the resources to collect subjective data. Following these suggestions, the Greater Toronto Area Coordinating Committee has conducted a QOL study for the Greater Toronto Area that supplements the objective indicators found in the model developed by Murdie et al. with subjective indicators gathered through an attitude survey.

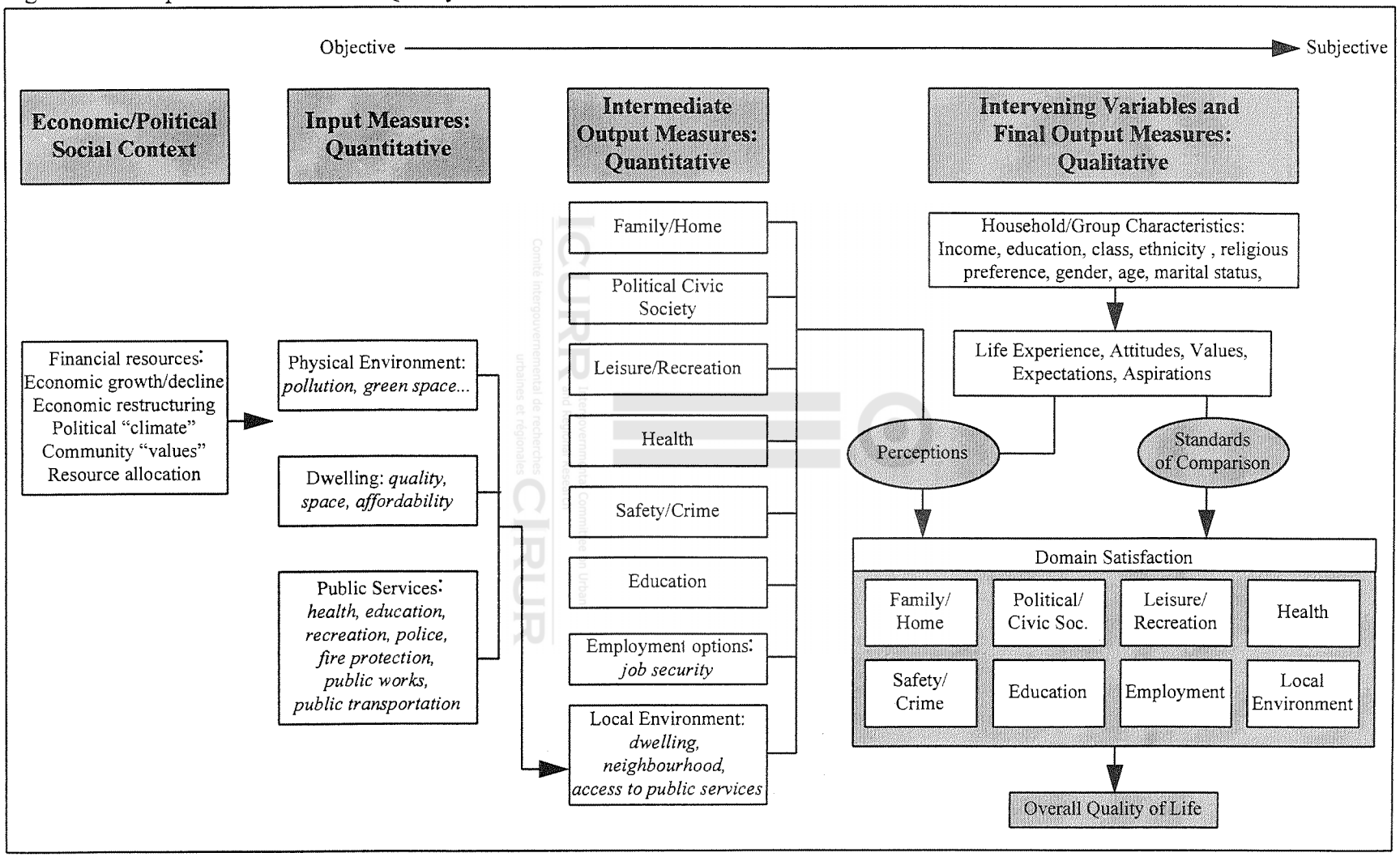
The exclusive use of objective indicators in QOL studies has often been rationalized by assuming that the correlation between the more accessible objective data and the non-measured subjective data was high enough to validate the results based only on the former (Kuz 1978). Support for this view comes from the empirical work of Miles (1985) and Knox and MacLaran (1978). However, results of a number of other empirical studies suggest a very weak relationship between objective and subjective indicators (See Kuz 1978; Greer-Wooten and Velidis 1983; Wish

1986). Andrews (1981) suggests that subjective indicators are only an imperfect measure of a person's actual evaluation of an objective condition, due to mental processes that intervene between the two sets of indicators. Hence, he states that it is not surprising when the two sets of variables are found to be fairly independent of one another. Because of the low levels of correlation found in many of these comparative studies, numerous researchers have concluded that both types of indicators have their characteristic utility and problems, and that both should be included in the measurement and monitoring of QOL (Campbell et al. 1976; Kennedy et al. 1978; Greer-Wooten and Velidis 1983; Cutter 1985; Myers 1987).

Subjective indicators have proven to be an important part of QOL reporting in Jacksonville, Florida. QOL studies have been released on a regular basis in Jacksonville for a number of years and data for subjective indicators are collected every year by means of a telephone survey of city residents (Jacksonville Community Council 1992).

In their CMHC study, Murdie et al. (1992) integrate many of the elements found in the traditional QOL literature into a conceptual framework for QOL at the urban level. This framework, shown in Figure 6, consists of four major segments. The first segment describes the social, political and economic context within which municipal government decisions are made. It is meant to signify the influence that local conditions can have on QOL. The second segment consists of quantitative, objective input measures which are characteristics of the local environment or facilities that are present in the municipality. The third segment lists intermediate output measures, which are the output or outcome of the input measures. For example, expenditure per capita on high school education, an input measure, may be associated with the high school drop-out rate, an output measure.

Figure 6. Conceptual Framework for Quality of Life at the Urban Level



Source: Murdie et al. (1992)

The fourth segment, the most complex, is based largely on qualitative data. Overall satisfaction with quality of life is assumed to be affected indirectly by household characteristics, which in turn are modified by personal characteristics. Both of these affect perceptions of "objective reality" and interpretations of the gap between what is possible or desired and what is being achieved.

Murdie et al. express dissatisfaction with this traditional model for a number of reasons. They note that an extensive amount of data collection is required to operationalize the model, particularly the qualitative elements in the final segment. They question its applicability for policy-making at the municipal level and doubt whether sufficient empirical evidence exists to specify linkages between specific input measures and output measures, or between context and input measures. They then propose a new model which is more holistic and multi-sectoral than the traditional model, and incorporates some of the ideas found in the sustainable development, ecosystems, and Healthy Communities literature.

The basic framework for this new model, known as the Community Oriented Model of the Lived Environment (COMLE), comes from Metropolitan Toronto's "liveable metropolis" concept. The liveable metropolis is defined by the three components of environmental integrity, economic vitality and social well-being (see Table 6). A liveable metropolis is one in which all three components are important and where none is emphasized at the expense of the others. Like the sustainability, ecosystems, and Healthy City literature, this framework recognizes the interactive nature of environment, society and economy, and the importance of balancing all three. It also includes the concept of intra-generational equity in its definition of social well-being and environmental sustainability in its definition of environmental integrity.

Table 6. Components of the Liveable Metropolis

Environmental Integrity: clean air, soil and water, and a variety of species and habitats maintained through practices that ensure sustainability over the long term.
Economic Vitality: a broadly based, competitive economy responsive to changing circumstances and able to attract new investments so that opportunities for employment and investment will be available in both the short and long term.
Social Well-Being: safety and health as well as equitable access to housing, regional, community and neighbourhood services and recreational and cultural activities.

Source: Metropolitan Toronto Planning Department (1991)

Murdie et al. (1992) add a fourth component to the liveable metropolis framework, which they name "cultural congruence". This component, central to much of the QOL literature, measures the extent to which current achievements or conditions match societal norms and expectations. Murdie et al. suggest that standards (such as environmental quality standards or public health standards) and norms (such as those found in the Canada Mortgage and Housing Corporation's concept of "core housing need") are expressions of cultural congruence.

Figure 7 presents the three segments of the COMLE model. The first segment consists of sectors for which municipal government typically has responsibility. The middle segment represents the components of liveability outlined in Table 6, and denotes the factors that should be used in evaluating policies or programs from each of the sectors in the first segment. Finally, the third segment consists of indicators of the liveability components for each municipal government sector. Some sectors, such as the natural environment, will not necessarily be related to all components of the liveability segment.

Figure 8 shows how the COMLE model can be operationalized for the Housing sector. The cultural congruence component is missing from this sectoral model and from all other sectoral models considered by Murdie et al., because of concerns that they have about defining the component and finding suitable measures for it at the municipal level. The selection of specific measures included in the model depended primarily on the availability of data. Murdie et al. note that while the indicators are considered complete, the measures are not definitive. Individual municipalities may find that different measures are better suited to their individual needs. A complete list of indicators and specific measures proposed by Murdie et al. can be found in Appendix B.

Figure 7. A Community Oriented Model of the Lived Environment

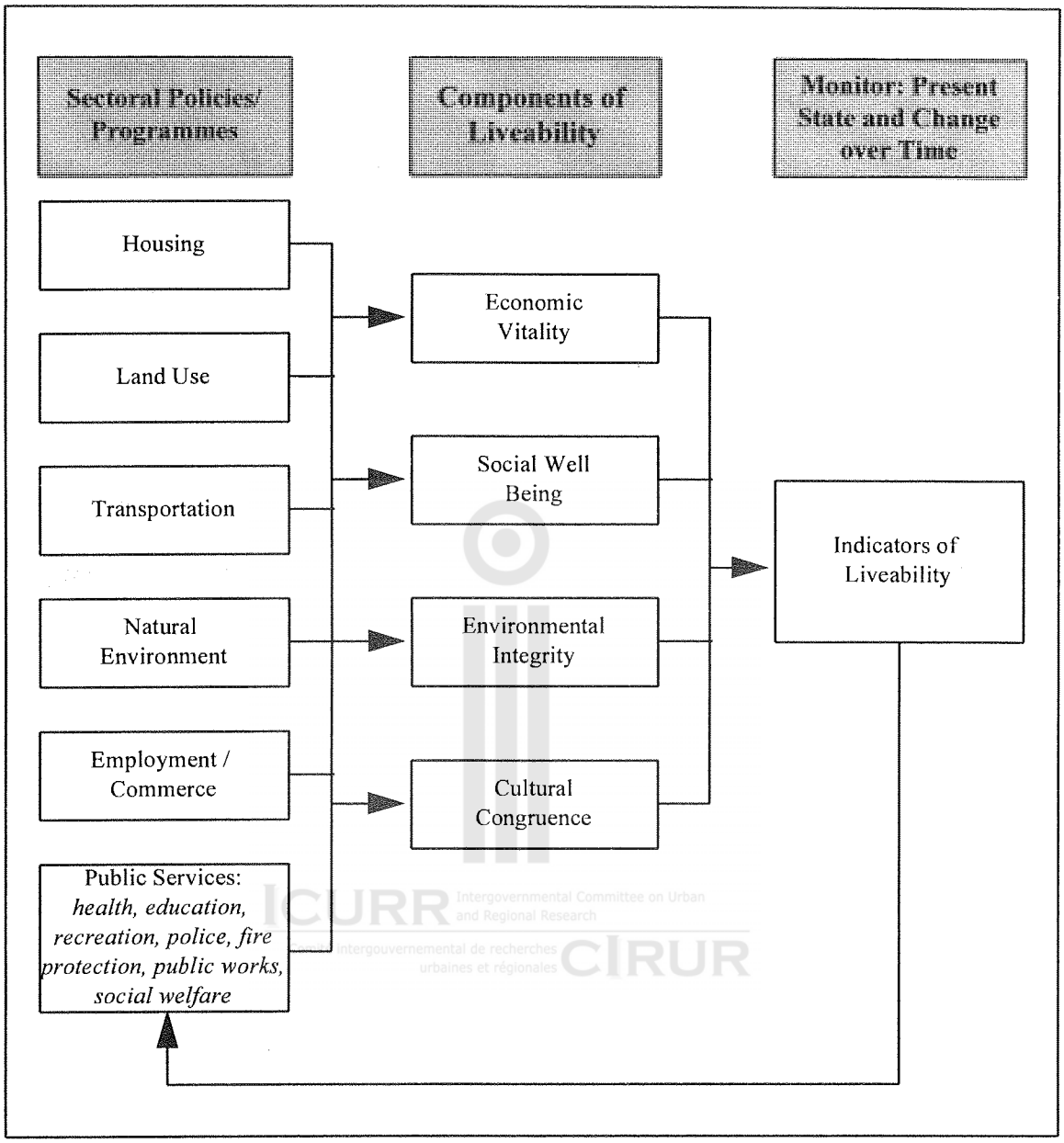
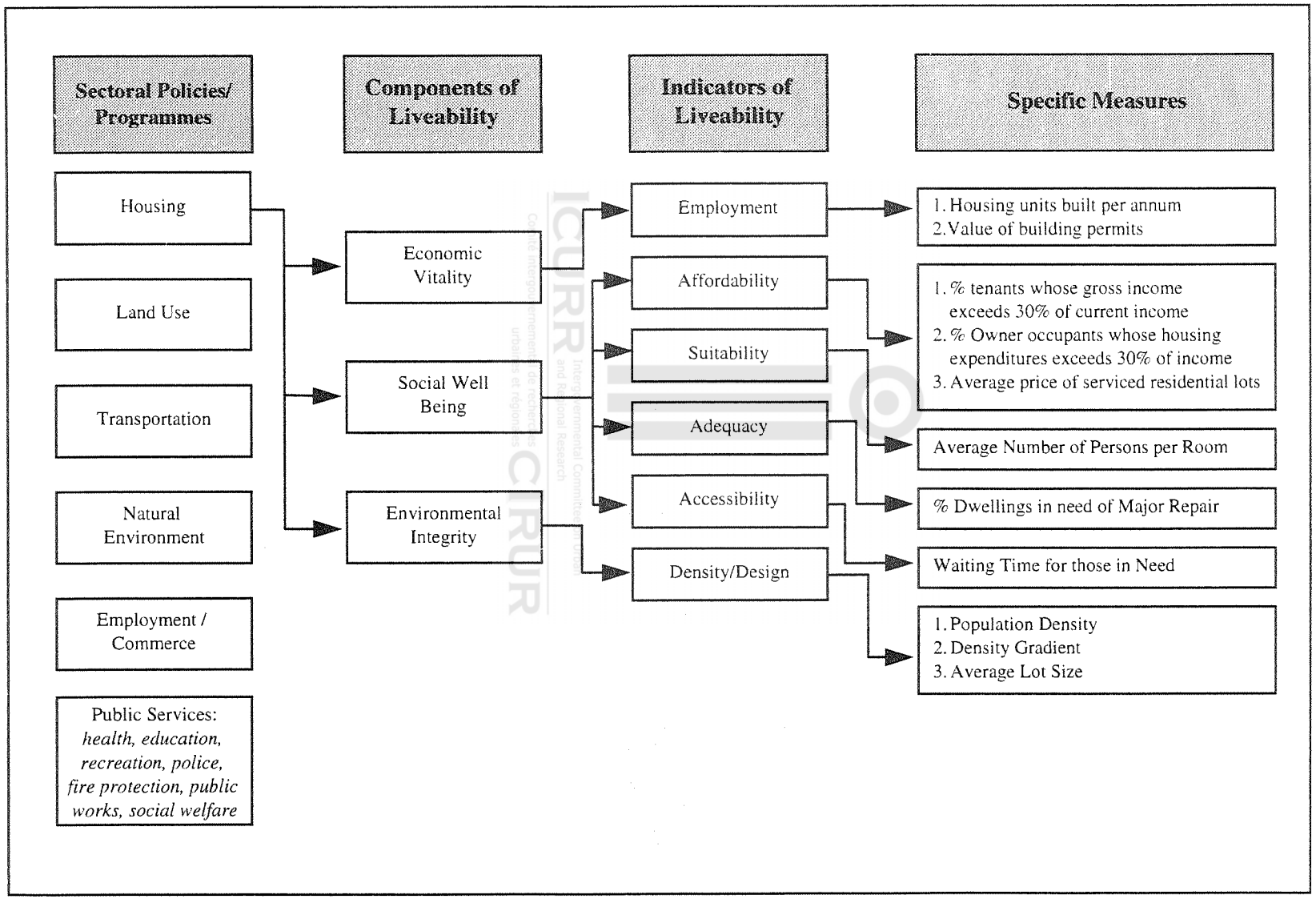


Figure 8. Indicators and Specific Measures of Liveability: Housing



Source: Murdie et al. (1992)

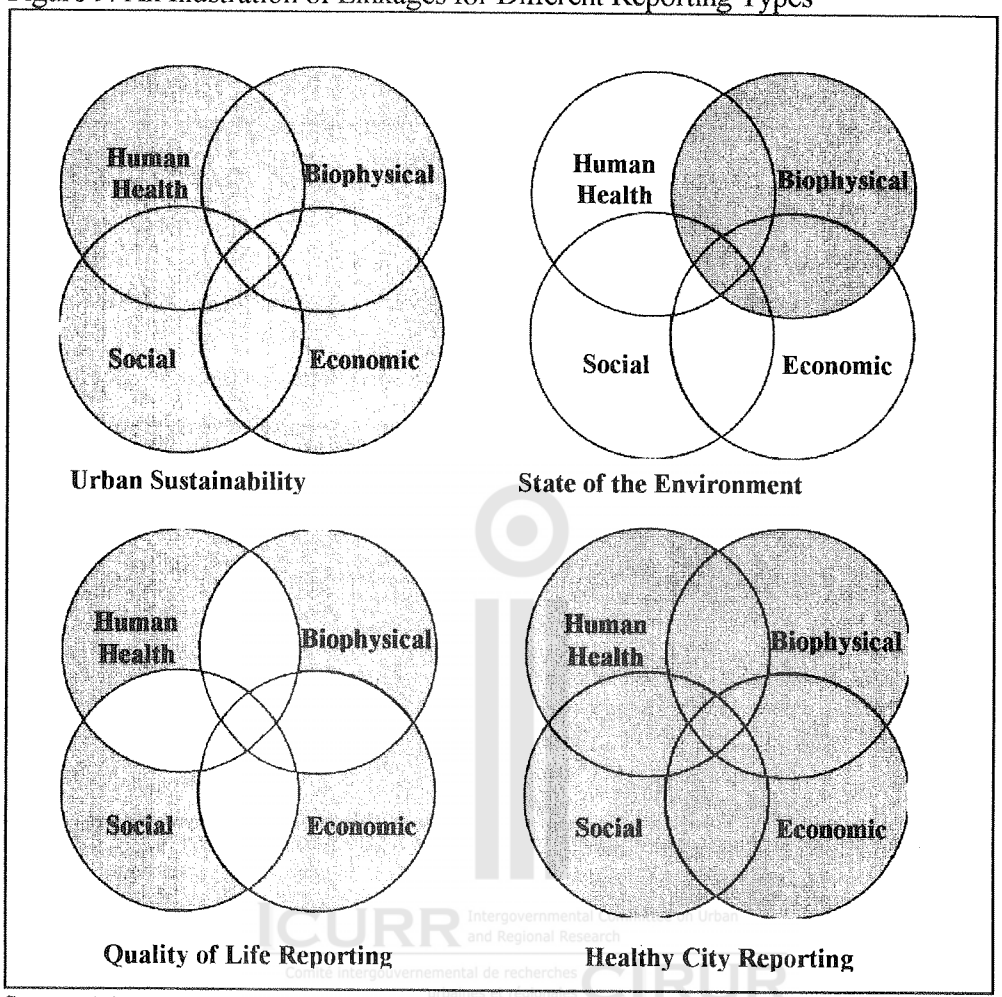
A significant contribution of the QOL literature to the development of sustainability indicators is the wealth of information that it provides about the distinction between objective and subjective indicators, particularly with respect to measurement problems. Subjective indicators have an important role to play in monitoring sustainability, but they tend to have been neglected in the past at the expense of objective indicators (B.C. Round Table on Environment and Economy 1994; Healthy City Toronto 1994). The United Kingdom's Local Government Management Board (LGMB 1994) and others claim that subjective indicators must be included in any list of sustainability indicators because of the strong community-based orientation of sustainability reporting, and the consequent need to measure community preferences and attitudes as part of the sustainability reporting process.

Urban Sustainability Reporting

The material presented in the previous sections suggests that there are some key differences between sustainability reporting and other types of reporting. The shading within the circles in Figure 9 illustrates the focus of each type of reporting. Throughout, health has been included as a separate circle rather than collapsed into the social circle, in order to represent the major contribution of Healthy City reporting.

While State-of-the-Environment reporting focuses on environmental conditions, sustainability reporting focuses on economic, social, and environmental conditions. Another difference between the two is the emphasis of sustainability reporting on the future, whereas State-of-the-Environment reporting has tended to concentrate on current status and past trends.

Figure 9. An Illustration of Linkages for Different Reporting Types



Source: Adapted from Campbell and Maclaren (1995)

The United Kingdom's Local Government Management Board (1994) suggests that the concept of quality of life is a way of interpreting "sustainability" in a manner that is meaningful to the general public. However sustainability is usually understood to be a broader concept than quality of life because it includes the idea of geographical equity and the impacts of a community outside its political boundaries. The concept of inter-generational equity is also missing from the quality of life literature.

One apparent difference between urban sustainability reporting and the other types of reporting reviewed is that sustainability reporting involves not just the reporting of indicators but also the explicit interpretation of the linkages among those indicators (B.C. Round Table on the Environment and the Economy 1994). SOE reporting also considers linkages, but only to the limited extent described above. Traditional QOL reporting, as pictured in Figure 9, tends not to emphasize linkages at all, but the new approach to QOL reporting embodied in the COMLE framework specifically recognizes such interactions. For example, housing programs are shown, in Figure 8, to affect environmental integrity by their design and density of construction.

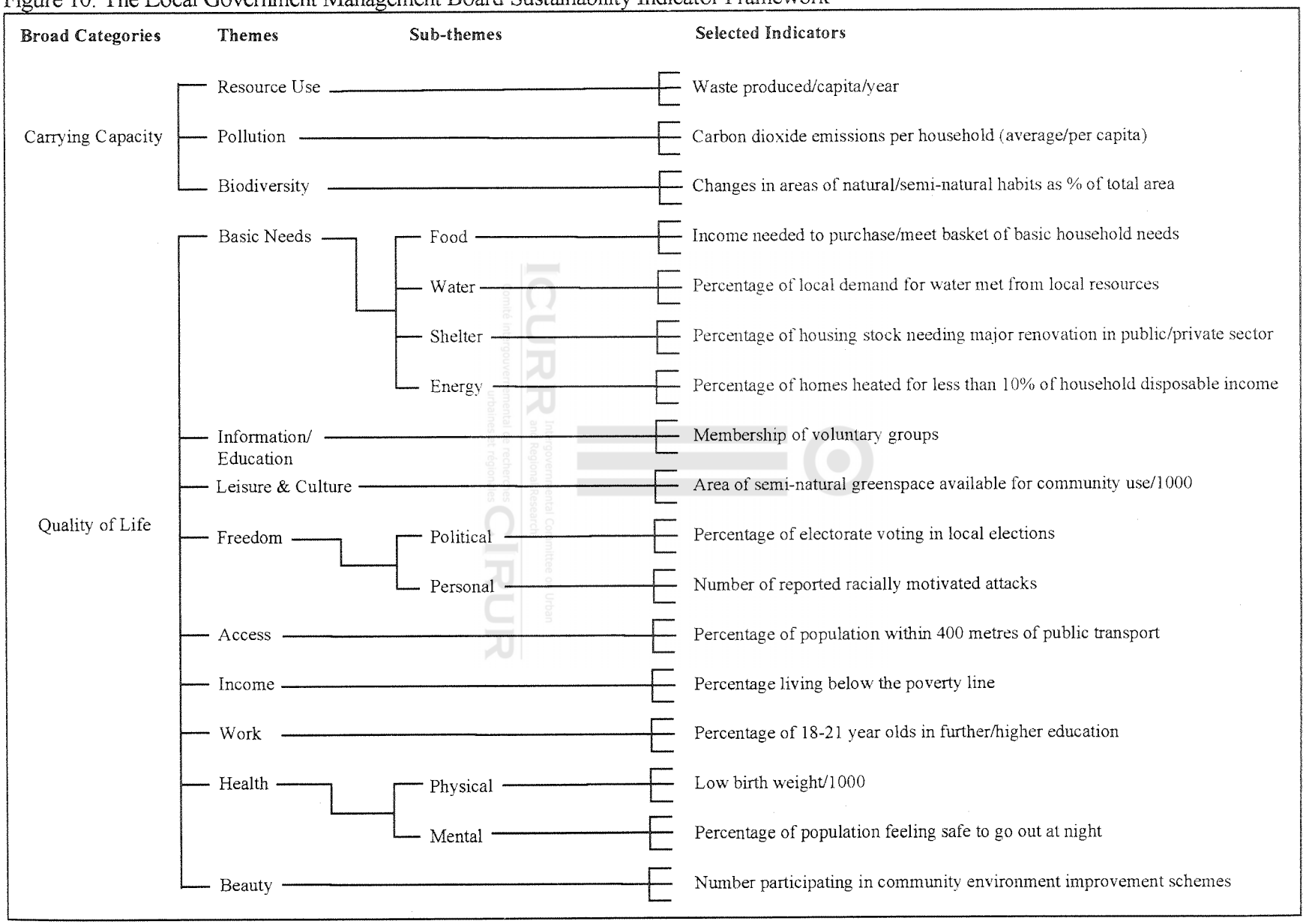
In many ways, Healthy City reporting and Urban Sustainability reporting are similar to one another. Although the former type of reporting emphasizes the human health sphere while the latter type of reporting gives more weight to the environment, both encompass indicators of the environment, the economy, human health and society. The City of Toronto's State of the City report is a good example of a Healthy City report that attempts to highlight important linkages between environment and health, environment and economy, economy and health, and so on.

There are only a few examples to date of studies which label themselves as "sustainability reports". Three of these will be examined in detail as case studies in Chapter 8. Three others, described below, are more conceptual in nature than the case studies. Although only one of them has reached the stage of actually collecting data for a proposed set of sustainability indicators, they present some of the leading ideas on how to organize and formulate indicators for sustainability reporting.

The United Kingdom's Local Government Management Board

The United Kingdom's Local Government Management Board (LGMB) proposes a hierarchical indicator framework consisting of four stages. The framework is illustrated in Figure 10 and described in more detail below.

Figure 10. The Local Government Management Board Sustainability Indicator Framework



Source: LGMB (1994)

Stage 1. *Define sustainable development.* In a precursor study to its work on sustainability indicators, LGMB recognized four key aspects to local sustainability. These are equity, futurity, quality of life and environment (LGMB 1993). These aspects are incorporated into the definition of a sustainable community proposed by LGMB in its indicator framework:

> A sustainable community lives in harmony with its local environment and does not cause damage to distant environments or other communities - now or in the future. Quality of life and the interests of future generations are valued above immediate material consumption and economic growth. (LGMB 1994:43)

Stage 2. *Identify broad categories of sustainability.* The categories chosen by LGMB were "Carrying Capacity" and "Quality of Life". An alternative categorization considered was "Environment", "Society", and "Economy", but this was rejected in favour of the first categorization because the latter was felt to be too familiar and therefore not useful for helping people move towards a new way of thinking. Also, former categorization was felt to be more suitable for dealing with the distinction between local and global environmental issues. Quality of life was felt to be primarily affected by local issues, while carrying capacity was interpreted as a concept with implications that are broader than the local community.

Stage 3. *Identify more specific themes and sub-themes or goals for a sustainable community within the broad categories.* These themes are elaborated upon with the identification of key sustainability factors, which describe the underlying rationale for the theme or sub-theme in the context of achieving sustainability. For example, the "Quality of Life" category contains a theme called "Basic Needs". This theme contains a sub-theme for "Shelter" and one of the key sustainability factors for Shelter is that: "Everyone should have access to adequate housing at reasonable cost."

Stage 4. *Identify candidate indicators for each sustainability factor.* LGMB provides a short paragraph describing selected strengths and weaknesses of each indicator, including the reason why the indicator was chosen, measurement problems that might be encountered, and data availability concerns. Indicators selected for the "Shelter" sub-theme and comments on their selection are shown in Table 7.

Table 7. Indicators for the "Shelter" Sub-Theme in the Local Government Management Board's Framework

INDICATORS	COMMENTS
Number of homeless households in temporary accommodation.	Local authorities are legally required to assist people in defined areas of priority need (Families with young children, pregnant women, and those made vulnerable through old age, physical disability, mental handicap, illness). Easy to understand indicator but information gathering needs to set the context.
Percentage of housing stock needing major renovations in the public/private sector.	Shows unmet need, but not responsive. Will require greater definition.
Percentage of local authority dwellings empty.	Audit Commission Indicator: may stimulate action.

Source: LGMB (1994)

The LGMB framework lists 101 potential indicators under 13 different themes. A representative sample of the proposed indicators is shown in Figure 10. The LGMB invites individual communities to select a much narrower set of indicators from this broad set, according to local preferences, sustainability concerns and, to a certain extent, data availability. Individual communities might also want to adapt the indicators to reflect local circumstances.

Stewart (1995) praises the LGMB report for its groundbreaking work in developing an indicator framework, but notes that several key weaknesses remain. First, the framework provides little guidance on targets and how they should be incorporated. Only a few of the LGMB indicators have some type of reference point. Among these are:

- the percentage of the population living below the poverty line;
- the percentage of housing stock with an energy rating of eight or greater;
- the percentage of population within 400 metres of public transit;
- the percentage of households living within 1 km. of a recycling facility.

Second, Stewart claims that the report provides a definition of "sustainable development" that lacks detail, with the result that it is difficult to determine whether the indicators chosen are adequate for tracking progress towards specific aspects of sustainable development. Third, there is little discussion of how social, environmental and economic indicators inter-relate in the framework.

Hodge's Framework for Systematic Sustainability Reporting

The conceptual framework proposed by Tony Hodge (1993, 1994, 1995) is part of a comprehensive approach for guiding both the process and the outcome of sustainability indicator selection. The first step of this approach is to define the meaning of the term sustainability. According to Hodge, sustainability is "the persistence over an apparently indefinite future of certain necessary and desired characteristics of both the ecosystem and the human subsystem within" (Hodge 1995:73).

At the heart of the Hodge approach is a conceptual framework consisting of four elements or domains that serve as areas of diagnosis for the reporting system. Table 8 describes the scope of each of these domains in the context of sustainability reporting for communities and settlements. The conceptual model is similar to the CSR framework in that it assesses conditions, stressors and responses, but these are organized in a different manner. The Interaction Domain contains indicators of human activity stressors and policy responses. The Ecosystem and People Domains contain indicators describing conditions: environmental conditions in the Ecosystem Domain and social and human health conditions in the People Domain. The Synthesis Domain does not introduce any new indicators but rather describes how the previous three domains link together and determines whether the overall pattern portrayed by the indicators represents a movement towards or away from sustainability.

Hodge makes the important point that the contents of each domain can vary depending on the scale of application. Possible applications include:

- individuals, families and households
- corporations and corporate groupings
- communities and settlements
- regional, provincial, territorial and federal governments

He suggests, for example, that an indicator of the strength of one's personal support network (among family and friends) would be useful for individual sustainability reporting but not relevant for community sustainability reporting.

Table 8. Indicators of Progress Towards Sustainability for Communities and Settlements

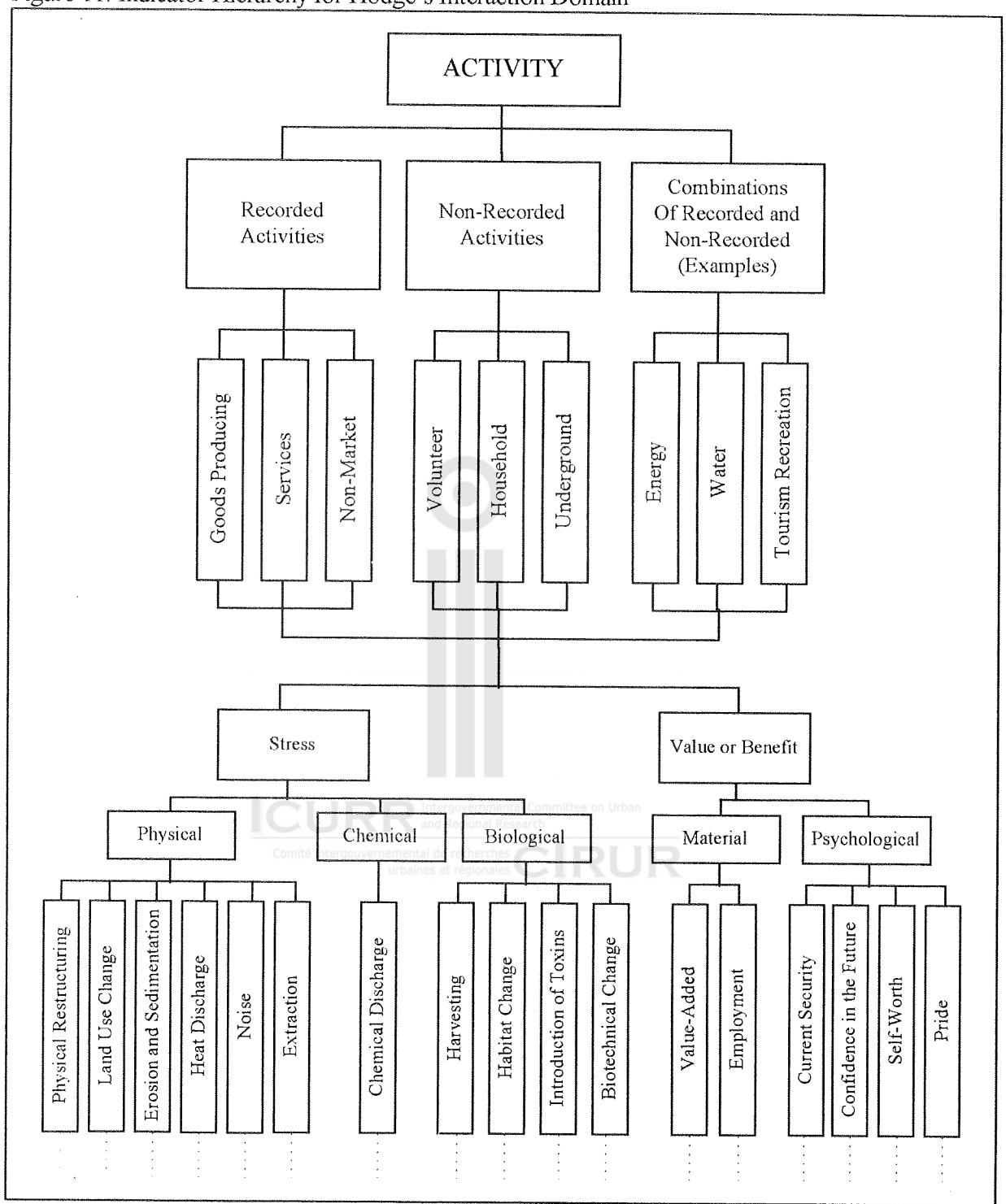
Domain I - Ecosystem: • the health and integrity of the ecosystems (natural, modified, cultivated, and built) with which the community has interaction
Domain II - Interaction between Human Activities and the Ecosystem: • human activity stressors (on physical, chemical and biological conditions) • opportunities for stress reduction and their relative success • opportunities for, and success at, restoration • the record of compliance with laws and regulations
Domain III - People: • the well-being of community members and how that compares to other communities • a profile and valuation of community activities
Domain IV - Synthesis: • key linkages among the three domains

Source: Adapted from Hodge (1995)

A hierarchy of indicator families can be found within each domain of the conceptual model. For example, the indicator hierarchy for the Interaction Domain is shown in Figure 11. It shows the indicators that will be used for measuring and assessing progress towards sustainability.

The top half of the hierarchy contains indicator categories for different types of human activity. These activities feed into the bottom half of the hierarchy as stressors on the environment, and contribute to economic or social "value" that results in enhanced quality of life and the provision of basic needs. To link the two parts of the hierarchy, Hodge relies heavily on such ratio indicators as "generation of contaminant emissions per unit of production" and "waste generation per capita".

Figure 11. Indicator Hierarchy for Hodge's Interaction Domain



Source: Hodge (1995)

The National Round Table on the Environment and the Economy has used Hodge's framework to develop a preliminary "short list" of sustainability indicators for Canada. Their list,

shown in Table 9, gives an idea of the broad range of indicators that are potentially relevant for sustainability reporting at the national level.

Table 9. Preliminary List of Sustainability Indicators Proposed by the National Round Table on Environment and Economy

DOMAIN	INDICATORS
Ecosystem	temperature (daily and trends over time)
	concentrations of common toxic and non-toxic contaminants in indoor and outdoor air
	concentrations of contaminants in water (mercury, DDT, PCBs, etc.)
	concentrations of contaminants in the tissue of fish, birds, wildlife and humans (lead, PCBs, etc.)
	rates of soil erosion
	acid deposition
	loss of wildlife habitat
	the state of genetic (diversity within species) and species (diversity in the no. of species) biodiversity
	species health (births, survival rates, deformities, etc.)
	population shifts of wildlife
Interaction	contribution to social well-being by activity (value-added by manufacturing, services, etc.)
	resource use (per unit of time or per unit of output)
	generation of contaminant emissions per capita/per unit of production and loadings by activity type
	proportion of materials recycled
	renewable resource harvest rates and non-renewable resource extraction rates
	degree of compliance with laws and regulations
People	infant mortality rates and life expectancy at birth
	literacy rates
	incidence of disease
	obesity (adults) and malnutrition (children)
	caloric intake and the proportion acquired from local, Canadian and foreign foods
	employment and unemployment rates
	income levels
	degree of pride in community and culture
	corporate bankruptcies
	level of indebtedness (individual, community and nation)

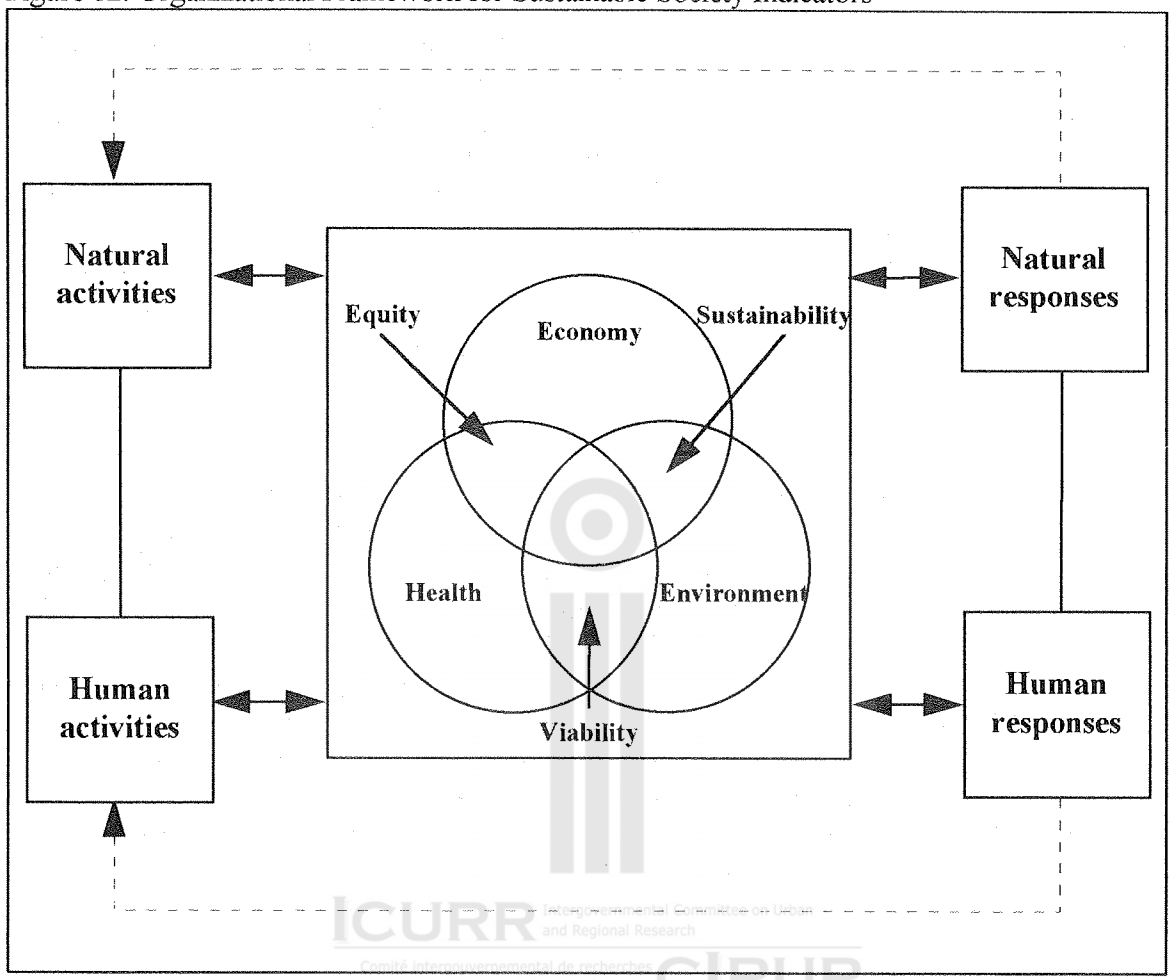
Source: National Round Table on the Environment and the Economy (1993)

Hodge's assessment hierarchy is similar to the LGMB framework in that it defines indicators in a hierarchical manner, moving from broad themes down to specific indicators of sustainability. However, there is a significant difference between the two approaches: the broad themes located at the top of the LGMB framework are sustainability principles, while in the Hodge framework, they are the ecosystem, people, and the interaction between the two. Hodge's assessment hierarchy also shares one of the weaknesses of the LGMB framework. Hodge concedes that his assessment hierarchies do not attempt to map linkages among indicators at the same level of the hierarchy, because they were not designed as complex system models. Also, while the Interaction Domain in the framework highlights the influence of human activity on the environment, it does not include explicit indicators of linkages from the environment to social or economic conditions. These linkages are only considered in a more qualitative sense in the synthesis domain. Regardless of these concerns, Hodge's framework offers a more detailed structure for developing sustainability indicators than does the LGMB framework.

Indicators for a Sustainable Society

The framework for sustainability indicators proposed by Gosselin, Belanger, Bibeault and Webster (1991), in their report, *Indicators for a Sustainable Society* (ISS), builds on the condition-stress-response (CSR) framework found in the literature on SOE reporting. The key difference in the ISS framework (shown in Figure 12), and the CSR framework is the addition of economic and health conditions as they interact with environmental conditions. Human activity and natural activities act as stressors which alter the three conditions and the relationships among the conditions. Economic and health conditions in the ISS framework can be affected directly by human activities, rather than only indirectly through changes in environmental conditions, as in the conventional CSR framework. Gosselin et al. highlight the importance of the intersections of the three conditions in the ISS framework. They refer to the intersection of environment and economy as "sustainability", the intersection of environment and health as "viability", and the intersection of health and economy as "equity".

Figure 12. Organizational Framework for Sustainable Society Indicators



Source: Gosselin et al. (1991)

Two-way arrows between the conditions box and the stressors and responses boxes illustrate another difference between the ISS framework and the conventional CSR framework. They suggest that conditions both receive impulses from, and act upon, stressors and responses. Gosselin et al. do not explain the two-way arrows in their report, but an example of the way in which conditions act upon stressors can shed light on their meaning: Unemployment (an economic condition) can reduce consumer purchasing power, and this, in turn, can reduce waste generation per capita (a human activity).

In contrast to their conceptual diagram which portrays three dimensions of sustainability (economy, environment and health), Gosselin et al. classify their indicators into four dimensions of sustainability: economy, environment, health, and equity (See Table 10). It is worth noting that many of the other indicator frameworks examined in this study combine the equity and health dimensions into a single dimension for "society".

Table 10. Indicators of a Sustainable Society

Theme	Indicator
Environment	Energy consumption per capita
	Dangerous waste products production
	Gas emissions leading to deterioration of the ozone layer
	Gas emissions contributing to the greenhouse effect
	Emission of major atmospheric pollutants
	Emission of major water pollutants
	Ratio of successful forest regeneration to harvest rate
	Area of protected territories
	Total of commercial fish and marine invertebrate catch
Economy	Military expenditures in relation to other government expenditures
	GNP per capita (adjusted for buying power)
	Ratio of number of jobs to population 15 years old and more
Equity	Public aid to and debt of developing countries
	Distribution of personal income/poverty levels
	Recovery rate of secondary materials
	Scholarization and literacy
	Use of public transportation compared to car
Health	Calories per capita, and ratio of food by vegetable and animal origin
	Life expectancy at birth
	Obesity and malnutrition proportions

Source: Gosselin et al. 1991

Synthesis

The indicator frameworks reviewed in this chapter suggest four general frameworks that can be used for developing sustainability indicators. These are: *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), and *causal frameworks*. Examples of each of these are given in Figure 13. The first three types of frameworks are mostly taxonomic in nature, while the last framework emphasizes causal relationships among the indicators. A fifth type of framework, known as an *issue-based framework*, has been added to this list because it is found in some of the case studies presented in Chapter 9 of this report. A sixth type of framework which has not been included in Figure 13 is a *combination framework*. It uses two or more of the frameworks described above.

Figure 13. A Typology of Frameworks 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
- ...
- ...

Issue Based

- Urban Sprawl
- Solid Waste Management
- Crime and Safety
- Job Creation
- Industrial Pollution
- ...
- ...
- ...

Causal

Conditions	Stresses	Responses
• Air Quality	• Automobile Use	• Policies to Encourage Public Transit
• Unemployment	• Inadequate Education	• Special Training Programs
• Human Health	• Air Quality	• Pollution Reduction
• ...	• ...	• ...
• ...	• ...	• ...
• ...	• ...	• ...

Each of the frameworks has its relative advantages. For example, a domain-based framework is most effective for ensuring coverage of the three dimensions of sustainability: environment, economy and society. It can be modified to add categories for linkages among the three domains (e.g. environment-economy, economy-society) and thereby accentuate the integrative aspect of sustainability.

The strength of a goal-based framework is that it reduces the number of indicators that need to be considered to those relating to specified sustainability goals. Use of a goal-based framework and its explicit characterization of sustainability also helps in evaluating whether indicators are showing movement towards or away from sustainability.

A sectoral framework may be most appropriate when the chief target audience is municipal government politicians or staff. The sectors can be tied to individual government departments, making it easier to determine accountability for particular problems or positive results revealed by the indicators. A disadvantage of the sectoral approach is that, because it compartmentalizes the indicators into specific areas of government responsibility, it is therefore not very effective for showing linkages across different areas.

An issues framework may have more popular appeal than the other types of frameworks, but its "shot-gun" approach to developing indicators lacks the structure provided by the explicit links to sustainability or policies found in the other frameworks.

A causal framework has the significant advantage of being able to suggest why certain indicators are rising or falling, and to show whether or not policy interventions are having an impact. The main difficulty with transferring the CSR causal framework found in SOE reporting to sustainability reporting is that the distinction between economic/social stressors and economic/social conditions is not always apparent. In addition, the connection between these types of stressors and conditions may be considerably more complex than that between human activity stressors and environmental conditions.

In practice, a combination framework is probably the most useful type of framework for urban sustainability indicators. The advantage of a combination framework is that it can consolidate the advantages of several individual frameworks while simultaneously overcoming some of their weaknesses.

The indicator frameworks reviewed in this chapter have provided examples of the following single and combination frameworks:

- goal-based (the United Kingdom's Local Government Management Board framework)
- causal (the condition-stress-response framework used by Environment Canada for State-of-the-Environment reporting)
- domain-based and sectoral (the COMLE framework for quality of life indicators by Murdie et al.)

- domain-based and causal (the Hodge framework, Indicators for a Sustainable Society by Gosselin et al.)
- sectoral and causal (the Villes et Villages en Santé framework for Healthy City indicators)

Although none of these examples uses more than two framework types, there is no reason why more could not be used simultaneously. Depending on the purpose and target audience for which the indicators are being developed, it may be desirable to use three or even four of the individual frameworks in combination.

Chapter 5

Indicator Selection Criteria

A methodology for developing sustainability indicators requires not only a suitable framework, but also a set of selection criteria. Commonly accepted indicator selection criteria can be found in the literature on social indicators (Hatrey et al. 1977), urban indicators (Schulman and Bond 1978; OECD 1978; UNCHS 1994), environmental indicators (Pocock 1981; Australian Department of Home Affairs and Environment 1983; Council of Great Lakes Managers 1991; Forrest and Morrison 1991; Carruthers 1994; Environment Canada 1991a), Healthy City indicators (Healthy City Toronto 1994; Flynn 1992) and sustainability indicators (Liverman et al. 1988; Braat 1991; Gosselin et al. 1991; Hodge 1995). The criteria analyzed in this chapter and summarized in Table 11, apply to the selection of all types of indicators and are therefore known as general selection criteria.

Table 11. General Selection Criteria for Sustainability Indicators

- scientifically valid
- representative
- responsive
- relevant to the needs of potential users
- relevant to stated goals
- based on accurate, available and accessible data that is comparable over time
- understandable by potential users
- comparable to thresholds or targets
- comparable with indicators developed in other jurisdictions
- cost-effective
- unambiguous
- attractive to the media

Scientific Validity

Scientific validity is a fundamental requirement for the selection of indicators, yet there is considerable scientific uncertainty over how to measure many of the complex concepts

associated with sustainability, such as ecosystem health and carrying capacity. Scientific validity is an important factor to consider when using causal frameworks, because a scientific basis for links between the stress indicators and the condition indicators selected must be established. With sustainability indices, scientific validity may have a bearing on the mathematical techniques used to aggregate the individual indicators.

Representative

A representative indicator is one which is represenative of the issue of concern or of a broad range of environmental, social and economic conditions. Representativeness is an important characteristic because of the frequently-stated requirement that the number of indicators be manageable and therefore relatively small. (United Kingdom 1994; Regional Municipality of Hamilton-Wentworth 1994).

Responsive

A responsive or sensitive sustainability indicator has been defined as one that can distinguish between normal cycles and movement away from or towards a sustainable state (Liverman et al. 1988). A responsive indicator can be expected to exhibit detectable change during the proposed planning horizon and will respond to changes in external stimuli, such as policy interventions.

Relevant to the needs of Potential Users

This criterion ensures that the needs of the target audience are being met. For example, policy-makers may be most interested in indicators of policy performance, while the general public may want indicators which can be linked with individual behaviour, such as waste generation per capita or level of public transit use.

Relevant to Stated Goals

For sustainability indicators, this criterion means that the indicators should be relevant to a set of sustainability goals, such as those described in Chapter 1, or to a broad vision of sustainability. The Alberta Round Table provides a good example of a technique for showing the relevance of indicators to a vision of sustainability. The Round Table released a Vision Statement in 1991 (Alberta Round Table on Environment and Economy 1991) of what Alberta should look like when sustainable development had been achieved. The Vision Statement consisted of nine sustainability principles and was approved by the Alberta Legislature in 1992. It was subsequently approved by numerous municipalities in the province. In 1993, the Round Table released a follow-up report that identified 59 indicators that could be used to guide the province towards the overall vision embodied in the nine vision elements. Included in this report was a Vision-Indicators Matrix showing the relationship between the indicators and each vision principle (see Table 12).

Table 12. Extract from the Alberta Round Table Vision-Indicators Matrix

INDICATORS	VISION PRINCIPLES								
	The quality of air, water and land is assured	Alberta's biological diversity is preserved	We live within Alberta's natural carrying capacity	The economy is healthy	Market forces and regulatory systems work for sustainable development	Urban and rural communities offer a healthy environment for living	Albertans are educated and informed about the economy and the environment	Albertans are responsible global citizens	Albertans are stewards of the environment and the economy
Air quality index	•	•	•		•	•	•		•
Purchase of ozone-depleting substances		•		•	•	•	•	•	•
Total area of contaminated sites	•		•	•	•				•
Percent of harvested forest that is successfully restocked	•	•	•	•	•			•	•
Condition of major rivers relative to water quality standards	•	•	•	•	•	•	•	•	•
Average education level attained				•		•	•		•
Employment index			•	•		•			•
Volunteer rate				•		•		•	•
Population growth		•	•	•		•	•	•	•

Source: Alberta Round Table on Environment and Economy (1993)

Most indicators selected were relevant for several principles, while three indicators (degree of non-compliance with environmental regulations, number of species at risk, condition of major rivers) were considered applicable to all nine vision principles. The Alberta Round Table report also provided a description of the relationship between each indicator and the vision principles. For example, the description provided for the indicator of major river conditions (measured as the relative attainment of water quality standards at high and low flow levels) states that:

> Rivers are major sources of water for drinking, irrigation, industrial uses and recreational uses. The quality of water in them is also essential in maintaining healthy aquatic ecosystems. Rivers at different flows have different characteristics. At low flow, they have reduced oxygen levels and are less able to assimilate contaminants; at high flow, they have high levels of suspended solids. Thus measuring river quality at both low and high flows is important to ensure that our rivers continue to support both human and non-human uses. (Alberta Round Table on Environment and Economy 1993:20)

Sometimes, as can be seen from this statement, the claimed linkages between an indicator and the relevant sustainability principles are not entirely clear from the explanations provided. This particular description does not help to explain why river conditions are relevant to the principle that Albertans should be educated and informed about the economy and the environment. Similarly, it is not clear why other indicators, such as those for contaminated sites or employment, are not relevant to this principle. Regardless of these minor problems, the matrix approach is a useful one for making explicit the linkages between indicators and sustainability principles.

Sustainability indicators are expressions of public priorities. They should therefore reflect community concerns and have meaning for the community (LGMB 1994). Indicators may also help individuals in the community to become aware of the implications of their own behaviour (LGMB 1994).

Based on Accurate, Accessible and Available Data that is Comparable Over Time

In the short term, this may mean working with indicators which are already being used or for which data already exists. In the longer term, this need not be a constraint since the indicator development process can identify data collection gaps that need to be filled. Involving all stakeholders, including local government departments who might have responsibility for collecting data, in the indicators development process, provides an understanding for all involved of the importance of additional information, and helps build support for future data-gathering exercises.

Understandable by Potential Users

The level of scientific detail that can be understood by different user groups will vary. The scientific content of an indicator must therefore match the assumed scientific knowledge of the target audience. Gosselin et al. (1991) interpret this criterion as "meaningfulness for the potential user". They refer to it as the "symbolic value" of an indicator, and suggest, for example, that an indicator of salmon or cod stocks would have a higher symbolic value to the general public than an indicator of smelt stocks.

Comparable to Thresholds Or Targets

Not only are thresholds or targets important for the development of sustainability indicators, as was discussed earlier in Chapter 3, but they have also received attention in the literature as a general selection criterion for other types of indicators. They are an effective tool for measuring progress towards a variety of goals and are therefore important from a policy perspective.

Comparable With Other Jurisdictions

Fulfilling this criterion allows municipalities to compare their progress towards sustainability with the progress being achieved by other municipalities and facilitates reporting on urban sustainability at the national scale. A disadvantage of this criterion is that some municipalities may not wish to be compared with others. Another consideration is that it may simply not be appropriate to use common indicators for comparing communities with widely divergent social, economic and environmental characteristics.

Cost-Effective

Cost-effectiveness will clearly have to be a consideration when selecting indicators, but cost should not be a permanent barrier against the use of a particular indicator. For example, in the longer term, it may be possible to develop data-sharing programs with other jurisdictions in order to reduce collection costs. The introduction of computerized information systems can also reduce costs in the long run.

Unambiguous

Indicators should be unambiguous. Everyone should be able to agree that a certain direction is desirable. However, many indicators can be interpreted in more than one way. For example, to some people, high rates of economic growth are good because they imply a healthy economy. To others, they are bad because they may be accompanied by environmental degradation and other externalities that outpace the assimilative capacity of the environment. A good example of this latter interpretation can be found in Sustainable Seattle's analysis of rapid population growth in King County, Washington:

> A local economic boom and positive nation-wide publicity have contributed to King County's rapid growth in recent years, although with the recession of 1991 and 1992, the pace has slowed down. Analysts expect the growth rate to decrease slightly through the remainder of the 1990's. It would be difficult to determine what level of human population is sustainable in any given area. But a slowly growing or stable population makes it easier to formulate and implement sustainable policies. King County's rapid population growth is putting pressure on existing infrastructure and on many social and environmental systems; for this reason, it is considered to be moving us away from sustainability. (Sustainable Seattle 1993:11)

Attractive To The Media

Gosselin et al. (1991:27) have as their stated goal the development of indicators that "... could make the front page of newspapers in a condensed form, and be attractive enough to generate more detailed presentation on the inside pages." They provide illustrations of how each of their proposed sustainable society indicators could be represented in graphic form and then summarized in a report card format. This format has become a popular choice for communicating indicator results in sustainability reports released to date.

The 12 selection criteria described in this chapter are not necessarily the only ones that should be used in evaluating indicators, but are simply those which have been most frequently used in the past and appear to be most suitable for sustainability reporting. Additional criteria or modified criteria may be more appropriate for the needs of a particular municipality. Of greater concern than the number of criteria, however, is the difficulty of finding indicators which will satisfy all of the selection criteria, regardless of the number chosen. The reasons underlying this difficulty will be elaborated upon in the next chapter when discussing the evaluation phase of a proposed process for developing urban sustainability indicators.

Chapter 6

Steps in the Development of Urban Sustainability Indicators

This chapter consolidates material from previous chapters that defined sustainability, reviewed alternative frameworks, and identified indicator selection criteria. It outlines a process for developing sustainability indicators. Some of the generic steps in this process have been proposed elsewhere (Environment Canada 1994; B.C. Round Table on Environment and Economy 1994; Healthy City Toronto 1994) and are modified here to fit the context of sustainability indicators.

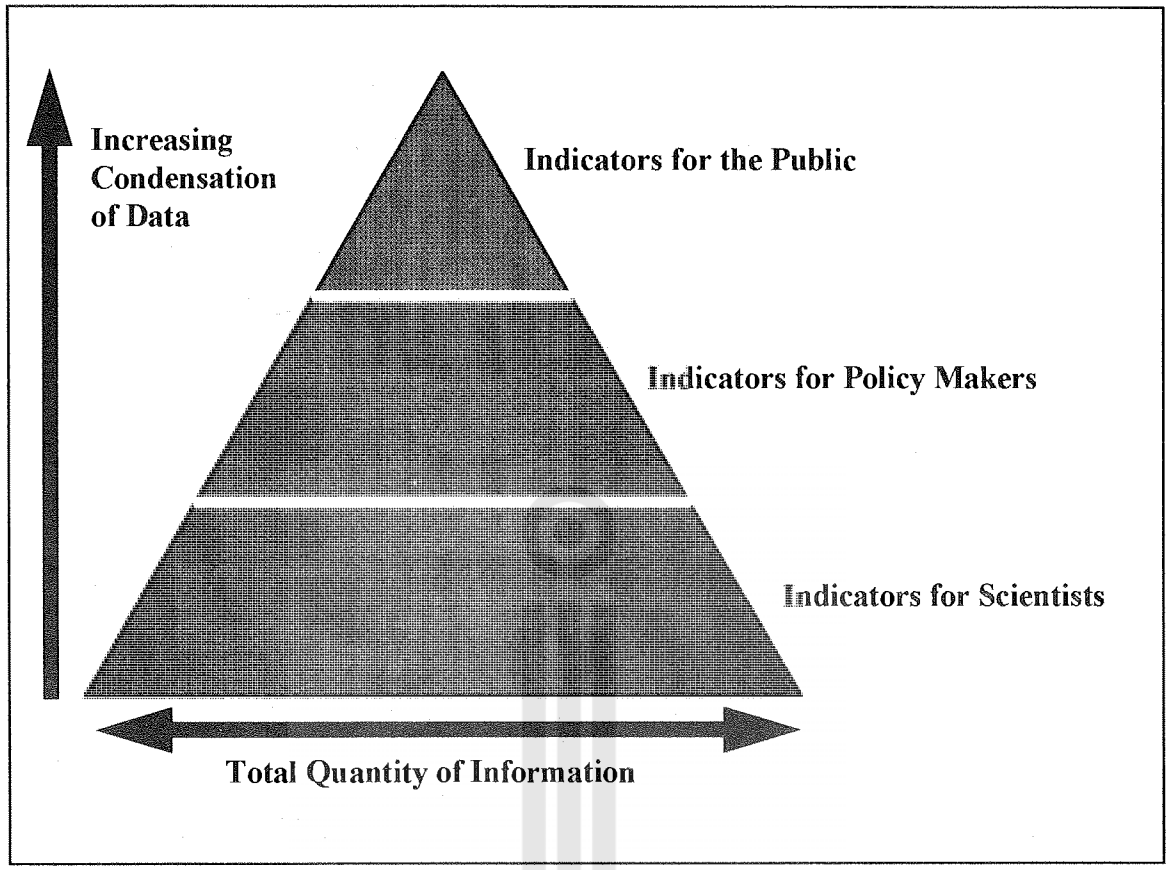
Step 1: Define and conceptualize the nature of the problem and the urban sustainability goals for which indicators are needed;

The urban sustainability characteristics and the range of urban sustainability definitions presented in Chapter 1 may be helpful for this first step. Some jurisdictions (see, for example, the Alberta Round Table on Environment and Economy and the Regional Municipality of Hamilton-Wentworth) have found that a visioning exercise can be a useful technique for articulating sustainability goals. The visioning exercise typically uses a multi-stakeholder, consensus-based approach in identifying how a community should look at some specified future date in order for it to be regarded as a sustainable community.

Step 2: Identify the target audience, the associated purpose for which indicators will be used, and the relative number of indicators needed

The format for presenting indicators and the number of indicators selected will vary according to whether the target audience consists of scientists, policy-makers or the general public. Professional analysts and scientists may be more interested in raw data and a highly detailed set of indicators that emphasize scientific validity and system complexity, but these may not be easily understood by the non-specialist. Policy-makers may prefer information that is directly related to policy objectives, evaluation criteria, and target values. The media and the public may be most interested in a reduced set of indicators that are easy to understand and representative of the issues of most direct concern to them. Figure 14 illustrates how these differing information needs can be conceptualized in the form of a target audience pyramid.

Figure 14. Target Audience Pyramid



Source: Braat (1991)

The shape of the pyramid implies that target audiences at the top will require fewer indicators than those at the bottom. The problem lies in attempting to determine how many indicators are enough, and how many are too many for the intended audience to absorb. Environment Canada (1991a) has made considerable progress towards developing a "core" set of environmental indicators that all provinces will be able to use. A key question that has yet to be resolved is whether or not it is possible to develop a core set of urban sustainability indicators for Canadian municipalities. Since indicator choices are shaped by community-driven sustainability goals and these, in turn, are influenced by local environmental, economic and social conditions, there may be considerable discrepancies among communities in terms of their preferred indicators.

Step 3: Choose an appropriate indicator framework

The relative advantages and disadvantages of different indicator frameworks that were described in Chapter 4 should be taken into consideration when choosing an appropriate framework. For example, if the target audience is the municipal policy-maker, then a sectoral framework may be most appropriate. If it is important to have indicators for monitoring cause-effect relationships, then a causal framework may be most appropriate. Alternatively, a

combination sectoral-causal framework may be most appropriate if the municipal policy-maker audience is concerned about cause-effect relationships.

Step 4: Define indicator selection criteria

The selection criteria listed in Chapter 5 are not necessarily exhaustive, but simply those which have been most frequently used in the past. Additional criteria or modified criteria may be deemed appropriate for the needs of a particular municipality. The urban sustainability goals and target audience chosen in previous steps will influence the way in which the selection criteria are defined.

Step 5: Identify a set of potential indicators and evaluate them against the selection criteria

Brainstorming sessions in a workshop format or questionnaire surveys may be useful ways to identify potential indicators. There is no consensus as to the role that different stakeholders, particularly representatives of the general public, should play during the identification phase. It may be most appropriate to rely on experts in preparing an initial list of indicators, because of the specialized knowledge that may be required in developing such a list. However, all stakeholders will probably want to become involved at the evaluation stage, since some of the selection criteria, such as understandability, cannot be judged by experts alone.

Carruthers (1994) provides a good example of how to evaluate proposed urban green space indicators against a set of nine selection criteria (Table 13). His evaluation resulted in the identification of 22 indicators, out of an original set of 58 indicators, that met seven of nine selection criteria. All of the selection criteria were given equal weight in the evaluation and all indicators were evaluated on a simple two-point scale ("present"-"absent"). More complex evaluation systems could incorporate weighting of the relative importance of the selection criteria and measurement of indicator performance on three-point ("high"-"medium"-"low") or five-point scales.

Gosselin et al. (1991) evaluate 36 indicators against seven selection criteria using a three-point scale for evaluation. Nine of these indicators and their ratings are shown in Table 14. The rating scale ranges from "1" for a low (or poor) rating on a particular criterion to "3" for a high (or good) rating. The overall rating score for each indicator is the average rating across the seven selection criteria. The objective of the evaluation was to select 20 final indicators from the initial list of 36, but the 20 indicators with the highest average evaluation score were not necessarily the ones selected. Other factors taken into consideration were: balance between and within the four categories of environment, economy, health and equity; and consistency with indicators chosen by other agencies, such as Environment Canada and OECD.

Table 13. Urban Green Space Indicators: Evaluation Framework

Indicator	Selection Criteria									
	1	2	3	4	5	6	7	8	9	Total
Proximity to offensive or pleasant views			√	√	√					3
Ambient noise levels	√		√		√		√		√	5
Percent of green management which is volunteered or through public participation				√					√	2
Vandalism (number of reported acts of vandalism within an assessment period)	√	√	√		√				√	5
Number of park benches per km^2				√	√					2
Interior green space area with a set buffer size	√	√	√	√	√		√		√	7
Access to water features	√	√	√		√	√		√	√	7
Green space area/population	√	√			√	√	√	√	√	7
Green space area/income	√	√			√	√	√	√	√	7
Green space diversion	√	√	√		√	√	√		√	7
Degree to which the system would change if humans were removed	√		√	√	√				√	5
The energy required to maintain the functioning of the system as it currently exists			√	√	√				√	4
The amount of native species/ total number of species	√		√	√	√	√		√	√	7

Notes for Table 13:

Evaluation of Potential Indicators with Selection Criteria:

1. scientifically valid;
2. supported by sufficient data to show trends over time;
3. responsive to changes in the environment;
4. representative;
5. understandable;
6. relevant to stated goals, objectives and issues of concern;
7. have a target or threshold level against which these can be compared;
8. either national in scope or applicable to regional environmental issues of national significance;
9. flexible enough to incorporate new scientific information and changing public perceptions.

Source: Carruthers (1994)

Table 14. Evaluation of Sustainable Society Indicators

NAME OF INDICATOR	Scientific Basis	Frequency	Historicity	Geographic coverage	Feasibility (and costs)	Symbolic value	Synthetic value	Avg. Score
Environment								
1. Greenhouse gases net addition	2	3	2	3	2	3	2	2.43
2. Ozone layer depletion gases production	2	3	2	3	3	3	3	2.71
3. SOx and NOx emissions	3	3	2	2	2	3	2	2.43
4. Atmospheric pollutants emissions	2	3	2	2	3	3	2	2.43
5. Air pollutant standards overstepping	3	3	2	2	2	3	2	2.43
6. Water pollutant emissions	2	3	2	2	3	3	2	2.43
7. % of industrials, mining and municipal waste water treatment	2	3	2	2	2	2	2	2.14
8. % of water quality standards overstepping	3	3	2	2	2	2	2	2.29
9. Total protected areas	2	3	3	3	3	3	1	2.57

Notes for Table 14:

Scientific basis: the level of reliability of the measure and its responsiveness to change in policy, program and individual initiatives.
Frequency : frequency of data collection.
Historicity : length of time for which data are available.
Geographic coverage: the potential for spatial disaggregation to the regional, national, OECD and International levels.
Feasibility: the accessibility and eventual costs associated with data collection.
Symbolic value: the cultural relevance and ease of understanding of the indicator for the general public.
Synthetic value: the capacity to incorporate the four key elements (environment, economy, health and equity) into the indicator.

Source: Gosselin et al. (1991)

Environment Canada (1991a) follows a less formal, iterative process for evaluating indicators, where some selection criteria assume more importance than others at different stages of the selection process. During the early stages of the indicator selection process, evaluation is largely internal and the criteria of concern tend to be scientific validity, representativeness, responsiveness, data accuracy and availability. In the final stages of indicator selection, when external comments are invited from interested stakeholders, the dominant selection criteria focus

more on user-related criteria, such as relevance, comparability, relationship to thresholds/targets and ease of understanding.

For the Regional Municipality of Hamilton-Wentworth, the indicator identification and evaluation process is heavily community-driven (Bekkring 1995, personal communication) with the aim of selecting indicators that are acceptable and understandable to the community. For example, the biotic health of fish in Hamilton Harbour is not of as much interest to the community or as interpretable by an individual in the community as is the number of sport fish that are there.

Regardless of the complexity of the evaluation system chosen or the relative importance assigned to different selection criteria, an evaluation matrix, such as the one illustrated in Table 15, is a useful way of organizing the information needed to evaluate urban sustainability indicators. This particular matrix evaluates indicators in the context of a combination framework created by linking together a domain-based, a goal-based and a causal framework. The matrix therefore differs from those presented in Tables 13 and 14 in a number of ways. For example, it includes distinct columns designating the relevance of the indicators to sustainability goals. A second difference is the addition of indicator category headings for integrating indicators that link two or more of the basic elements of sustainability. A third difference is the presence of boxes identifying whether the indicators selected represent a balance of conditions, stressors and responses.

Table 15. Urban Sustainability Indicator Evaluation Matrix

Type of Indicator	Proposed Indicators	Sustainability Goals			General Criteria			Condition	Stress	Response
		A	B	...	A	B	...			
Environmental	1									
	2									
	...									
Social	1									
	2									
	...									
Economic	1									
	2									
	...									
Environmental-Social	1									
	2									
	...									
Environmental-Economic	1									
	2									
	...									
Social-Economic	1									
	2									
	...									
Environmental-Social-Economic	1									
	2									
	...									

A key issue in performing evaluations of urban sustainability indicators is the possible existence of conflicts among the general selection criteria. It may not be possible to find an indicator that fulfils all of the general selection criteria simultaneously. For example, it is possible that some indicators found to be scientifically valid may not be as easily understandable or as relevant to the needs of potential users as those which are more intuitive in nature, and for which there is less scientific support. If such is the case, then decisions will have to be made about the relative importance of the criteria. These decisions are probably best undertaken by means of a consensual multi-stakeholder consultation process, because of the nature of the value judgements involved.

Once such decisions have been made, one of two general approaches can be taken to identify the preferred set of indicators. The evaluation performed by Carruthers (1994) is an example of a one-step procedure where all the indicators are evaluated against all of the selection criteria simultaneously. The evaluations performed by Gosselin et al. (1991), and the approach used by Environment Canada (1994), are examples of a sequential procedure. With a sequential procedure, the most critical criteria or, sometimes, the more objective criteria, are used during the first step of the evaluation, and different sets are used during later steps. Each step of the evaluation reduces the number of indicators requiring further analysis.

The evaluation phase of the indicator selection process used by the Alberta Round Table on Environment and Economy in reducing its initial list of 850 suggested indicators to a final list of 59 offers another approach: a hybrid sequential procedure. The distinguishing characteristic of this approach is that it allows for the introduction of new indicators at later phases of the evaluation if it becomes apparent that certain criteria are not being met by any of the indicators in the initial set.

In the first phase of their evaluation, the Alberta Round Table used seven general criteria[3] which had to be met by all indicators, followed by a second phase in which the indicators were rated relative to attainment of the Round Table's Vision principles (Alberta Round Table on Environment and Economy 1994). At this point, several new indicators were introduced because it was discovered that some vision elements were not well covered by any of the indicators. The third and final phase of their evaluation was the most subjective in nature: Round Table members had to determine whether the selected indicators were capable of adequately measuring progress towards the Round Table's Vision.

Step 6: Choose a final set of indicators and test their effectiveness

Carruthers' (1994) study of urban green space indicators illustrates how to apply this final step in the indicator selection process. He tested six indicators, using 1986 Canadian Land-Use Monitoring Program data to identify Ottawa-Hull urban land cover, and Statistics Canada 1986 Census data for population, income and boundary data in the Ottawa-Hull region. Methodological and data availability problems encountered during the testing reduced the number of suitable indicators from six to three. One of those discarded was a composite indicator of the level of connectivity among green spaces, because it was found to oversimplify and obscure the representation of a diverse and complex phenomenon. A second indicator was discarded because the highly detailed data needed to make the indicator meaningful proved to be unavailable. The third indicator was found to be unsatisfactory because a hypothesized relationship between the amount of green space in an area and income levels did not materialize when tested.

Once the final list of indicators has been tested, it is ready for use. Periodically, however, it will need to be re-evaluated, as a community's sustainability goals evolve, as better data becomes available, as there are advances in scientific knowledge concerning the validity of selected indicators, and as other factors change over time.

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[3] The criteria used were: reflective of stakeholders' concerns, measurable, understandable, responsive, meaningful, data availability, and existence of potential actions to stimulate movement in the indicator toward a specified target.

Chapter 7

An Evaluation of Some Potential Urban Sustainability Indicators

Examples of Potential Urban Sustainability Indicators

There are many indicators of sustainability, proposed in the past or currently in use, that deserve detailed analysis. The tables in Appendices B and C give some idea of their range. This chapter deals only with a limited subset of sustainability indicators, partly drawn from these tables and chosen to illustrate certain desirable indicator properties.

It is also important to state at the outset that the sustainability indicators included in this chapter emphasize applicability at the local level. Some indicators appropriate for use at the national or provincial level are not as appropriate when disaggregated to the level of the individual municipality, and have therefore been excluded from consideration here. In other words, scale has been used as a criterion when selecting the illustrative indicators analyzed below[4].

This chapter describes 16 potential urban sustainability indicators and then analyses the rationale for their use. Some of the indicators are fairly simple in their construction, while others are more complex and require lengthier explanation. Space limitations meant that it was only possible to highlight one or two of the key advantages or disadvantages of each indicator. In practice, a much more detailed analysis of the relative merits of each indicator would be necessary to establish its overall suitability for sustainability reporting. The last part of this chapter presents an evaluation of the indicators, using the combination framework proposed in Table 15, the 11 selection criteria from Chapter 5, and eight of the sustainability goals discussed in Chapter 1.

[4] The value of scale as a consideration in developing indicators can be illustrated by the following example. One of the urban environmental indicators regularly reported by Environment Canada is the percentage of municipal population possessing waste water treatment facilities and the type of facility (i.e. for primary, secondary or tertiary treatment). Within Canada, there is considerable variation in terms of the types of treatment facilities being used by urban residents. Within any individual urban area, however, the vast majority of the population will likely be connected to the same type of treatment system (i.e. the system provided by municipal government), so there will be very little variability in treatment system types, even over time (until a new system is installed). Therefore, this indicator may not be as useful at the local scale as it would be at the national scale.

Exceedances of Air Quality Objectives

The number of times that air quality objectives are exceeded during a given period of time is an indicator used by municipal SOE reports in Canada, by the national SOE report, by Environment Canada's national series of environmental indicators, and by the British Columbia Urban Sustainability Report. One important advantage of this indicator is that data are widely available for many cities in Canada. A second advantage is the presence of scientifically-based National Ambient Air Quality Objectives against which progress can be measured. A disadvantage is that certain pollutants of concern for which objectives have not yet been established will be excluded.

Primary Commuting Modes

Since automobiles are less energy efficient and more polluting per passenger kilometre than alternative forms of transportation such as transit and bicycles, high levels of automobile use in an urban area are not consistent with urban sustainability. Mode of transportation used for commuting or for daily trips is an indicator that has been proposed as a sustainability indicator by the Alberta Round Table, and used by the British Columbia Urban Sustainability Report and by Canada's SOE report. The indicator is typically sub-divided into four categories of transportation: automobile, transit, bicycle, and walking. Decreases in the percentage of trips made by automobile in comparison to other modes of transport is an indicator of decreases in the per-trip emissions of a wide range of pollutants associated with automobile use.

Residential Water Use Per Capita

Water consumption per capita is an indicator found in several Canadian municipal SOE reports, in the Alberta Round Table's sustainable development report, and in indicator bulletins produced by Environment Canada. Increasing levels of water consumption imply increased need for waste water treatment, for water purification, and for the associated energy and material inputs needed to operate such facilities. The indicator is useful for tracking the impact of water conservation efforts, and data are widely available. It is particularly useful for communities that experience periodic water shortages or impose restrictions on water use. According to Environment Canada (1994b), about one in five communities experience these problems.

Adult Literacy Rate

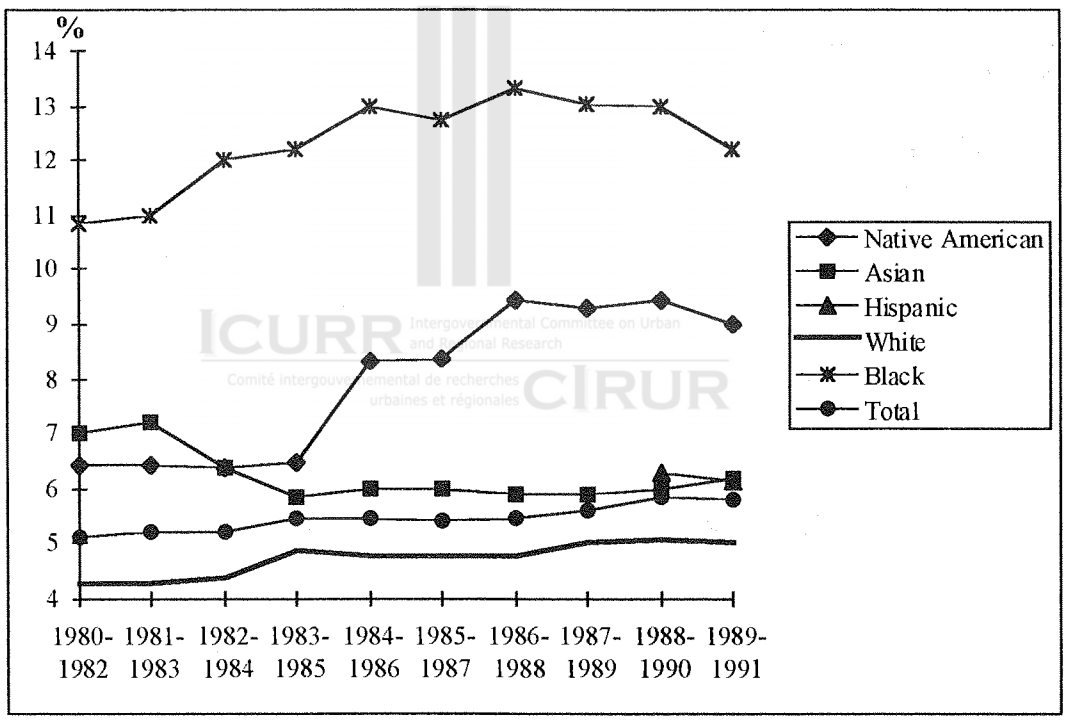
This indicator has been proposed by Hamilton-Wentworth and used by Sustainable Seattle as an indicator of social stress. Sustainable Seattle contends that sustainable communities rely on an informed public, and that literacy is a fundamental requirement for being adequately informed and educated. Illiteracy has been linked with high participation in welfare and other social programs, and with lower earnings (Sustainable Seattle 1993).

Low Birthweight Infants

Low birthweight infants have a much higher risk of death than normal weight infants and, during childhood, are at much higher risk for neurological and respiratory problems. Low birthweight infants are good indicators of the inter-generational equity aspect of sustainability: a decrease in the number of low birthweight infants should contribute to the overall health of the next generation.

Sustainable Seattle argues that this indicator also meets the general indicator selection criterion of representativeness, because it is correlated with a number of other social and economic factors such as low income, poverty during a mother's childhood, limited education, teen pregnancy, poor health habits such as drug use and smoking, poor maternal nutrition, and late or no prenatal care. Data presented in Figure 15 show how disaggregating the incidence of low birthweight infants by ethnic and racial groups highlighted intra-generational inequities in the Seattle region (King County).

Figure 15. Low Birth-weight Infants in King County, 1980-1991



Source: Sustainable Seattle (1993)

Crime rate

The crime rate is a widely used indicator of public safety and social conditions. The British Columbia Urban Sustainability Report notes that efforts to create sustainable communities will have to address the root causes of criminal behaviour. The report also recognizes that there is

considerable debate and uncertainty over the key factors that contribute to increasing crime rates.

The crime rate is typically reported for different crime categories, such as violent crimes (as in the Toronto State of the City Report and COMLE), crimes against persons and property (as in the British Columbia Urban Sustainability Report), and juvenile crime (as in the Sustainable Seattle). Other typical reporting categories include crime rate disaggregated by the location of the crime, and by the victim's age and sex. It may also be useful to report on the public's perception of crime risk in a community, since it may be lower or higher than the statistical crime rate.

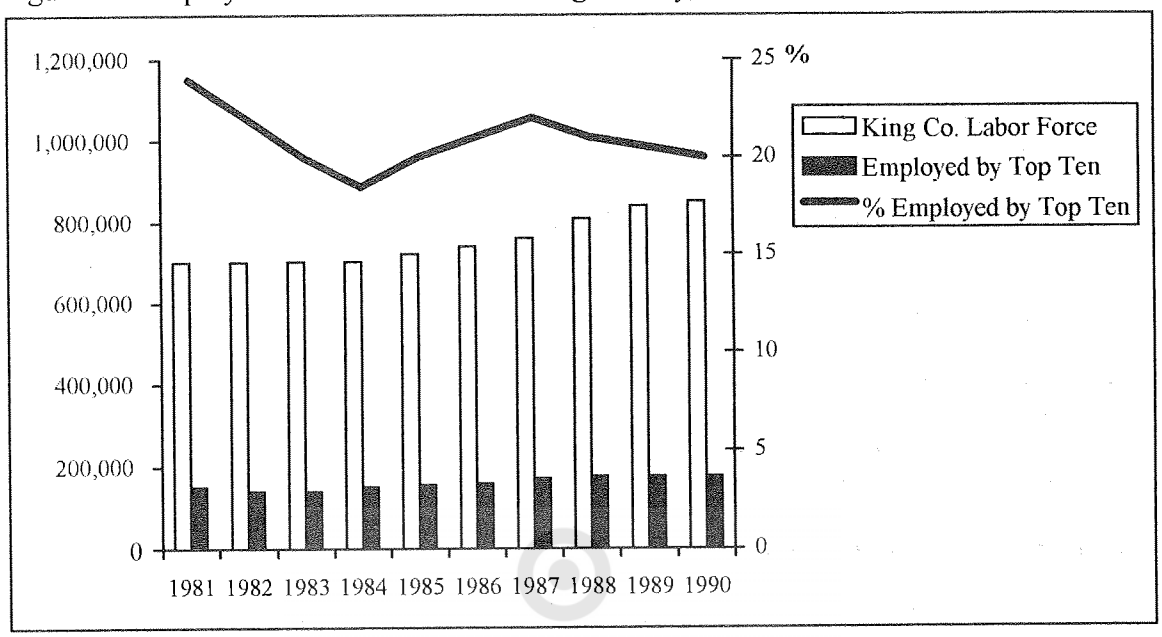
Employment Concentration

An indicator used by Sustainable Seattle and proposed by Hamilton-Wentworth measures economic diversity as the percentage of the local labour force employed by the top ten local employers. The values of this indicator for Seattle from 1981 to 1990 are shown in Figure 16. Sustainable Seattle interprets the trend towards a lower percentage of employment concentration in the top ten employers from 1987 to 1990 as a decline in vulnerability to employment shocks arising from single employer departures, and thus as a move towards sustainability.

Figure 16 also provides an example of how to communicate information on several indicators simultaneously. The clever use of visual aids in presenting indicator data may allow for a larger number of indicators to be included in a core set without overwhelming target audiences with detail. Visual aids may also be more effective than composite indicators at describing complex inter-relationships among different indicators.

Another way to measure employment concentration is by the percentage of employees working in different economic sectors. A very heavy concentration of employment in one sector could indicate a lack of economic diversity, while a significant loss of employment in a given sector over time could indicate a decline in economic diversity. This indicator has been proposed by COMLE and used in the British Columbia Urban Sustainability Report.

Figure 16. Employment Concentration in King County, 1981-1990



Source: Sustainable Seattle (1993)

Value of Building Permits

COMLE proposes the value of building permits issued as an indicator of economic vitality in the community and, more specifically, of employment opportunities in the construction industry. It can also be linked with increases in the local property tax base.

Unemployment Rate

The unemployment rate is an indicator of economic stress proposed in COMLE and used by Toronto's State of the City Report. British Columbia's Urban Sustainability Report uses a related indicator: unemployment insurance recipients. A sustainable community should provide opportunities for its residents to earn an adequate income. The unemployment rate is a measure of the number of people in the community who do not have that opportunity. When reported by sex and age, the unemployment rate can help to identify groups most heavily impacted by short-term and longer term downturns in the urban economy, and which may therefore need special attention from employment creation programs.

Although this indicator typically appears under an "economic" heading in the reports reviewed, it may also be considered a contributor to social stress and a measure of inequity. COMLE recognizes the dual role played by unemployment by listing the overall unemployment rate as an indicator of economic vitality, and then listing employment rates by sex and age as indicators of social well-being.

Low Income Households

The percentage of low income households has been used or proposed as an indicator by almost all reports reviewed for this study. It is an indicator of both economic and social stress. The data are available from Statistics Canada, but only every five years, with the release of national census data. Revenue Canada releases income data annually but only for the annual average individual income level in communities across the country.

Expenditures on Health Promotion and Disease Prevention

Annual expenditures by local government on health promotion and disease prevention has been proposed by Hamilton-Wentworth as a policy response indicator directed at relieving stressors that contribute to poor health. It is relevant for the sustainability principle of individual well-being and can also be considered an economic input indicator of policy performance. A disadvantage of this indicator is that it is an indicator of input rather than output and, therefore, does not provide information on results, such as the level of community health or the quality of health care.

Volunteer Participation in Environmental Restoration Activities

The number of people, or the percentage of the population, participating in volunteer environmental restoration activities is an indicator of community activism, community concern for the environment, and environmental remediation. Although it has been neither applied nor proposed in any of the reports reviewed in this study, a number of related indicators have been advanced. The Alberta Round Table proposes to use the volunteer rate as an indicator of the extent to which members of the community are involved in meaningful and rewarding roles other than paid employment. An indicator of community empowerment under consideration by Hamilton-Wentworth is the percentage of the adult population contributing time to community or service clubs, volunteer programs, sports and recreation.

Green Space

COMLE suggests that average distance to green space can be used as an indicator of social well-being. Carruthers (1994) emphasizes the environmental and aesthetic benefits of green spaces. He notes that, as the average distance to green space decreases, the potential to derive benefits from them increases. Carruthers recommends the use of an indicator which calculates the proportion of land in the urban area within 0.8 km of green space. In practice, it may be easier to measure the average green space per capita in an urban area rather than average distance to green space.

Defensive Expenditures

Expenditures made to prevent or compensate for environmental degradation are referred to as defensive expenditures. As defined by the United Nations (1993:5), defensive expenditures are:

> the actual environmental protection costs involved in preventing or neutralizing a decrease in environmental quality, as well as the actual expenditures that are necessary to compensate for or repair the negative impacts of an actually deteriorated environment.

Estimating defensive expenditures on the environment is an important component of the search for sustainability indicators that are based on environmental and resource accounting frameworks. Environmental and natural resource accounting refers to the inclusion of defensive expenditures and environmental and natural resource losses, such as the loss of mineral and forestry resources, that are currently left out of traditional national economic accounts. The OECD has been a leader in researching this approach internationally; in Canada, some of the most important work at a regional scale is being undertaken by researchers at the University of Victoria's Centre for Sustainable Regional Development. The Centre is developing a regional resource accounting system for the Fraser River basin at the watershed and sub-watershed levels (Prudham and Lonergan 1992; Lonergan 1995, personal communication).

An example of an index that could be used to measure defensive expenditures is the cost-of-repair index. This index represents the cost of cleaning up or restoring the environment to desired levels. It is therefore a form of defensive expenditure. It was originally proposed in the 1970's by Inhaber (1974), Herfindahl and Kneese (1973) and Fiering and Holling (1974) and more recently by Rogers (1993).

Public sector clean-up costs could encompass a wide variety of programs, such as the cost of installing tertiary waste water treatment plants, the cost of diverting additional materials from landfill by means of recycling, the cost of upgrading the energy efficiency of public buildings, or the cost of restoring degraded streams and rivers.

Rogers (1993) suggests that a measure of the cost to industry of cleaning up their effluents in order to meet specified water quality standards could be calculated as follows:

> Cost-of-Repair for Industry = [(the value of production in industry without treatment) **x** (the per unit value of the production cost of meeting the standard)] + [(the value of production in industry with some treatment) **x** (the per unit value of the production cost of upgrading treatment to meet the standard)]

The advantages of this index are that: (a) it uses a single, widely recognized measurement unit, dollars, so that weighting of the different component parts is not necessary; (b) it can incorporate standards or desirable future targets; and (c) it integrates environmental and economic factors.

The disadvantages of the index are that: (a) it can require considerable amounts of data; (b) like many attempts to put an economic value on the environment, it has difficulty capturing the repair costs for intrinsic values (such as loss of aesthetic values or solitude) and habitat loss; and (c) it may not capture the externalities produced by a particular type of repair approach, such as the increase in particulate loadings to aquatic systems associated with the use of scrubbers for improving air quality.

A measure that is conceptually somewhat similar to Roger's cost-of-repair index, but with an urban focus, emerges from Jerrett's (1994) defensive expenditure analysis of municipal budgetary expenditures for the protection of air, water, land and the removal of waste. Table 16 gives examples of the types of municipal programs that incur defensive expenditures, classified according to categories proposed by the United Nations (1993) for national defensive expenditure analysis. An indicator that measures total municipal defensive

expenditures could be used as an indicator of municipal response to both human activity stressors and to degraded environmental conditions.

Table 16. Defensive Expenditure Categories for Municipal Programs

Preventive Environmental Protection

- Health education programs
- Environmental education programs
- Land use planning to avoid conflicts between environmentally incompatible land uses
- Land use planning favourable to public transportation
- Land use planning favourable to resource conservation
- Energy conservation programs
- Public transit programs
- Bicycling and walking promotion programs
- Environmental screening and assessment activities
- Fire prevention programs
- Health and safety inspection programs
- Water works
- Sewer works
- Recycling programs
- Solid waste management programs
- Environmental administration
- Enforcement of environmental laws and related approvals processes
- "Green" purchasing programs

Environmental Restoration (Reactive Environmental Management)

- Contaminated soil clean-up programs
- Watershed management plans and programs
- Reforestation of landscapes and ecosystems through tree planting
- Fisheries stocking programs
- Parks programs
- Environmental administration
- Urban forestry programs

Avoidance of Damage Due to Environmental Deterioration

- Environmental assessment of new developments and municipal programs
- Fire protection activities
- Flood control and stormwater management
- State-of-the-Environment reporting
- Corporate environmental audits of municipal government Water works
- Animal control

Treatment of Damages Caused by a Degraded Environment

- Repairs to buildings, historical monuments, etc. damaged by environmental degradation
- Recycling programs

Source: Jerrett (1995, personal communication)

An advantage of this indicator is that it would fit well with on-going work on defensive expenditures at the national and international levels, and would provide a more comprehensive estimate than currently exists of the economic investment that municipal governments have in environmental protection. Although not as ambitious as Roger's index, in that it excludes private sector expenditures, municipal defensive expenditures data may be easier to obtain. Even so, the amount of data required is still quite extensive, and difficult to derive from current municipal accounts. For example, it is often hard to determine what portion of expenditures in a particular accounting category are defensive expenditures on the environment. In the category of "fire protection activities", what portion of expenditures should be allocated to the prevention of fires or clean-ups associated with toxic chemical accidents, and what portion should properly be allocated to other functions, such as residential property protection? Traditional accounting systems do not make this distinction, so that additional research is needed to arrive at reasonable estimates.

The defensive expenditures indicator also retains many of the weaknesses found in the cost-of-repair index. However, perhaps the most serious problem with this indicator is its ambiguity. Does an increase in defensive expenditures indicate progress towards or away from sustainability? It could be argued that, as defensive expenditures increase, environmental quality will increase because more money is being spent on environmental restoration and on preventing environmental damage that might otherwise have occurred. It could also be argued that an increase in defensive expenditures does not necessarily represent movement towards sustainability because the increase could have come about simply as a result of the need to keep pace with the environmental damage caused by increases in economic and population growth.

Index of Environmental Elasticity

Dufournaud and Rogers (1994) have developed an index that can be used to compare how countries perform on critical environmental indicators relative to critical economic indicators. This index to fulfils the recommendation by Jacobs (1991) that an "environmental impact coefficient" of GNP be developed to measure the environmental impact associated with a one-unit change in GNP. The Dufournaud and Rogers index, which the authors refer to as environmental elasticity (EE), is calculated as follows:

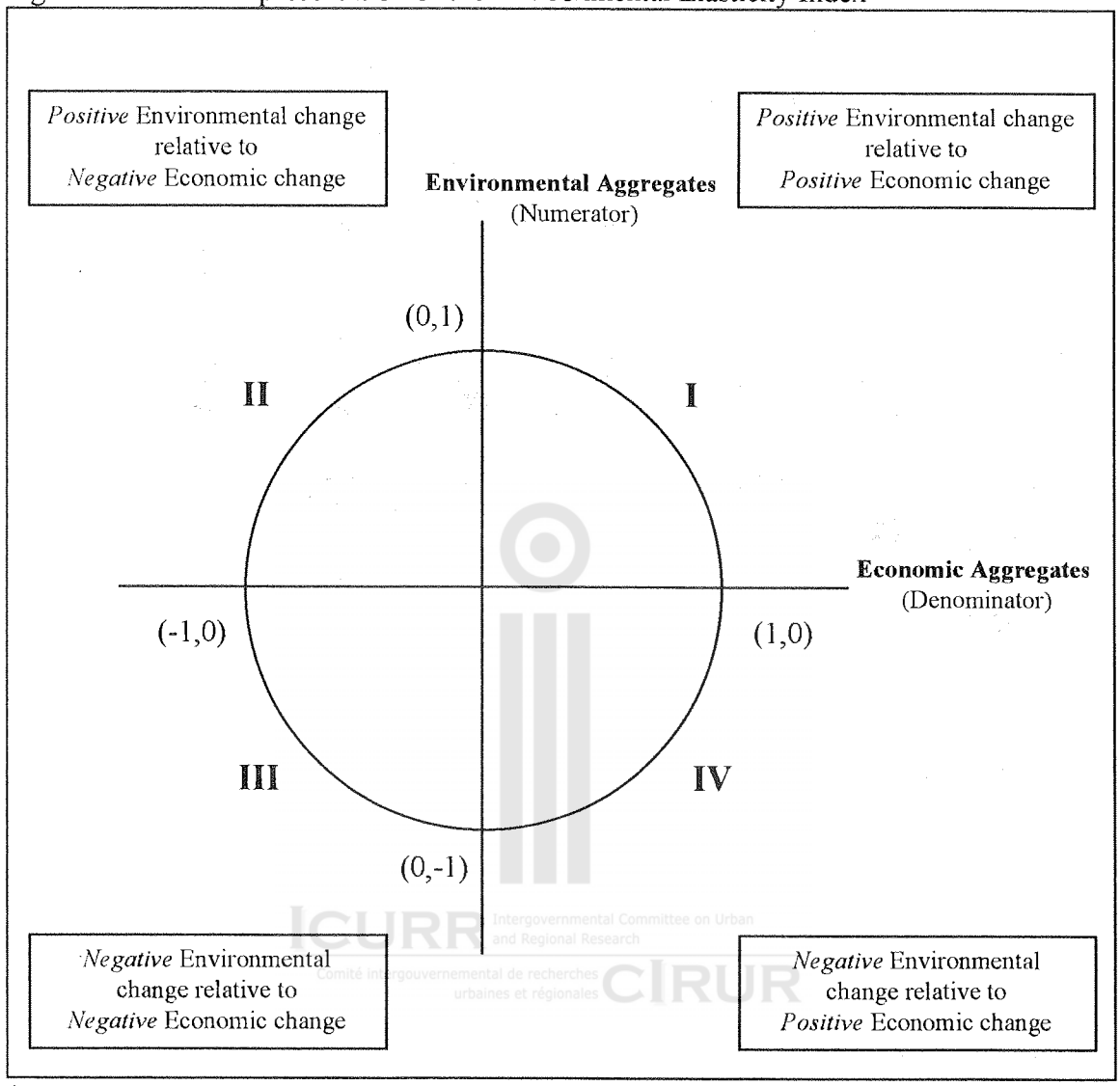
$$EE_k = \frac{\sum_i p_{k,i} \cdot \frac{(x_{k,t+1,i} - x_{k,t,i})}{x_{k,t,i}}}{\sum_j p_{k,j} \cdot \frac{(y_{k,t+1,j} - y_{k,t,j})}{y_{k,t,j}}}$$

where **k** indexes countries, **i** indexes environmental variables (**x**), **j** indexes economic variables (**y**), and **p** represents weights reflecting the importance of the individual variables. The environmental and economic variables included in the equation will vary depending on data availability and on perceived relevance to sustainability. The weights for the environmental variables sum to one, as do the weights for the economic variables. Although Dufournaud and Rogers insert national environmental and economic indicators into the index, equivalent local indicators could also be used to produce a local index of environmental elasticity.

An attractive feature of the index is the method that the authors recommend for communicating its results. This is displayed in Figure 17. EE values in which both the numerator and denominator are both positive fall in Quadrant I, reflecting positive environmental change accompanied by positive economic change. The other quadrants reflect different combinations of positive and negative environmental and economic change. Quadrant I is most desirable in that it indicates simultaneous economic and environmental progress. Quadrant III is least desirable because it signifies declining environmental quality along with a declining economy.

Figure 18 shows how the G7 countries fared on the index between 1970 and 1990. Environmental change is measured by changes in six environmental indicators: CO_2, SO_x, NO_x, water withdrawals, access to waste water treatment, and nitrogen releases, all weighted equally. Except for access to waste water treatment, increases in the environmental indicators are recorded as negative changes. Economic change, measured by changes in current GDP, will be positive when GDP increases.

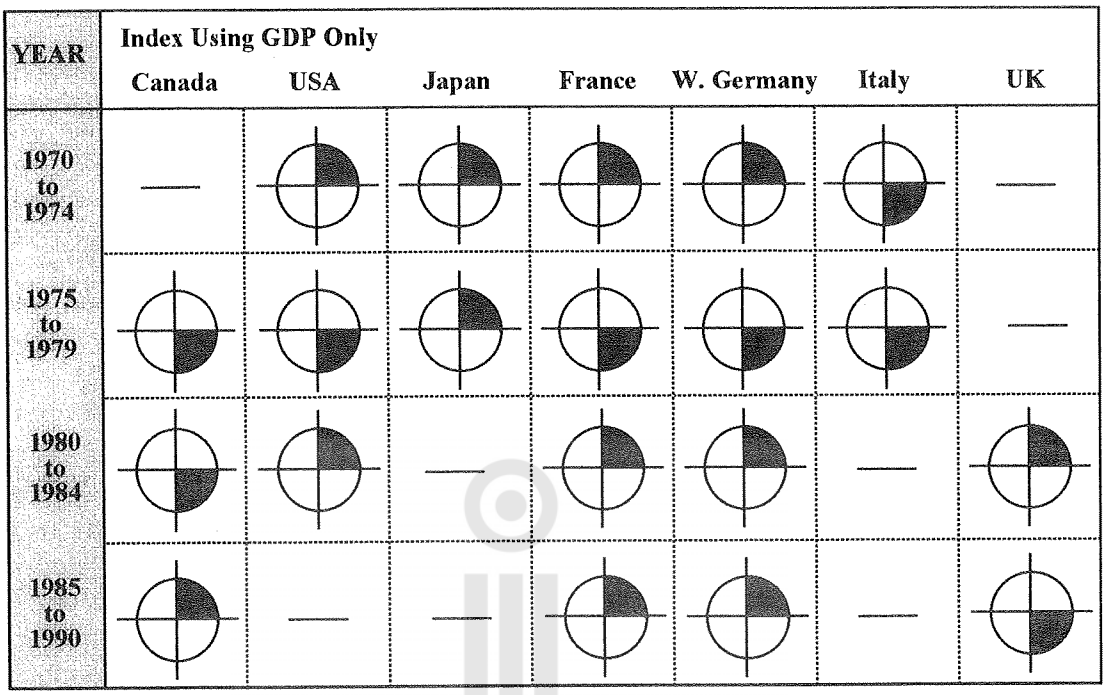
Figure 17. Visual Representation of the Environmental Elasticity Index



Source: Dufournaud and Rogers (1994)

Figure 18 shows that the measure of economic change chosen is not very effective in distinguishing among countries during the period of analysis, because all countries experienced only positive economic change. Hence, there is no shading in the left-hand quadrants of any of the circles. Using constant rather than current GDP might have produced different results. The index is more successful in highlighting differences in environmental change. For example, between 1980 and 1984 only Canada experienced negative environmental change. This result also highlights one of the major weaknesses of composite environmental indicators: they can hide improvements in one indicator when another indicator deteriorates. Between 1980 and 1984, CO_2, SO_x, NO_x emissions declined in Canada, and access to waste water treatment improved, but water withdrawals and nutrient additions increased at a relatively higher rate (Environment Canada 1991b). Consequently, the overall environmental change component of the EE Index was negative.

Figure 18. Environmental Elasticity Index for OECD Countries, 1970-1990



Source: Dufournaud and Rogers (1994)

The advantages of this index are that it is both integrating and relatively easy to understand. Data for most of the environmental variables used by Dufournaud and Rogers are available at the municipal level in Canada. Local economic indicators such as employment, office space vacancy rates, and average personal income would have to be used in the place of GNP. Another advantage of the index is its flexibility. It could easily be modified to reflect "social elasticity" by the inclusion of social variables in the place of environmental variables. It could also be modified to show how environmental conditions have changed in relation to social conditions over a given period of time.

As the authors themselves recognize, one of problems with the index is that it hides changes in individual indicators. There is no guarantee, therefore, that an index value with both positive environmental and economic change is actually reflecting a progression towards sustainability on all of the dimensions being measured by the individual indicators.

Appropriated Carrying Capacity

Carrying capacity has traditionally been defined as the maximum population that a given region can support in perpetuity. Another perspective on carrying capacity emerges by asking the following question: "How much productive land and water area in various ecosystems is required to support the region's population indefinitely at current consumption levels?" (Rees and Wackernagel 1994: 370).

Rees (1992) calls this area of land and water a region's "ecological footprint" and, along with Wackernagel and others, shows how it is possible to estimate the size of the footprint for a typical urban area in Canada (Wackernagel et al. 1993). Interestingly, their calculations demonstrate that an urban region "consumes" much more land than is contained within its political boundaries. In other words, urban regions "appropriate" carrying capacity from other regions and other countries as well as from the past (e.g. fossil fuel) and the future (e.g. badly eroded land that is no longer productive) (Wackernagel et al. 1993). The magnitude of an urban economy's appropriated carrying capacity (ACC) is a measure of the size of its ecological footprint.

Rees and Wackernagel (1994) have calculated the ACC for the 1.7 million residents of the Vancouver-Lower Fraser Valley Region of British Columbia. The residents of this region require 5.1 ha. of land per capita or 8.7 million ha. of land in total to support their consumption of food, forest products and fossil fuel. Since the total area of the region is only about 400,000 ha., the regional population is "appropriating" the productive capacity of an area of land elsewhere that is 22 times greater than the area of land that it occupies.

An important principle embodied in the ACC methodology is that a sustainable economy is one that relies on renewable rather than non-renewable energy resources. Therefore, the ACC associated with energy consumption is the amount of land required for the support of renewable energy production. Wackernagel et al. (1993) suggest that ethanol can be considered an appropriate high-quality, renewable energy substitute for non-renewable fossil fuels. The land consumption associated with renewable energy consumption can be calculated as the amount of land required to grow the biomass[5] needed for ethanol production times the conversion efficiency of biomass into energy.

Another way of determining the land-area equivalent needed for energy production is to calculate the forested land area needed to absorb the excess CO_2 that accumulates in the atmosphere as a result of fossil fuel combustion. Wackernagel et al (1993) show that the size of the forest required to create such a carbon sink is approximately the same size per capita as the land area needed per capita for ethanol production.

The detailed set of instructions provided by Wackernagel et al. (1993) on how to calculate ACC includes the matrix shown in Table 17. This matrix provides estimates of the amount of land in different land use categories required to support the average Canadian's consumption of products and services. Entries in the table for which data were partially missing or about which there was considerable uncertainty are noted by a "?". In total, the average Canadian "consumes" 4.8 ha. of land. This version of the matrix does not include the land required for absorbing solid, liquid and gaseous wastes (other than the absorption of CO_2 implied in the energy calculations). The importance of the assumptions about renewable

[5] Wackernagel et al. (1993), after reviewing a variety of studies on biological productivity and conversion efficiencies for ethanol production, choose fast growing poplar trees as the method of production that has the highest net productivity and the strongest research support.

energy as a substitute for non-renewable energy becomes apparent in this table: almost two-thirds of the ACC consists of land consumed for ethanol production (or, alternatively, for CO_2 absorption).

An example of how the ACC for clothing is determined illustrates the nature of the calculations required to estimate individual ACCs. First, the simplifying assumption is made that the raw material inputs for clothing consist only of cotton, wool and energy. To calculate the amount of land appropriated by cotton, the U.S. consumption of cotton per capita per year (and assuming that similar figures would hold for Canadians) is divided by the U.S. average yield of cotton per ha. per year to give an estimate of the ACC for cotton of 0.02 ha. per capita. A range of estimates is developed for all ACC figures, reflecting different assumptions and different data sources. The ACC range for cotton is from 0.01 to 0.05 ha. per capita. The figure of 0.02 ha. per capita was felt to be the best estimate from within this range.

The advantages of the ACC indicator are that it is conceptually easy to understand, links environmental impacts with economic activity, is a good indicator of geographical equity, and can be modified to show variation by income group and by individual households. One of the disadvantages of the indicator is that it requires an enormous amount of data and research to develop an ACC estimate tailored for a particular community. Another weakness, acknowledged by its authors, relates to the numerous assumptions that must be made about data applicability and environment-economy relationships. A third weakness of the current version of the ACC model has to do with the exclusion of other forms of renewable energy resources, such as solar, geothermal, or wind energy, in the calculations of ACC required for energy production.

Table 17. The Consumption-Land Use Matrix for an Average Canadian (1991)

PRODUCTS AND SERVICES CONSUMPTION	EQUIVALENT LAND CONSUMPTION (all units are in ha/capita)						
	ENERGY (1)	BUILT (2)	GARDEN (3)	CROP (4)	PASTURE (5)	FOREST (6)	TOTAL
FOOD	0.41		0.02	0.60	0.33	0.02	1.38
Vegetarian	0.17		0.02	0.18		0.01?	0.38
Animal Products	0.24			0.42	0.33	0.01?	1.00
HOUSING	0.51	0.06?	0.002?			0.40	0.97
Const'n/Maint.	0.07					0.35	
Operation	0.44					0.05	
TRANSPORTATION	0.98	0.06?					1.04
Motorized private	0.74	0.05?					
Motorized public	0.08	0.00?					
Transp'n of goods	0.16	0.01?					
CONSUMER	0.66	0.02?		0.06	0.13	0.17	1.04
GOODS	0.13					0.04	
Packaging	0.14			0.02	0.13		
Clothing	0.08					0.03?	
Furniture & appl.	0.07					0.10	
Books/magazines	0.07			0.04			
Tobacco & alcohol	0.04						
Personal care	0.12						
Recreation equip.	0.01						
Other goods							
RESOURCES IN	0.36	0.01?					0.37
SERVICES							
REQUIRED	0.07						
Gov't (& military)	0.09						
Education	0.10						
Health care	0.005						
Social services	0.01						
Tourism	0.02						
Entertainment	0.005						
Bank/insurance	0.06						
Other services							
TOTAL	2.92	0.15?	0.02	0.66	0.46	0.59	4.80

Notes for Table 17:

1. ENERGY = commercial fossil energy consumed, expressed as the land-equivalent necessary to produce ethanol
2. BUILT = degraded land or built environment
3. GARDEN = gardens for fruit and vegetable production
4. CROP = crop land
5. PASTURE = pastures for dairy, meat and wool production
6. FOREST = prime forest

Blank = probably insignificant
? = lacking data

Source: Wackernagel et al. (1993)

Evaluation

Table 18 presents a preliminary evaluation of the 16 examples of potential sustainability indicators described above. The table classifies the indicators as simple or multiple domain indicators, and then evaluates them with respect to a set of sustainability principles found in Figure 1, the general selection criteria found in Table 15, and the condition-stress-response framework. A "√" placed in a cell of the matrix means that the relevant indicator is appropriate for measuring attainment of a particular sustainability principle, fulfils a particular selection criterion, or can be classified as a condition, stressor or response indicator. Not all of the columns have been filled because of lack of information or because the judgements are highly user-dependent. For example, without knowing who the potential users were likely to be, it was impossible to fill in Column D, "Relevant to the needs of potential users". A simple checklist was used in this table but more complex methods, such as rating scales, could also have been used as a means of judging the merits of the individual indicators relative to the selection criteria.

Once the table has been completely filled in, a number of decision rules can be used for selecting the final list of indicators. For example, if the aim is to identify no more than ten indicators for a final list, then one way of reducing the current set of 16 indicators would be to sum the number of check marks for each indicator and then choose the ten indicators with the most check marks. On the other hand, this may not be satisfactory if some of the chosen indicators do not meet any of the sustainability goals. If such is the case, then a modified decision rule could be to choose the top ten indicators from among those which meet at least one sustainability goal. A wide variety of decision rules are possible but, ultimately, the particular decision rule chosen will depend on the extent to which each of the selection criteria and each element of the chosen conceptual framework need to be satisfied, and on the total number of indicators desired.

Table 18. Urban Sustainability Indicator Evaluation Matrix Containing Potential Sustainability Indicators

Type of Indicator	Potential Indicator (Examples)	Sustainability Goals								General Selection Criteria											C	S	R
		1	2	3	4	5	6	7	8	A	B	C	D	E	F	G	H	I	J	K			
Environmental	Exceedances of Air Quality Objectives	√		√	√										√	√	√	√	√	√	√		
	Primary Commuting Modes	√		√		√					√				√		√	√	√	√		√	
	Residential Water Consumption	√		√	√										√		√	√	√	√		√	
Social	Adult Literacy Rate		√						√						√		√	√	√	√		√	
	Low Birthweight Infants	√							√		√				√		√	√	√	√		√	
	Crime rate		√						√						√		√	√	√	√	√		
Economic	Employment Concentration						√	√							√		√	√	√		√		
	Building Permits						√								√		√	√	√	√		√	
	Unemployment Rate		√				√		√						√		√	√	√	√	√		
Environmental-Social	Environmental Restoration Activities	√		√											√		√		√	√			√
	Green Space		√			√									√		√		√	√			√
Environmental-Economic	Defensive Expenditures	√		√			√										√						√
	Environmental Elasticity	√		√			√										√				√		
Social-Economic	Low Income Households		√						√		√				√		√	√	√	√		√	
	Health Care Expenditures						√		√						√		√	√	√	√			√
Environmental-Social-Economic	Appropriated Carrying Capacity	√	√	√	√	√					√				√		√		√	√	√		

Notes for Table 18:

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 is comparable over time
F. Understandable by potential users
G. Comparable to thresholds or targets
H. Comparable with indicators developed in other jurisdictions
I. Cost effective to collect and use
J. Unambiguous
K. Attractive to the media

C = Condition, **S** = Stressor, **R** = Response

Chapter 8

Case Studies: The Development and Application of Sustainability Indicators

This chapter presents several detailed case studies of urban sustainability indicators in use. The most widely known example of a community undertaking sustainability indicator development in the United States is Seattle. In Canada, Hamilton-Wentworth is one of the leading examples of urban sustainability reporting. When developing indicators, both of these communities relied heavily on a community-based approach. The third case study is the British Columbia urban sustainability report, the only example of urban sustainability reporting at the provincial level in Canada to date. Each case study traces the steps taken to develop the indicators, describes the presentation of results and comments on how the indicators have been used in practice. The chapter concludes with a brief overview of sustainability indicator initiatives in Richmond, British Columbia and the Fraser Basin.

Sustainable Seattle

Background

Sustainable Seattle is the name of a multi-stakeholder group that was established in 1990 as a volunteer network and civic forum for the promotion of community sustainability. It is very much a community-based initiative whose membership includes representatives from the general public, business, environmental groups, social activist groups, city and county government, labour, religion, and education. The primary purpose of this group since its establishment has been to develop a set of sustainable community indicators that will lead to a longer-term effort to stimulate positive change in the community. Sustainable Seattle is administered by the local YMCA and governed by an independent board of trustees. Most of the work conducted by the group has been done by volunteers. Financial assistance has been provided by a limited number of grants and donations from individuals, businesses and foundations.

After development of their sustainability indicators, future plans for Sustainable Seattle include: creation of programs to promote the development of sustainable homes, businesses and communities; possible development of a "Sustainability Impact Assessment" to help individuals and the community as a whole to think through the broader impacts of major policy or development decisions; and continued sponsorship of forums for dialogue and networking.

Definition of Sustainability

Sustainable Seattle has not attempted to define sustainability in great detail. It is simply described as "long term cultural, economic and environmental health and vitality. We emphasize the 'long term' part of that definition, together with the importance of linking our social, financial, and environmental well-being." (Sustainable Seattle 1993:2)

This definition recognizes economy-environment-society linkages and, indirectly, a form of inter-generational equity (present in the phrase "long term") as being the essential components of sustainability. Sustainable Seattle has not attempted to formulate a set of sustainability principles to accompany this definition. As a result, it is difficult to determine in some cases whether the indicators that were developed are true measures of their concept of sustainability.

Target Audience

The target audience is not specified explicitly in the 1993 and 1995 Sustainable Seattle reports. However, the indicator selection criteria chosen suggest that the main audiences for the report are individual members of the community and the local media. Individuals are encouraged to use the indicators to educate themselves about important sustainability trends and to assess their own actions in terms of how they can affect these trends. The report also suggests that businesses, planners and local politicians may find the information of interest.

Indicator Identification Process

Starting in 1991, development of the indicators proceeded through the following four phases:

1. Creation of a volunteer, multi-stakeholder Task Team of 15 people with responsibility for preparing a preliminary list of indicators. The task was completed within a six-month period.

2. Submission of the list to a Civic Panel of over 150 key representatives from the community. After six months of work, the Panel proposed 99 indicators grouped into ten topic areas.

3. The Task Team undertook a technical review of the indicators and narrowed this number down to 40, using the selection criteria described in the next section.

4. The first set of 20 indicators was released in 1993. The second set required additional collection of both objective and subjective data and was released in late 1995. Between 1993 and 1995, some of the original 40 indicators were deleted and replaced by better indicators.

In its 1993 report, Sustainable Seattle classified the indicators into four theme areas: environment, population and resources, culture and society, and economy (see Appendix C, Table C1) but later modified those categories slightly by expanding the theme area for culture and society into two new categories: youth and education, and health and community (Sustainable Seattle 1995). Although the indicator identification process did not refer to an explicit conceptual framework, elements of the condition-stress-response framework are evident in the descriptions of the indicators that were selected. Each indicator measures an important dimension of sustainability, but the collection of indicators is not meant to be comprehensive. Debate over what constitutes a sustainable community, and about which indicators measure it best is expected to continue.

Indicator Selection Criteria

Sustainable Seattle used the following criteria in selecting their indicators:

1. the indicator should be a bellwether test of sustainability and reflect something fundamental to the long term economic, social or environmental health of a community over generations;

2. the indicator should be easily understood by members of the community and generally agreed to be a valid sign of sustainability;

3. the indicator should be appealing for use by the local media;

4. the indicator should be statistically measurable in the Seattle area and a practical form of data collection should either exist or be possible.

5. the indicator should preferably be comparable to indicators that would be available for other communities.

Evaluation of the Indicators

The Sustainable Seattle reports tell us very little about how the selected indicators were rated with respect to the selection criteria. They simply assert that each of the final 40 indicators meets all of the indicator selection criteria.

Presentation

The Sustainable Seattle reports present almost all the indicators in time series format. They define each indicator in some detail and explain why the indicator is important from a sustainability perspective. The indicators' past trends are identified and evaluated in terms of whether the trend illustrates a movement towards or away from sustainability. The analysis of each indicator includes a discussion of the linkages between that particular indicator and social, economic and natural environment conditions, stressors and, occasionally, responses. By way of illustration, Table 19 shows the trend and evaluation components, and the linkages

for a single indicator from the 1993 report. Sustainable Seattle judged the trend for this indicator to be representative of a movement away from sustainability.

Table 19. Example of an Indicator Description from Sustainable Seattle

Indicator: Vehicle Miles Travelled and Fuel Consumption per Capita in King County

Interpretation. *Vehicle miles travelled have increased from 5,763 per capita in 1970 to 9,344 in 1991. Growth averaged about 150 miles per year from 1970 to 1985, and more than 200 miles per year between 1985 and 1991. Some change has taken place in the last three years with growth levelling off and, perhaps, decreasing. Adding in the effect of population growth, total miles travelled almost doubled between 1970 and 1991. Increased fuel efficiency and improved emissions controls have helped to reduce some of the impact of this growth on air quality. Gasoline consumption per capita was about the same in 1991 as in 1980, and is slowly turning downward.*

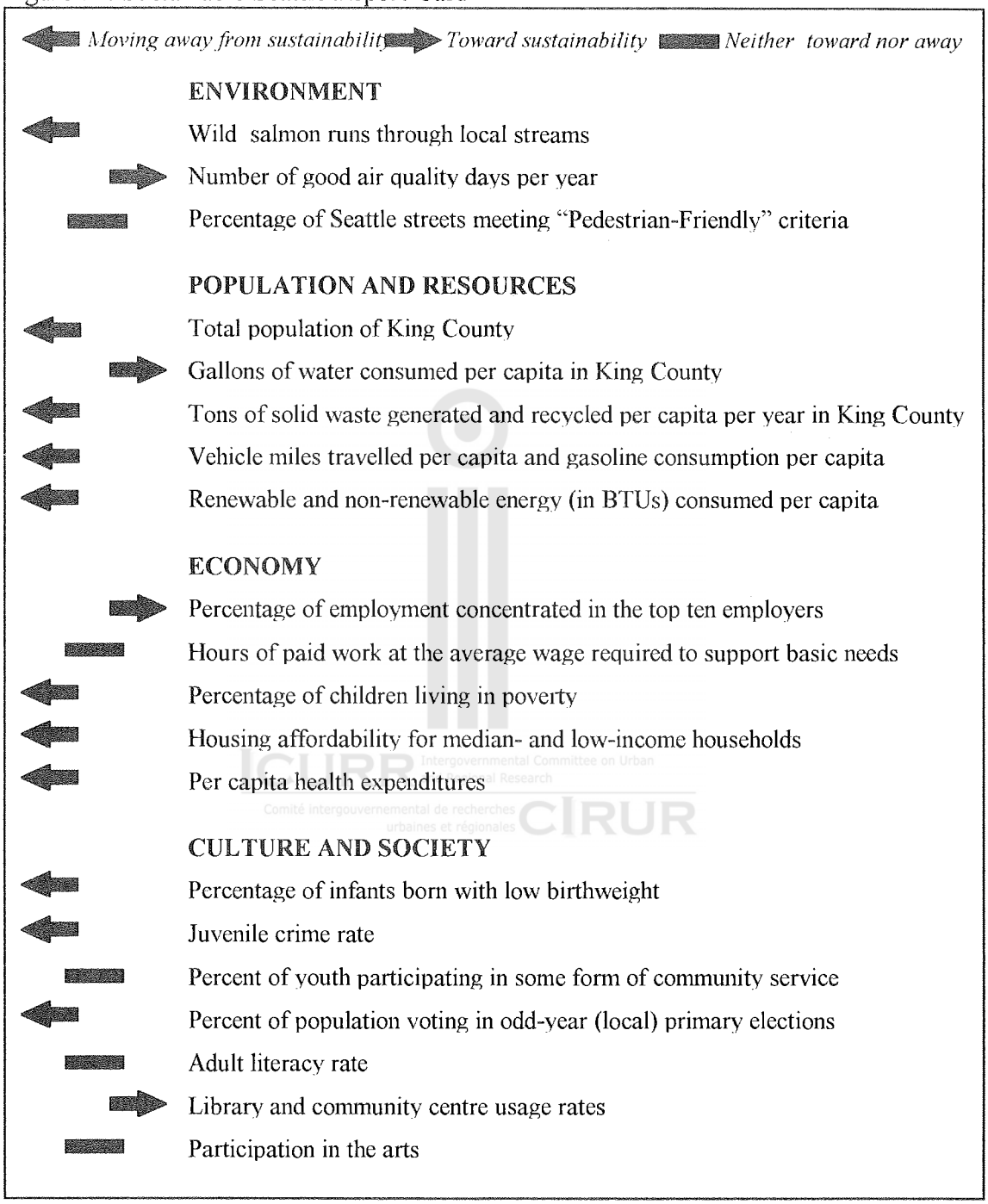
Evaluation. *There are encouraging signs that we are beginning to level off and perhaps make small improvements in transportation use. If this pattern continues, we may be able to balance the effects of population growth. In the long run, however, more major changes in land use, vehicle technology, employment patterns, and vehicle use habits are required in order to achieve sustainability.*

Linkages. *Vehicle use and gasoline consumption are links to excessive use of non-renewable resources, pollution, loss of open space and wildlife habitat, decreased social health as a result of stress and pollution, and a declining sense of community. Many of these can be improved by switching transportation modes to more use of mass transit, walking and bicycling, as well as increasing efficiency. Others may require action on land use and other social factors. An increase in the availability of affordable housing near work would make vehicle use less necessary. A stable population would also reduce sprawl and help make increases in vehicle use less likely.*

Source: Sustainable Seattle (1993:19)

The overall implications of the 1993 indicator analysis are summarized by Sustainable Seattle in report card format (Figure 19). This format is easy to understand and therefore well suited to communicating indicator results to the general public and to the media, the two main audiences of concern for Sustainable Seattle. The danger of the report card format is that it can over-simplify complex issues and obscure value judgements that were made when interpreting underlying data. Sustainable Seattle overcomes this problem by clearly describing, within the body of its report, the rationale for assigning a negative, positive or neutral rating to each indicator. A slightly modified version of the report card format was used in 1995.

Figure 19. Sustainable Seattle Report Card



Source: Sustainable Seattle (1993)

No specific sustainability targets or benchmarks are identified in the Sustainable Seattle reports. However, four of the 20 indicators are related to a standard or reference point. The air quality indicator compares air quality in Seattle to levels defined as acceptable by the Environmental Protection Agency's Pollution Standards Index. The indicator for housing affordability defines "affordable" as monthly mortgage payments that are no more than 25% of household income and monthly rental payments that are no more than 30% of monthly income. The indicator for children living in poverty uses the U.S. government's definition of the poverty line as its reference point. Low birth-weight infants are defined as those weighing less than 2,500 grams (about 5.5 pounds).

A striking feature of the Sustainable Seattle reports is the attention paid to describing the linkages between each of the indicators in the report and related environmental, economic and social conditions and stressors. The interdependence of environmental, economic and social issues is clearly articulated. Some of the indicators chosen for inclusion in the report link to one another, either directly or indirectly (e.g. population and water consumption), but most were chosen because they link to a wide variety of environmental, social and economic indicators not included in the report. In other words, they possess the desirable characteristic of representativeness.

A weakness of the reports as a scientific document is that, for the most part, references to empirical evidence supporting the claims about linkages are absent. However, since the reports make no claim to being a scientific document, but rather seek to communicate material in an easily understandable format, this omission may have been intentional.

Another weakness of the Sustainable Seattle reports is that they are presented as a call to action for citizens concerned about sustainability, yet they contain few concrete recommendations for what individuals can do or what policies they should support. The emphasis of the reports is on describing past trends and current conditions.

Application

It has only been two years since the release of the first Sustainable Seattle report and no formal evaluation has yet been conducted of the effectiveness of Sustainable Seattle in modifying individual behaviour or its impact on the city's progress towards sustainability. However, the project director for Sustainable Seattle reports that there was ongoing and increased public participation in the indicator identification process during the second phase of indicator selection for the 1995 report. This is a favourable sign of continued success for the project.

There is some question about the extent to which the report has influenced the framework policy for Seattle's new comprehensive plan. A planner interviewed in Seattle said that she had found the Sustainable Seattle indicators to be user friendly and effective at representing a given value statement or point of view but she felt that the planning department was more interested in indicators that could be used to measure the progress or lack of

progress being made in achieving specific municipal policy goals. Because the planning department has different objectives for indicator use than does Sustainable Seattle, the department has found the Sustainable Seattle report to be interesting but not enormously useful. This is not surprising, as the main target audience for Sustainable Seattle, and the main participants in the indicator selection process, were individuals in the community, not municipal government.

Regional Municipality of Hamilton-Wentworth

Background

The Sustainable Community Indicators Project in the Regional Municipality of Hamilton-Wentworth is a continuation of the region's Sustainable Community initiative that began in 1990. At that time, Regional Council appointed a citizens' Task Force on Sustainable Development with the mandate of examining the concept of sustainable development as a basis for review of all regional policies. The Task Force completed the first phase of its work in 1992 with the release of a document entitled **Vision 2020** (Regional Municipality of Hamilton-Wentworth 1992). This document describes the type of community that Hamilton-Wentworth could be in the year 2020 if the community follows the principles of sustainable development. The production of the document was the result of an extensive public participation program that involved over 400 individuals and 50 community groups. Vision 2020 was formally adopted by Regional Council in 1992 as a guide for regional policy creation and decision making. Subsequent reports produced by the Task Force in 1993 detailed how to implement Vision 2020 (Regional Municipality of Hamilton-Wentworth 1993a, 1993b).

It became clear after the release of the Vision 2020 documents that indicators for monitoring progress towards achieving the Region's vision of sustainability needed to be developed. The Sustainable Community Indicators Project was launched in May 1994 to achieve this task. After identifying a set of sustainability indicators, the Region proposes, in the longer term, to develop an overall index or measure of sustainability for the region.

Definition of Sustainability

The following definition of sustainability taken directly from Vision 2020 was used during the indicator identification process:

> Sustainable development is positive change which does not undermine the environment or social systems on which we depend. It requires a coordinated approach to planning and policy-making that involves public participation. Its success depends upon widespread understanding of the critical relationship between people and their environment and the will to make necessary changes. (Regional Municipality of Hamilton-Wentworth 1992:4)

This definition emphasizes the links between human activity and the environment, the importance of maintaining viable social systems, and the role of the community in planning for sustainable development. The following principles of sustainable development found in Vision 2020 provide additional detail:

- fulfil human needs for peace, clean air and water, food, shelter, education, and useful and satisfying employment;
- maintain ecological integrity through careful stewardship, rehabilitation, reduction in wastes and protection of diverse and important natural species and systems;
- provide for self-determination through public involvement in the definition and development of local solutions to environmental and development problems; and
- achieve equity, with the fairest possible sharing of limited resources among contemporaries and between our generations and that of our descendants.

These principles clarify that Vision 2020's concept of sustainability means meeting basic human needs, maintenance of ecological integrity, community self-determination, and achievement of intra- and inter-generational equity.

Target Audience

The indicators are meant to be of use to a wide range of decision makers, including individual members of the community, community organizations, businesses, and local governments. The importance of the community as an audience is apparent from the primary goal of the Indicator Project, "to develop a set of indicators that are understood by the community and are presented in such a manner that people can see how their own activities and decisions can influence the indicators". (Regional Municipality of Hamilton-Wentworth 1994b:3)

Indicator Identification Process

Both the process used in identifying indicators, and the eventual indicators themselves, are meant to motivate people into taking action that will move the Region towards Vision 2020. Government documents from the Regional Municipality of Hamilton-Wentworth emphasize that community participation is a key element of sustainability and an essential component of the Indicators Project.

One of the goals of the Indicator Project is to develop indicators that show the relationship between "the three legs of sustainable development": social/health issues, the physical environment, and the economy of the Region. In other words, the preference is for integrating rather than single-factor indicators.

The indicator identification process began in May 1994 and is scheduled to culminate 19 months later on Sustainable Community Day in November 1995, with the release of the Region's first annual Vision 2020 report card. The report card will identify the current status of the indicators as well as the way in which they can be influenced by individuals, organizations, business, local government and the community as a whole. The indicator identification process is being directed by a project team consisting of representatives from the regional government, McMaster University and the International Council for Local Environmental Initiatives.

An implicit objective of the project has been to encourage public ownership of the indicators. The first step in the indicator identification process was the distribution of a questionnaire to about 100 people who attended the Region's 1994 Sustainable Community Day. Respondents were asked to identify the elements of Vision 2020 which they felt were most crucial to community sustainability and to evaluate how well Hamilton-Wentworth was progressing towards sustainability. The two areas felt to be most important for sustainability were protection of natural resources and community well being. The concern expressed for natural resource protection was not surprising, given the fact that most of the people responding to the questionnaire came from environment-related groups. They were therefore particularly knowledgeable about the environment, and more than ordinarily concerned with environmental issues. (Scanlon 1995, personal communication). About 30 individuals who answered the questionnaire continued to participate during the next community involvement phase of the selection process.

The project team identified approximately 80 indicators to be considered during a public consultation phase. The consultation process is employing a three-pronged approach for involving individuals from a variety of agencies, organizations and the public at large. The three elements of this approach are facilitated sessions with focus groups, direct input from interested individuals and organizations, and a community forum to review the short list of indicators.

Participants in the first two elements were asked to fill in a workbook of potential indicators where they evaluate each of the suggested long-list indicators, and recommend goals or targets for those indicators. The workbook indicators fall into the following general categories: natural areas, water quality, air quality, waste management, energy, urban form, transportation, health and well-being, community empowerment, livelihood, and agriculture. Vision 2020 goals for each of these categories are included in the workbook as points of reference. One section of the workbook is presented in Table 20 as an example of the kinds of indicators that are being considered. Appendix C contains the remainder of the proposed indicators and the associated Vision 2020 goals.

The results of the workbook exercise will be used to narrow the long list of indicators to 30. The community forum will provide final scrutiny of the short list before submission to Regional Council.

Table 20. Sample Workbook Entry for Hamilton-Wentworth

Vision 2020 Goals	Possible Indicators
Urban Form To curb urban sprawl and suburban encroachment on the rural and agricultural lands. To encourage that development which makes efficient, and economical use of infrastructure and services. To minimize the environmental, social, and financial costs of new development to the residents of Hamilton-Wentworth. To preserve the natural and historical heritage of the region. To encourage redevelopment of Hamilton's central core as the regional centre. To reduce commuting distances. To encourage, promote and facilitate the everyday use of alternative modes of movement, such as walking, bicycling, and public transit.	1. Office (and retail commercial) vacancy rates in the regional centre. Target: (5%). 2. The percentage of building/sites protected on the heritage inventories of all area municipalities. 3. Average commuting times or distances. 4. Measure of the building densities constructed as a ratio of the total density permitted in the plans and zoning by-laws. 5. No. of applications to extend urban and rural settlement boundaries annually.

Source: Regional Municipality of Hamilton-Wentworth (1995)

Indicator Selection Criteria

The instructions in the workbook note that the indicators are supposed to measure the conditions or elements of sustainability embodied in the Vision 2020 goals. The key question asked of those filling in the workbook is:

"Which of the indicators seem to be most important or meaningful to you?"

Respondents were asked to use this criterion to grade each indicator on a report card scale from A (excellent) to E (poor). At the back of the workbook, additional indicator selection criteria are listed and a "good" indicator is defined as one which is:

1. **Measurable**: the indicator is sensitive to an improvement or deterioration in the condition it targets. Changes in the indicator should be significant enough to be useful for decision makers.

2. **Easy to collect**: the data needed for the indicator should already be available, preferably on an annual basis at least. The information should be readily

obtained, without extra collection costs. The public should be able to participate in collecting the data.

3. **Credible and Valid**: the indicator is easy to understand. There will be no debate over its meaning. It should measure something that is important to individuals in the community. It should be possible to collect data for the indicator in the same manner and under the same conditions from year to year so that comparisons will be valid.

4. **Reflective of a balance between environment, economy and social/health aspects**: the best indicators are those which can measure all three aspects simultaneously. For example, the number of species of fish found in local water bodies is a measure of environmental conditions. The number of species of sports fish is an indicator of environmental conditions as well as the economic and social/health considerations associated with a healthy recreational fishery.

5. **Potentially useful for affecting change**: individuals, groups or communities can do something to move the indicator toward sustainability. Emphasis should be placed on choosing indicators which measure conditions that members of the local community can influence through participation in the decision making process or by taking specific actions, rather than on indicators that require action by those outside the community.

Respondents were asked to consider each of these criteria, in addition to the "meaningful" criterion, when evaluating the indicators.

Evaluation of the Indicators

In addition to the community-based evaluation described above, the Project Team undertook their own evaluation, using a more formalized evaluation procedure. The Project Team discovered during the early stages of the workbook exercise that the public had difficulty in applying the recommended evaluation criteria, except for the "meaningful" criterion. In particular, the criteria relating to data availability and ease of collection were not found to be useful when soliciting input from the public, because the public is unlikely to be aware of what data is collected and what is not.

In its own evaluation, the Project Team rated all of the indicators on a three-point scale, as shown in Table 21, and then summed individual scores for each criterion in order to arrive at an overall score. Both the community and the Project Team evaluations will be used to produce the short list of indicators.

Table 21. Criteria and Scales for Selection of Hamilton-Wentworth Indicators

	Measurability
-1	difficult to measure
0	can only be measured indirectly or infrequently
+1	readily measured
	Ease of Collection/Cost
-1	data collection is difficult or requires significant new resources
0	requires cooperative arrangement with agency or other government
+1	data is held by Region or readily accessible
	Credibility
-1	rather abstract or difficult for users to see logic or linkages
0	requires minimal explanation
+1	straight-forward, linkages apparent
	Balance Between Environment/Economy/Society/Health
-1	reflects one aspect
0	reflects two aspects
+1	reflects three aspects
	Potential for Affecting Change
-1	can only be influenced by senior government action, legislation or commitment of expenditures
0	public could affect change through political pressure or community influence
+1	opportunity for individuals to take action, make a difference

Commentary

Like Sustainable Seattle, the Hamilton-Wentworth Indicator Project is strongly community-based. It has a stronger goal-oriented framework than Seattle because of the existence of a Vision Statement. This allowed for the creation of a specific set of objectives for the indicator selection process and a set of sustainability principles, which were lacking in the Seattle case study, but which provide significant guidance for the selection of indicators. It is too early to comment on either the appropriateness of the indicators or the presentation format since the indicator selection process has not yet been completed.

British Columbia State of Sustainability Report

Background

The British Columbia Round Table's State of Sustainability Report is an ambitious examination of urban sustainability at the provincial level. It follows on from the work of the Round Table in developing a sustainability strategy for the province (B.C. Round Table 1992) and sectoral sustainability strategies for energy, education, communities and the economy. The report was meant to be the first of a series of three sustainability reports that would include examination of regional sustainability and sustainable living in the province. However, the B.C. Round Table was phased out upon completion of the urban sustainability report and the fate of the two other reports is not clear.

Since reporting on the sustainability of all cities in B.C. was considered impossible, the Round Table selected a sample of cities to represent the broad regions of the province as well as a variety of environmental, economic and social conditions. The cities selected were: the Greater Vancouver Regional District, Greater Victoria (the Capital Regional District), the City of Prince George, the City of Kelowna, and the City of Cranbrook. Together, these five cities account for about two-thirds of the province's population.

Definition of Sustainability

The B.C. Round Table clearly advocates a balanced view of sustainability and recognizes the link between sustainability and quality of life:

> Sustainability means achieving an equilibrium between human impacts and the carrying capacity of the natural world which can be sustained indefinitely. Sustainability takes into account three interdependent elements: the environment, the economy, and the social system. A balance between these elements will demand the adoption of a new ethic, a new lifestyle and new expectations to ensure our collective survival. Sustainability is the key to our future quality of life. (B.C. Round Table on the Environment and the Economy 1994:15)

A set of guiding principles provides more detail on how to achieve sustainability:

- Minimize the depletion of non-renewable resources
- Stay within the carrying capacity of the natural environment
- Protect and preserve the natural environment (including biological diversity, renewable resources, and life support systems)
- Promote long term economic development that does not draw down the stock of environmental resources (through diversification and increased resource use efficiency)

- Meet basic human needs
- Provide for a fair distribution of the costs and benefits of resource use and environmental protection
- Foster decision making and governance that promotes local and individual empowerment (proactive, participatory and long term)
- Promote sustainability values (through information and education)

The authors of the Round Table report regard certain aspects of sustainability as unique to each community, because of differences in underlying community conditions, attitudes and values. However, there are other aspects of sustainability that are common to all communities, and it is these aspects that the sustainability report is meant to measure.

Target Audience

The Round Table report does not identify a particular target audience. However, throughout the report, there are suggestions that the intended audience is a broad one: the report is seen as a guide for modifying "personal and institutional behaviour" (p.22), information contained in the report is meant to be "credible and understandable to the public" (p.31), and the report is to be used as input for planning and policy decisions (p.24).

Indicator Identification Process

A Steering Committee made up of Round Table members was given responsibility for guiding the indicator identification process and subsequent evaluation phase. The first step in the identification of indicators was to distinguish a number of theme areas as a means of defining the scope and context for reporting. The five theme areas identified were: (1) human settlements and population, (2) the urban environment, (3) the urban economy, (4) social well-being, and (5) governance and responsible citizenship. Each of the themes includes two to three sub-themes and topic areas, as shown in Table 22. A long list of indicators was identified from existing reports and studies and then subjected to an evaluation, using seven indicator selection criteria.

Data availability was felt to be a critical factor in the indicator selection process. Most of the data came from secondary sources, but a short survey was also sent to municipalities and regional districts in the province. There were 22 responses to the survey, which requested statistics on urban form, natural habitats, mobility, resource quality and conservation, the urban economy, and local governance. An acknowledged weakness of the report is the relatively small number of subjective indicators included for measuring attitudes and values. This information is lacking because secondary sources were inadequate, and because there were insufficient resources to conduct a province-wide survey of public attitudes.

Table 22. Indicator Categories for the B.C. State of Sustainability Report

I. HUMAN SETTLEMENTS AND POPULATION GROWTH
- Population Growth
- Household Growth and Change

Sprawl
- Settlement Patterns and Land Use
- Housing Types
- Roads and Servicing
- Urban Containment

Mobility
- Private Automobile Use
- Transit and Alternative Modes of Travel

II. THE URBAN ENVIRONMENT
- Public Concerns
- Natural Habitats

Use of Natural Capital
- Solid Waste
- Energy
- Water
- Air Quality
- Liquid Waste Management

III. THE URBAN ECONOMY
- Vibrancy
- Equity

Diversification
- Economic Sector Performance
- Income Sources

Costs of Growth
- General Expenditures
- Capital Expenditures

IV. SOCIAL WELL-BEING
- Demographic Change
- Health and Safety
- Education

Health, Safety and Well-being
- Personal Wellness
- Environmental Effects on Family Health

V. GOVERNANCE AND RESPONSIBLE CITIZENSHIP
- Process
- Participation

Source: British Columbia Round Table on the Environment and the Economy (1994)

The B.C. report identifies 60 indicators of urban sustainability that could not be used because of lack of information. For example, a desirable indicator of the impact of car-dependency on urban land consumption would be the percentage of urban land devoted to automobile-related uses (including roads, parking lots, service stations, etc.). However, data was only available to develop an indicator measuring road area as a percent of total land area in each of the cities examined.

Indicator Selection Criteria

The B.C. Round Table drew on a report prepared for the City of Toronto's Healthy City Office (York University Centre for Health Studies 1990) in developing the following indicator selection criteria (B.C. Round Table on the Environment and the Economy 1994):

1. **Comprehensiveness**: the indicators should measure all dimensions of the issue of concern, in this case, urban sustainability.

2. **Data Availability**.

3. **Responsiveness**: the indicators should be sensitive to changes over time and in different cities.

4. **Disaggregation**: the indicators should be capable of being used at different levels of aggregation.

5. **Understandable**: the indicators should be understandable and accessible to policy-makers and the public.

6. **Validity**: the indicators should be scientifically valid measures of the phenomenon of interest.

7. **Reliability**.

Evaluation of the Indicators

The indicators on the initial long list were reduced to a final set of indicators by members of the Steering Committee, using an iterative, informal process for applying the selection criteria. Data availability was a determining factor in retaining or discarding indicators.

Presentation

The presentation format consists of a detailed descriptive and graphical presentation for each indicator. The descriptive component includes information on:

1. the theme and topic being addressed,

2. a specific description of the indicator,

3. a brief interpretation of the data, indicating whether progress is being made towards or away from sustainability, as well as an analysis of the relationship of the indicator to other indicators or aspects of the sample cities,

4. a discussion of the issue in terms of Round Table initiatives, and major institutions or programs involved with the specific aspect of sustainability under review.

The graphical component includes a graph or table showing trends over time for each city, and indicates the source of the information presented. For the most part, the graphs and tables show historical trends. The trend data mostly extends back to the middle 1980s and some go back as far as the mid 1970s. Several examples of explicit forward-looking indicators are included in the report. One, found in Table 2 shows the impact of alternative development densities on urban land consumption in B.C. by the year 2021. Another example is the discussion of demographic change, which includes graphs showing 20-25 year forecasts. A third example is a table of transportation-related indicators. The indicators describe the impact on kilometres travelled, air quality, and transportation costs of moving towards a more compact urban form in the Greater Vancouver Regional District between 1991 and 2021 in comparison to a continuation of current trends.

The overall results of the indicator analysis are summarized in report card format, as shown in Table 23. The B.C. format differs from the Seattle report card in that it reports on current conditions with respect to sustainability as well as evaluating the sustainability of future trends. This approach is useful because it highlights how a trend that will preserve the status quo for future generations (i.e. a "neutral" trend) may meet the sustainability requirement for intra-generational equity, but is not necessarily desirable if the current condition is only "poor". Although a detailed description of each indicator is contained in the main report, the report card itself is prefaced by a three page summary of the results of the main report that offers justifications for the ratings assigned to each theme. The summary for "Social Well-being", which received a rating of "fair" for current condition and "neutral" for trend, is shown in Table 24.

Table 23. British Columbia Urban Sustainability Report Card

Theme	Topic	Data Quality	Condition	Trend
Settlements and Population		*Fair*	*Poor*	*Negative*
	Population Growth	Good	Poor	Negative
	Urban Sprawl	Poor	Poor	Negative
	Mobility	Fair	Poor	Negative
Urban Environment		*Poor*	*Poor*	*Negative*
	Natural Habitats	Poor	Poor	Negative
	Resource Use	Fair	Fair	Positive
Urban Economy		*Fair*	*Good*	*Neutral*
	Vibrancy	Good	Good	Neutral
	Equity	Fair	Good	Neutral
	Diversity	Poor	Poor	Neutral
	Cost of Growth	Poor	Fair	Neutral
Social Well-being		*Fair*	*Fair*	*Neutral*
	Health	Good	Fair	Positive
	Education	Fair	Fair	Neutral
Governance and Citizenship		*Poor*	*Fair*	*Positive*
	Process	Poor	Fair	Positive
	Participation and Citizenship	Fair	Fair	Positive

Source: British Columbia Round Table on the Environment and the Economy (1994)

Table 24. Summary Description for Social Well-being in the B.C. Report Card

Social Well-Being

Indicators of social well-being in the sample cities show no consistent pattern. Although life-expectancy is generally increasing, suicide rates, low birth-weight babies, teenage pregnancies, and crime rates increased in some cities and decreased in others. Homelessness persists in our cities, and poor households are consistently more numerous in cities than in suburbs. Too many children still live in poverty. New post-secondary school graduates find it increasingly difficult to find work in their fields. Education levels are rising, but so are high school drop-out rates. Broad improvements in education are necessary if British Columbia is going to successfully participate in a changing domestic and global economy, and if the population is to meet the challenges of sustainability.

Source: British Columbia Round Table on the Environment and Economy (1994:11)

Another difference between the B.C. report card and Sustainable Seattle's report card is the inclusion of data quality evaluation in the former. This makes the B.C. report card somewhat cluttered, but was felt to be important because sustainability reporting plays a major role in identifying gaps in data availability and weaknesses in data quality.

Another significant difference between the Seattle and B.C. sustainability reports is the inclusion of recommendations in the B.C. report. It concludes with 17 recommendations aimed at bringing about urban sustainability. These range from recommendations for new legislation and provincial policies to recommendations for education and information gathering.

Application

The report is being used by the Capital Regional District Round Table to identify priority environmental issues and by the British Columbia Ministry of Municipal Affairs in their search for 20 core indicators of sustainability (West 1995, personal communication).

Although less than one-fifth the size of Canada's State-of-the-Environment report, The B.C. report has been criticized for being too big and daunting to use (Harper 1995, personal communication). It has been cited in newspaper editorials in British Columbia, but some users have complained that it contains too much statistical detail.

Since the British Columbia Round Table was disbanded, no agency in the province currently has responsibility for seeing that the report is implemented or for ensuring the continuation of comprehensive urban sustainability reporting at the provincial level. Several other multi-stakeholder groups in British Columbia, such as the Council for Sustainability, the Commission on Resources and Environment, and the Fraser Basin Management Program are investigating the use of sustainability indicators, some of which may have relevance for future urban sustainability reporting.

Other Case Studies

Another example of a jurisdiction that is also well advanced in developing sustainability indicators is Richmond, B.C. Planning and Health Department officials in Richmond are working with the community and with members of the University of British Columbia (UBC) Task Force for Planning for Healthy and Sustainable Communities to develop sustainability indicators. It is anticipated that these indicators will be used in support of a proposed environmental action plan for the community (Brownlee 1995, personal communication).

Richmond has chosen to use the COMLE framework during its indicator identification process. The city's preliminary list of sustainability indicators contains all the COMLE indicators plus 81 additional indicators drawn from a variety of sources, including the work of the British Columbia Round Table and the UBC Task Force for Planning for Healthy and Sustainable Communities. The new indicators are distributed fairly evenly among the ten major divisions of the COMLE framework, except for the relatively weak environmental component which received 20 new indicators. A new component labelled "Community Well Being" has been added to the framework with the following indicators:

1. Extent of public participation - volunteer hours per capita.
2. Rate of population growth.

3. Number of active community residents in planning and decision making groups.
4. Percentage of pedestrian-friendly streets.

The draft list of indicators has been sent to a number of public groups for review. A check list of indicators was also sent to developers for review, with the aim of ultimately incorporating the check list into the development application process.

Researchers at UBC are calculating Richmond's appropriated carrying capacity and are working on a new concept, known as "social caring capacity", as a complement to the "appropriated carrying capacity" concept. Social caring capacity consists of criteria which foster an increase in individual and community quality of life, including social equity, diversity, interconnections in the community, safety, access to recreational and open space, minimization of family stressors, and inclusion in decision making processes (Aronson and Charles, no date). According to the UBC researchers, healthy and sustainable communities are those that seek to increase their social caring capacity while simultaneously attempting to decrease their appropriated carrying capacity.

Another initiative of interest is the sustainability reporting work being undertaken by the Fraser Basin Management Program. A program was established in 1992 with the goal of encouraging economic, environmental and social sustainability in the basin. It is run by a 19-member, multi-stakeholder Management Board consisting of representatives from government, First Nations, business, labour, non-government organizations and other stakeholders in the Basin. One of the sustainability objectives addressed in the Management Board's recently released State of the Basin Report and accompanying report card is urban growth and sprawl. The report evaluates progress being made towards achieving 20 other sustainability objectives within the context of eight critical sustainability issues. All of the issues and their related sustainability objectives are shown in Table 25.

Table 25. Fraser Basin Report Card

Issue	Sustainability Objectives	Grade
Population Growth	Manage Urban Growth and Sprawl	D
	Achieve a More Sustainable Lifestyle	C-
Water Resources	Address Non-Point Source Pollution	C-
	Upgrade Lower Mainland Municipal Sewage Waste water Treatment	F
	Reduce Organochlorines in Pulp Mill Liquid Effluent to Zero by 2002	B-
	Develop a Comprehensive Groundwater Management Regime	D
	Address Water Exports and Inter-basin Water Transfers	B
Salmon Fisheries	Achieve Cooperation Among Users of Salmon Resources	C-
	Protect and Rehabilitate the Fish Habitat	C-
	Reach International Agreement on Salmon Allocations	Not Graded
Forest Resources	Achieve Sustainable Harvest Levels	B-
	Minimize Environmental Impact of Forest Harvesting	C
	Stabilize Job Prospects in the Forest Industry	Not Graded
Economy	Create Jobs and Upgrade Skills	Not Graded
	Reduce Economic Uncertainty	Not Graded
Aboriginal/Non-Aboriginal Relations	Achieve Effective Participation of First Nations in Decision Making	Not Graded
	Define and Resolve Aboriginal Title	Not Graded
Planning Processes	Ensure That All Interests are Represented in Land Use Planning Processes	C+
	Coordinate and Link Land Use Planning Processes	C+
Decision Making	Achieve Inter-agency Coordination and Harmonization	C
	Involve Local Interests in Decision Making	B

Source: Modified from the Fraser Basin Management Program (1995)

Although neither the report card nor the State of the Basin report include sustainability indicators, work is underway to develop indicators for future reports. The approach taken by both of the current reports is to describe each sustainability issue (including selected stressors and conditions affecting the issue), present management responses, evaluate those responses, and make recommendations for future action.

The report card differs from the Sustainable Seattle and British Columbia State of Sustainability report cards in that it assigns letter grades to measure progress on each of the sustainability objectives. It gives low marks to objectives where little or no progress has been achieved and where development of new policies or legislation is a low priority. High marks were given where measurable results had been achieved. When the Board could not reach a consensus on an issue, no grade was assigned. Like all report cards, the grades or ratings have little meaning unless the report card also contains a full description of the reason for assigning such a grade. An example of the kind of description provided by the Fraser Basin report card is given in Table 26 for the grade of D assigned to the sustainability objective "Manage Urban Growth and Sprawl":

Table 26. Description of the Urban Growth and Sprawl Issue in the Fraser Basin

Manage Urban Growth and Sprawl

The Issue. *Forests, wetlands and farmlands are disappearing as suburban areas expand and "ribbon" or "strip" developments occur. Habitat is being lost and degraded. Only two of the original 50 free-flowing streams in the City of Vancouver still exist. Sub-division of ranches in the Interior has had an impact on winter ranges of ungulates (e.g. moose, deer, etc.). Biological diversity is being lost. Non-point source pollution is increasing as more roads, parking lots and buildings are built and more vehicles are used.*

Responses. *The provincial government, the Greater Vancouver Regional District (GVRD) and the City of Surrey recently allocated $28.5 million to create 1,000 hectares of new parkland between Abbotsford and Richmond. Canadian Forest Products Ltd. donated $2 million worth of land. Urban growth management is now being recognized in initiatives such as the GVRD Liveable Region Strategies Act, the Georgia Basin Initiative and official community plans (e.g. Vancouver CityPlan). Land will be exempted from development under the new Forest Land Reserves system and the existing Agricultural Land Reserve. Stream stewardship guidelines are being implemented through federal and provincial government activities.*

Good News. *Growth management initiatives are focusing on higher density housing, the development of complete communities, provision of access to transportation links and education. Urban sprawl issues are being recognized by municipal and regional governments and the public is being involved in developing solutions. The middle and upper regions of the basin have an opportunity to avoid problems associated with urban sprawl by monitoring and learning from experiences in the Lower Fraser Region. High land values are encouraging a movement to higher density housing.*

Bad News. *Urban sprawl is continuing at an alarming rate in the lower Fraser Valley, where low-density development and an automobile-dependent lifestyle are still generally preferred by the average resident. Previous urban development has already done a great deal of damage: since 1900, 82% of the salt marsh of the Fraser Estuary has been lost. In the Interior, floodplains have been significantly affected because most city growth has taken place on floodplains. People are still demanding single-family dwellings.*

Source: Fraser Basin Management Program (1995:4)

The introduction to the report card emphasizes that the assignment of grades was a subjective exercise. This is evident from the description of the urban sprawl issue in the Table. The authors of the report card state that the grading system will become more rigorous in future, once sustainability indicators and benchmarks are developed and when more data becomes available. In the meantime, the report card is meant to draw attention to problem areas, acknowledge progress towards sustainability where it has occurred, stimulate discussion, and encourage efforts to develop sustainability indicators. It will be supplemented in the near future by a "Public Report Card" which will include subjective indicators, based on ratings made by residents of the Fraser Basin, of progress towards achieving sustainability in the Basin.

Chapter 9

Conclusions

There is considerable interest in the development of urban sustainability indicators both in Canada and elsewhere. Work on this topic is being performed at the municipal, provincial and federal levels in Canada, as well as by Round Tables and various other agencies. This study has examined a variety of sustainability indicator frameworks, a number of indicator selection criteria, examples of indicators, and case studies. Some suggestions of indicators that deserve consideration as urban sustainability indicators have been provided, but much work remains to evaluate a broader range of potential indicators.

Although substantial progress has been made over the past few years in defining the concept of urban sustainability and in measuring it, several key methodological, theoretical and practical questions still need to be resolved in order to assist in the growth of sustainability reporting and the development of useful sustainability indicators. Seven specific questions raised in this report, and recommended as issues to be discussed at the "Measuring Urban Sustainability" workshop, are reviewed and commented upon below.

1. ***Is there a common definition of urban sustainability that should be used when developing indicators of urban sustainability?*** There are many definitions of urban sustainability and related concepts to be found in the academic literature and in government documents. A common theme of all these definitions is long term protection of the environment and the wise use of natural resources. At one end of the spectrum, some consider this to be the only theme relevant to sustainability. At the other end are those who feel that protection of the environment is a fundamental aspect of sustainability, but that it must be balanced against economic and social considerations. Not only may interpretations of the general meaning of urban sustainability differ: so may views on the specific characteristics of sustainability that should be considered when developing sustainability goals. Since there is a range of views on the meaning of urban sustainability, it is not surprising that there is, as yet, no consensus on the types of indicators that are most appropriate for reporting on sustainability.

2. ***Which indicator framework offers the most promise for developing urban sustainability indicators?*** There are six general type of frameworks that can be used to develop urban sustainability indicators. These are: goal-based frameworks, issue-based frameworks, sectoral frameworks, domain-based frameworks, causal frameworks and combination frameworks. Each of the first five frameworks has its own strengths and weaknesses: a combination framework has the advantage of being able to draw on all of these strengths while downplaying the weaknesses. A hypothetical combination framework might require that all indicators be linked with urban sustainability principles, that the indicators be selected to cover a broad range of conditions, stressors and responses, and that the indicators be relevant to municipal government programs. Another variation, which has been used by Sustainable Seattle and is now being used by the

Regional Municipality of Hamilton-Wentworth, emphasizes indicators that are relevant to individuals in the community rather than to municipal government programs.

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?*** This study identified eleven general indicator selection criteria: scientific validity; representativeness; responsiveness; relevance to stated goals; accuracy, accessibility and availability of data; understandable by potential users; comparable to thresholds or targets; comparable with indicators developed in other jurisdictions; cost effective to collect and use; attractive to the media; and unambiguous. It may be impossible to find indicators that satisfy all eleven criteria. Consequently, judgements will have to be made about the relative importance of different criteria. For example, it will be necessary to decide whether scientific validity or meaningfulness to individuals in the community should be given first place in the list of selection criteria. Whether data availability limitations should exclude certain otherwise desirable indicators is also open to question. It may be necessary, in the end, to apply criteria sequentially, and to accept trade-offs among them.

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?*** One advantage of having a core set of urban sustainability indicators is that it would provide municipalities with much-needed guidance on how to measure urban sustainability. It would also allow municipalities to compare their progress towards sustainability with the progress being achieved by other municipalities, and permit reporting on a national basis with comparable data. This latter advantage may also be considered by some to be a disadvantage, however, because some municipalities may not want to be compared with others. Another disadvantage of having a single set of core indicators is that changes and conditions in one community, say a large, industrialized community, may not be comparable to changes in a smaller, rural community. A single set of indicators might not, therefore, be appropriate for all community types or all geographic scales from local to national and international. On the other hand, it may be possible to identify groups of communities with similar social, economic and environmental characteristics, for which common indicators are appropriate.

Another consideration in designing a core set is the number of indicators to be included. Too few indicators may not be able to capture all of the essential elements of urban sustainability, while too many indicators may be overwhelming from the point of view of data collection, communication and synthesis. One alternative to developing a single core set of indicators may be to develop a fairly large menu of indicators from which individual municipalities can select a smaller number appropriate for local conditions. A disadvantage of this menu approach is the loss of comparability that will result.

A possible compromise solution to these problems is to supplement a small core set with two other sets of indicators. The first set would consist of sub-sets of indicators designed for communities experiencing common environmental, economic and social characteristics, and the second set would consist of a broad range of indicators from which communities could choose indicators which are most appropriate to their unique circumstances or particular sustainability goals.

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?*** The Canadian experience in identifying urban sustainability indicators to date has relied heavily on a multi-stakeholder decision-making process. In British Columbia, the provincial Round Table guided the indicator selection process. At Environment Canada, a public advisory committee and a broad cross-section of stakeholders have assisted in the indicator selection process. In Hamilton-Wentworth, the entire indicator selection process was community-driven from the beginning. When the target audience is individuals in the community, representatives of that community should be involved in selecting indicators that are understandable and meaningful to the individual. When the target audience is municipal politicians, performance indicators for government programs and policies may dominate the selection process.

6. ***How can "forward-looking" indicators be constructed?*** A key principle underlying urban sustainability is inter-generational equity. Many practitioners and academics suggest that "forward-looking" indicators will be needed to measure progress towards inter-generational equity. One way of constructing a forward-looking indicator is to relate the indicator to a desired future state designated by a target or threshold. Typical targets used at the municipal level have included waste reduction targets or carbon emissions reduction targets (e.g. reduce by 50% by the year 2000). Typical thresholds are air quality and water quality standards. Another way to formulate a forward-looking indicator is to use a form of scenario development that asks the question: "If a given indicator achieves or is set at a certain level, what will the level of an associated indicator be in the future?" A final type of forward-looking indicator is the predictive indicator.

7. ***Should attempts be made to develop composite indicators or indices of sustainability?*** A composite indicator can reduce a great deal of information to a single number, and is a highly useful way of presenting a wide variety of environmental, economic and social indicator data simultaneously. Although composite indicators have been used frequently in the past in a number of contexts (e.g., for measuring air quality and quality of life), several methodological problems can be encountered when attempting to apply them. For instance, alternative ways of combining the individual indicators into a composite indicator can produce different index values from the same original data. Judgements must be made about the relative importance of individual indicators in a composite indicator, and about how they will be weighted. The final index value will depend on the relative weights assigned and, therefore, on who is making the judgements. Standardization methods must be used when aggregating indicators that are measured in different units. Alternative standardization methods can produce different index values from the same original data. Finally, composite indicators can be difficult to understand and can hide changes in individual indicators. Despite these problems, there is a growing interest in the construction of sustainability indices. No index of urban sustainability has been developed as yet, but the Regional Municipality of Hamilton-Wentworth is currently investigating the creation of such an index.

In conclusion, it should be remembered that the creation of a widely accepted set of sustainability indicators cannot be accomplished overnight. Economic, social and environmental indicators have been in existence for many years and are still evolving. The development of sustainability indicators faces even greater challenges because of the

complexity of the economic-environmental-social relationships that need to be portrayed, and because of the absence of a commonly understood measurement unit, comparable to monetary units commonly employed in economic indicators.

Another complication is that the types of issues for which indicators are needed are likely to change over time as perceptions and attitudes shift, and as our understanding of the nature of ecological, economic and social relationships improves. Therefore, the indicator selection process should be seen as a dynamic process, which will need to respond to changing conditions and priorities.

A key area of future research will be the development of examples of "good" sustainability indicators that meet as many general selection criteria as possible while satisfying the needs of a chosen conceptual framework. Although much work remains to be done, it is already evident from the theoretical, methodological and case study material examined in this report that urban sustainability indicators are likely to become an important new tool in planning for sustainability.

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Appendix B.

Environmental, Health and Quality of Life Indicators

Table B1. Urban and Urban-related State-of-the-Environment Indicators for Canada

ENVIRONMENTAL MEDIA	INDICATOR	YEARS
Number of Times Air Quality Objectives Exceeded	ground-level ozone	1979-1992
	sulphur dioxide, nitrogen dioxide, carbon monoxide	
	airborne particles	1979-1992
		1979-1992
Municipal Water Use and Waste water Treatment	daily municipal water use by sector	1983-1991
	% of municipal population served by waste water treatment	1983-1991
	effect of pricing structure on residential water use	1991
Stratospheric Ozone Depletion	stratospheric ozone levels	1955-1995
	global atmospheric concentrations of ozone-depleting supplies	1977-1995
	new supplies of ozone-depleting substances	1979-1993
Marine Beach Closures	faecal coliform count per 100 ml. of marine water	1985-1995*
Canadian Passenger Transportation	how Canadians travel	1950-1992
	fossil fuel use of new automobiles	1950-1992
	fuel efficiency of new automobiles	1965-1992
	urban transit and automobile use	1950-1992
Energy Consumption	consumption of energy	1958-1993
	fossil fuel consumption	1958-1993

Note: Urban and Urban-related indicators are under development for rural to urban land conversion, urban green space, and solid waste generation and management.
* Indicator development is in progress

Source: Environment Canada, State of the Environment Directorate, Environmental Indicators Bulletins produced or in production, 1993-1995.

Table B2. Hamilton-Wentworth Sustainability Indicators

Hamilton-Wentworth Air Quality Indicators

INDICATOR	MEASURE	TIME SPAN
Air Pollution Index (SO_2, SP)	number of times index exceeded 32	1971-92
Total suspended particulates	annual geometric mean	1971-92
Sulphur dioxide	annual mean	1970-92
Carbon monoxide	annual mean	1970-92
Nitrogen dioxide	annual mean	1975-92
Ozone	number of times hourly average exceeded 80ppm	1974-92
Total reduced sulphur	number of times the hourly average exceeded 10ppb	1975-92

Hamilton-Wentworth Land Quality Indicators

INDICATOR	MEASURE	TIME SPAN
Waste disposal at regional landfill	annual tonnage	1986-89, 1992
	annual geometric mean	1971-92
Waste stream flow	annual tonnage	1992
Recycling	tonnes marketed	1992-93
	tonnes contaminated	1992-93
	net cost	1992-93
	subsidies	1992-93
	revenues from grants and material sales	1992-93
Flora and fauna	number of native, non-native, extirpated and extinct, and total number of species	1993

Hamilton-Wentworth Water Quality Indicators

INDICATOR	MEASURE	TIME SPAN
Lake Ontario phosphorus	loading in metric tonnes/year	1990
	total phosphorus in mg/l at 1m depth in spring	1971-91
Phosphorus in Hamilton Harbour	loading in kg/day	1974-92
	loading in kg/day, contribution by source	1992
	concentration in mg/l	1974-92
Ammonia in Hamilton Harbour	loading in kg/day	1970-92
	loading in kg/day, contribution by source	1992
	concentration in mg/l	1978-92 (monthly)
Unionized ammonia in Hamilton Harbour	concentration in mg/l	1978-92 (monthly)
Kjeldahl nitrogen in Hamilton Harbour	concentration in mg/l	1992
Suspended solids in Hamilton Harbour	loading in kg/day, contribution by source	1992

Hamilton-Wentworth Water Quality Indicators

INDICATOR	MEASURE	TIME SPAN
Iron in Hamilton Harbour	loading in kg/day	1974-92
	concentration in mg/l	1975-92
	concentration in mg/l, contribution by source	1992
Zinc in Hamilton Harbour	loading in kg/day	1977-92
	concentration in mg/l	1977-92
	concentration in mg/l, contribution by source	1992
Phenols in Hamilton Harbour	loading in kg/day	1974-92
	concentration in mg/l	1984-92
	concentration in mg/l, contribution by source	1992
Cyanide in Hamilton Harbour	loading in kg/day	1974-92
	concentration in mg/l	1988-92
Phosphorus in Cootes Paradise	loading in kg/day	1975-92
	concentration in mg/l	1979, 1980, 1989-92
Suspended solids in Cootes Paradise	loading in kg/day, contribution by source	1992
Iron in Coots Paradise	loading in kg/day, contribution by source	1992
Zinc in Cootes Paradise	loading in kg/day, contribution by source	1992
Phenols in Cootes Paradise	loading in kg/day, contribution by source	1992
SS, TS, TP, NH2, TKN, Zn, FC, BOD5, Pb, and Cu in Hamilton Harbour and Cootes Paradise	loading in kg/day, contribution by municipal facility sources	1994, 199?? (unspecified future when HW population - 500,000)
Suspended solids in Lower Grindstone Creek	loadings in tonnes	1987-91
Suspended solids at 5 stations on creeks entering Hamilton Harbour	loadings in tonnes	1990
8 phenoxy acid herbicides in 2 creeks	frequency of detection in wet and dry weather conditions	no date
	concentration in mg/l for wet and dry weather conditions	no date
Suspended solids in Woodward STP final effluent	average concentrations in mg/l	1987-92, monthly
BOD5 in Woodward STP final effluent	average concentrations in mg/l	1987-92, monthly
Total Phosphorus in Woodward STP final effluent	average concentrations in mg/l	1987-92, monthly
Soluble phosphorus in Woodward STP final effluent	average concentrations in mg/l	1987-92, monthly
Ammonia-N in Woodward STP final effluent	average concentrations in mg/l	1987-92, monthly

Source: Regional Municipality of Hamilton-Wentworth (1994)

Table B3. Hancock's Healthy City Indicators

PARAMETER	POSSIBLE INDICATOR
1. Physical Environmental Quality - pollution - housing	- overall index - air pollution index - per cent national/international standards
2. Ecosystem Sustainability - viability - sustainability	- local survival of sensitive species - rations of non-renewable imports to local renewable energy production
3. Community Strength - mutuality	- coherence - self-esteem perceived social support
4. Participation and Control	- municipal democracy index
5. Basic Human Needs - food and water - shelter - income - safety	- POLI index - per cent hungry - per cent homeless - per cent below poverty line - relative distribution of income - violent crime rate - per cent employed (formal and informal economies)
6. Access to Variety - access - variety - experiences - resources - contact/interaction	 - perceived and objective - scope and variety reported
7. Diverse City Economy - variety - types of enterprise - size of enterprise - innovation - level of wealth - distribution of wealth	
8. Sense of Connectedness - history - culture - nature/biology	- sense of ties, networks
9. City Form - fit	- stability - adaptability
10. Optimum Public Health and Health Care Services - appropriateness - accessibility - health protective legislation	- extent of primary care, home care - per cent not covered by insurance - non-smoking by-laws - community prevention index
11. High Health Status a) high positive health - preventive behaviour - perceived well-being - social well-being - overall b) low negative health - risk behaviour - stress - morbidity - mortality	 - diet or exercise - happiness, satisfaction with health - support, perceived - coherence - per cent smoking - life events - days of reported disability - life expectancy at age 40

Source: Hancock and Duhl (1986)

Table B4. Healthy Community Indicators

PARAMETER	POSSIBLE INDICATOR
1. Clean, Safe, High Quality Environment	- number of days per year with average acid pollution (NOX, SO2) above WHO guidelines - perceived annoyance indicator (composite index of noise, smell and dirtiness) - to be developed - percentage of substandard dwellings (defined according to the standards in each city) - rate of reported violent crime (as defined by police) - percentage of people reporting they feel safe walking at night in the area
2. A Stable, Sustainable Ecosystem	- percentage of domestic waste recycled
3. Mutually Supportive, Non-exploitive Community	- perceived accessibility to local shops - self-perceived loneliness; percentage reporting loneliness often or always - percentage of people reporting the city as a good or very good place to live
4. Public Participation and Control over Decisions	- percentage of people reporting involvement in a health, social, peace or environmental group
5. Meeting Basic Needs - food, water, shelter, income, work	- working satisfaction (to be developed) - percentage of families without independent dwelling (as nationally defined) - percentage of unemployment (as nationally defined) OR percentage of families living below the poverty line OR percentage of population receiving welfare/social assistance OR percentage of population receiving less than 50% of the average wage (national if no city average available) - incidence of salmonellosis (per 1000 population per year)
6. Optimum Public Health and Sick Care Services	- percentage of city budget devoted to public health for new health promotion activities
7. High Health Status	- proportion of daily smokers in the population - percentage of people reporting they have restrictions on smoking in their workplace (covers only the working population) (to be developed) - percentage of reported motor vehicle accidents - incidence of motor vehicle accidents - percentage of people reporting daily use of tranquillisers (or number of tablets or tranquillisers sold per adult population) - average days of reported restricted activity - prenatal health: rate of babies born below 2500 gr. - potential years of life lost due to cardiovascular disease under the age of 70 - standard death rates due to AIDS or HIV positive tests per total number of tests performed

Source: Jackson (1991)

Table B5. COMLE Sustainability Indicators

Housing Indicators

COMPONENT	INDICATORS	MEASURES
Economic Vitality	Employment	1. Housing units built per annum 2. Value of building permits
Social Well-Being	Affordability	1. %Tenants whose gross rent exceeds 30% of current income 2. % Owner occupants whose housing expenditures exceed 30% of income 3. Average price of serviced residential lots
	Suitability	1. Average # of persons per room
	Adequacy	1. % dwellings in need of major repair
	Accessiblity	1. Waiting time for those in need
Environmental Integrity	Density / Design	1. Population Density 2. Density Gradient 3. Average lot size

Land Use Indicators

COMPONENT	INDICATORS	MEASURES
Economic Vitality	Availability	1. Amount vacant services land for commercial and industrial use 2. Average time of approval for building permits
	Affordability	1. Average cost of serviced commercial and industrial lots 2. Average cost of serviced residential lots 3. Average lot levy
Social Well-Being	Proximity	1. Average distance to green/park space 2. Spatial difference in distance to green/park space 3. % Households within 1km of playground, elementary school, local services
	Availability	1. No. and acres of park and recreation areas per capita
	Variety	1. Average block length 2. Index of land use mix 3. Mix of building ages, dwellings only
Environmental Integrity	Density	1. # Dwellings per hectare

Employment and Commerce Indicators

COMPONENT	INDICATOR	MEASURES
Economic Vitality	Availability of Capital	1. Federal and provincial investment in municipality 2. Household wealth (HIFE) 3. Incidence of low income
	Employment	1. Unemployment rate 2. Average annual wages/ salaries 3. Total # job openings in local neighbourhood 4. % Available skilled, semi-skilled, unskilled jobs vacant 5. % Available clerical-sales, managerial or professional jobs vacant
	Cost of Living	1. Cost of Living Index
	Level of Business Activity	1. Retail sales per employee 2. Net change in # of business establishments
	Variety	1. # Retail trade establishments per capita 2. Department stores per capita 3. Shopping malls per city 4. % labour force age 15+ employed in 8 major sectors
Social Well-Being	Employment Equity	1. Labour force participation rate for minorities, youth, women, men 2. % Jobs that are full-time 3. % Labour force unionized 4. Female unemployment rate 5. Male unemployment rate 6. Youth unemployment rate
	Income Equity	1. Average weekly wages -males 2. Average weekly wages -females 3. Average professional earnings as ratio of average earnings

Social Welfare Indicators

COMPONENT	INDICATOR	MEASURES
Economic Vitality	Employment	1. average weekly unemployment rate 2. # of welfare cases
Social Well-Being	Availability	1. annual expenditure on welfare 2. # social service agencies per capita
	Variety	range and scope of agencies

Health Indicators

COMPONENT	INDICATOR	MEASURES
Social Well-Being	Availability	1. # Hospital beds per capita 2. % Acute and chronic care hospital beds per capita 3. # Physicians per capita 4. # Community care centres or beds per capita 5. # Public health workers per capita
	Incidence	1. Infant mortality rate 2. Age adjusted mortality rates for men and women 3. Suicide rate 4. Workers compensation claims

Education Indicators

COMPONENT	INDICATOR	MEASURES
Social Well-Being	Quality	1. Student/teacher ratios: primary, secondary levels 2. Expenditure on education by school board 3. High school drop out rate
	Availability	1. # Primary, secondary schools 2. # Post-secondary institutions
	Variety	1. # School Boards (public, separate) and private schools 2. % and kind of supplementary educational services 3. % students in Special Education 4. % students in French Immersion
	Educational Attainment	1. % Population 20-34 without high school diploma 2. % population age 25+ with university degree 3. % population age 25+ with college certificate

Natural Environment Indicators

COMPONENT	INDICATOR	MEASURES
Environmental Integrity	Availability	1. Particulate matter suspended in air 2. Concentration of atmospheric NO2, SO2 and CO2 3. Water quality
	Resource Consumption	1. Kilos of waste per person per year 2. Volume of city waste generated by industrial sectors 3. % City waste recycled and marketed
	Conservation	1. % Land area retained in "natural state"

Recreation Indicators

COMPONENT	INDICATOR	MEASURES
Economic Vitality	Availability	1. Per capita expenditure on parks and recreation
Social Well-Being	Availability/ Variety	1. # per capita
	Sports	swimming pools tennis courts arenas, curling rinks, golf courses
	Leisure	neighbourhood bars bowling alleys, bingo halls, amusement places theatres and movie theatres
	Clubs	sports and leisure clubs youth clubs social clubs
	Other	library books museums and art galleries symphony, opera and dance companies
Environmental Integrity	Conservation	1. No. and hectares parks and recreation areas per capita

Crime and Safety Indicators

COMPONENT	INDICATOR	MEASURES
Economic Vitality	Availability	1. government expenditure on policing 2. local government expenditure on fire protection per capita
Social Well-Being	Availability	1. population per police officer 2. # fire employees per capita 3. fire protection classification of community
	Variety	1. #, range and scope of public safety services
Incidence		1. traffic accidents per capita 2. violent crime rate 3. property crime rate 4. average annual fire losses: dollars per capita

Transportation Indicators

COMPONENT	INDICATOR	MEASURES
Economic Vitality	Availability	1. % Public expenditure allocated to public transit including infrastructure 2. Expenditure for street maintenance per capita per year
	Employment	1. % Population living and working in the city
Social Well-Being	Availability	1. Distance or travel time to transit 2. % Street km. served by public transit
	Equity	1. Public transit for disabled
	Safety	1. # Crimes on public transit
Environmental Integrity	Energy Resource Consumption and Pollution	1. Motor vehicle registrations per capita 2. % population using public transit

Source: Murdie et al. (1992)

Appendix C.

Urban Sustainability Indicators

Table C1. Sustainable Seattle Indicators

THEME	INDICATOR	MEASURE	TIME SPAN
Environment	Wild salmon returning to King County to spawn, in two rivers	- % change relative to 1978 counts, using a 3-year moving average	1978-92
	Pollutant standards index of air quality (CO, SP, SO_2, O_3) for Seattle	- number of days that all pollutants were below acceptable levels	1980-92
	Pedestrian-friendly streets in Seattle	- as a % of all streets	1985
Population and Resources	Population of King County	- number of people	1970-92
	Population growth rate in King County	- percentage change	1970-92
	Residential water consumption in King County	- mega-gallons/person/year	1970-92
	Solid waste generated in King County	- pounds/capita/day	1976-92
	Solid waste recycled in King County	- pounds/capita/day	1976-92
	Vehicle miles travelled in King County	- miles/capita/year	1970-92
	Fuel consumption in King County	- gallons/capita/year	1970-92
	Renewable energy use in King County (renewable electricity)	- BTUs/capita/year	1980-92
	Non-renewable energy use in King County (gasoline, natural gas, non-renewable electricity)	- BTUs/capita/year	1980-92
Economy	Employment concentration in King County labour force	- number and % employed by top ten employers	1981-90
	Employment in King County	- number employed	1981-90
	Work required to meet basic needs in King County	- number of hours/month at the average King County wage	1980-90
	Children living in poverty in Seattle and King County	- % of all children living in families with incomes below the poverty line	1979, 1989

THEME	INDICATOR	MEASURE	TIME SPAN
Economy (continued)	Owner-occupied housing affordability ratio for median and low income households in King County	- ratio of affordable housing cost for median income household (25% of household median income) to average housing costs - ratio of affordable housing cost for low income household (25% of 50% of household median income) to average housing costs	1982-92
	Rental housing affordability ratio for median and low income households in King County	- ratio of affordable monthly rent for median income household (30% of household median income) to average rent - ratio of affordable monthly rent for low income household (30% of 50% of household median income) to average rent	1982-92
	Health care expenditures in Washington State	- $/capita/year - % of average annual personal income, - % of total state and local government expenditures	1980, 1990
Culture and Society	Low birthweight infants by race and ethnicity	- moving 3-year average of the % of infants with birthweights less than 2,500 grams	1980/82-1989/91
	Juvenile crime in King County	- number of felonies and misdemeanours involving individuals under 18 years of age	1980-92
	Voter participation in primary elections in King County	- % eligible voters registered - % registered voters voting - % of population over 18 voting	1983-91 (every 2 years)
	Adult literacy in King County	- % of literate adults	1990
	Library usage in King County and Seattle	- number of books checked out/capita/year	1970-91 (every 3 years)
	Community centre usage in Seattle	- number of visits/capita/year	1983-91
	Public participation in the arts in King County	- % of population reporting exposure to different artistic modes (art, music, plays, dance, etc.)	1992

Source: Sustainable Seattle (1993)

Table C2. Hamilton-Wentworth's Long List of Indicators

VISION 2020 GOALS	POSSIBLE INDICATORS
Natural Areas To develop a system of interconnected protected natural areas, which provides for the growth and development of natural flora and fauna and, where appropriate, provides access for all citizens of Hamilton-Wentworth.	1. Total % of ESAs 'protected'. Target: 100% 2. Total kilometres public trails in the Region. 3. The total number of different species identified in the Annual Christmas Bird Count. 4. Annual participation in environmental education programs run by Naturalists' Club, Conservation Authorities, Royal Botanical Gardens. 5. Annual visitation at nature or interpretive centres in the region. 6. Number of trees planted annually along regional roads. 7. Percentage of schoolyards in region which have been 'naturalized'.
Water Quality To ensure the water quality in streams, creeks, Cootes Paradise, Hamilton Harbour and other surface water bodies is generally good, that the water is clean and clear and that swimming is a safe activity To identify and eliminate all significant sources of potential chemical contamination by the year 2000. To reduce the combined municipal water use of households and businesses by 50% by the year 2000. To restore the adequate habitat for fish and birds to a level necessary to restore the populations to a healthy and productive state. To ensure the quality of groundwater throughout the Region is suitable as potable water and as a pure recharge source for surface waters. To ensure that water quality is not affected by run-off and sedimentation due to changes in the watershed.	1. An overall indicator of the state of Hamilton Harbour based on indicators being monitored by the Remedial Action Plan. 2. Per capita residential and business water consumption. Target: 50% Reduction by 2000. 3. Percentage of consumers in Hamilton-Wentworth on metered water. Target 100% by 2000. 4. Number of 'beach open' days for all beaches in Region between Victoria Day and Labour Day. 5. Length of shoreline along Lake Ontario and around the Harbour which is physically and legally accessible to the public. 6. Volume of untreated sewage discharged to the bay annually (per capita?)

VISION 2020 GOALS	POSSIBLE INDICATORS
Air Quality To ensure the Region has the best air quality of any major urban area in Ontario by the year 2000, as determined by the Ministry of the Environment.	1. Number of days of good air quality according to the Province's Air Quality Index. 2. Numbers of trees planted annually by Region, Area Municipalities, and Conservation Authorities. 3. Total area of Region under forest cover.
Waste Management To develop and implement a comprehensive waste prevention and management plan with a focus on pollution prevention, and with a strategy consisting of three components, in order of priority: 1) the reduction of waste going to the curb and down the sewer; 2) the diversion of waste for reuse or recycling; and 3) as a last resort, the disposal for the remaining minute amount of waste after reduction and diversion. To reduce and virtually eliminate hazardous waste.	1. Per capita residential solid waste generation. 2. Per capita toxins turned into municipal depots or collected on special days. 3. Number of composters distributed annually by region and associated volume of waste diverted. 4. Total area of known contaminated sites. 5. Space consumed at landfill sites (% site consumed annually).

VISION 2020 GOALS	POSSIBLE INDICATORS
Urban Form To curb urban sprawl and suburban encroachment on the rural and agricultural lands. To encourage that development which makes efficient, and economical use of infrastructure and services. To minimize the environmental, social, and financial costs of new development to the residents of Hamilton-Wentworth. To preserve the natural and historical heritage of the region. To encourage redevelopment of Hamilton's central core as the regional centre. To reduce commuting distances. To encourage, promote and facilitate the everyday use of alternative modes of movement, such as walking, bicycling, and public transit.	1. Office (and retail commercial) vacancy rates in the regional centre. Target: (5%). 2. The percentage of building/sites 'protected' on the heritage inventories of all area municipalities. 3. Average commuting times/distances. 4. Measure of the building densities constructed as a ratio of the total density permitted in the plans and zoning by-laws. 5. No. of applicants to extend urban and regional settlement boundaries annually.

VISION 2020 GOALS	POSSIBLE INDICATORS
Transportation To develop an integrated sustainable transportation system for people, goods and services which: · is environmentally friendly, affordable, efficient, convenient and accessible; · meets community needs; · provides a level of service for people with disabilities which is comparable to regular public transit; · considers safety in public spaces, through location and design of transit shelters, public walkways, bicycle paths and parking areas; · provides access to all areas of the Region; and · integrates public transit, bicycles, pedestrians, truck and automobiles. To encourage a shift in personal lifestyle and behaviour toward transportation choices that enhance personal health, fitness and save money with the lowest environmental effect.	1. Percentage of buses in HSR fleet with automatic lowering entry. 2. Transit ridership in annual trips per capita. 3. Per capita Regional transit subsidy vs. auto subsidy. 4. Total kilometres in regional bike network. 5. Number of accidents (per capita) by transportation mode (car, truck, bicycle, pedestrian). 6. Percentage HSR buses converted to natural gas. 7. Percentage of Regional population served by public transit.

VISION 2020 GOALS	POSSIBLE INDICATORS
Health and Well-Being To increase the number of years of good health for all citizens by reducing illness, disability and premature deaths. To develop cultural institutions that reflect our historical development and to encourage contributions from our increasingly diverse population. To develop the social and physical environments that allow all citizens to participate fully in our community. To ensure all levels of government are coordinated, efficient, effective and easily accessible to all citizens. To develop a population that is literate, educated, possesses the skills of lifelong learning and supports the concept of sustainable development.	1. Adult literacy rate in Region. Goal: 100%. 2. Low birth-weight babies as a % of total. 3. % Children in Region on nutrition programs. 4. % Children in Region living below poverty line. 5. Waiting time for affordable housing. 6. Percentage of regional health care budget spent on health promotion and disease prevention. 7. Per capita divorce rate.
Community Empowerment To allow all citizens from our diverse population the opportunity to have meaningful participation in government and in cultural, educational, health and social service institutions.	1. Percentage of females on elected and appointed regional and municipal councils, boards and commissions. Goal: 50%. 2. Voter turnout for municipal elections. 3. Percentage of the population who do not speak English or French. 4. Hamilton Spectator readership as a percentage of the total Regional daily newspaper circulation. 5. Percentage adult population who read a newspaper daily. 6. Percentage of adult population contributing time to community or service clubs, volunteer programs, sports and recreation.

VISION 2020 GOALS	POSSIBLE INDICATORS
Livelihood To improve the ability of local businesses to compete both locally and globally and thus provide all citizens with an opportunity to have an income to meet, as a minimum, the necessities of life. To increase the number of businesses that are non-polluting and those that actually produce quality of life products which control, reduce and prevent pollution. To make Hamilton-Wentworth's labour force the best trained and adaptable in the world, in order to ensure local business is competitive and innovative.	1. The real employment rate. Target 95-97%. 2. Percentage of the workforce having completed post-secondary (e.g. certificate, papers, diploma or degree). 3. Percentage of regional workforce employed in ten largest firms or organizations. 4. Percentage of workforce employed by 'environmental' industries. 5. Percentage of eligible secondary school students participating in co-op programs. 6. Average per capita hours of training per worker in Region. 7. Average 'real income' or 'real wages' in community.
Agriculture Promote sustainable farming techniques. Make agriculture a viable economic activity in Hamilton-Wentworth.	1. Percentage farms with environmental farm plans or stewardship agreements. 2. New lots created from agricultural land. Target: None by 2020. 3. Percentage of all prime agricultural lands (soil classes 1,2,3,4) designated as Agricultural Land Reserve in the Regional Official Plan. Target: 100%. 4. Amount of road salt used on Regional and Local roads in rural areas of Hamilton-Wentworth. Target: 0 by 2000. 5. Crop diversity -number of different crops grown in region. 6. Annual production of food in region by volume.

Source: Regional Municipality of Hamilton-Wentworth (1995) "Guide to the Participant's Workbook"

Table C3. British Columbia State of Sustainability Indicators

British Columbia Human Settlements and Population Growth Indicators

TOPIC	INDICATORS	TIME SPAN
Population growth	Population in 5 cities[1]	1981-91 (every 2 years)
	Annual population growth rates in 5 cities[2]	1975-2021
	Net migration and natural population increase in 5 cities[1]	1975-2021
Household growth and change	Number of households in 5 cities[1]	1981-91 (every 5 years)
	Persons per household in 5 cities[1]	1981-91 (every 5 years)
	Areas in the Lower Mainland where population growth trends fall below, at, and above proposed growth targets	1991-2021
	Land area needed for cities to serve additional British Columbia residents in the year 2021 at various residential densities	
	Areas in B.C. with significant constraints to development	
	Population growth in 5 settlement areas[3] in Puget Sound/Georgia Basin	1991-2021

British Columbia Human Settlements and Population Growth Indicators - Sprawl

TOPIC	INDICATORS	TIME SPAN
Settlement patterns and land use	Urban and non-urban residential densities in 5 settlement areas[4]	1981-91 (every 5 years)
	Deletion of land (ha.) from provincial forest reserves in 4 forest regions[5]	1983-93
Housing types	Single and multiple family housing starts for 5 cities[1]	1983-93 (every 2 years)
Roads and servicing	Length of water and sewer lines per household for 5 cities[1]	1983-91 (every 2 years)
	Kilometres of road per household for 5 cities[1]	1983-91 (every 2 years)
	Road area as a percent of total land area for 5 cities[1]	1983-91 (every 2 years)
Urban containment	Percent of jurisdictions in B.C. that use development cost charges	1993
	Percent of suburban jurisdictions in B.C. that use urban containment boundaries	1993
	Percent of land zoned for mixed use in 5 cities[1]	1993

British Columbia Human Settlements and Population Growth Indicators - Mobility

TOPIC	INDICATORS	TIME SPAN
Private automobile use	Number of motor vehicle registrations in 5 cities[1]	1985-93 (every 2 years)
	Number of motor vehicles per household in 5 cities[1]	1985-91 (every 2 years)
	Modal split for 2 cities[6]	1993
Transit and alternative modes of travel	B.C. transit service in 5 cities[1] by population served, no. of buses, people per bus	1993
	Average number of transit trips per person per year in 5 cities[7]	1981-91 (every 5 years)
	Annual transit ridership in 3 cities[8]	1980/81 - 1992/93
	Percentage of population in 4 cities[9] within 300-450 metres of a bus route	1993
	Percent of routes in 4 cities[9] with frequency of service less than 30 minutes in peak hours	1993
	Percent of routes in 4 cities[9] with frequency of service less than 60 minutes in off-peak hours	1993
	Transportation and land use implications for the GVRD of compact urban form policies versus present trends	1991-2021

British Columbia Urban Environmental Indicators

TOPIC	INDICATORS	TIME SPAN
Public concerns	"In which areas of B.C. (wilderness, rural, urban, all same) are you most concerned about environmental quality?", by community size	no date
	"How concerned are you about the quality of environment in your area?", by employment status and sex, 1986-1990,1992	1986-90, 1992
	Perceived quality of the local environment, by community size	1986/87, 1988/89, 1990, 1992
	Perceived change in quality of the local environment, by community size	1985/86, 1988/89, 1990/91, 1992
Natural habitats	"How important is the loss of parkland?", by age	1982
	"How important is the loss of parkland?", by annual income	1982
	Park area per capita in 5 cities[1]	1985-91 (every 2 years)
	Percent of jurisdictions in B.C. which have mapped environmentally sensitive areas	1993
	Percent of jurisdictions in B.C. which have programs to acquire or protect environmentally sensitive areas	1993

British Columbia Urban Environmental Indicators - Use of Natural Capital

TOPIC	INDICATORS	TIME SPAN
Solid waste	Solid waste generation per household per year for 5 settlement areas[10]	1990-92
	Amount of waste recycled per household for 5 cities[4]	1992
	Percent of household waste stream that was recycled in 5 cities[4]	1992
Energy	Annual residential electricity sales for 7 settlement areas[11]	1985/86 - 1991/92
	Annual electricity use per unit by household type, South Interior (Cranbrook)	1985/86 - 1991/92
	Annual residential electricity sales by housing type, for 4 settlement areas[12]	1985/86 - 1992/93
	Actual and target energy savings from "Power Smart" energy conservation program in 7 settlement areas[13]	1992/93
	Residential natural gas use in 4 settlement areas[14]	1990-93
Water	Average annual household water bill for 4 cities[15]	1983-93 (every 2 years)
	Percent of jurisdictions with water demand management programs	1993
	Percent of jurisdictions in B.C. with community watershed or ground water management programs	1993
	Average number of days per year that watering restrictions were applied in 3 cities[16]	1992/93
Air quality	Point source air emission non-compliance exceedances or pollution concerns for 5 cities[1]	1990-93
	Percent of jurisdictions in B.C. that have implemented clean air initiatives	1993
Liquid waste	Percentage of homes connected to primary or secondary treatment or septic treatment for liquid waste, for 4 cities[15]	1993
	Total annual volume of effluent discharged, for 5 cities[1]	1987-93 (every 2 years)
	Sewage effluent non-compliance exceedances or pollution concerns for 5 cities[1]	1990-93

British Columbia Urban Economic Indicators

TOPIC	INDICATORS	TIME SPAN
Vibrancy	Average personal income, for 5 cities[1]	1983-91 (every 2 years)
	Number of business licenses issued, for 5 cities[1]	1987-93 (every 2 years)
	Number of bankruptcies and incorporations, for 5 cities[1]	1987-91 (every 2 years)
	Percent of labour force receiving unemployment insurance, for 5 cities[1]	1983-91 (every 2 years)

British Columbia Urban Economic Indicators - Diversity

TOPIC	INDICATORS	TIME SPAN
Economic sector performance	Jobs by sector, for 5 cities[1]	1981-91 (every 5 years)
Income sources	Sources of income as a percent of total community income, for 5 cities[1]	1985-91 (every 2 years)
Equity	Proportion of low income households, for 5 cities[1]	1981-91 (every 5 years)
	Incidence of low income family units in urban and non-urban areas, for 5 settlement areas[10]	1986, 1991
	Percent of households spending more than 30% of income on housing, for 5 cities[1]	1981-91 (every 5 years)

British Columbia Urban Economic Indicators - The Costs of Growth

TOPIC	INDICATORS	TIME SPAN
General expenditures	General operating expenditures per household for protective services, transportation, recreation and culture, for 5 cities[1]	1987-91
Capital expenditures	Capital expenditures per household for protective services, transportation, recreation and culture, for 5 cities[1]	1987-91

British Columbia Social Well-Being Indicators - Health, Safety and Well-Being

TOPIC	INDICATORS	TIME SPAN
Personal wellness	Estimated life expectancy at birth, for 5 cities[1]	1971-91
	Low birth-weight babies per 1,000 live births, for 5 cities[1]	1987-91 (every 2 years)
	Teenage mothers per 1,000 live births, for 5 cities[1]	1987-91 (every 2 years)
	Suicide rates per 1,000 population, for 5 cities[1]	1987-91 (every 2 years)
Environmental effects on family health	Perceived seriousness of local pollution, by community size	1982, 1984
	Perceived family health effects of pollution, by income	1982, 1984

British Columbia Social Well-Being Indicators (Continued)

TOPIC	INDICATORS	TIME SPAN
Demographic change	Population age groups, for 5 cities[2]	1976-2018 (every 6 years)
	Population dependency ratios (ratio of old or young to total workforce), for 5 cities[2]	1975-2021 (every 3 years)
	Birth and death rates, for 5 cities[2]	1975-2021 (every 3 years)
Health and safety	Crimes against persons per 1,000 population, for 5 cities[1]	1985-91 (every 2 years)
	Crimes against property per 1,000 population, for 5 cities[1]	1985-91 (every 2 years)
	Other criminal offences per 1,000 population, for 5 cities[1]	1985-91 (every 2 years)
Education	Education level as a percentage of total population over 15, for 5 cities[1]	1981-91 (every 5 years)
	Graduates as a percent of Grade 12 enrolment, for 5 cities[1]	1981-93 (every 2 years)
	English as a second language enrolments, for 5 cities[1]	1988-93
	Library circulation per capita, for 5 cities[1]	1981-91 (every 2 years)

British Columbia Governance Indicators

TOPIC	INDICATORS	TIME SPAN
Process	Percent of jurisdictions in B.C. with a community vision statement	1993
	Percent of jurisdictions in B.C. with a local round table or similar multi-stakeholder advisory planning group	1993
	Percent of jurisdictions using defined environmental standards for evaluating development proposals and government actions	1993
	Proportion of plans prepared that have a time horizon of more than 5 years, for 5 cities[1]	1993
Participation	Percentage of eligible voters who voted in local elections, for 5 cities[1]	1983-93 (every 2 years)
	Percentage of eligible voters who voted in provincial elections, for 5 cities[1]	1986, 1991
	Number of public meetings and hearings held, for 5 cities[1]	1993
	Percent of ratepayer or similar groups active in jurisdictions in B.C.	1993
	Percentage of board and council members who are women or ethnic minorities for jurisdictions in B.C.	1993

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3. The Delegation of Planning Responsibilities in Canada, by Terry Ann Romanelli and Claude Marchand, reviews the delegation of planning responsibility from senior levels of government to municipalities. The report includes the results of a survey of 262 planning officials across Canada. 113 pp., 1991. **$12.50**

4. Successful Local Economic Development Initiatives, by Dennis Young and Janine Charland, explores successful community economic development activities and the reasons for their success. 53 pp., 1992. **$12.50**

5. Sustainable Urban Development in Canada: From Concept to Practice, by Virginia Maclaren, examines the programs and tools which have been used at the local level to implement sustainable development. The report comprises three volumes: Volume I – *Summary Report* (40 pp.); Volume II – *Annotated Bibliography* (24 pp.); Volume III – *Compendium of Initiatives* (275 pp.), 1992. **$35.00**

6. The Rural-Urban Fringe: A Review of Patterns and Development Costs, by Janine Charland and Claude Marchand, reviews the literature on the economic impact of urban sprawl. 52 pp., 1992. **$12.50**

7. Canada's Aging Rural Population: The Role and Response of Local Government, by Gerald Hodge, documents the challenges facing small municipalities with an aging population. The study includes a survey of 209 municipalities which sheds light on essential services provided to seniors. 43 pp., 1993. **$12.50**

8. Municipal Consolidation in Canada and its Alternatives, by Allan O'Brien, examines how Canadian provincial governments have approached the restructuring of municipal governments over the last decade. 119 pp., 1993. **$20.00**

9. Directory of Organizations Engaged in Urban and Regional Research in Canada, by Engin Isin, contains detailed information on public and private sector agencies involved in urban and regional research. 114 pp., 1993. **$12.50**

10. The Land Use Implications of Alternative Municipal Financial Tools: A Discussion Paper, by Enid Slack, examines the impacts of three municipal revenue-generating techniques (user fees, property taxes and development charges) and of two potential revenue-generators (site value taxes and land value capture taxes). 60 p., 1993. **$12.50**

11. Environmental Policy Review of 15 Canadian Municipalities, by Paule Ouellet, reviews the environmental policies and programs of 15 Canadian municipalities. 2 volumes. Volume 1 – *Summary Report* (68 p., bibliography); Volume 2 – *Appendices* (207 p.), 1993. **$25.00**

12. Population Distribution and the Management of Urban Growth in Six Selected Urban Regions in Canada, by Christopher R. Bryant and Daniel Lemire, examines patterns and impacts of population change and urban growth in six of Canada's urban regions: Halifax, Montreal, Toronto, Winnipeg, Calgary and Vancouver. 193 p., 1993. **$20.00**

13. Development Charges In Canadian Municipalities: An Analysis, by Enid Slack, provides a national overview of legislation governing development charges and detailed findings from a survey of how thirty-one municipalities across Canada view and use development charges. 59 pp., 1994. **$15.00**

14. Ecosystem Planning for Canadian Urban Regions, by Ray Tomalty, Robert Gibson, Donald Alexander and John Fisher, takes an in-depth look at the use of ecosystem planning to manage the growth of urban areas. 183 pp., 1994. **$25.00**

15. The Role of Canadian Municipalities in Economic Development, by Michael Skelly, presents a national perspective on how Canadian municipalities see their role in economic development and determines the roles they would ideally like to play. It also examines the tools and techniques which Canadian municipalities have used to foster economic development. 141 pp., 1995. **$25.00**

16. The Impact of Aboriginal Land Claims and Self-Government on Canadian Municipalities: The Local Government Perspective, by Theresa Dust, determines the impacts of federal policy on the creation of new urban reserves on municipalities, analyzes how framework agreements resulting from land claims have affected municipal governments, examines municipal taxation issues related to reserve lands and reviews recent and relevant court decisions. The report includes three case studies. 59 pp., 1995. **$25.00**

17. Developing Indicators of Urban Sustainability: A Focus on the Canadian Experience, by Virginia Maclaren with the assistance of Sonia Labatt, Jennifer McKay and Michael Van de Vegte, reviews a range of frameworks and selection criteria for urban sustainability indicators. Canadian examples figure largely in the review. 149 pp., 1996. **$25.00**

18. Alternative Service Delivery in Canadian Municipalities, by Michael Skelly, documents Canadian and other local government experience with alternative service delivery practices and evaluates a series of case studies according to efficiency, effectiveness, accountability and equity criteria. 62 pp., 1996. **$25.00**

Notes for Table C3:

1. Capital Regional District (CRD), Greater Vancouver Regional District (GVRD), Kelowna, Prince George, Cranbrook
2. CRD, GVRD, Central Okanagan, Prince George, Cranbrook
3. South Coast Mainland, Southern Vancouver Island, Metropolitan Vancouver, Whatcom-Skagit, Metropolitan Seattle
4. CRD, GVRD, Prince George, East Kootenay, Central Okanagan
5. Vancouver Forest Region (GVRD and CRD), Kamloops Forest Region (Kelowna), Nelson Forest Region (Cranbrook), Prince George Forest Region
6. City of Victoria, Kelowna
7. CRD, GVRD, Kelowna, Prince George, Portland
8. CRD, GVRD, Portland
9. CRD, GVRD, Kelowna, Prince George
10. CRD, GVRD, Central Okanagan, Fraser-Fort George, East Kootenay
11. Metropolitan Vancouver, Lower Mainland North, Lower Mainland South, Northern (Prince George), South Interior (Cranbrook), Vancouver Island South, Kelowna
12. Metropolitan Vancouver, Northern (Prince George), Vancouver Island South, South Interior (Cranbrook)
13. Metropolitan Vancouver, Lower Mainland South, Lower Mainland North, Okanagan, Vancouver Island South, Prince George, Cranbrook
14. GVRD, Fraser Valley, Inland (Prince George), Columbia (Cranbrook)
15. GVRD, CRD, Kelowna, Cranbrook
16. GVRD, CRD, Cranbrook

Source: British Columbia Round Table on the Environment and the Economy (1994)