CANADIAN HANDBOOK ON HEALTH IMPACT ASSESSMENT

Volume 2
Decision Making in Environmental Health Impact Assessment

DRAFT

DECEMBER 1999

ACKNOWLEDGEMENTS

The *Canadian Handbook on Health Impact Assessment Volume 2: Decision Making in Environmental Health Impact Assessment* was written under contract by Dr. Pierre Gosselin MD MPH and Pierre Chevalier PhD with contributions from Marcel Belanger MD, Daniel G. Bolduc Msc, Gaetan Carrier MD PhD, Daniel Gagne MSc, Marcel Gaucher MSc, Denis Gauvin MSc, Benoit Gingras MD, Benoit Girard MD, Isabelle Giroux MSc, Jacques Grondin MA, Andre Labelle MD, and Pierre Lajoie MD MIH.

The *Canadian Handbook on Health Impact Assessment Volumes 1, 2 and 3* are being prepared under the general guidance of the Federal/Provincial/Territorial Committee on Environmental and Occupational Health (CEOH). The CEOH has membership from all provinces, territories and the federal government. Membership on the CEOH represent environment, health and labour sectors.

Reviewers from within Health Canada include Dave Stieb of the Air Quality Health Effects Research Section, Kathy Hughes with the Priority Substances Section and Steve Wong of the Herbicide Toxicological Evaluation Section, all of whom provided comments on the Volume 2 material that pertained to their areas of expertise.

Health Canada's Office of Environmental Health Assessment (OEHA) is coordinating the production of the Handbook under the guidance of Roy Kwiatkowski, with the assistance of Sandra Owens.

TABLE OF CONTENTS

1.0 HANDBOOK PRESENTATION

1.1 Introduction

This second volume of the Canadian Health Impact Assessment Handbook is designed to create an integrated approach to developing a public health perspective within the framework of environmental assessments. More than a decade ago, the World Health Organization (Giroult, 1988) addressed the need to promote the importance and the benefits of integrating health into the environmental assessment process. Nation-wide consultations held in 1996 (Health Canada, 1996) clearly demonstrated that practitioners were interested in this subject. In particular, practitioners pointed out that while the case for the social component was well-known and developed, the relevant procedures, methods and indicators were less clear (Health Canada, 1997). They stressed the need to combine the efforts of the health sector and environmental assessment specialists, while also taking into account the views of the public. This Handbook has been developed to respond to these needs.

This second volume and the one that follows are practical extensions of the first volume, which presented the rationale for the necessary presence of the health sector in the area of environmental assessment, as well as a summary of current practices in Canada and in other countries. The present volume focuses on the procedures to follow when evaluating the implementation of a project or program in a given region. It also presents criteria for conducting an analysis, and provides detailed examples of impacts as a guideline for public health professionals.

The scope of the environmental assessments produced in Canada varies considerably, in accord with requirements of the provinces and the federal government. It would be impossible to cover the entire range of methodologies and disciplines that are available or useful, but the third volume of the Handbook provides a summary of the essential information on current approaches. The current volume deals with the types of projects and programs that are likely to require the expertise of local or regional public health authorities.

1.2 Target audience

The primary target audience will be health professionals who lack expertise in the area of environmental assessment (EA) but are occasionally asked to provide their views on

issues such as the community health impacts of mining developments, landfill sites or high-voltage lines. Specifically, this could apply to doctors, nurses, sanitarians or environmental health inspectors who work in private practice, in community centres, or in local or regional public health services.

The Handbook may also be useful to other stakeholders who use or conduct environmental assessments, such as consulting firms in the fields of engineering and social science who conduct impact studies in Canada, as well as project proponents and the officials responsible for authorizing projects.

1.3 Contents of this volume

The following five sections focus on:

- the role of the health sector in EA (chapter 2);
- sustainable development as a framework for integrating risks and benefits to public health (chapter 3);
- an analysis of the data on health risks (chapter 4);
- the integration of a public health approach in developing public notices and public health interventions in EA (chapter 5);
- the development of a process for communicating with the public (chapter 6).

Readers should note that this volume was designed to allow for expansion in the future. More specifically, if the consultations which the Federal/Provincial/Territorial Committee on Environmental and Occupational Health is currently holding with various organizations are fruitful, the goal will be to develop a standard approach that would serve as a basis for the practice of public health professionals across the country. Several examples of the main environmental and health impacts of different types of projects are also presented in Appendix 1. If the consultations demonstrate the usefulness of developing summaries and grids for the main impacts of generic classes of projects, cooperation among the provinces, territories and federal government may lead to the development of summaries and grids for other economic sectors, building on the skills of the various stakeholders.

Although the approach used in Canada, including the regular and sometimes systematic involvement of public health officials in environmental assessment, is relatively new and inconsistently applied, it represents an exception when compared with other countries in

the world (IAIA, 1996, 1997). Many countries, international organizations and universities have come to the conclusion that involving public health officials in the process will be necessary in the future, and are following the development of the Canadian Handbook with interest. Forseeably, our collective efforts and experience in this field will make a contribution on a far larger scale in years to come.

2.0 USEFUL CONCEPTS IN ENVIRONMENTAL ASSESSMENT

2.1 Introduction

This section will present a number of essential concepts in examining the function and role of health professionals in EA. Some of these concepts have been explored in greater detail in Volume 1, and will be dealt with briefly here. Others will be discussed more thoroughly. These concepts are:

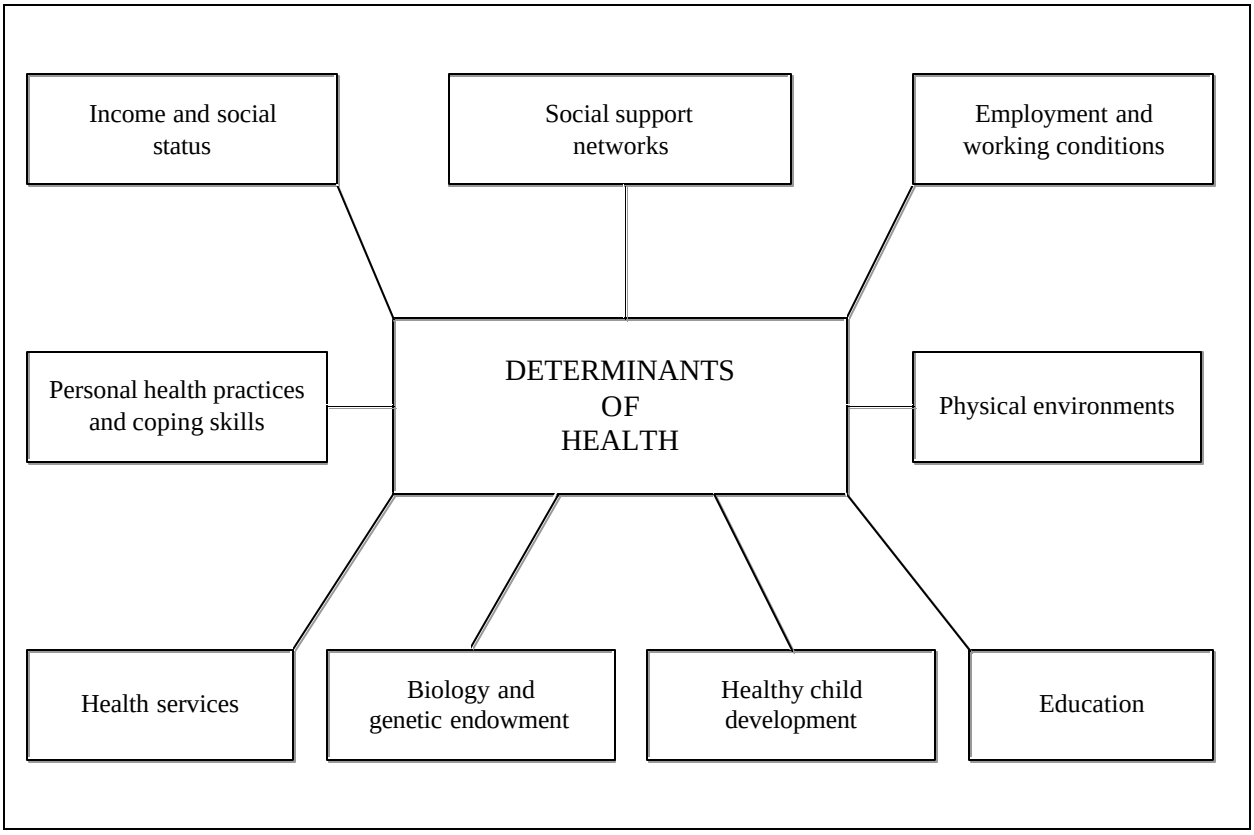
- the determinants of health (review);
- the various types of environmental assessments and their content;
- the normal sequence of events in the environmental assessment process (review);
- the role of health professionals in this process;
- suggested levels of involvement for health organizations in a variety of situations.

2.2 The determinants of health

Countless scientific studies have clearly stated that the health of individuals and populations is determined by a number of complex interacting factors.

Figure 2.1 summarizes the determinants of health (Health Canada, 1997).

Figure 2.1: Outlining the Determinants of Health



Some determinants have greater applicability for individuals, while others relate more particularly to the community and the forms of social organization. The health impact of these factors varies for individuals, regions and countries, and also depends on the virulence or toxicity of harmful exposures.

Although most of these concepts may appear self-evident to many health professionals trained in Canada, it is important to note that this is not necessarily the case in other parts of the world. Doctors and nurses who work in the public health field, for example, are familiar with the determinants of health and the broader concept of health promoted by the World Health Organization (WHO), which defines health as “a state of complete physical, mental and social well-being” (WHO), 1947).

However, they often overlook the fact that for many members of their profession, for professionals in other disciplines and for a large segment of the public, health remains, above all, the absence of illness or disease, with the latter often considered a misfortune which is unrelated to behaviour, or the result of poor access to health care services (Evans and Stoddard, 1994). In the context of EA, it is important to consider that these

perceptions hold sway among proponents, public officials and the general population. Those seeking a more detailed discussion of these concepts are urged to consult Volume 1 of this Handbook (Health Canada, 1999).

2.3 Types of environmental assessments

Often, the terms *environmental assessment* and *environmental impact assessment* are used interchangeably. Some have maintained however, that environmental assessments have a broader scope. One recent study (Sadler, 1996) offered the following definitions:

- *Environmental assessment* is a systematic process which consists of evaluating and documenting the possibilities, capacities and functions of natural resources and systems, in order to facilitate sustainable development planning, and decision-making in general, as well as to manage the adverse impacts and effects of specific development proposals.

- *Environmental impact assessment* is a process that consists of defining, predicting, evaluating and attenuating the biophysical, social and other effects of development projects and physical activities, before important decisions and commitments are made.

- *Strategic environmental assessment* is a preliminary process for reviewing and evaluating policies, plans and programs, as well as other draft proposals for large-scale projects and initiatives.

The academic field of environmental assessment has spawned a number of sub-disciplines which are more conceptual than actual in nature, given that they are really components of EA. These include economic, fiscal, demographic, technological and social assessment (Vanclay and Bronstein, 1995). Many would also include political analysis in this category.

Volume 1 of this Handbook offered a descriptive definition of environmental assessment. This definition provides a good summary of the various components of EA and may be more useful for health professionals:

Environmental Assessment (EA)

A comprehensive and systematic process designed to identify, analyze and evaluate the environmental effects of a project in a public and participatory manner; environmental assessment involves the use of technical experts, research and analysis, issue identification, specification of information requirements, data gathering and interpretation, impact prediction, development of mitigation proposals, external consultations, and report preparation and review. In this Handbook, the term "environmental assessment" is used synonymously with "environmental impact assessment", "impact assessment", etc.

Two areas of focus are discernible:

- *Mezzosocial focus:* At this level, the main tools are local or regional environmental impact studies, which are conducted before projects are developed. Once in place, projects (factories, highways, etc.) are monitored for both environmental and health impacts. Environmental audits are also conducted to determine whether companies are managing their processes in a manner consistent with established standards such as ISO 14000 or the equivalent.

- *Macrosocial focus:* The principal tools at this level are strategic environmental assessments and product life-cycle studies which attempt to predict impacts on an entire ecosystem, ecozone, large administrative unit (such as a province or country), or continent. Follow-up activities take the form of reports on the state of the environment and the National Accounts as they pertain to natural resources (forests, water, etc.), as well as reports on health (mortality, morbidity, biological contamination, surveys on habits and perceptions). Reports on health sometimes focus on a specific risk factor or a particular sub-group within the general population, and examine the level of perceived or presumed risk. Exposure to organochlorines among Natives, or to heavy metals among pregnant women, are some examples of issues addressed through this traditional public health approach.

Table 2.1 Types of studies conducted in environmental assessment

STAGE	MEZZOSOCIAL FOCUS	MACROSOCIAL FOCUS
Prior to project development: *Prediction and investigation*	C Impact studies	C Strategic studies C Product life-cycle studies
During project development and after: *Monitoring and follow-up*	C Environmental and health follow-up (workers and neighbouring populations) C Audits (ISO 14000)	C Reports on the state of the environment C National Accounts - resources C Reports on health status

2.4 The role of health professionals

The role of health professionals varies according to the function they fulfill within their organizations, as well as on whether they become involved in local issues as private citizens. A number of demands are made of health professionals, and a variety of tasks are required to properly analyze a project or program submitted for review. These roles will be examined with respect to project justification, the type of environmental evaluation under review and the unfolding of projects over time. In conclusion, a few criteria for involvement by health agencies will be suggested.

2.4.1 Project justification

In examining or preparing an environmental assessment, it is crucial to determine whether the goal of the assessment is simply to control the adverse impacts that have been identified with respect to the project, or whether the assessment process will also attempt to decide whether the project is in fact justified and necessary. This latter option is included in a number of provincial processes (in Quebec for example). Ideally, this requires that a number of options, including project cancellation, be considered before the most appropriate one is selected. Typically, examining the justification for projects is not favoured among private proponents and governments. On the other hand, it is standard amone many citizens' groups, environmental groups and municipalities to question the justifications put forward for projects. This is particularly so when a development may bring the group no benefits and cause them inconvenience. Typical examples would be the

installation of power lines in agricultural areas, or the development of a regional landfill site, which would have potentially adverse impacts on local residents.

Such substantive issues tend to remain unresolved, since those who oppose a project will always seek to question its soundness, regardless of whether such considerations are actually part of the process. Health professionals must be aware of this difficulty and take it into account, since their role does not consist of simply following a legal process, but entails protecting and promoting public health, regardless of whether or not a perceived risk is legitimate. In order to render their judgment on the acceptability of a project from a health perspective, they will need to concern themselves, at least minimally, with the justification for the project. We will return to this subject later.

2.4.2 Assessment content and the role of health professionals

The information contained in the various types of assessments and follow-ups is necessarily different. For example, health monitoring for workers in a factory can be very detailed and narrow in scope, and is sometimes conducted daily or on a continuing basis for some risk categories, such as exposure to chlorine. However, general population testing for the presence of heavy metals or organochlorines in mother's milk is not conducted on a frequent basis since temporal variations in these contaminants are slow to develop in a normal context.

Similarly, the role of health care providers varies according to the organization to which they belong and the training they have received (see Figure 2.1). It must be emphasized that all these various roles are complementary and essential, since the study of macrosocial aspects would not be possible without the input of clinicians from across the country. As well, practitioners count on large-scale studies in order to adapt their daily practice to emerging or newly-recognized risks.

Figure 2.2: Roles performed by health professionals in EA

	PREDICTION COMPONENT	KEY PLAYERS	MONITORING & FOLLOW-UP COMPONENT
POLICIES PROGRAMS PLANS	Strategic assessment	Clinical and research personnel in international organizations, government departments and university institutes: *Population surveillance; modelling; etiological research; knowledge synthesis*	Reports on health status
MANUFACTURED PRODUCTS	Product life-cycle analysis and technology assessment		Surveillance systems
PROJECTS	Impact studies	Local clinicians and regional public health practitioners: *Critical analysis and surveillance*	Various scientific publications
INDUSTRIAL AND OTHER PROCESSES		Doctors, nurses, occupational hygienists: *Surveillance and health program design*	Audits; environmental and health monitoring

The content of environmental assessment studies can vary considerably, depending on the subject matter, the type of study, the available data and the methodology employed.

The shortest studies are often those that deal with the most complex projects. The strategic environmental assessment conducted by the federal government in connection with the North American Free Trade Agreement (NAFTA) contained only 120 pages (Canada, 1992), although it dealt with a decision of the highest importance that would permanently alter natural resource consumption patterns and commercial exchanges across the continent. Under pressure from the United States, a parallel accord on the environment was added to NAFTA. At the time, however, no adequate data, provisional models or evaluation framework existed to permit an in-depth study. In addition, it is often difficult to foresee how thousands of companies and millions of consumers will conduct themselves,

or exactly where impacts will be felt. These factors can render decision-making very difficult.

However, standard environmental impact studies, such as those conducted for large factories, mines and freeways, often contain as many as 1,000 pages, while studies examining even larger projects, such as northern mines and hydro-electric developments, may contain as many as five to ten thousand pages.

Many complex studies of this nature are read only by a few brave souls. Most stakeholders simply consult the sections that concern them. While the health component is normally allotted a single chapter in these studies, a more thorough reading of the impact study as a whole is necessary to understand and critically analyze this material. Clearly, in the majority of cases, environmental assessment requires a team effort involving both health professionals and specialists in a variety of environmental or technical areas that can have an impact on health. Health professionals need to consult broadly to understand and accurately assess the value of the more technical components of these studies.

2.4.3 Sequence of events and involvement of health professionals

Regardless of the type of environmental assessment being examined, there is one constant where health professionals are involved: they must perform their appropriate role and contribute their input to the process. Theirs is an important primary prevention activity, ultimately involving secondary prevention activities such as screening, follow-up, and various clinical functions. The environmental assessment process has been around for approximately thirty years in North America; a number of habitual responses have developed during this period. One frequent response is to underestimate public health considerations. Thus it is crucial that health professionals, as well as health agencies and institutions, play a significant and active role in the process.

Macrosocial focus

At this level (large ecosystem, province, country, continent), more often than not the task consists of examining the broad thrust of public policy (energy, transportation, agriculture, etc.) to ensure that public health concerns are included early in the process. Some countries, Canada among them, conduct strategic environmental assessments. World-wide, however, practices tend to be more makeshift and informal (Thérivel and Partidario, 1996), and the public health component is often neglected. The same is often true at the provincial level, although efforts have been made in recent years, for example in British Columbia (Lewis, 1998) and in Quebec (CSEQ, 1998). These efforts include interdepartmental agreements that require a systematic examination (by representatives of the Ministry of Health among others) of policies, programs, regulations and guidelines that may have an impact on the environment (DHSS-MEF, 1987, 1992).

It is therefore necessary for public health officials, professional bodies (doctors, sanitarians, etc.) and other non-governmental organizations to get involved at the earliest stages of policy formulation. This can be accomplished by working with political parties, government departments, interdepartmental committees and parliamentary commissions, and by participating in public consultations and other mechanisms designed to give voice to concerns. Institutional settings may vary from one jurisdiction to the next, depending on the administrative structures in place.

Still, formal analysis of the public health effects of the environmental impacts of government policies, plans, and programs, is a science that has yet to be explored, and a relatively undeveloped discipline. As a result, policy statements and ideological declarations are encountered more frequently than substantive analysis. However, some organizations have begun to address this need by undertaking often detailed assessments of draft legislation and regulations to determine their impact on public health. For example, strategic assessments focussing on issues of health were recently conducted on new anti-tobacco legislation (DHSS, 1998), as well as on regulatory proposals regarding the quality of drinking water (MEF, 1992).

The scope of strategic environmental assessments is broad and can include an examination of the following elements (Buckley, 1998; Goodland, 1998; Thérivel, 1996) in terms of their environmental and health impacts:

- public policy, including administrative policies (such as privatization and budget cuts);
- budgets and taxation;
- international and national treaties;
- significant pollutants (e.g. dioxins and mercury);
- geographic region (e.g. the Arctic, rivers);
- temporal trends (e.g. urbanization, agricultural land use);
- technology (e.g. biotechnology in food production);
- economic sectors (e.g. impact of the automobile);
- generic project categories (e.g. cogeneration of electricity using gas).

Although environmental assessments in Canada already focus on a number of these elements, this practice is neither systematic nor automatic. However, the current trend is to include this type of analysis, which is an essential part of developing policies that are consistent with the principles of sustainable development. In the absence of such analysis, governments often end up adopting policies that run counter to these principles. Project assessment cannot compensate for an initial concept that is unsound.

Mezzosocial focus

At the local or regional level, the role of health professionals is more clearly defined, since legal and administrative processes are more firmly established, and the stages of project development more clearly circumscribed. These stages may vary from one province to the next, but usually adhere to the following five-step model, which was described in Volume 1 of this Handbook:

- *Project description:* Describe the project and determine whether or not an EA is required;
- *Scoping:* Scope or identify the key issues to be considered in an EA;
- *Determining public participation significance:* Assess the potential effects and determine their significance;
- *Mitigation and follow-up:* Identify mitigation measures to prevent, minimize or compensate for the impacts and monitor the project once it is in operation;
- *Recommendations:* Make recommendations on the fate of the project and conditions attached to its approval.

Health professionals can play a useful role at every stage of the process. In the preliminary stages, this role involves determining the content of the guidelines for preparing an impact study. While these guidelines have tended to be specific to individual projects, the current trend is towards generic guidelines for entire classes of projects (MEF, 1997-98), including a health component developed in consultation with public health authorities. An example of this type of generic guideline is provided on the next page (MEF, 1998). In some Australian states, such as Tasmania (PEHB, 1997), a separate process is favoured for health component guidelines, but these remain generic guidelines that can be applied to all projects.

Box 2.1 Sample generic guidelines for describing the impacts of a hydro-electric power line

- disturbances to the aquatic environment caused by water crossings: effects on water levels, discharge and ice regime; effects on riparian vegetation and fauna (fish and waterfowl), etc.
- impact of the development on the quality of soil, surface water and ground water (drinking water in particular).
- effects on faunal populations and their habitats, with a particular attention to threatened or vulnerable species or species likely to be designated as such, and to the habitats of such species (surface area affected, number of species affected, population density, etc.).
- effects on vegetation, in particular plant species that are threatened, vulnerable or likely to be designated as such.
- impact on current and anticipated land use, in particular the effect on recreational uses of creating new access to the area, including such uses as vacation homes, hunting and fishing.
- anticipated effects on the area's agricultural potential, loss of acreage and economic value of the land, effect on access to the land and on the movement of farm machinery, changes in agricultural drainage, consequences for farm animals.
- anticipated effects on the area's forestry potential, loss of acreage and economic value of the land, significance of these losses for the forestry activity in the region.
- impact on existing or projected public infrastructures, such as roads, electrical power lines and stations, water intake, parks and other natural sites, bicycle paths and other recreational amenities, hospitals, schools, etc.
- effects on lot sizes and building set-backs, including changes in building access, destruction of existing land subdivisions, fragmentation of land holdings and expropriations.
- changes in levels of exposure to electromagnetic fields for residents in the vicinity of the proposed line.
- biological effects of electromagnetic fields on public health, including an overview of current national and international research on this topic.
- economic impacts of the project, including job creation, the attraction of energy-intensive industries to the region, and effects on land and property values, local government revenues, etc.
- disadvantages linked to the construction phase (disruptions in the transportation network, noise, dust, etc.).
- repercussions linked to vegetation control on rights-of-way, including potential impacts on public health.

Source: MEF (1998)

This type of generic approach requires sufficient familiarity with the practice of environmental assessment, as well as a fairly high volume of activity. Otherwise, project-specific guidelines remain preferable. Samples of project-specific guidelines are available from the Canadian Environmental Assessment Agency (CEAA, 1998) or from provincial Environment Ministries. The major difference between these two approaches lies in the discretion (and responsibility) given to proponents under the generic approach. Proponents are required to: identify significant impacts; determine health problems requiring study; select methodologies; determine which multi-criteria analyses are to be conducted, etc. They must also justify their choices. The generic approach demands a high level of expertise, and automatically requires that promoters conduct broad consultations to ensure that their impact studies will withstand scrutiny. Among other things, project-specific guidelines state which chemical products are to be examined, the species that will be considered and the tests and methodologies that will be used. Therefore, the onus is on the proponent to adhere faithfully to the requirements. This approach often generates an abundant literature of questionable usefulness examining insignificant impacts. Box 2.2 on the following page provides a sample of project-specific guidelines.

Box 2.2 Project-specific guidelines: Sample

Impact prediction should be as factual an exercise as possible. It should demonstrate the nature, magnitude (quantitative aspect), scope (spatial aspect), duration (temporal aspect), risks and uncertainty factors of any change to significant elements of the environment. Impact predictions will be general in nature, given the fact that the location and size of the areas to be sprayed with pesticides have not yet been established.

The initiator must first develop predictions with respect to impacts on human health, using the toxicological risk analysis technique. Particular attention should be paid to workers involved in spraying, as well as to the populations that live in nearby areas, including Native populations.

Risks to be considered include any new risk of cancer, as well as other effects that are harmful to health, including immunosuppressive effects, and potential effects on reproduction and development. The risk analysis must begin by identifying toxic pesticides that may pose a significant risk to public health. For these substances, analysis includes a detailed examination of potential exposure for individuals residing in or near the spray area. Exposure analysis should consider all potential pathways of exposure, with particular attention to inhaled substances and the consumption of locally grown fruits and vegetables (wild fruit and local vegetable gardens). A detailed description of all the models used to simulate the transfer or fate of pesticides in the environment must be provided, along with the values of the variables used for modelling purposes. The initiator must also provide a brief overview of the toxicological and epidemiological studies performed on the substances under review, and indicate the basis established to estimate risks (reference doses or quantitative methods employed to assess any new risk of cancer).

Impact predictions must also encompass organisms that are not targeted, including mammals, birds, fish, amphibians, land and aquatic micro-organisms and, more particularly, pollinizers and vegetation.

The proponent must pay particular attention to bird populations and provide a summary of the work dealing with direct and indirect effects (such as efforts to capture insect-eating birds).

Predictions concerning impacts on water, air and soil must also be provided.

Finally, particular attention should be paid to cumulative impacts.

An analysis of the methodological soundness of impact studies, including conclusions and recommendations, is a cornerstone in developing local action to prevent or mitigate health impacts. Once again, a team effort is required to monitor the start-up of projects and their subsequent operation. This analysis and monitoring is described in greater detail in the following sections.

2.4.4 Criteria for the involvement of health agencies

Introduction

The degree of involvement of health agencies and professional associations in EA is clearly dependent on available resources and on the interest (in the broadest sense) which a given project or policy generates.

In Quebec for example, the regional public health branches (directions régionales de santé publique or DRSP) were invited to submit their views on a number of projects (mines, factories, pesticide spraying in forests) in the early 1980s, at the request of citizens groups and public agencies. After a period of wavering, during which some DRSPs seemed hesitant about providing their views on projects, it has become common practice since 1990 for the branches to conduct in-depth analyses on all projects submitted to the environmental assessment process, and to issue public notices. Key factors in bringing about this change include: the expectations of the public and of government departments and organizations involved in EA; resource sharing among regions, including providing expertise to areas where this is lacking; and the development of a common procedure for conducting assessments (CSE, 1993).

Despite these efforts, the study of the health component remains a neglected aspect of the EA process (Davis, 1997). It is estimated that as many as 90 to 95% of all environmental assessments conducted in the world are deficient in the areas of health and safety (Sloff, 1995).

At the ministerial level, the involvement of public health agencies can take a very different form. Indeed, the regional role largely consists of critically analyzing projects, contributing to and taking part in public consultations, and performing monitoring and follow-up activities that normally fall to local or regional public health agencies. In the case of strategic assessments, however, the general expectation is that the Minister of Health will take charge of conducting and funding the necessary research. Given that the questions involved are often complex and difficult to address, this can be an arduous task, difficult to integrate into current programming.

Two examples of the types of issues confronting central agency managers (EEA, 1995) are provided below:

- a comparison of various scenarios for managing household waste, including their respective impacts on health;

- the justification, environmental impacts and health impacts of agricultural subsidies.

Similar issues arise in many sectors which consume large amounts of energy and resources, such as industry, energy, transportation, forestry and tourism.

Criteria

The following criteria can be used to assist organizations in determining the scope of the effort that is required. These criteria can also help organizations and institutions acting as project or program proponents to make way for more substantial involvement by the health sector, in preparing and analyzing an environmental assessment study.

At the ministerial level

All program, plan, and policy initiatives in economic sectors with a major impact on the environment should involve health authorities at an early stage. Agreements to this effect already exist in several Canadian provinces, and are part of the federal environmental assessment process. The sectors most likely to interest the health sector include:

- land-use management and urban planning;

- industries (including mining);

- energy generation and transmission;

- road, rail and air transportation;

- agriculture and fisheries;

- forestry;

- tourism and recreation;

- waste management.

Since health care services have grown to represent approximately 10% of GDP, and produce their own waste and other impacts, it would be appropriate for them to address their own contribution. Therefore, it is important to add:

- health care and health care services.

Aside from the impacts already identified, other criteria include technological innovations, which are best examined in depth prior to implementation, and public interest. The latter is something to which all *public* health agencies must remain responsive. Of course, the anticipated scale of any initiative remains a determining factor.

Public health authorities must also examine a number of other aspects (PEHB 1997), including:

- the likelihood of large-scale demographic or geographic changes within the community, including impacts on infrastructure;

- the likelihood of human exposure to physical, chemical or biological contaminants;

- the likelihood of impacts on vulnerable groups (for example children, the elderly, the chronically ill);

- the likelihood of impacts on disease vectors in the environment or on recreational resources;

- the likelihood of impacts on the food chain, including agricultural land;

- the likelihood of impacts on liability risks.

Increasingly important are concerns about what is commonly known as “global change”. This includes climate change, ozone depletion, and ecosystem change, and their admitted or perceived role in increasing liability risks, as well as new infectious diseases, the geographic spread of tropical disease carriers and toxic algae.

Table 2.2 Suggested degree of involvement for central public health agencies

	Small-scale initiatives	**Large-scale initiatives**	**Large-scale initiatives involving technological innovations or strong public interest**
Economic sectors which have a major impact on the environment	average	significant	very significant
Economic sectors which have a more moderate impact on the environment	low	average	significant

Frequently, there is a sharp increase in the number of small-scale projects within a given region, province or country. In recent years, for example, we have seen a significant increase in the number of hog farms in several regions of Canada. When considered on its own, a hog farm may appear to have a relatively low impact on the environment or on human health. However, when there are fifty such projects within a given watershed, the impact can be very great. Similar issues arise with the proliferation of thermal power stations and small-scale hydro-electric dams. Sound analysis requires situating the project within a broader context.

At the local or regional level

The criteria outlined at the ministerial level also apply at this level. Added to these are criteria that are more concerned with the scale of a project (expressed in monetary terms) in relation to the size of the host community. Parameters to determine the appropriate degree of involvement for public health authorities and their partners are suggested in Table 2.4:

Table 2.4 Suggested degree of involvement for regional and local public health agencies

Type of community	Small-scale projects < 1 $M	Medium-scale projects 1 to 10 $M	Large projects 10 $M to 1 $B	Very large projects > 1 $B
small/isolated	low	significant	very significant	very significant
small < 10k inhabitants	low	average	significant	very significant
average 10k to 100k inhabitants	low	low	significant to very significant	very significant
large > 100k or very large > 1M inhabitants	low	low	average to significant	significant to very significant

The sectors that are deemed to have a high impact on the environment are the same at this level.

There are many ways to determine an appropriate level of involvement by public health authorities. As a guide for determining the kinds of efforts that are frequently required in documenting the public health component of EA, a few parameters are proposed below:

- *Low level of involvement:* Use of guides and simple literature reviews; determination of compliance with standards in force; informal consultations by key communicators; succinct written notices.

- *Average level of involvement:* The preceding items, as well as informal consultations with specialists and key communicators; determination of compliance with the strictest standards in force in the world; brief written notices.

- *Significant level of involvement:* Exhaustive reviews of pertinent literature; formal consultations with specialists; formal public consultations; risk analyses; reports and briefs; dissemination through the usual channels.

- *Very significant level of involvement:* The preceding items, as well as surveys, epidemiological studies, psychosocial studies; reports and briefs; major dissemination initiatives.

The last two levels of involvement are most often the domain of larger teams normally found within government departments, institutes or universities. However, interventions at these levels are sometimes managed by regional organizations, if adequate specialist support can be provided. Indeed, large projects are often undertaken in more peripheral regions. It is still essential to actively involve regional public health agencies and health professionals charged with managing the future implementation of a project.

3.0 SUSTAINABLE DEVELOPMENT AND HEALTH: FRAMEWORK FOR INTEGRATING PUBLIC HEALTH INTO ENVIRONMENTAL ASSESSMENT

3.1 Introduction

The preceding sections have examined the critical role health professionals can play in environmental assessment. To adequately fulfill this role, and to base their views on reliable criteria, health professionals need a shared world view, one which includes values connected with health protection, risk and disease prevention, and the promotion of behaviours that sustain health. This vision must also encompass other aspects, including economic development, as well as environment and ecosystem protection. This is the approach behind the concept of sustainable development, which is now part of many federal and provincial laws, as well as international treaties. Even the very conservative Organization for Economic Cooperation and Development is now using this concept to chart its future course (OECD, 1997).

3.2 Definitions

The definition of sustainable development has been the subject of much debate, which has been joined by many excellent publications. The human health component is neglected in some publications (for example CCME, 1993) and highlighted in others (Health Canada, 1997), according to the respective mandates of each. In conducting environmental assessments, it is desirable to identify the health component as a key element of sustainable development, on a par with economic and environmental components (Figure 3.1) This approach does justice to the interdependence of various determinants of healthy and equitable development.

Figure 3.1: Health in the context of sustainable development

Activities having a natural origin				Natural response
	Equity	Economy	Sustainability	
		HEALTH		
	Social system		Environment	
Human activities		Viability		Human response

Source: Gosselin (1991)

Whereas health professionals generally include the social component in their definition of health, in EA the practice is different: health is often considered a facet of the social component, particularly in matters not related to toxicology or technological risk (these normally fall into the environmental component). Given that the approach favoured has more to do with past training than any other factor, these classifications are of little importance; it is sufficient to know that they exist.

What *is* important is to understand the goals of sustainable development and to derive operational principles that may be useful in developing public health input. In this connection, the line of thought suggested by Robert Goodland and Herman Daly (1995) presents many important similarities with the official policy of governments across Canada in matters of health, the environment and the economy (see Appendix 1). The challenge that remains is to put the goals outlined in Figure 3.2 into practice in our daily decision-making.

Figure 3.2: Objectives of sociosanitary, economic, and environmental sustainability

SOCIOSANITARY OBJECTIVES

Empowerment
Participation
Equity
Poverty alleviation
Social cohesion
Population stability and Health
Institutional development

ECONOMIC OBJECTIVES	**ENVIRONMENTAL OBJECTIVES**
Development for all countries	Ecosystem integrity
Growth for LDCs	Conserve carrying capacity
Efficiency	Climatic stability
Poverty alleviation	Conserve biodiversity
Equity	

As Grø Harlem Bruntland suggested in the report which originally put forward the concept of sustainable development (WCED, 1987), the focus of all sustainable development is ultimately human health, which is dependent on social, economic and environmental sustainability. Clearly, this is a very ambitious objective, but it can also be useful in

developing a clearer vision of the goals we must achieve to ensure that social development is consistent with the promotion and protection of public health.

3.3 Significance of the three realms of sustainable development

For those who may not be familiar with the scientific studies that led to the concept of sustainable development, a number of references to background information are provided in the bibliography at the end of this Handbook. Here we will examine a few basic concepts (ecosystem, economy and social system) which may be of assistance to the reader.

3.3.1 Ecosystem

The most significant trend observed throughout the 20th century has been typified by a demographic explosion and the marked deterioration of many ecosystems around the world. The Earth's population has undergone a five-fold increase in less than a century, and the demand for fresh water, arable land, energy, wood, fish, and other resources has often outstripped the capacity of ecosystems to regenerate themselves. This view is shared by every organization in the UN and thousands of scientists around the world, who have come to realize that human beings are taking up more and more space, harming other species and interfering with the ability of air, soil and water to renew themselves (Keating at al, 1997). In addition, the unintended pollution caused by a number of technological innovations such as PCBs and the automobile have only made matters worse.

It is also important to note that many services that we derive from our ecosystems, such as water and air purification, waste recycling and food production, are never recognized in our national accounts, whose best known statistic is the gross domestic product or GDP. In our current economic system, the fact that a dollar value is not attached to ecosystems often means that managers give these considerations little or no attention. This persists despite the fact that ecosystems provide irreplaceable services, such as ground water and the atmosphere itself.

Table 3.1: Classification of services provided by ecosystems (after Costanza et al., 1997)

1.	Gas regulation
2.	Climate regulation
3.	Disturbance regulation
4.	Water regulation
5.	Water supply
6.	Erosion control and sediment retention
7.	Soil formation
8.	Nutrient cycling
9.	Waste treatment
10.	Pollination
11.	Biological control
12.	Refugia
13.	Food reproduction
14.	Raw materials
15.	Genetic resources
16.	Recreation
17.	Cultural

The authors of one recent study (Costanza et al., 1997) attempted to assess the monetary value of the services provided by ecosystems in different biomes (water, land, etc.). Their estimate, which they have termed conservative, is US$33 trillion per year. By comparison, the gross domestic product of the entire planet is approximately US$18 trillion per year. Most of these ecological services are indispensable to life on Earth and many form the basis of our economic activities. Yet they are rarely considered in cost-benefit analyses, and seldom integrated into the decision-making process. There are many reasons to rigorously protect our life-sustaining ecosystems, including human life itself, our economic activities, and the fact that ecosystems are irreplaceable.

3.3.2 Economy

There are now hundreds of studies attesting to the effects of adequate or deficient incomes on health. This variable is so significant that epidemiological studies control for it in an attempt to isolate its effects from other less important causal factors.

A number of international publications have demonstrated the link between low incomes and poor health in developing countries (for example UNDP, 1997), but these disparities exist in Canada as well (CPHA, 1997). Some of these studies show disparities in life

expectancy, on the order of 10 years, between the residents of affluent and poor neighbourhoods within the same city. The relationship is sometimes indirect, as in the case of behaviours that are harmful to health; but it can also be direct, as with the permanent stress induced by financial insecurity (see Evans et al., 1994). This effect would appear to be cumulative, with a dose-response curve (Lynch, 1997).

In general, an average income is sufficient to ensure good health, beyond minimum subsistence. The experience of many countries shows that investments in primary health care (vaccination, care for pregnant women), in education and environmental health (drinking water, waste management, air quality) are crucial factors in the relationship between economics and health. Clearly, an adequate income for individuals does not suffice: sound government decision-making is required, particularly regarding investments in pollution control, preventing environmental degradation and promoting the benefits derived from our ecosystems.

3.3.3 Social system

The economic system and the social system are closely linked and interdependent. Direct and indirect links can also demonstrated between health and the social system.

Even in Canada, health professionals sometimes need to be reminded that after genetics and age, the social environment is probably the most important determinant of health (Evans et al., p.74). The relationships that evolve among individuals or groups of individuals influence their state of health. These relationships can encompass the ways in which work is organized, criminality, power structures, culture, dietary influences, and other factors. Some would also include equitable income distribution within the social sphere. Individuals' sense that they can control their own lives also appears to be highly important, as is the ability to rely on family or a social support network in case of need. Significant discrepancies in mortality and morbidity can be observed in situations where individuals feel they have little control over their professional lives. The studies conducted by Marmot (1998) with British civil servants showed age-specific mortality rates that were three times higher among lower-level employees when compared to rates for upper management. In studies performed by Wilkinson (1989, 1992) death rates adjusted over time, as well as comparative rates between countries, show similar discrepancies relating to the distribution of material resources within populations. In the third volume, an entire chapter is devoted to this subject.

These discrepancies in the area of health can be significantly reduced if governments are prepared to invest wisely in such areas as education, primary care and environmental management (Caldwell, 1986). This can be observed by contrasting the experiences of nations of comparable economic standing but markedly different sanitary conditions. Equitable income distribution among individuals is also a key variable influencing the health

of the population. It has been observed that countries in which wealth is distributed more equitably achieve a higher level of population health than other nations of comparable affluence. Increased social stress can also bring about a significant deterioration in the health of a population, as the recent experience in Russia eloquently demonstrates (Leon, 1997). In 1994, a Russian male had only a 50% chance of living beyond the age of 60, as compared to a 90% chance among Canadian males. Tobacco and alcohol consumption, poor nutrition, significant social and economic instability, depression and deteriorating health care have all been identified as causal factors in this new situation (Notzon, 1998). Between 1990 and 1995, the life expectancy for Russian men decreased by approximately seven years.

3.4 Sustainable development as a daily focus

It would appear that those in charge of making political and economic decisions have an inadequate understanding of the issues that have been raised here. As a result, information dissemination is another task faced by health professionals in preparing public health notices in connection with EA.

Adopting the sustainable development framework as a criterion in preparing public health notices in EA means that health agencies must provide their views on:

- the likelihood that contaminants or anticipated hazards may have an impact on health and quality of life and, ultimately, health agencies' views on desirable levels;

- the foreseeable equity in the distribution of risks, disadvantages and benefits, and, ultimately, health agencies' views as to what would constitute a desirable distribution;

- the impact of the initiative being considered on the preservation of life-sustaining ecosystems and on the services derived from these ecosystems, and, ultimately, health agencies' views on desirable impact mitigation measures.

Most initiatives, projects, programs and policies contain both positive and negative elements; from a public health perspective, it is important that these be brought into balance. Still, many useful actions which can move society toward sustainable development require a social consensus, which develops gradually and often slowly. Therefore, it can be useful to propose concrete compensatory or mitigation measures for specific projects. Such actions can include planting a forest or creating wetlands to compensate for losses brought about by new construction projects, or setting up a social development trust fund for a community coping with the residual inconvenience caused by a new factory.

For public health agencies, opposing the development of a project by invoking sustainable development principles can sometimes be delicate. On the other hand, it is entirely appropriate to give greater weight to this criterion when developing government policies and programs, or when planning mega-projects (or a series of projects) which can have a major impact on the course of a society. Energy supply policies, subsidies favouring the automobile, and hydro-electric developments in virgin wilderness are examples of high impact initiatives which must now undergo the test of sustainability.

The concept of sustainability implies the existence of a limit to resource use. Limits are accepted when it comes to elevators or bridges; parking lots have a limited number of spaces and common sense should tell us that a lake contains a finite number of fish. However, many people are not prepared to admit that such limits should apply to our use of natural resources (Carins, 1997). Economist Kenneth Boulding (1966) summed up this position rather well more than 20 years ago:

> Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist.

It bears repeating that project-related public health notices mainly deal with the effects of contaminants on health and quality of life, and on the fair distribution of risks and benefits. The ecosystem integrity component applies most often in the case of strategic assessments, or when a mega-project (or a series of projects) is being proposed. With smaller projects, the focus is on preserving the recreational or cultural uses of ecosystems, although it is generally recognized that avoiding all forms of inconvenience may be difficult at times. In such cases, it becomes important to adequately replace ecosystem loss, either in the immediate vicinity or elsewhere in the region.

3.5 Developing concrete sustainable development objectives

Box 3.1 offers concrete sustainable development principles, in a variety of categories, as guidelines for developing policy or implementing major projects (Écosommet, 1995). These principles were developed during broad multiparty consultations held in Quebec from 1994 to 1996 with a view to developing sustainable projects, and are inspired by the major orientations of Agenda 21 (Keating, 1993), WHO (1992), and a number of Canadian publications that deal with this topic (including CCME, 1993; NRTEE, 1993, 1994). The proposed principles can ultimately serve as criteria for examining projects and policies and developing useful initiatives to promote sustainable development.

Box 3.1: Specific sustainable development principles

Biophysical environment

Natural resources (including energy resources): One of the goals of sustainable development is to ensure that these natural resources are managed rationally, and that access to renewable and non-renewable resources is equitable. The basic principles are the following:

- never exceed the regeneration rate of renewable natural resources;
- never exploit non-renewable resources at a rate or at a price that will necessitate their eventual replacement by renewable resources;
- improve knowledge and monitoring of natural resources;
- promote the conservation of natural resources by reducing the pressure on these resources (over-consumption, air, water and soil pollution), especially in areas that hold a particular attraction.

Biodiversity and habitats: Sustainable development seeks to maintain ecosystem integrity through an integrated management approach. The basic principles are the following:

- minimize the loss of genetic, species and ecosystem diversity;
- ensure landscape and habitat conservation, including both our natural and architectural heritage;
- clean up and restore habitats that have been altered or destroyed;
- limit or prohibit human activities that can translate into adverse impacts on natural species and architectural heritage;
- develop human activity in harmony with the natural environment.

Human environment

Health: Sustainable development also implies taking action to promote and protect health and prevent disease. The basic principles are the following:

- reduce gaseous, liquid and solid emissions, in order to minimize risks to public health through the contamination of food, water, air or soil;
- develop and improve emergency plans to deal with environmental accidents, as well as measures to monitor the environment, especially exposure to substances that are harmful to human health;
- in the workplace, replace hazardous technologies and materials with alternative products and technologies that are less harmful;
- create conditions that promote healthy lifestyle habits (physical exercise, good nutrition, anti-tobacco measures, etc.).

Quality of life: Improving quality of life is an important aspect of sustainable development. The basic principles are the following:

- reduce or eliminate irritants (noise, unpleasant odours, visual degradation of the landscape) which affect quality of life for human populations, both in rural and urban areas;
- promote the revitalization of urban and rural environments;
- make nature and culture accessible to the public through leisure and community-based activities;
- develop a social and physical environment that favours the dissemination of information and involves citizens of all ages in community management.

Economy and employment: The concept of sustainable development implies that actions taken must be economically viable and fair for affected populations, particularly in the case of regional development. The basic principles are the following:

- create employment, particularly for young people living in communities and areas dealing with high levels of unemployment and social assistance;
- improve and maintain quality of life within the framework of existing employment;
- internalize the costs and benefits of external project effects (pollution for example), including the public health protection aspect;
- improve the level of education and training of individuals to enable them to play an active role in society.

Stakeholders

Achieving sustainable development goals requires a concerted effort on the part of all stakeholders, including private citizens, corporations, public and private organizations, and government.

Citizens: Development cannot occur in a sustainable manner without the active involvement of citizens. The basic principles are the following:

- develop measures to encourage the population to modify its attitudes, habits and behaviour, with a view to reducing over-consumption of water, energy, natural resources and chemical products, and reducing the production of waste that is harmful to the environment;
- intensify measures designed to promote reduction, reuse and recycling and the reclamation of primary and secondary resources;
- support concrete cooperative actions designed to promote the accountability of citizens and citizens' groups, and to encourage them to address their own individual impact on the environment;
- aim for a fair balance in the distribution of benefits and disadvantages connected with development.

Corporations and public and private organizations: The involvement of employers, companies, workers and public and private organizations is essential and provides the ability to intervene on a variety of levels. The basic principles are the following:

- reduce and monitor air, water and soil pollution;
- limit the production of goods and services that are harmful to ecosystems and human society;
- promote the quality and sustainability aspects of goods and services;
- ensure that pollution and waste do not exceed the environment's ability to absorb them;
- implement measures to reduce, reuse, recycle and develop primary and secondary resources;
- develop technological innovations that increase production efficiency by reducing the use of natural resources, energy and water;
- develop and utilize new technologies that offer better performance from an environmental standpoint.

Governments: The various levels of government are key players in the promotion of sustainable development. The basic principles are the following:

- promote education and awareness among all social groups (public, NGOs, universities and industry) with respect to the importance of sustainable development;
- foresee and prevent problems instead of attempting to solve them once they have

- improve and adapt policies, legislation, and existing financial and fiscal measures, with a view to promoting activities that protect and improve ecosystems, and discouraging actions that are harmful (over-consumption of natural resources, disposal of solid or dangerous waste, greenhouse effect, acid rain and ozone depletion);
- organize information (assessment tools, data regarding indicators) to make it more accessible (reliable, available and factual).

4.0 ANALYZING HEALTH RISK DATA

4.1 Introduction

It is normally easy to obtain data on the benefits of a given project, program or policy because proponents usually give this aspect considerable prominence. The quality of the data provided with respect to the advantages and benefits of a project can vary, and merits at least a cursory assessment. This aspect is discussed in greater detail in Chapter 5 of this volume and in Volume 3 (see sections dealing with the economy and social impact assessment).

Assessing data that deals with the risks of a project can be a more difficult exercise. The public generally expects that the responsible public health agency will examine this issue in depth and that, in the final analysis, risks will be negligible. For their part, proponents tend to expect a review that will recommend an acceptable or reasonable degree of risk. Definitions of these terms tend to be somewhat ambiguous, given that the people who bear the burden of risk are often not the people who derive the benefits. The issue of risk management and the concept of acceptable risk are discussed in Chapter 5.

4.2 Common problems in conducting an analysis

A brief overview of problems frequently encountered in preparing or analyzing an environmental assessment is provided below.

4.2.1 Spatial and temporal scale

It is often difficult to identify a single analytical scale for the assessment of health impacts. On a spatial scale, the zone of influence varies based on the nature of exposure to a risk factor. For example, the zone affected by the effluent produced by a smokestack is different than the area affected by noise; as well, economic spinoffs can “travel”. On a temporal scale, toxicity can be variously described as acute, chronic or transgenerational. Therefore, it is important to specify desirable spatial and temporal scales for every significant risk.

4.2.2 Risk groups

Similarly, the types of groups that are judged to be at risk will vary based on the type of problem being addressed. Generally speaking, we know that certain individuals are susceptible to greater exposure to contaminants due to:

- physiology (e.g. newborns, children, pregnant or breastfeeding women, the elderly);
- illness (e.g. the immunocompromised and those suffering from respiratory conditions or allergies);
- lifestyle (e.g. Natives who consume large amounts of game meat, smokers);
- behaviour (e.g. children's habit of putting objects in their mouths);
- insecure living conditions (e.g. among immigrants).

It is also important to specify, for each significant risk factor, which populations warrant study. Some social groups are more likely than others to see their quality of life being affected by a project, due to such factors as: the distribution of available employment; the training required for such employment; the internal management practices of the newly installed company; and the distribution of impacts from a land-use perspective.

4.2.3 Workers

Generally, workers are the group most exposed to contaminants. Still, within the framework of an environmental impact study, it is difficult to predict exposures and determine the concrete measures that need to be taken, however desirable that might be.

For example, it is practically impossible to adequately simulate contaminant emissions for an industrial process before engineering details have been worked out, which normally occurs after a proponent has been authorized to proceed with the project. Consequently, it is preferable to place the emphasis on workplace health and safety programs that make use of the best practices available for environmental monitoring and health surveillance. This applies at all stages of a project, although the stages presenting the greatest risk are construction and the "breaking-in" phase.

The relationship which develops between new workers and local communities can also assume considerable importance in some situations. A typical example is the development of large sites in isolated regions. This relationship can have a positive or adverse impact on the health of individuals and communities.

4.2.4 New technology

Frequently, projects submitted for EA include a new technology component. When information on the new technology is lacking, this can further complicate the process. The following principles may assist in evaluating the potential performance of new technologies:

- In most industrial processes, there is a financial incentive to use the least amount of natural resources possible (water, wood, energy, etc.) when such resources are sold at market price. As a result, the efficiency of new technology can be compared with that of the technology being replaced by examining resource consumption per unit of production. Greater efficiency implies less waste, although total production volumes also need to be taken into account.

- The experience and seriousness of proponents and their consultants need to be assessed, based on similar projects developed in the past.

- Proposals put forward by proponents with respect to the surveillance of technology and the monitoring and control of emissions must be rigorous and completely transparent.

4.2.5 Relevance of existing health data

Making use of existing health data in environmental assessment raises a number of important methodological problems (Davies, 1997):

- Health information is usually collected for specific purposes and can be difficult to modify or adapt for use in EA. For example, most medical data are difficult to use in EA because information is collected for physician billing, insurance and health care planning, or health care utilization studies. As a result, the accuracy of diagnoses varies considerably.

- Although most countries collect national health statistics, there is often a shortage of information on health status and the determinants of health for specific communities and for individuals. In particular, there is a shortage of information on morbidity, psychological well-being and socio-economic factors.

- Health information is rarely examined in relation to environmental quality. Although the biophysical environment is a recognized determinant of health, the study of precisely how the environment affects health is still in its infancy. More particularly, causal relationships remain difficult to establish with respect to individuals.

4.2.6 Methodology

A variety of methodologies can be useful in assessing health impacts. Table 4.1 succinctly presents the principle methods used in environmental assessment, and a number of methodologies are discussed in the third volume of this Handbook. It is important to remember that every methodology offers both benefits and disadvantages (see Davies, 1997, Table 3), which means that a considerable amount of professional judgement is required in selecting an appropriate approach. Such considerations as cost and the expertise available within a given team must also be taken into account. For example, geographic information systems (GIS) still require a considerable investment and in no way represent a panacea. Experienced EA practitioners like Canter (1998) have stressed that the simplest methods in terms of data, personnel and technology requirements are also those that prove the most enduring. Such methods include the study of analogs and the use of checklists, expert opinion and matrices.

It is important to develop a coherent approach and to provide reports of great transparency that specify limits. Ultimately, it is always preferable to consult a few experts or citizens' groups by phone than to take no action; such consultations represent an effective and low-cost methodology.

In the next chapter, we will examine a number of risks frequently encountered with different types of projects.

Table 4.1: Brief description of 22 types of methods in EIA (Canter, 1998)

1.	Analogs refer to information from existing projects of a type similar to the project being addressed; monitoring information related to experienced impacts is used as an analogy to the anticipated impacts of the proposed project.
4.	There are many variations of checklists, with this type of methodology utilized frequently. Conceptually, checklists typically contain a series of items, impact issues, or questions which the user should address.
5.	Decision-making checklists are primarily related to comparing and conducting trade-off analyses for alternatives. In this regard, such methods are useful for the synthesis of information in relation to each viable alternative.
6.	Environmental cost-benefit analysis (ECBA) represents an emerging method. ECBA supplements traditional cost-benefit analysis with increased attention to the economic value of environmental resources, and to the valuation of impacts of the proposed project and alternatives on such resources.

7. Expert opinion, also referred to as professional judgment, represents a widely used method. Specific tools to facilitate information development include the conduction of Delphi tools, the use of the adaptive environmental assessment process to delineate qualitative/quantitative models for impact prediction, or the separate development of models for environmental processes.

8. Expert systems refer to an emerging method that draws upon the professional knowledge and judgment of experts in particular topical areas. Such knowledge is encoded, via a series of rules or heuristics, into expert system shells in computer software.

9. Indices or indicators refer to selected features or parameters of environmental media or resources which represent broader measures of the quality/quantity of such media or resources. Specifically, indices refer to either numerical or categorized information which can be used in describing the affected environmental and impact prediction and assessment. Indices are typically based on selected indicators and their evaluation.

10. Laboratory testing and scale models refer to the conduction of specific tests and/or experiments to gain qualitative information relative to the anticipated impacts of particular types of projects in given geographical locations.

11. Landscape evaluation methods are primarily useful for aesthetic or visual resource assessment. These are derived from indicators, with the subsequent aggregation of relevant information into an overall score for the environmental setting (similar to number 7).

12. Literature reviews refer to assembled information on types of projects and their typical impacts. As noted for analogs, such information can be useful for delineating potential impacts, quantifying anticipated changes, and identifying mitigation measures.

13. Mass-balance calculations refer to inventories of existing conditions in comparison to changes in such inventories that would result from the proposed action. Inventories are frequently used for air and water pollutant emissions, along with solid and hazardous wastes to be generated.

14. Interaction matrices represent a widely used type of method within the EIA process. Variations of simple interaction matrices have been developed to emphasize particular desirable features.

15. Monitoring (baseline) refers to measurements utilized to establish existing environmental conditions and interpret the significance of anticipated changes from a proposed action.

16. Monitoring (field studies) of receptors near analogs represents a specialized approach, in that it is possible to monitor actual impacts resulting from projects of similar type to the project being analyzed.

17. Networks delineate connections or relationships between project actions and resultant impacts. They are also referred to as impact trees, impact chains, cause-effects diagrams, or consequence diagrams. Networks are useful for showing primary, secondary and tertiary relationships.

18. Overlay mapping was used early in the practice of EIA, with the usage consisting of the assemblage of maps overlaying a base map and displaying different environmental characteristics. The application of geographical information systems (GIS) via computer usage has been an emphasis in recent years. This technology represents an emerging method.

19. Photographs or photomontages are useful tools for displaying the visual quality of the setting and the potential visual impacts of a proposed action. This method is related to landscape evaluation.

20. Qualitative modelling refers to methods wherein descriptive information is utilized to address the linkages between various actions and resultant changes in environmental components. Such modelling is typically based upon expert opinion (professional judgment, as described earlier).

21. Quantitative (mathematical) modelling refers to methods that can be used especially for addressing anticipated changes in environmental media or resources as a result of proposed actions. Quantitative models can encompass simplified models to very complicated three-dimensional computer-based models requiring extensive data input.

22. Risk assessment refers to an emerging tool initially used for establishing health-based environmental standards. It encompasses the identification of risk, consideration of dose-response relationships, conduction of an exposure assessment, and evaluation of the associated risks. Risk assessment can be viewed from the perspective of both human health and ecological risks.

23. Scenario building refers to considering alternative futures as a result of differing initial assumptions. Scenario building is utilized within the planning field, and it has EIA applicability, particularly in the context of strategic environmental assessments.

24. Trend extrapolation refers to methods that utilize historical trends, extending them into the future based on assumptions related to either continuing or changed conditions.

5.0 PUBLIC HEALTH NOTICES AND INTERVENTIONS IN ENVIRONMENTAL ASSESSMENT

5.1 Introduction

The preceding chapters have demonstrated that health practitioners can intervene in the process in many different ways. The potential goals of public health interventions include impact prediction, surveillance, prevention and mitigation, as well as the correction of impacts once they have occurred.

Public health notices and interventions can focus on specific projects, such as the construction of a road or factory, or address the effects of legislation, regulations, programs and policies of an economic nature, which often have a major impact on environment and health.

The tools available are varied and draw on a number of disciplines. What is important, ultimately, is the health professional's ability to use these tools in analyzing and interpreting information. Regardless of how valuable information may be, it must be made comprehensible and useful to the public and decision-makers. The onus is on the health professional to perform this task with respect to the public health component of EA.

The sustainable development framework has been retained as a general criterion for the purposes of public health analysis, which mainly deals with:

- the likelihood that contaminants or anticipated irritants will have an impact on health and quality of life, as well as the ultimate issue of desirable levels;

- the foreseeable equity in the distribution of risks, disadvantages and benefits, and, ultimately, their desirable distribution;

- the impact of the initiative being considered on the preservation of life-sustaining ecosystems and on the services derived from these ecosystems, and, ultimately, desirable impact mitigation measures.

The objective of the public health notice is to contribute to the inclusion of adequate measures to:

- protect public health and safety;

- eliminate, reduce or mitigate environmental and social impacts that have an adverse effect on health and quality of life;

- promote impacts that are beneficial to health and quality of life;

- maintain and improve life-sustaining ecosystems.

This approach is consistent with the objectives of Health Canada with respect to sustainable development (Health Canada, 1997) and the good practices recommended by the OECD (1996). It has also been adopted by a number of governments, including that of New Zealand (PHC, 1995).

This chapter is essentially devoted to providing a more detailed description of the analysis and preparation involved in producing a public health notice.

5.2 Risk management: a brief history

1960-1980

The Atomic Energy Control Board (AECB) recently summarized the history of risk management as follows:

> [translation]"... the first *virtually safe dose* proposed in the United States was designed to limit the risk of cancer to one in one hundred million (10^{-8}) for a lifetime of exposure [see Rodricks et al., 1987], the idea being that if the total population of the United States were to be exposed to a virtually safe dose, or a dose very close to it, only one or two persons would be affected among the country's total population (approximately 150 million at the time). Soon after, it became clear that this criterion placed an almost intolerable burden on regulatory agencies charged with guaranteeing the safety of food additives, while ensuring that the considerable advantages of these additives could be exploited. The majority view then became that a risk of one new case of cancer per million inhabitants could be considered negligible. At this rate, only three new cancer cases per year would occur if all Americans were exposed.
>
> Over the course of the next few years, the standard of *one in one million* became institutionalized as an *acceptable* risk and when it became understood in the latter part of the 1960s and early 1970s that ambient exposure carried a risk of cancer, the concept of a negligible lifetime risk (set at one in one million or 10^{-6}) was frequently applied, especially in the United States [Kelly and Cardon, 1984]. Early on, the greatest source of concern was generalized risk, such as that induced by exposure to polychlorobiphenyls (PCBs) or pesticide residues in the environment. Later, the same

> standard was applied to risks that are far less generalized, such as the risk encountered in the areas surrounding industrial sites and hazardous waste disposal sites.
>
> In time it became clear that a risk of one in one million (10^{-6}) was in fact a highly rigorous standard in cases where the number of individuals exposed was relatively small (US EPA SAB, 1992). For the U.S. Environmental Protection Agency (EPA), risk levels equal to or higher than one in ten thousand are considered acceptable in setting maximum levels of contamination by cancer-causing agents in drinking water, when it is technically or economically unfeasible to achieve greater reductions. However, the general view is that risk levels higher than one in ten thousand are excessive, even when very few individuals are exposed, and require the implementation of measures to reduce both exposure and risk (US EPA SAB, 1992)."

Without making this an official policy, Canada and its provinces adopted a similar approach, within their respective areas of jurisdiction. At the time, risk management was generally defined as a decision-making process in which the results of risk assessment were integrated with other considerations. In 1983, the National Research Council defined risk management as [translation]: *a decision-making process involving the consideration of information of a political, social, economic and technological nature, in addition to data concerning risks, in order to develop, analyze and compare regulatory options; the goal of this process is to select the most appropriate response with respect to potential risks that may pose a chronic threat to health* (NRC, 1983, translated in CSE, 1993).

In Quebec, risk management has been variously defined as [translation] *a process for determining the actions and measures required in order to control or eliminate risk* (Cardinal, 1989) or as [translation] *a process designed to integrate the results of risk assessment with social, economic, political and technical data, in order to select the most appropriate option from a public health perspective* (CSE, 1993). For its part, the CCME (1996) has defined risk management as [translation] *the selection and implementation of a strategy to control risk, followed by the monitoring and assessment of that strategy to determine its effectiveness; the choice of a particular strategy can be based on an examination of the information obtained in the course of the risk assessment.* This definition is substantially the same as the one adopted by Health Canada (1997).

Throughout the last few decades, no proposals have been put forward to adopt a consistent approach to quantifying an acceptable level of residual psychosocial risk. It would appear that negotiation practices, external advisories (commissions, government departments, municipalities, and others) and the usual power relationships that exist among the various parties involved are the only formal criteria being used to decide what constitutes an acceptable level of psychosocial risk for communities. However, there are a number of municipal regulations and government guidelines with respect to the most common irritants (noise, odours, dust).

1990 to today

Over the years, this concept of risk management has come under considerable criticism, particularly from industry, environmental groups and academics (NRC, 1994) for, among other things, the highly variable cost of measures undertaken with respect to health (from $200,000 to $5,000,000,000 per life saved, for example). Current thinking is shifting risk management toward an approach and a definition broader than those traditionally employed. In recent years, several organizations have reviewed and analyzed the conceptual framework put forward by the NRC in 1983, including its principles, organizational aspects and methodological elements (EPA, California, 1996; National Research Council, 1994, 1996; Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997a, 1997b).

In 1997, the Presidential/Congressional Commission on Risk Management and Risk Assessment issued its two final reports (1997a, 1997b). The Commission was created by the American Congress in the wake of changes made to the Clean Air Act. The Commission was given the mandate to conduct a study into the political implications, as well as the uses of risk assessment and risk management, in programs created under federal law to prevent cancer and other chronic diseases that can result from exposure to chemical substances.

The work of the Commission made it clear that the traditional approach to assessing and reducing risk was in need of change. The Commission issued numerous recommendations and introduced new dimensions to traditional approaches used in risk management, as well as a broader and more integrated definition of risk management itself.

> *Risk management is the process of identifying, evaluating, selecting, and implementing actions to reduce risk to human health and to ecosystems. The goal of risk management is scientifically sound, cost-effective, integrated actions that reduce or prevent risks while taking into account social, cultural, ethical, political, and legal considerations.*

The framework for risk management proposed by the Commission comprises six steps: developing a broad definition of the problem; analyzing the risk; examining options for addressing the risk; making decisions; taking actions to implement the decisions; and conducting an evaluation of the actions' results. Every step is conducted in cooperation with stakeholders, beginning with efforts to develop a definition of the problem. In addition, the approach may include an iterative process, requiring that previous steps be repeated if new information is uncovered at a given stage.

Figure 5.1 Frame of Reference Proposed in the United States

	Problem/context	
Evaluation		Risks
	Engage Stakeholders	
Actions		Options
	Decisions	

Source: The Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997. *Framework for Environmental Health Risk Management.* Volume 1. p.3.

The proposed framework emphasizes cumulative risks and takes into account the benefits, costs and social, cultural, ethical, political and legal aspects of risk reduction options. According to the Commission, the advantages of this framework is that it provides an integrated approach to solving public health and environmental problems; it ensures that decisions rely on the best scientific evidence; it emphasizes collaboration, communication, and negotiation with the public; it produces risk management decisions that are more likely to be successful; and it accommodates new information that may emerge at any stage of the process.

The "risk" stage refers to the risk assessment process, but it should also include and emphasize the goals of risk management. Analysts must make use of scientific information in combination with their own professional judgement. The result of risk assessment is a "characterization" or "estimation" of risk, which should provide stakeholders and decision-makers with all relevant information.

The integrity of assessments must be ensured by enlisting external reviewers. To the greatest extent possible, the analysis conducted should address such dimensions as the multisource, multimedia, multichemical and multirisk contexts. It should also seek to identify the perceptions of stakeholders and take these into account in presenting results.

We are witnessing the formal inclusion of psychological and social components as integral parts of the risk management process and as key criteria in decision-making, replacing the perception that these are mere irritants which interfere with a process conducted among experts. The review of the risk management process which is currently underway at Health Canada is expected to give considerable weight to these prevailing trends, some of which have already been incorporated into the Department's practices.

5.3 Connection with environmental assessment

Risk management, an essential component of the public health notice, is also a key element in the complex negotiation process called environmental assessment. The first quality of a public health notice is its existence and the second is clarity. Frequently, the critique of an impact study results in a vague paper with no definite conclusion. Therefore, it is important to take a clear position as to what constitutes an acceptable risk and what does not, and to indicate what improvements are necessary and desirable from a public health and public safety perspective. The section that follows deals with project analysis, although the proposed approach can also be applied to programs and policies.

One noteworthy contextual element is the fact that public health notices deal with public facilities or factories with a normal life-span of 25 to 50 years, and sometimes more, as is the case with large factories, mines and dams. The timeframe for policies, programs and important fiscal initiatives is often shorter, with provisions made for review after 5 or 10 years. Once established, however, programs tend to endure and often entail a succession of construction projects, demolitions and renovations, with their attendant environmental and health impacts. Public health notices must take the longevity of projects into account and make rigorous requirements to protect public health.

A public health notice cannot take the place of the authority responsible for making the final decision with respect to specific projects and policies. Rather, it must take a rigorous, independent and clear position in favour of mitigating the adverse aspects of initiatives and promoting the benefits. A variety of criteria have been proposed for guiding decision-making and developing a position. The standard public health criteria are presented in volume 1 of this Handbook, and in the international study (Sadler, 1997). It is also useful to contextualize public health within the framework of the general criteria used in environmental assessment. An excellent summary of these criteria was recently produced by the Commission for Environmental Cooperation, a body created under NAFTA (CEC, 1997) to assess the significance of transboundary impacts requiring a comprehensive review. The CEC list can also serve more general purposes, as demonstrated by Box 5.1. It also integrates and gives equal importance to environmental, social, health and economic considerations, in keeping with the approach developed in this Handbook.

Box 5.1 Factors for determining significant adverse transboundary impacts

The determination of whether adverse transboundary environmental impacts are significant involves consideration of the following factors:

1. *Context:* Context factors potentially relevant to the determination of significance of a transboundary environmental impact include, for example:

- the potentially affected human populations and vulnerable segments of the population (e.g. children, elderly persons);
- geographic extent (region and localities);
- ecological context;
- unique characteristics of the geographic area (e.g. proximity to historic or cultural resources, park lands, wetlands, wild and scenic rivers, or ecologically critical areas);
- where provided by the Potentially Affected Party, standards regarding the protection of health or the environment as specified in international, national and subnational legal instruments;
- probability of occurrence;
- scientific uncertainty.

2. *Intensity:* Intensity factors potentially relevant to the determination of severity or magnitude of transboundary environmental impacts include, for example:

- degree of toxic and other impacts on public health or safety;
- degree to which environmental impacts involve unique or unusual risks;
- degree to which a project establishes a regulatory precedent, or causes the issuance of a permit in a new area, and therefore may cause future projects to be carried out with significant transboundary environmental impacts;
- duration, potential for recurrence and frequency of impacts;
- degree of irreversibility of impacts;
- relationship to other projects which, even though individually insignificant, cause cumulative impacts, or can reasonably be anticipated to cause significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment; it is independent of whether a project is temporary in nature or is broken down into small component parts;
- degree to which physical or biological impacts of the project may adversely affect important historical or cultural resources, or traditional uses by indigenous people of cultural, historical and natural resources;
- degree to which a project may adversely affect threatened or endangered species or their habitats which have been determined to be critical;
- degree to which biodiversity is affected;
- degree to which natural ecological systems and landscapes are transformed;
- degree to which a project may foreclose or reduce the quality or availability of renewable and non-renewable resources.

5.4 Drafting a public health notice

The following elements should be included in public health notices:

- a review of the availability of data, a determination of the quality of data and an assessment of the degree of reliability in estimating both adverse and beneficial impacts (health and social components);

- a comparison of the risk levels obtained with current standards, or with levels generally considered to be safe;

- an identification of grey areas and adverse impacts for which no social consensus or standards exist;

- a review of comments and positions of the various publics and populations that will contribute to determining the social acceptability of the project;

- a summary of benefits and disadvantages and a statement on the acceptability of the project from a public health perspective, which addresses the likelihood of physical, psychological and community health impacts, the equity in their distribution, as well as ecosystem preservation.

5.4.1 Review of existing data

The matrix presented in Appendix 1 can assist in evaluating the completeness of the available data on possible adverse health impacts. In short, the object is to determine whether the information provided by the proponent for each of the cells in Figure 6.2 appears to be:

- complete (is the literature review up-to-date?);

- accurate (are the interpretations those of the authors of the studies or those of the proponent?);

- transparent with respect to any uncertainty or weakness in the basic scientific data (unknown or little- known risks are clearly identified), or any limitations of the prediction model that was used.

Figure 5.2 Matrix of adverse health impacts

AGGRESSOR /EXPOSURE	Type of aggressor	Environmental impact	Zone of influence	Monitoring measures	Standards or recommenda-tions	Health impact	Population at risk	Probability of occurrence and uncertainty	Biological indicator/ environment (follow-up)
Technological hazard									
Gaseous or air emissions									
Liquid emissions in water									
Solid emissions in soil									
Irritants									
Indirect psychosocial impacts									

Assessing the availability and reliability of data on the positive effects of a project is essentially the same activity, although the emphasis is usually reversed, with socio-economic aspects gaining greater prominence. The terms employed are different and the categories of impacts vary as well within a given field (Table 5.1).

Table 5.1 Adverse and positive impacts

Adverse impacts	Positive impacts
Damage, emissions	Ecosystem component
Irritants	Quality of life component
Indirect psychosocial impacts	Socio-economic component

Some projects help reduce environmental risks to health; for example, when an outdated coal-fired electric power plant is replaced by a gas turbine, or when emergency health care services are improved by providing more rapid means of transportation. Figure 5.3 summarizes these positive impacts.

Figure 5.3: Matrix of positive health impacts

Expected benefits	Type of impact	Zone of influence	Population affected	Probability of occurrence & uncertainty	Monitoring & follow-up measures	Health impact	Compliance with recommendations or S.D. principles
Socio-economic component C revenue/taxes C employment C public C infrastructure C perceptions C social cohesion							
Quality of life component: C landscape C recreational uses C cultural uses							
Ecosystem component: C water C air C soil C biospecies							

Assessing the quality of data dealing with socio-economic or environmental impacts is more delicate since health professionals often do not have access to the necessary expertise. However, this exercise remains an essential part of formulating public health notices, because it is important to determine whether the project justification is consistent with current policy, and whether the social or economic studies conducted are in keeping with current methodological standards. By referring to their own knowledge of the environment and consulting with experts and public health officials, practitioners can normally acquire a fairly solid understanding of the subject.

Frequently encountered pitfalls include:

C When no official public policy exists for overseeing a given project, formulating a justification becomes more difficult; a project (such as the development of a large hog farm) can sometimes serve as a test for other similar projects to come. Situations like these require closer scrutiny.

- Economic studies deal only with the spin-offs (in terms of employment) of the monetary resources that will be spent. Caution is advised in dealing with these “pre-scientific” studies, since any expenditure can bring about job creation to a greater or lesser extent, depending on the sector involved. Generally speaking, health care services are among the sectors that create the most employment, with heavy industry at the other end of the spectrum. If the main argument in favour of a project rests on the study of economic spin-offs, this is a clear sign of a weak argument.

- When more exhaustive economic studies are available (e.g. cost-efficiency, cost-benefit), the debate will centre on a number of methodological assumptions that are essential to any study. Examples include the discount rate to be used, the project timeframe, and the area being studied. In this situation, it may be useful to ask the proponent to present several scenarios in which different levels are used for a number of key variables. Thus, the soundness (or weakness) of the models used for these variables can be assessed. Consulting with independent experts can also be helpful here.

- The distribution of benefits and disadvantages almost invariably gives rise to problems. Local authorities should always be consulted to determine whether the proponent’s proposals and requirements are realistic. The employment component can be a delicate area: companies often require a high level of technical training, which can be difficult to find in some centres. The impact on municipal and regional services (water, waste management, fire department, police, roads, health services, etc.) is frequently underestimated in these studies. In order to avoid future disappointment and to temper the enthusiasm in some municipal quarters, complete transparency regarding any uncertainty in predicting impacts is advisable.

The review of available data should conclude with a notice regarding the quality of the data, as well as requests for more detailed information or additional studies judged to be crucial for the future.

5.4.2 Making comparisons based on existing standards

When standards already exist, the task becomes considerably easier. In conducting environmental assessments, however, it is important to remember that the life-cycle of a facility can extend over many decades. Consequently, adherence to the strictest standards is advised when dealing with new facilities. The strictest standards are generally found in Western jurisdictions with a high population density (e.g. California, Europe) and pollution levels that are higher than those in Canada.

Adopting this approach avoids the risk of using outdated standards as a goal for decades to come. With most new technology, it is possible not only to comply with the strictest standards

but often to achieve emission levels that are 100 to 1,000 times lower. Since the trend in scientific studies conducted over the past 30 years is to detect increasingly subtle effects at very low levels of exposure, providing a margin of safety for the long term would appear to be a good idea.

When no standards exist, the situation varies depending on whether a risk to health is deemed to be serious and irreversible (for example cancer or death) or less severe (eye irritation, discomfort caused by noise, etc.), or whether the risk at issue is a complex one affecting an entire community (as in the case of rapid development).

5.4.3 Making comparisons in the absence of standards

Acceptable risk levels which have been incorporated into standards may be applicable here. Standards generally provide for levels of acceptable risk on the order of one new death per million for a lifetime of exposure (70 years), a level rightly considered to be very safe when applied to a small population, which is most often the case.

For example, if 1,000 people live in the vicinity of a smokestack and are thereby exposed to a carcinogenic contaminant, one would theoretically have to wait 70,000 years for a case of cancer to occur. Therefore, such levels would appear to be adequate in the absence of standards. Levels of exposure lower than this would be considered negligible, meaning that no corrective measures would be required with respect to the project under review. It should also be mentioned that epidemiological methods cannot measure such risks, even when health status is rigorously monitored. Even if such risk levels were measurable, data on numerous other potential cancer causes extending over a period of 60 to 70 years would be required, including lifestyle habits and heredity. The same disease can result from many different causes and the human body has a limited number of ways of manifesting disease. For example, one could examine a hundred organic or anthropogenic chemicals associated with liver disease, while overlooking such things as infectious agents, alcohol consumption and nutrition.

In 1989, the Dutch government proposed that explicit limits be set for judging the acceptability of risks. This risk management framework (VROM, 1989) was subsequently made part of the Netherlands' environmental policy. This global approach to risk management has the advantage of being comprehensive and of setting clear limits which facilitate decision-making. For almost ten years, this framework has proven appropriate in the vast majority of risk management situations (de Boer, 1997). Since 1993, it has also been recommended as a general reference for public health branches in the province of Quebec, where it has proven equally useful. It is summarized here as a guide for public health practitioners, who may find it helpful as a template for evaluating risk levels obtained through impact studies. Readers

interested in the rationale underlying these levels may wish to consult the original document (VROM, 1989), which is also available from the CSE (1993).

Individual risk

This approach also uses as a threshold one new death per million persons exposed for life (10^{-6}) as a point of departure. Then a *negligible* risk level is established at 1% of the base level, or one additional death per 100 million (10^{-8}). These levels are applied for individual risk associated with technological accidents or chemical substances newly introduced into the environment.

The proposed approach also requires that practitioners take into account the fact that new risks are added to existing risks. In order to factor in this chemical or technological *background*, a level of one new death per 100,000 persons exposed for life (10^{-5}) has been suggested as an *acceptable* level for all combined risks within a given category (chemical, technological, radiation). Therefore, exposure to ionizing radiation is also included here. Exposure is calculated on the basis of a 24-hour day in both cases, which ensures an additional margin of safety.

Collective risk

For collective risk, defined as the probability of 10 or more deaths, the *acceptable* level is set at 10^{-5}/year, and at 10^{-7}/year for 100 deaths or more, and so on. Any situation in which the probability is greater than 10^{-5}/year necessitates the implementation of risk reduction measures.

Chemical substance thresholds

When chemical substances have a threshold beneath the level at which toxic effects can be measured, this threshold (NOEL) is used, along with the standard margins of safety. This is the standard practice in Canada; however the methods used to calculate margins of safety can vary in different countries, for different forms of exposure, etc.

Ecological risk

The Dutch model defines acceptable risk to the ecosystem as a level of lethal concentration which eliminates 50% of test organisms (LC 50) for major hazards, and an LC of 5% for chronic exposure to chemical substances. In the latter case, 95% of the species in an ecosystem would be protected. These standards apply to new situations and are to be considered a goal for existing situations.

5.4.4 Comparisons based on the principles of sustainable development

No standards exist to determine what percentage of new employment should accrue to local residents or whether the integrity of the landscape is being adequately protected. A number of authors have pointed to an established practice among proponents, which consists of ensuring that 10 to 25% of project-related jobs accrue to the host community. This would appear to be a threshold that significantly improves a project's acceptability (Hobart, 1983, 1984). Of course, higher levels of employment spin-off are often achieved, depending on the human and entrepreneurial resources available in a given community. Some companies also implement compensation policies with respect to residual impacts, establishing a level ahead of time. (Hydro-Québec reserves 2% of capital costs for community-based projects.) More recently, other formulas for gaining greater host community involvement have been put forward, such as local share ownership or royalties for the use of natural resources.

However, complying to the greatest extent possible with the concrete principles presented in section 3.5 should, ideally, help to maintain a strong sustainable development focus. This type of analysis will take a different form for a project (such as a cogeneration plant) than it would for a program or policy.

For example, a factory or highway development project cannot be expected to use non-renewable resources at a rate that would permit their eventual replacement with other types of resources, because that is not its role. Consequently, exercising good judgement is crucial in selecting the proper criteria. However, when one is asked to comment on the government's energy supply policies, examining this criteria is essential.

Ultimately, sustainable development depends on an equitable distribution of benefits and disadvantages across a given population, and among regions and generations. The role of public health practitioners and agencies is to monitor the views of groups within the population and to take into account a number of inter-regional considerations (transportation of pollutants over great distances, contamination of the food chain, etc.), as well as intergenerational issues (long-term risks, resource or ecosystem depletion, etc.).

In summary, specifying clear risk levels and criteria for intervention are useful aspects of preparing a public notice, since this provides a set of guidelines, however approximate, as well as comfort and discomfort zones for public health professionals and proponents. The levels presented above are fairly representative of the current situation in industrialized nations, but will require a significant effort in a number of economic sectors. Exceptions to these levels can also be made to correct existing high-risk situations (10^{-4} for example) and achieve a lower level (such as 10^{-5}) at a reasonable cost. The levels indicated also compare favourably with several other social risks (cars, sports, lifestyle habits, etc.) which are more closely linked to individual choice or past choices.

5.4.5 Identifying grey zones and other adverse impacts

A public health notice should identify any point that is contentious from a health perspective. After reviewing the risk levels outlined in the preceding section, the practitioner may conclude that actual risk levels appear to be high for one or more contaminants. It should be kept in mind that the method selected to analyze the risk can leave one exposed to criticism; consequently, any deficiency should be clearly pointed out.

Normally, several other risks of greater or lesser toxicity and with a degree of probability often approaching 100% will be encountered. These risks most commonly come in the form of:

- irritants (noise, unpleasant odours, traffic, etc.);
- psychosocial impacts (perceptions of the project, employment, revenue, municipal services, development of the affected community, etc.);
- impacts on life-sustaining ecosystems (water, air, living organisms).

The role of health professionals consists of correctly identifying these impacts and verifying the accuracy of forecasts and the adequacy of proposed mitigation or compensation measures.

There are, in fact, many different types of measures for attenuating impacts, and it is often advisable to consult experts in each of the contentious areas identified to ensure that irritants are minimized. With some projects, such as open-pit mines and hog farms, the nuisance factor becomes highly contentious. It is not uncommon to find proponents who show little concern for the disturbance they are causing their neighbours, and who often fail to meet municipal, provincial, federal or international standards. Due to past experience, the public's perception of such projects is often very negative; this can make it difficult to introduce new technology, even when it promises to perform very well.

Psychological and social impacts constitute another crucial area of intervention for public health practitioners, one that merits considerable attention. Public health practitioners and agencies need to publicly acknowledge that the community's perception of a project is not only legitimate, but also capable of inducing its own health impacts. Any perception, be it negative or positive, is likely to influence the types of impacts that are felt in the community, in terms of employment, social cohesion, taxation, etc. Economists are beginning to acknowledge that a healthy community is an important part of a well-functioning economy (Putnam, 1994). Social cohesion, civic involvement, mutual aid and many other similar activities bind communities and make it easier to adapt to large or small-scale changes. Examples can be found of well-planned and competently managed projects that have generated very positive social benefits despite their size. Oil development projects in the North Sea are one example (Hill, 1998).

Conversely, the social and economic upheaval currently experienced by many of Canada's First Nations as a result of development projects, has produced a number of adverse social impacts and negative perceptions (Grondin, 1994).

Impacts on life-sustaining ecosystems also need to be pointed out to public health authorities. With the increase in human economic activity and its attendant impact on ecosystems (see Figure 6.2), it is important to ensure that these ecosystems remain intact or that future losses are completely replaced in the area sustaining the impacts or elsewhere.

Figure 5.2 World ecosystem in relation to the economic sub-system

A. Ecosystem and economic sub-system in 1900

Finite global ecosystem
Expanding economic sub-system

Primary materials	Production - $60 trillion in goods and services	Secondary materials
C energy C resources		C pollution C waste
Reuse/recycling of materials		

B. Ecosystem and economic sub-system in 1990

Finite global ecosystem
Expanding economic sub-system

Primary materials	Production - $20,000 trillion in goods and services	Secondary materials
C energy C resources		C pollution C waste
Reuse/recycling of materials		

SOURCE: CCME 1993

5.4.6 Reviewing other positions

It is important to cite, with the authors' permission, the comments and positions expressed with respect to the project by various organizations and key individuals. This review can also encompass official documents (relating to public hearings, for example), and media coverage. Public health notices should also mention the experts and managers who were consulted by public health authorities, as well as the reports and other relevant documents that were reviewed.

5.4.7 Summary of benefits and disadvantages

Taking a clear position on the acceptability of a project requires sound professional judgement. A number of useful criteria for making this judgement have already been suggested in earlier sections of this Handbook.

In summary, the proposed approach is based on the principles of sustainable development and seeks to achieve extremely low levels of contamination, to distribute benefits and disadvantages equitably, in a manner that is widely accepted by the community, and to preserve existing ecosystems.

With experience, one discovers that projects often have elements that are acceptable, as well as others that are questionable or that require major modification. These aspects, as well as the work that remains to be done, should be pointed out without hesitation, keeping in mind that the role of public health authorities is not to address the engineering or other solutions required to solve a problem, but rather to indicate desirable overall directions.

A measure of self-censorship and self-deprecation is also in order. We have seen many mega-projects undergo substantial revision for reasons of public health or be halted completely because of public opinion. At times, environmental authorities seem to overlook the need to protect ecosystems: some help and support for reasons of human health can surely do no harm.

5.4.8 Social acceptability

Attempting to determine what will be socially acceptable can be difficult, as politicians and proponents often discover. It is possible, however, to identify factors that help anticipate controversy, and others that can facilitate project acceptance. A useful review of several waste management projects and programs undertaken in Canada (Toronto, Montreal, Quebec City, Halifax) and in New York State, identified some of these factors (Delisle, Transfert Environnement, 1996). Waste management is in fact a good example, since it gives rise to many different risks, irritants, perceptions and social and ecological impacts.

Delisle identifies two particularly sensitive factors that can easily become irritants and trigger resistance to a project. These are:

- accumulated frustration, and
- symbolic triggers.

Accumulated frustration can take many different forms. It can range from the perception of social injustice to the anger that sometimes spills over in areas where too many contentious projects have been developed or in areas that are already polluted (such as industrial zones), prompting citizens to reject any further development. When this type of "psychosocial saturation" sets in, even projects that could improve current conditions are met with suspicion and rejection.

Symbolic triggers are components of a project or facility that create controversy. In the case of waste management projects, the authors point to a number of symbolic triggers, including the importing of waste, the involvement of a multinational corporation, the presence of smoke stacks or hazardous waste, the degradation of the visual aspects of the landscape, and unpleasant odours. These reactions are entirely human. It is also likely that only the good neighbourhoods are spared offence--such developments cannot occur there, due to zoning laws and the price of land.

Many examples of this type of meta-analysis are available. An awareness of the factors likely to provoke resistance in a given context can assist in designing projects that will find acceptance and in presenting such projects as part of a facilitating process. Clearly, respect for collective priorities and pro-active social attitudes are key ingredients of sound social management. Collective priorities have now been integrated into the environmental component of EA and into certain aspects of sustainable development, a fact which is reflected in many laws, regulations, professions, surveys, etc. Governments and corporations are also being called on to adopt a coherent approach. Issues that go beyond pollution management and recycling now need to be addressed, including resource conservation, reuse of formerly contaminated sites, and community involvement in the development of environmental management systems. There is more involved than simply providing sound management. Indeed, the changes that are taking place point to new social choices and a new collective vision.

Pro-active social attitudes, a subject much discussed by the EPA (1988), imply honest and credible behaviour and attitudes on the part of proponents, as well as a genuine receptivity to the expectations of the community. However, much headway remains to be made in this area.

6.0 CREDIBILITY AND COMMUNICATION

6.1 Effective communication tailored to expectations

In a study examining the implementation of approximately twenty incinerator projects, Konheim (1988) observed that the standard risk assessment process failed to address the concerns being voiced by the public. Konheim outlined ten recurring questions expressed by citizens and their representatives (Box 6.1). These concerns are highly consistent with the issues that commonly arise with most large projects.

Konheim also reports that when an incinerator project was proposed in the New York area, a citizens advisory committee was more comforted by the qualitative conclusions of two physicians from Mt. Sinai School of Medicine, indicating that health effects of the plant were "minimal" and "non-detectable", than they were by the quantitative predictions of a scientific expert to the effect that the risks of dioxins from the plant would be in the range of 0.24 to 5.9 X 10^{-6}. This suggests that the public's expectations are more often qualitative than quantitative in nature.

In their guide for government risk communication, Chess et al. (1988) stress the importance of understanding community expectations, developing and maintaining credibility, controlling the timing of disseminated information, interacting with the community and taking the time to explain the various aspects of risk assessment.

Box 6.1 Typical questions raised by the public when faced with the development of incinerator projects

1. What are the specific risks compared to the benefits of the project? Is the risk to each group worth the benefit gained? What are the benefits and risks of alternative solutions? What are the benefits and risks of taking no action?

2. How did you calculate the risk? Is there one standard way of doing it, or are there several? Is there a prevailing consensus on the basic facts in the scientific community? Or are there distinguished dissidents?

3. Did you base your calculation on data from facilities already in operation, or is the data base theoretical?

4. If you based the data on already-operating facilities, were they very similar to the proposed project? If not, how would their differences alter the analyses?

5. Does the design of the facility make the risk as low as it possibly can be? Can the facility be updated later if new ways are found to lower the risk?

6. Who in the community bears the burden of risk? Are older, younger, and sick people more at risk?

7. What is the chance of a serious accident? If one occurred, what would be the worst possible impact? How often do accidents happen in currently operating facilities? Will their likelihood increase over time? What is their magnitude? Would the effects of an accident be irreversible? What provisions have been made to handle accidents?

8. Will risks be identifiable? Who will monitor the performance of the plant? Can the risk be reduced?

9. Can the public influence how the facility is designed and operated?

10. Does approving the project mean foreclosing future, potentially less risky, options?

Source: Konheim, C.S., Risk Communication in the Real World, Risk Analysis, Vol. 8, No. 3, 1988.

According to Covello (1992), the key to effective communication is the confidence and credibility of the individual or organization conveying the message to the public. Studies have shown that organizations and individuals perceived as being credible in matters of risk assessment include health professionals, university professors, the media, non-profit health organizations and respected local citizens who are considered to be impartial and well-informed about risks. The research demonstrates that the general population views doctors and academics as being motivated by noble goals, the former being dedicated to healing and the latter motivated by the quest for knowledge and truth. Both groups are perceived as being economically independent from the organizations that hire them as consultants, and therefore unconstrained in rendering their professional judgment.

Covello (1992) identifies four factors that influence the perception of confidence and credibility:

- *The perception of empathy and caring:* This would seem to be the most important factor. Does the communicator give the impression that he/she is interested in health, safety, the environment and fairness? Does he/she take the time to listen to his/her audience? More often than not, the public makes its mind up about this factor from the initial contact. Once the public has passed judgment, perceptions be very difficult to change.

- *The perception of competence and expertise:* This perception is largely influenced by the past accomplishments of a government organization or agency and by factors that relate to the communicator, including training, experience, knowledge and verbal skills.

- *The perception of honesty and openness:* This perception is influenced by actions, words and non-verbal communication. A communicator who is unable to meet the gaze of others, or the placing of physical barriers between the communicator and his/her audience, are forms of negative non-verbal communication.

- *The perception that the communicator is dedicated to the cause:* This perception arises from the impression that the communicator is a hard worker who diligently strives to achieve goals connected with health, safety and environmental protection. The audience normally forms this impression based on various verbal and non-verbal cues: Is the communicator available outside of office hours? Does the communicator remain for the entire public meeting?

Such studies are extremely useful in understanding the nature of effective communication. They suggest that successful risk communication is a complex art that requires skill, knowledge, training and practice. They also suggest that risk communication involves intrinsic limitations, even when the communicator possesses all these qualities. Credibility and honesty must be present from the outset.

Exchanges between citizens' committees/representatives and risk assessment practitioners during the public consultation phase is another key component of successful communication. In addition to helping experts gain a better understanding of the community's needs and expectations, citizens' representatives can play the role of risk communication facilitators. The mere fact that citizens are given the opportunity to review the risk analysis process enhances credibility.

Citizens' committees also play an important role in examining issues of surveillance and environmental monitoring with respect to risk. It has been noted that the public is generally less fearful of risks over which it feels it has the ability to exercise some control. Involving community representatives constitutes a definite investment: when a future course is charted and decisions made, the public will recognize that it was not excluded but, rather, made an integral part of the process (either directly or through its representatives).

Where the health network is concerned, a number of issues need to be considered in coordinating public participation. These include:

- the specific risk evaluation context;
- respecting data confidentiality (when necessary);
- respecting the stakeholders involved in the process;
- avoiding any possible bias that might give rise to criticism and undermine credibility.

Ideally, public participation should be generated and encouraged by the organization responsible for managing the process. Public health organizations should always support the involvement of citizens.

Those charged with communicating risk have an interest in translating numbers (often expressed as a fraction over several thousand or several million) into an order of magnitude that will be more accessible to the general population. For example, Carrier et al. (1991) have estimated that the average individual risk of cancer for the 6,800 citizens residing less than 500 metres from the Des Carrières incinerator in Montreal is 1 in 2.04 million. This somewhat abstract assessment has been translated into a collective annual risk of one chance in 300 (for a population of 6,800) after 70 years of incinerator operation. In other words, it would take 300 years to be sure that one case of cancer among 6,800 individuals developed as a result of incinerator operations. Mathematical conversions of this kind can help the public better understand communicated risk levels.

Risk comparison can also assist in putting a specific situation into context, although this approach has both advantages and disadvantages. In their Handbook for plant managers,

Covello et al. (1988) organized 14 types of comparisons into 5 categories, based on their likelihood of success with the public. Selecting one of these categories over others should be done with caution, since some risk comparisons are less acceptable than others and may in fact have little to recommend them. The various categories are outlined in Appendix II of this Handbook. While the risk comparison approach is not universally endorsed (Rahm-Crites, 1998), a number of authors recognize the usefulness of comparisons, pointing to the evolution of the concept of risk and the maturity of the public. The key, then, is the ability to adapt one's approach to the target audience.

Whenever possible, the preferred approach is to use measured or estimated concentrations of substances in the environment and to compare these with concentrations deemed to be acceptable based on toxicological and epidemiological studies.

It is also important to specify whether risks are acute or chronic and to address the probability of occurrence for each substance under review.

Regardless of the numeric value attached to a risk, it is impossible to express risk without specifying:

- any uncertainty associated with obtaining these values;
- any uncertainty associated with the extrapolations made (high dose/low dose, animal experiments and extrapolations for humans);
- that the risk is not uniformly distributed throughout the population, that some individuals will have a greater exposure (in terms of concentration or duration of exposure); and (in the absence of specific risk estimates for particular sub-groups within the population), that some individuals will manifest a greater sensitivity when exposed.

The seven rules of effective risk communication recommended by the EPA (1988) provide a good summary of the desired approach:

1. Accept and involve the public as a legitimate partner.
2. Carefully plan and evaluate your efforts.
3. Listen to the public's specific concerns.
4. Be honest, frank and open.
5. Coordinate and collaborate with other credible sources (organizations or individuals).

6. Meet the needs of the media (be open and accessible).

7. Speak clearly and with compassion.

If the communication of risks and results in EA still seems somewhat nebulous to readers, they should know that they are not alone! This was also the conclusion of several organizations and researchers cited in a recent methodological review (Rahm-Crites, 1998). Their conclusion was that this field is still at the experimental stage and that solid information on effective and efficient approaches is lacking.

Still, it is important to invest in two key areas, which are preparation and credibility. Both of these areas are examined below.

6.2 Preparing a communication strategy

Effective communication requires careful planning. This involves several essential steps:

- *Ensure that the notice is specific with respect to risks/benefits and proposals:* the magnitude of the risk to be communicated, the benefits involved and the options to be proposed must be clear in the mind of the communicator.

- *Establish communication objectives:* risk communication objectives should be clearly defined. Is the purpose of the message to inform the public about a risk to health? Is the purpose to improve understanding? Does the message imply that a change in behaviour is in order? Does the public health notice propose new options?

- *Identify the various target audiences:* Identify the target population for risk communication and segment the various groups within that population. Do not overlook professional audiences (public servants, doctors, engineers, etc.), including your own colleagues.

- *Remain mindful of the socio-cultural environment:* A solid understanding of the prevailing values of a community and its subgroups is important since it enables practitioners to choose the means of communication that are best suited to social (and cultural) preferences about information dissemination. This step allows for necessary adjustments with respect to power and information dissemination structures.

- *Select an approach that is appropriate for the target groups and the socio-cultural environment:* This can take the form of oral, written or visual communication, or a

combination of all three. It is also important to identify the individual (or individuals) most likely to communicate the message successfully. Four communication techniques are available: public relations, paid advertising, resource materials and community-based activities.

- *Public relations* refer to activities conducted with a view to obtaining the free cooperation of individuals or the media. Press conferences, letters, open-lines, radio and television programs, exhibits, information booths and contests are some examples of activities falling into this category. Working with the media can be an easy way to convey a message to a large audience, given the considerable credibility the media enjoys with the public. However, since the media controls content, problems can sometimes arise.

- *Paid advertising* includes any form of promotion in the press and electronic media (radio and television), including community, commercial, local, regional and national media. This provides a way of reaching selected groups but often at a substantial cost.

- *Resource materials* include print and audiovisual tools such as posters, brochures, slide presentations, video and instructional games. This approach facilitates the inclusion of more complex elements. However, the method of dissemination and the target audience must be chosen with care. Again, significant costs are sometimes involved.

- *Community-based activities* are defined as any direct communication with a target audience. Public assemblies and information sessions fall into this category. Involvement in community events can be another useful way of getting a message across. Generally speaking, this technique can have considerable impact since it appeals to community values and the need for identification. The cost involved is usually low.

Based on the situation at hand and the objectives pursued, a combination of these techniques can also be effective.

- *Prepare the message:* Draft press releases, additional information, letters of invitation to public meetings and any other material to be disseminated, and transmit these to the various target audiences.

- *Implement the communication program:* coordinate activities and establish schedule targets.

- *Evaluate the impact of the communication strategy:* As much as possible, the effectiveness of the communication strategy and its impacts (including any negative consequences) must be assessed. Evaluating the process can assist in making adjustments to a strategy already underway or in improving future communication strategies.

Some public health stakeholders tend to believe that their role is solely a matter of communicating information to the public in an honest, easily understood manner. However, this may lead them to overlook a number of factors affecting the perceptions held by individuals. More often than not, this kind of oversight leads to conflict and the organization's credibility being called into question. (Goldberg, 1992).

The involvement of citizens' committees or citizens' representatives with public health professionals can help ensure success in establishing a dialogue with the public. It is important to remember that communication also involves listening to the views of others. Frequently, the communication of a public health notice or risk is the final step in an arduous process in which time constraints often play a role. In spite of all this, a way should be found to give it the time and energy it requires.

6.3 Credibility

Credibility is difficult to establish and can easily be lost. It remains the key ingredient of successful communication.

Organizations and individuals must employ a variety of means to develop and maintain their credibility. These include maintaining a high level of scientific knowledge, competently using research methodologies, and maintaining a consistent presence and a steady dialogue with the community and organized groups.

Another essential aspect is having an independent mind and rendering balanced judgements, while maintaining an exclusive focus on public health. That focus forms the very basis of the health professional's mandate, although it can be difficult to remain mindful of this when dealing with cases in which the emphasis is on economic or environmental considerations. Practitioners must remain firmly rooted in the public health field and address other fields through questions or requests submitted to the competent authorities.

Box 6.2 presents a series of ethical principles that can useful in conducting environmental assessments.

Box 6.2 Useful ethical principles for environmental assessment

In fulfilling their role, health professionals must:

- perform their work in accordance with the most appropriate, tested and up-to-date scientific information and methods;
- avoid all forms of discrimination, in accordance with the law;
- show discretion and respect for the rules of confidentiality under existing laws and regulations (with respect to both information on paper and electronically-processed information);
- exercise their functions in an impartial manner;
- avoid any real or apparent conflict of interest, meaning any situation in which practitioners or organizations have ties with parties whose interests run counter to the interests of public health.
- ensure that, in any circumstance, the results of the public health risk assessment will be divulged at the proper time, if necessary;
- promote ongoing training and the development of expertise by sharing experiences and knowledge.

7.0 CONCLUSION

In conclusion, it is important to emphasize that a number of policy positions developed in recent years support the approach advocated in this Handbook. These include the Rio Declaration, as well as numerous charters and declarations around the world, under the sponsorship of international organizations, including the United Nations. Although these policy statements concern us all, it is crucial that our own leaders take similar steps. In fact, this has taken place in Canada, even though it seems to have gone unnoticed: in December 1996, every provincial and federal minister of Health and the Environment signed on to an important declaration with unavoidable implications for the environmental assessment process (see Box 7.1). This declaration gives greater legitimacy to the active involvement of health professionals in environmental assessment. It also supports the approach advocated in these pages, which is to expand the role of public health beyond the physical health component, to include both the social and ecological components. The next phase, which is the implementation of these principles, will be the most difficult but also the most rewarding. Good luck in your work.

Box 7.1: Principles for health/environment cooperation

PRINCIPLES

The Ministers of Health and the Environment recognize that human health, ecosystem health and the economy are interdependent. We believe that:

- all Canadians must have the opportunity to live, work and play in environments that are in harmony with nature;
- ecosystem health is essential to the health of all life forms on Earth;
- development occurring today must not prevent current and future generations from pursuing their own development and meeting their environmental needs;
- where there is a risk of serious or irreversible damage, lack of scientific certainty should not be invoked as a reason to postpone the implementation of effective measures to halt environmental degradation;
- sustainable development needs to be better understood at the scientific level, which implies sharing knowledge and adopting innovative technologies;
- preventive measures are preferable to corrective ones;
- the Canadian population needs to be better informed to make decisions that promote and maintain human and ecosystem health.

Canadians have a responsibility to make decisions that promote human and ecosystem health. The Canadian government must ensure that its own decisions protect the health of the population and the environment, creating conditions that encourage individuals and communities to adopt practices that are consistent with the principles of sustainable development.

AREAS OF COOPERATION

In witness whereof the various governments commit themselves, in the interest of present and future generations of Canadians, to do their utmost to:

- expand knowledge and exchange information on human health, ecosystem health and the determining factors of each;
- identify priority areas requiring Canada-wide action;
- support cooperation between departments and ministries of Health and the Environment and other departments and ministries which have a role to play;
- develop interdisciplinary strategies to promote human and ecosystem health;
- strengthen links between governmental and non-governmental organizations;
- facilitate and promote public awareness programs and public participation.

Source: CCME, November 1996