An Examination of Risk Assessment Associated with Northern Hydrocarbon Resource Development as Conducted in the Federal Environmental Assessment and Review Process

by

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AN EXAMINATION OF RISK ASSESSMENT ASSOCIATED WITH NORTHERN HYDROCARBON RESOURCE DEVELOPMENT AS CONDUCTED IN THE FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS

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A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

ABSTRACT

Risk assessment associated with northern hydrocarbon resource development as conducted in the Federal Environmental Assessment and Review Process was examined in terms of both general methodology and review criteria for the assessment of environmental hazards. The Beaufort Sea/Mackenzie Delta Region Environmental Assessment and Review Process was used as a case study upon which conclusions and recommendations were based.

Risk assessment as it was conducted in the context of the Beaufort Sea/Mackenzie Delta Region Environmental Assessment and Review Process was not adequately structured to contend with the paucity of data relevant to environmental hazards. Formal risk assessment of the Beaufort Sea/Mackenzie Delta Region hydrocarbon resource development proposal was limited to environmental risk assessment. Future environmental assessments and reviews should also encompass risk assessments respecting economic and socio-economic concerns. Data bases concerning northern hydrocarbon resource development currently available, upon which risk assessment studies can be based, are incomplete. Risk assessments which are prepared utilizing analogous and extrapolated data are of limited reliability, and are largely unacceptable for

decisions regarding northern hydrocarbon resource development.

In cases where formal risk assessment is not possible because of a lack of reliable data, the procedure of risk assessment may provide a useful framework for the organization of available data and for the identification of deficiencies. Generic guidelines should be developed respecting risk analysis in the context of environmental assessment and reviews. Such guidelines would assist in the delineation of gaps in the practice and understanding of the role of risk analysis in the Federal Environmental Assessment and Review Process. Guidelines which require risk assessment in the context of environmental assessment and review should include criteria for validation of data and scientific understanding and should include recommendations on how to contend with scenarios where these criteria cannot be met.

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INTRODUCTION

1.1 BACKGROUND

Energy issues are among the most important faced by Canada today. International, national and regional pressures have raised the problems of energy supply, demand and deliverability to unprecedented levels of attention and action. The economic, social, political and environmental issues which surround energy questions have made analysis and decision-making very complex (Nelson, 1978).

In Canada, the quest for secure supplies of petroleum products has focused attention on the frontier regions. Rapid change is occurring in Canada's North. Much of the change is evolving as a consequence of resource development projects, recently undertaken or proposed, which focus on the North's hydrocarbon potential (Nelson, 1978). Resource development projects north of 60 degrees latitude will have considerable impact on the national economy, particularly on the degree of energy self-reliance (energy security) Canada is able to achieve (Environment Canada, 1983). Moreover, northern resource development projects offer the promise of a powerful stimulus for the nation's manufacturing, service

and high technology industries, and they present the prospect of new job opportunities for southern Canadians (Environment Canada, 1983). All Canadians, therefore, will be affected by the course of the northern enterprise.

Petroleum exploration is not new to the Beaufort Sea/Mackenzie Delta Region of the Canadian arctic. The first exploratory well in the Northwest Territories, drilled in 1920 at Norman Wells, resulted in an oil discovery (Pallister, 1978). Pallister notes that oil seepages have been known to exist on the banks of the Mackenzie River for a century or more. Barry (1979) states that other than the development of the Norman Wells field, there was scant exploration and development activity in the Arctic until the years of World War II, when the Norman Wells field was extended and an oil pipeline laid to a refinery in Whitehorse. This pipeline was in fact never put into operation.

Exploration in the Arctic was renewed in the 1950's as oil and gas discoveries in northern Alberta and British Columbia generated interest in similar prospects in the southern Northwest Territories and in the southern and central Yukon Territories. This exploration led to natural gas discoveries at Rabbit Lake, N.W.T. in 1955, in the Eagle Plains, Yukon Territory in 1960, at Beaver River, Yukon Territory in 1964 and at Pointed Mountain, Yukon Territory in 1967 (McCrossan, 1973).

In the High Arctic, petroleum exploration was stimulated by the 1955 "Operation Franklin" reconnaissance geological and geophysical surveys carried out by the Geological Survey of Canada (Dome Petroleum Limited et al., 1980). Industrial geophysical exploration and drilling resulted in the discovery of natural gas on Melville Island in 1969. Subsequently, other oil and natural gas discoveries have been made in the Arctic archipelago.

In the Western Arctic, the first well was drilled on Richards Island in the Mackenzie Delta in 1965. Exploration in the Mackenzie Delta Region was accelerated by the twelve billion barrel oil discovery on the North Slope of Alaska at Prudhoe Bay in 1969. (Dome Petroleum Limited et al., 1980). In the Eastern Arctic, marine geophysical surveys and exploration drilling commenced in 1969, and the first offshore drilling took place in 1979 in Davis Strait and Lancaster Sound.

The first exploration permits in the Beaufort Sea/Mackenzie Delta Region were issued to the petroleum industry by the federal government in 1965. The purpose of these permits was to encourage industry to explore for hydrocarbon resources in the Beaufort Sea/Mackenzie Delta Region. To retain the permits, industry was obliged to carry out a specific, minimum level of exploration related activity. Since 1965, exploration for hydrocarbon resources in the Beaufort Sea/Mackenzie Delta Region has evolved through three distinct phases. In the first phase, 1965 to

1973, all drilling was carried out onshore. A number of oil and gas discoveries were made, however, the reserves found were too small to warrant development. In 1973, a new phase was initiated when Imperial Oil (now Esso Resources Canada Limited) drilled the first offshore well in the Beaufort Sea from an artificial island built in three metres of water. Imperial Oil and others had developed 18 such islands in the shallow waters of the Beaufort Sea by 1981. A combination of disappointing exploration results, more favourable geology further offshore and evolving technology led to the start of a third phase of activity in 1976 when Dome Petroleum Limited began drilling from reinforced drillships further offshore in the deeper waters of the Beaufort Sea. This resulted in a tremendous surge of geological and geophysical exploration activity, leading to a number of significant hydrocarbon discoveries (Nelson, 1978).

While the resource development projects promise significant benefits, they have also raised many issues of concern to the public. Basic concerns are being expressed about the maintenance of environmental quality in the North (Canadian Arctic Resources Committee, 1984). As a result of successful exploration, discovered reserves of hydrocarbon resources were sufficient to warrant consideration of production and transport of oil and gas to southern markets. World oil prices are paramount in any consideration of

production and transport of hydrocarbon resources from the Beaufort Sea/Mackenzie Delta Region. Unstable world oil prices may delay or even invalidate the prospect of exploitation of remote northern hydrocarbon resources.

As of mid-1986, all exploration and development of hydrocarbon resources in the Beaufort Sea/Mackenzie Delta Region was suspended pending stabilization of world oil prices. Nevertheless, the exploration and development of Canada's frontier northern hydrocarbon resources remain as inevitable forces in the realization of Canada's resource potential. In 1981, Canada was importing approximately 500,000 barrels of oil per day to the net detriment of the national economy. Despite ambitious attempts to conserve oil, a 1978 National Energy Board report predicted that by 1990 Canada's demand for imported oil would increase to approximately 1,000,000 barrels per day (Dome Petroleum Limited et al., 1981). The hydrocarbon developers in the Beaufort Sea/Mackenzie Delta Region contend that sufficient potential exists in the Region to reduce this shortfall substantially.

1.2 PROBLEM STATEMENT

Northern development, and government policies which promote development, have affected the Beaufort Sea/Mackenzie Delta Region profoundly (Milne and Herlinveaux, 1979). The National Energy Program, announced in October, 1980, generously promoted northern hydrocarbon resource exploration and development. The program was terminated in October, 1985, and was replaced by a new series of initiatives titled Canada's Energy Frontiers - A Framework for Investment and Jobs.

Offshore hydrocarbon resource development in the Beaufort Sea Region was referred to the Federal Environmental Assessment and Review Process (EARP) in 1980. The Beaufort Sea Environmental Assessment Review Panel (BEARP) was appointed in May, 1981 by the Minister of the Environment to identify the major positive and negative effects of hydrocarbon production and transportation from the Beaufort Sea/Mackenzie Delta Region upon the human and natural environments in Canada's north, and to recommend methodologies for dealing with these effects. (Federal Environmental Assessment Review Office, 1984). The three major Proponents, Dome Petroleum Limited, Gulf Canada Resources Incorporated, and Esso Resources Canada Limited prepared and submitted a seven volume environmental impact statement (EIS) to the Beaufort Sea Environmental Assessment Review Panel in 1982, on behalf of forty companies holding

exploration permits in the Beaufort Sea/Mackenzie Delta Region (Environment Canada, 1985). The EIS outlined the possible environmental, social, and economic implications of commercial development and transport of hydrocarbon resources from the Beaufort Sea/Mackenzie Delta Region.

The Proponents contended that with the proven hydrocarbon reserves and the potential for additional discoveries, planning should proceed for the production and transport of these reserves to southern markets (Federal Environmental Assessment Review Office, 1984). The Proponents expected most of the hydrocarbon products from the Beaufort Sea/Mackenzie Delta Region to come from offshore reservoirs (Federal Environmental Assessment Review Office, 1984).

Three transportation scenarios for crude oil produced were identified by the Proponents. These were: transportation to markets through an overland pipeline, transportation via icebreaking tankers and transportation by a combination of overland pipeline and icebreaking tankers (Federal Environmental Assessment Review office, 1984) (Figure 1). In accordance with its Terms of Reference, the Beaufort Sea Environmental Assessment Review Panel, directed its review of the Proponents' submissions towards the identification and assessment of major issues and concerns associated with the Proponents' EIS submissions. One of the principal concerns of the Beaufort Sea/Mackenzie Delta Region Environmental Assessment and Review was oil spills

risk assessment, as the possibility of oil spill was the major environmental concern expressed by many northern residents and intervenors. As a consequence of these concerns and technical disagreements among experts regarding the degree of risk, the Proponents with their experts, the Department of the Environment and technical specialists held numerous discussions on risk assessment and throughout the environmental review process.

The Beaufort Sea Environmental Assessment Review Panel published its report titled "Beaufort Sea Hydrocarbon Production and Transportation Proposal" in July, 1984. The Panel report discusses potential effects, both positive and negative, upon the physical, biological, and socio-economic environments affected by the Proponents' development proposals. The Panel's report makes recommendations as to how adverse effects of the proposed development could be mitigated or avoided. An entire chapter of the Panel report is devoted to the discussion of oil spill risk assessment, the causes and prevention of accidents, the types of spills which could occur as a result of Arctic oil production and transportation and oil spill clean-up techniques. The Panel report includes comments on the capability of governments to control Beaufort Sea hydrocarbon development, and on the need for subsequent periodic reviews (Federal Environmental Assessment Review Office, 1984).

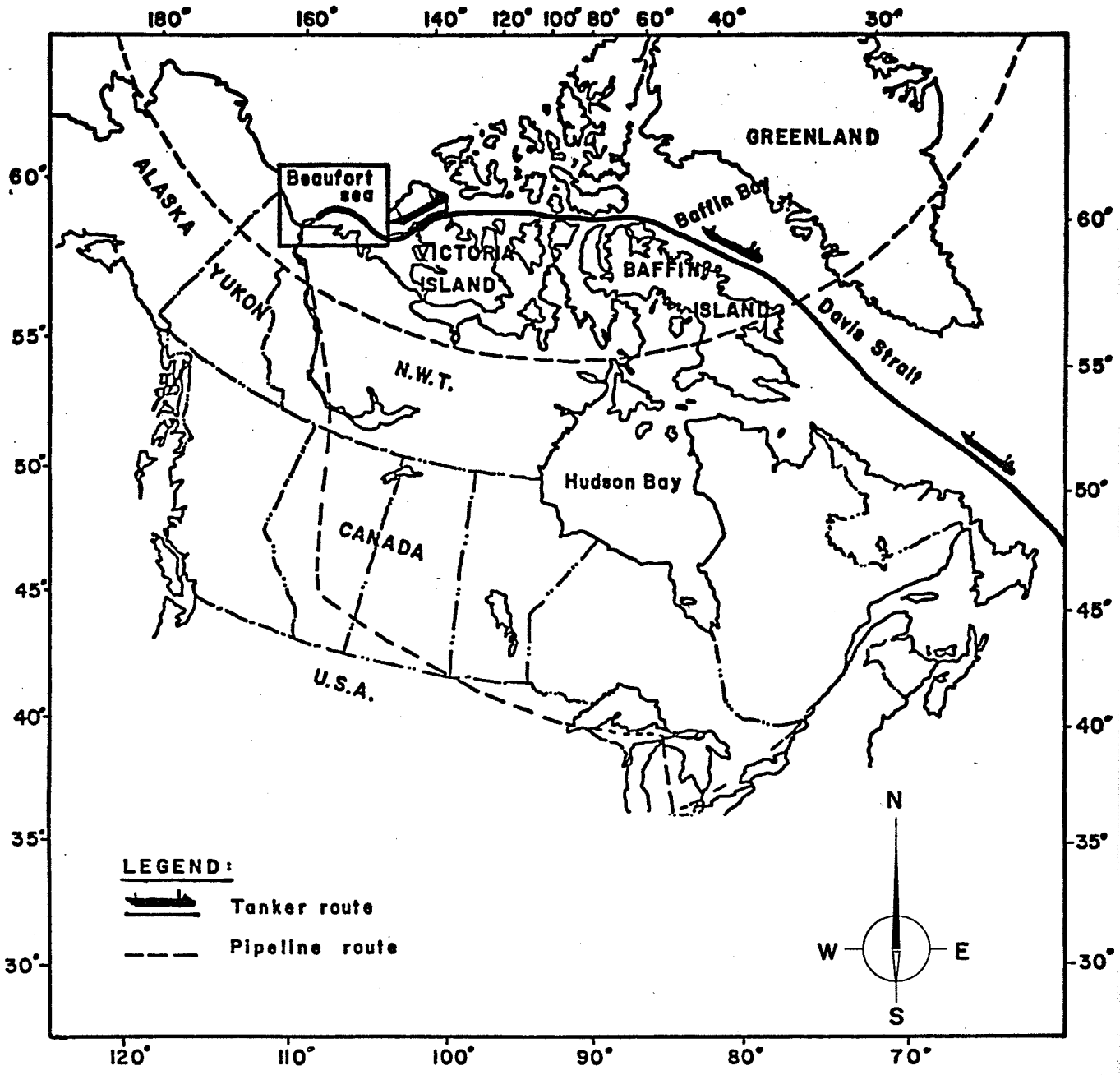

Figure 1: Proposed transportation routes for hydrocarbons produced in the Beaufort Sea/Mackenzie Delta Region (After Dome Petroleum Limited et al., 1982)

1.3 RESEARCH OBJECTIVES

The primary purpose of the study was to examine risk assessment as included in the Federal Environmental Assessment and Review Process, with reference to the transport of hydrocarbons from the Beaufort Sea/Mackenzie Delta Region.

Specific objectives were:

1. to develop and discuss a general methodology for conducting risk assessments related to environmental hazards in an environmental impact assessment, with specific regard to transport of hydrocarbon products in the North;
2. to review criteria for assessment of environmental hazards in the context of environmental impact assessments;
3. in light of objectives 1 and 2, to critically comment on risk assessment as it is presently conducted in the context of the Federal Environmental Assessment and Review Process, with specific regard to hydrocarbon transport in the North.

1.4 METHODS

Methods employed in the study included:

1. a comprehensive review of existing literature and risk analysis information and data pertaining to the environmental impacts of the proposed transport scenarios;
2. a review of the criteria for assessment of environmental hazards in the context of environmental impact assessment;
3. personal and telephone interviews with government regulatory personnel, representatives of the private sector and faculty members at the Universities of Manitoba and Alberta to ensure the acceptability of the analytical methods and their proposed applications.

Chapter II

JURISDICTION OVER NATURAL RESOURCES AND THE FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS.

2.1 PREAMBLE

This chapter is intended to serve two basic functions. The first section will outline the broad legislative jurisdictional framework over natural resources in the Canadian North. The following section will outline the Federal Environmental Assessment and Review Process having regard to the legislative framework.

2.2 JURISDICTION OVER NATURAL RESOURCES NORTH OF 60 DEGREES LATITUDE

The original Constitution of Canada was a statute of the United Kingdom titled the British North America Act, 1867 (now entrenched as the Constitution Act, 1867). The preamble to the Constitution Act, 1867 provides that the Canadian Constitution should be similar in principle, to that of the United Kingdom (Hogg, 1985). In the United Kingdom, Parliament is sovereign in its jurisdiction as it has the inherent power to make, or dissolve any law whatsoever. There is no limit to Parliament's legislative power and it may delegate its powers to anyone such as a

Minister to enforce legislation. Therefore, the source of a delegate's power or duty is Parliament which may delegate a broad general authority or discretion to act. In the absence of authority, such delegates do not have jurisdiction to act (Jones and De Villars, 1985). The Constitution Act, 1867, created a federal system for governing Canada in which the power to legislate is divided between the federal parliament on the one hand, and the several provincial legislatures on the other (Hogg, 1985). Thus, in Canada, the right to legislate is divided between two levels of government. Each government is sovereign within its own designated jurisdiction, and may not purport to enact legislation on any subject matter which is beyond its power as set out in the Constitution Act, 1867 (Hogg, 1985). These "heads of power" are set out specifically in sections 91 and 92 of the Constitution Act, 1867.

The Canada Lands are those areas of Canada which fall under federal jurisdiction under the British North America Act, 1867 (Constitution Act, 1867), and which are said to include the areas off Canada's coast the Yukon and Northwest Territories, and small areas scattered throughout Canada (Thompson, 1972). The Canada Lands comprise an area almost twice as large as that constituted by the ten provinces (Thompson, 1972). The federal government has exclusive jurisdiction over all natural resources in the Canada Lands. The power of the federal government to legislate in the

north is entrenched in the preamble to section 91 of the Constitution Act, 1867. The preamble guarantees that the federal parliament may enact laws for peace, order and good government in relation to matters not coming within the classes of subjects or heads of legislative powers assigned to the provincial legislatures. As well, subsection 91(2) of the Constitution Act, 1867 respecting trade and commerce power, creates a large federal jurisdiction over the regulation of natural resources not coming under provincial authority. The designated provincial jurisdiction over non-renewable natural resources is specified in section 92(a) of the Constitution Act, 1867. Territorial legislative power has been delegated by the Yukon Act and the Northwest Territories Act. This power provides for executive, legislative and judicial responsibilities that more or less coincide with the power granted to a province, with the exception being the control of natural resources. Since jurisdiction to enact territorial legislation is derived from a federal delegation of power, any enactment of the Territorial Council must give way to any paramount enactment of Parliament (Lewis, 1972). This subordination of territorial jurisdiction has not been challenged, and it is unlikely to be, until the Yukon or Northwest Territories gain provincial status.

Canadian federal jurisdiction over the offshore extends to the Yukon/Alaska boundary in the Beaufort Sea in the

northwest; to the median line between Canada and Greenland in the northeast; over the continental shelves of the Arctic Ocean and Atlantic Ocean (and beyond, to the limit of ability to exploit) in the north and east, and to the Canada/U.S. boundary to the southeast (Dome Petroleum Limited and the Government of the Northwest Territories, 1980).

The Department of Indian Affairs and Northern Development (DIAND) administers the federal jurisdiction over petroleum and natural gas beneath the land and waters north of 60 degrees latitude (the Canada Lands) (Department of Indian Affairs and Northern Development, 1979). The Northern Affairs Program of DIAND is charged with controlling the development of natural resources in the Yukon and Northwest Territories. A primary objective of the Northern Affairs Program is to see that any such development is for the benefit of all Canadians and does the least possible damage to the environment and to the lifestyles of all northern residents (Department of Indian Affairs and Northern Development, 1981). No less than 25 different pieces of legislation (acts of Parliament or sets of regulations), as well as a number of special cabinet directives set out the rules governing the many types of resource development in the North (Department of Indian Affairs and Northern Development, 1981).

2.3 OVERVIEW OF THE FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS

Much has changed in the past two decades with respect to the theory and process of natural resources development. Historically, it was generally thought that environmental protection and economic development were conflicting policy issues. However, a new awareness and focus that environmental considerations must provide the integrating framework for social and economic decision-making is becoming widely accepted (Canadian Environmental Advisory Council, 1988). Much of this change has followed as a result of a federal cabinet memorandum dated December 20, 1973, which indicated that environmental matters were henceforth to be given the same degree of consideration as economic and technical matters in decisions respecting federal projects and proposals (The Rawson Academy of Aquatic Science, 1987). This represented a bold initiative regarding a mechanism for more balanced developmental decision-making in areas of federal jurisdiction.

Following the 1973 Cabinet memorandum, the Federal Environmental Assessment and Review Process (EARP) was implemented on April 1, 1974, under the authority of the Minister of the Environment (Couch et al., 1981). Its object was to require all Initiators of federal government projects, programs, or activities, and certain Crown corporations and regulatory agencies to establish review

mechanisms to fulfill their mandates and meet, at an early stage, their responsibilities in accordance with the Environmental Assessment and Review Process before irrevocable decisions were made (Wolf, 1982). The Environmental Assessment and Review Process was to be an important planning tool for predicting the potential environmental consequences of development proposals with the concurrent opportunities to alter or abandon plans if significantly negative environmental effects could not be attenuated or eliminated (Federal Environmental Assessment Review Office, 1987b).

As a result of experience and comments received, the Environmental Assessment and Review Process was amended on February 15, 1977, to allow for the appointment of panel members from other departments as well as from outside the federal public service to ensure that all relevant information was provided to the Minister of the Environment in evaluating projects or proposals, and to ensure that public input and participation was sought early in the planning stages. These changes were made with the following goals in mind (The Rawson Academy of Aquatic Science, 1987):

- to raise public awareness of the environmental and related social consequences of development, and to make explicit the trade-offs that must be made between the consequences of development and the economic benefits of material growth.

- to help even the odds between competing weak and powerful interests in society. Specifically, the Environmental Assessment and Review Process was to provide a public forum for impacted individuals and communities to make their case when projects favouring developers and, often distant, consumers were being considered.
- to bring balanced information and judgement to bear on the policy making and project approvals process.
- to enhance the accountability of public servants and politicians by exposing the environmental basis of decision-making.

Though legislation has not been specifically enacted to establish the Environmental Assessment and Review Process, the federal government in June, 1984 issued Guidelines Order PC 1984-2123 (Canada Gazette, Part II, 11 July, 1984) under section 6(2) of the Government Organization Act, 1979 regarding the implementation of the federal policy on Environmental Assessment and Review. Section 6(1) provides for the Minister of the Environment to initiate, recommend and undertake programs to ensure that new federal projects, programs and activities are assessed early in the planning process for potential adverse effects on the quality of the natural environment and that a further review is carried out of those projects, programs and activities that are found to have probable significant adverse effects, and the results

thereof taken into account. Section 6(2) provides for the Minister of the Environment, with the approval of the Governor in Council, to establish guidelines for use by departments, boards and agencies of the Government of Canada and, where appropriate, by corporations listed in Schedule D (now Schedule C) to the Financial Administration Act and by regulatory bodies (Wallace, 1986). This Order defined the terms, outlined the scope and application of the process, and defined responsibilities for the Initiating department, the Proponent, and the Federal Environmental Assessment Review Office (FEARO). The Order also confirmed that self-assessment was the underlying concept behind the Process. It confirmed the evolving practice that environmental assessment should include not only the environmental effects, but also the social effects directly related to those environmental effects, as well as any effects that are external to Canadian territory. The Order also extended application of the process to all corporations listed in Schedule D (now Schedule C) to the Financial Administration Act and to any regulatory body, subject to certain qualifications concerning corporate policy, legal impediments and duplication. The Order left to the minister of the Initiating department the key decision-making responsibility for determining which proposals would be referred for public review, as well as deciding which Panel recommendations to accept. (The Rawson Academy of Aquatic Science, 1987).

The term "Initiating department" is defined as any department, board or agency of the Government of Canada or any corporation listed in Schedule D (now Schedule C) to the Financial Administration Act and any regulatory body that is, on behalf of the Government of Canada the decision-making authority for a proposal. The Initiating department is given the lead role in the entire Environmental Assessment and Review Process. EARP guidelines are to be followed whenever an Initiating department (Federal Environmental Assessment Review Office, 1988b):

1. intends to execute a proposal put forth directly by a government department.
2. has the authority to make decisions about a proposal of another department, board, agency or listed corporation that:

    i) might have an environmental effect on an area of federal responsibility,
    ii) would require financial support from the Government of Canada,
    iii) would be undertaken on lands administered by the federal government, including the Canada Lands and those offshore.

3. intends to execute a proposal which might have an environmental effect on other countries.

The Federal Environmental Assessment Review Office was created by Order in Council under the Government Organization Act, 1979, on June 22, 1984 to oversee the Federal Environmental Assessment and Review Process on behalf of the Minister of the Environment. Though it receives administrative support from the Department of the Environment, it maintains an independent relationship. This is necessary as the Minister of the Environment can be an Initiator or Proponent in a public review and is almost always an active participant (Federal Environmental Assessment Review Office, 1987a). The Federal Environmental Assessment Review Office is primarily active in the following matters (Federal Environment Assessment Review Office, 1987a):

- the office provides advice and procedural guidelines for the application of the process.
- the office provides the secretariat for public reviews carried out by Panels appointed by the Minister of the Environment.
- the office normally approves the chairperson for each Environmental Assessment Review Panel.
- when necessary, FEARO negotiates provincial, or territorial participation in a review, federal participation in a provincial review, or any other such cooperative arrangement.

- the office advises the Minister of the Environment on environmental impact assessment, and is the federal voice on environmental impact assessment in the initial stages of EARP.
- the office provides funding, secretariat, and technical support to the Canadian Environmental Assessment Research Council.

The Environmental Assessment and Review Process has three distinct phases:

1. the initial assessment phase in which the Initiating department undertakes the preliminary review of a proposal to determine the potential environmental impacts and related social impacts that could result from the implementation of a proposal.
2. the public review phase in which proposals with potentially significant environmental impacts are subjected to a public review by a Panel appointed by the Minister of the Environment.
3. the implementation phase in which the proposal is implemented, subject to such environmental constraints as may have been developed through the Environmental Assessment and Review Process

Each agency of the Government of Canada is responsible for ensuring that each proposal for which it is the decision-making authority is subjected to initial

assessment. Initial assessment determines whether, and to what extent, there may be any potentially adverse environmental effects anticipated from the implementation of the proposal.

The purpose of initial assessment is ultimately to determine whether the proposal should proceed directly to the implementation phase (no significant impacts, or adverse effects known to be mitigable) or to refer it to the Minister of the Environment for a public review (significant adverse effects or public concern). Only a small minority of proposals are referred for review (Federal Environmental Assessment Review Office, 1980).

During the initial assessment phase, the Initiating department is wholly responsible for:

- assuring that proposals under its jurisdiction are subjected to environmental screening or initial assessment.
- making the decision either to proceed with, or defer the project at this stage, or to refer it to the Minister of Environment for public review.

While the Initiating department may seek advice or take part in various inter-departmental referal procedures, no other government department or public interest group has any legal right of access to the initial assessment stage of EARP nor formal recourse to a higher authority in the event

of later disagreement over a screening decision (The Rawson Academy of Aquatic Science, 1987).

A number of key decisions are made at the initial assessment phase. Two of these are straightforward:

- automatic exclusion from study.
- automatic referal for public review.

Exclusions are those types of proposals that would not produce any adverse environmental effects and can go ahead without assessment. Automatic referals are those types of proposals that could produce significant adverse environmental effects and therefore, must be referred to the Minister of the Environment for public review by an independent Panel.

If a department neither automatically excludes a proposal from study nor automatically refers it for public review, the decision will be to:

1. proceed with the proposal,
2. abandon the proposal, or
3. refer it for public review

For those projects that are neither abandoned nor referred for public review, an important component of the initial assessment stage is the identification of appropriate mitigation measures and the incorporation of these measures into the project design.

After a decision has been made, there must be public access to information about the proposal, the decision and an opportunity to respond to this information before the proposal is carried out (Federal Environmental Assessment Review Office, 1987b).

Should a department determine that a public review is warranted, the Proponent's (the organization that desires to carry out the project) proposal is referred to the Minister of the Environment for review by an Environmental Assessment Review Panel consisting of a group of experts chaired by the executive chairperson of the Federal Environmental Assessment Review Office or its delegate. The first major task of the Panel is to prepare clear and explicit guidelines for the preparation of an environmental impact statement (EIS). The Proponent bears the responsibility of preparing the EIS. The EIS is a document which contains a comprehensive environmental analysis of the proposal including alternatives, descriptions of present resource use, social concerns, potential impacts, and indications of how any potentially adverse impacts will be mitigated or avoided altogether. The EIS also states where the proposed development will occur, how long it will last, how it can be carried out, and the preferred methods of implementation (Federal Environmental Assessment Review Office, 1987a). In effect the environmental impact statement should contain documentation of all the factors respecting environmental

and socio-economic impacts which must be considered and which will become the focus of the public review of the proposal. It is extremely important that the EIS be grounded on valid and accurate data and based upon clear, explicit guidelines or the entire Environment Assessment and Review Process will effectively be undermined (Canadian Environmental Advisory Council, 1981). Using the Guidelines provided, the Proponent prepares an EIS and submits it, through the Initiator, to the Panel. In its review of the EIS, the Panel consults with technical agencies of governments and the public, particularly local residents who may be affected by the project. Depending on the complexity of the EIS and the thoroughness with which it is completed, the Panel will either (Federal Environmental Assessment Review Office, 1980):

- ask technical agencies of governments for comments on the EIS and the proposed project, and then make the comments available to the public to assist the public in its own review, or
- ask both technical agencies and the public to carry out their review simultaneously and to provide written comments to the Panel.

On receipt of comments from technical agencies and the public, and after its own review, the Panel may issue a Statement of Deficiencies to the Proponent. This document is made public and specifies additional information that the

Panel considers necessary for a proper review. When the Proponent has responded to the Statement of Deficiencies, and after allowing time for the Panel and the public to study the response, public meetings may commence.

Public meetings provide a forum to the Proponent of the proposal to explain or respond to questions concerning the proposal, as well as allowing the public an opportunity to express any views about the proposal.

The meetings, while structured, are informal and co-operative in nature. This design provides an opportunity for a non-confrontational exchange of views which may lead to conclusions that make it possible to improve a proposal that is compatible with the environment or to reject a proposal that constitutes a threat to the quality of the environment.

After concluding a public review of the proposal, the Panel will produce a report that describes the proposal, the issues raised, outlines its conclusions and makes recommendations in accordance with its Terms of Reference. The Environmental Assessment Panel Report is then submitted to the Minister of the Environment and the Proponent and is normally released to the public shortly thereafter (Federal Environmental Assessment Review Office, 1988a).

Decisions on the Panel's recommendations are made by the Minister of the Environment and the Minister of the

Initiating or sponsoring department. If they agree to accept the recommendations, the appropriate department(s) or agencies are instructed to implement them. Their decision may also identify the federal departments or agencies responsible for any surveillance and monitoring needed, if this has not been detailed in the Panel Report. Should there be any disagreement between the two Ministers, the matter can be referred to the Federal Cabinet for resolution (Federal Environmental Assessment Review Office, 1980).

The third phase of the Process is that in which proposals subjected to EARP are implemented. During this phase FEARO has no continuing role and the Panel (if the proposal was subjected to a public review) will generally no longer exist. It is important though to note that EARP is not yet completed. For proposals which proceed to this phase, the government decision-makers will have selected conditions (such as the use of suitable mitigation measures) which must become a part of the approval. These decisions may have been taken during the initial assessment phase if no public review was undertaken; or the decisions may have been based on the recommendations of a Panel. The Initiating department is responsible for seeing that these conditions are incorporated into the design, construction and operation of the proposal and that suitable implementation, inspection and environmental monitoring programs are established. The Proponent is responsible for ensuring that appropriate

post-assessment monitoring, surveillance and reporting, as required by the Initiating department, are carried out (Federal Environmental Assessment Review Office, 1980).

2.4 SUMMARY

This chapter has set out the basic jurisdiction over natural resources and the framework of the Federal Environmental Assessment and Review Process, as it exists today. As stated previously, much has changed in the past two decades with respect to the theory and process of natural resource development. It is to be expected that with increasing awareness of environmental concerns, this natural process of change will continue and result in an increasingly more efficient and workable framework for resource development with sufficient flexibility to meet long-term decision-making requirements (Federal Environmental Assessment Review Office, 1988c). For example, the following proposals are under study at the present time and may impact on future development (Federal Environmental Assessment Review Office, 1988c):

- the definition of "environment" should be broadened in keeping with the present focus on sustainable development and the need to integrate biophysical and socio-economic concerns in planning and decision-making.

- the Environmental Assessment and Review Process should be based on legislation with clearly stated objectives.
- environmental assessment should be part of an integrated process of federal planning and decision-making.
- all Crown departments, agencies, and corporations should be subject to the Environmental Assessment and Review Process.
- the Environmental Assessment and Review Process should incorporate procedural checks and balances to ensure greater accountability, transparency, openness, and to minimize duplication and reduce inefficiency.
- effective funding programs should be implemented to guarantee public access to the process.
- a formal appeal process should be set in place.

The preceding recommendations are but a fraction of the proposals which are currently under study or are proposed for study. Commentary on each of these is beyond the scope of providing a context for understanding current jurisdiction over natural resources and the framework of the Federal Environmental Assessment and Review Process.

Chapter III

RISK ASSESSMENT IN THE FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS

3.1 PREAMBLE

This chapter is intended to provide background information on the discipline of environmental risk management. The sections will introduce risk analysis, the scope and process of environmental risk management, risk identification, risk estimation, risk evaluation and risk control.

3.2 INTRODUCTION

The process of environmental protection has become increasingly involved with the need to make policy and regulatory decisions in the face of uncertainty, risk, strong economic pressures, conflicting objectives and disparate social values. This is exemplified in the proposal by development Proponents to produce and transport hydrocarbon products from the Beaufort Sea/Mackenzie Delta Region to southern markets. The fundamental notion of risk management is that trade-offs have to be made between risks and benefits, between risks and costs and between one risk and another. In this regard, Whyte and Burton (1980) refer

to environmental risk management as the search for the "best route" between social benefit and environmental risk. In addition to the notion of trade-offs, environmental risk management is intended to enhance the quality of such decision-making through the use of analytical techniques which are procedurally rational and which integrate scientific information with considerations of economic and social values. It is assumed that "superior" choices are selected on the basis of deliberate searches for all relevant information relating to alternative courses of action. In addition, thoughtful and systematic consideration must be given to all available information, and trade-offs must be made explicit.

Risk management (analysis) is still in its infancy and as such is being pursued simultaneously and independently by several different disciplines. As a consequence, there is often a lack of agreement on terminology, definitions and methodology. What follows is the author's interpretation of an appropriate consensual view, and application, of risk management to the issues at hand.

3.3 THE CONCEPT OF RISK

In the context of risk management, the term risk can be defined as the potential for realization of unwanted negative consequences of an event (Rowe, 1977). Rowe (1977) notes that this definition points out the two-dimensional nature of risk, that is, that a hazardous outcome is associated with a situation, action or system and that there exists uncertainty as to the nature, magnitude and likelihood of the hazard's occurrence. Whyte and Burton (1980) state that since rational decision-making requires quantitative measures of risk (so that they may be assessed or compared), the uncertainty aspects of risk are most often expressed in terms of a probability. Krewski et al. (1982) suggest that the simplest and perhaps the core model for quantitative risk be can expressed as:

$$\text{Risk} = \text{Hazard} \times \text{Probability}$$

where the hazards are defined in consistent units relevant to the issue, such as deaths/million/year. This equation is perhaps an over-simplification for the purposes of demonstration. It does not explicitly take into account either the extent of the hazard, or how public perceptions or disparate social values might affect the magnitude of the possible consequences. Krewski et al. (1982) note that a more realistic relationship would follow the general form:

$$\text{Risk} = (\text{Hazard}, \text{Exposure}, \text{Probability}, \text{Significance})$$

with each term adequately quantified.

3.4 UNCERTAINTY AND PROBABILITY

Whyte and Burton (1980) state that uncertainties will play an increasingly important role in environmental decision-making. Therefore it is critical that the concept of uncertainties regarding the components of a system under consideration be thoroughly understood. The fundamental concept of uncertainty as used by Whyte and Burton (1980), is the absence of knowledge. Thus the term "degree of uncertainty" addresses that proportion of the information about a system, that is unknown. This absence of information may be about past, present or future events, values or conditions. Rowe (1977) notes that most commonly, one is dealing with the "what if?" approach during the assessment of risk. Therefore, interest is in those uncertainties which affect our ability to simulate the outcome of particular actions, the so called predictive uncertainties (Rowe, 1977).

Rowe (1977) states that predictive uncertainties can be classified into four types: stochastic uncertainty, scientific uncertainty, external uncertainty and analytical uncertainty. Stochastic uncertainty is related to the prediction of events which by their nature or random behavior are uncertain. Scientific uncertainty stems from a lack of knowledge, information, or scientific agreement regarding cause-effect relationships. Rowe (1977) notes that scientific uncertainty itself has two components,

descriptive uncertainty and measurement uncertainty. Descriptive uncertainty refers to uncertainty of knowledge regarding what parameters and interrelationships define the system, while measurement uncertainty is concerned with the assignment of quantitative values to the system parameters (Rowe, 1977). External uncertainty relates to the knowledge of other decisions which may have relevance to the problem at hand, but which are outside the control of the decision-making group. Rowe (1977) describes analytical uncertainty as stemming from the inability of predictive tools (e.g. models) to faithfully represent reality.

Risk assessment attempts to quantify predictive uncertainties through probabilistic estimates of likelihood. Rowe (1977) notes that in some instances, most notably in the field of stochastic uncertainty, probabilities may be derived from historical information using conventional statistical techniques. In many cases, however, data bases are inadequate to enable such calculations to be performed. New technologies or rare events commonly lack substantive historical data bases which can be used to estimate the probability of occurrence values. Thus, the estimation of the likelihood of occurrence for such systems must turn to other means. Spetzler and Stael Von Holstein (1975) suggest the use of judgemental probabilities in such cases. Judgemental probabilities are arrived at by the use of probability theory to summarize the judgement of experts on

the occurrence of an event, or the accuracy of a scientific hypothesis. Despite the inherent uncertainties, risk analyses encompassing rare events can provide useful information for decision-makers who are faced with decisions that must be made before, rather than after the fact.

3.5 THE SCOPE AND PROCESS OF ENVIRONMENTAL RISK MANAGEMENT

Coping with environmental risk has been an intrinsic aspect of life for all societies throughout history. Since the natural environment is not totally benign, and man's understanding of its working mechanisms is far from complete, the process of procuring a living necessarily involves risks or adverse environmental consequences. Thus in the search for the environmental goods regarded as necessary to improve social well-being (e.g. food, energy, raw materials), there will be associated environmental costs, some of which will be observable, some calculable, and some unknown. Kates (1977; 1978) and Burton et al. (1978) note that all societies, regardless of their state of scientific knowledge or technological development are faced with environmental costs which must be paid in return for environmental goods. All social groups have evolved coping mechanisms in order to live with environmental risk (Kates, 1977). Figure 2 describes this relationship in simple, diagrammatic terms. Figure 2 also shows that environmental risks are the unintended, but inevitable by-products of

resource exploitation, which itself is the outcome of striving for a better life. Figure 2 also implies that the terms environmental impact and environmental risk are broadly similar. Whyte and Burton (1980) and the Council for Science and Society (1977) note that, conventionally speaking, impact is the outcome and risk is the probability of occurrence. The collective phrase, environmental risk is often used to express both an adverse event and its likelihood of occurrence. The term environmental impact assessment (EIA) is now being incorporated in the more inclusive concept of environmental risk management. The more specific term risk assessment, or the calculation of the probabilities of hazardous consequences of certain courses of action, is also encompassed within the risk management concept (Whyte and Burton, 1980). Whyte and Burton (1980) point out that the advantage of this fusion of terms lies in the linkage between analysis and control, for the notion of risk management includes the institutions and regulations designed to cope with risk, as well as the techniques for calculating it. Environmental impact assessments are regarded principally as analytical accounting devices, while risk assessments are viewed more as modelling and balancing mechanisms. Figure 2 also indicates that environmental risk management encompasses the links between social and technological processes (abilities), the application of these processes (activities), and the effect on social well-being in terms of net gains (sometimes referred to as risk-benefit analysis).

The task of environmental risk management identified in Figure 2 is described in more detail in Figure 3. Environmental risk management is the search for the safest route between social benefit and social loss, and is often regarded as a balancing process in which different combinations of risks are compared with various beneficial outcomes (Turner, 1985; Kates, 1978; Whyte and Burton, 1980). In general terms, environmental risk management consists of four components which, in any given instance, do not necessarily follow each other in a logical sequence. These are: risk identification, risk estimation, risk evaluation and risk control.

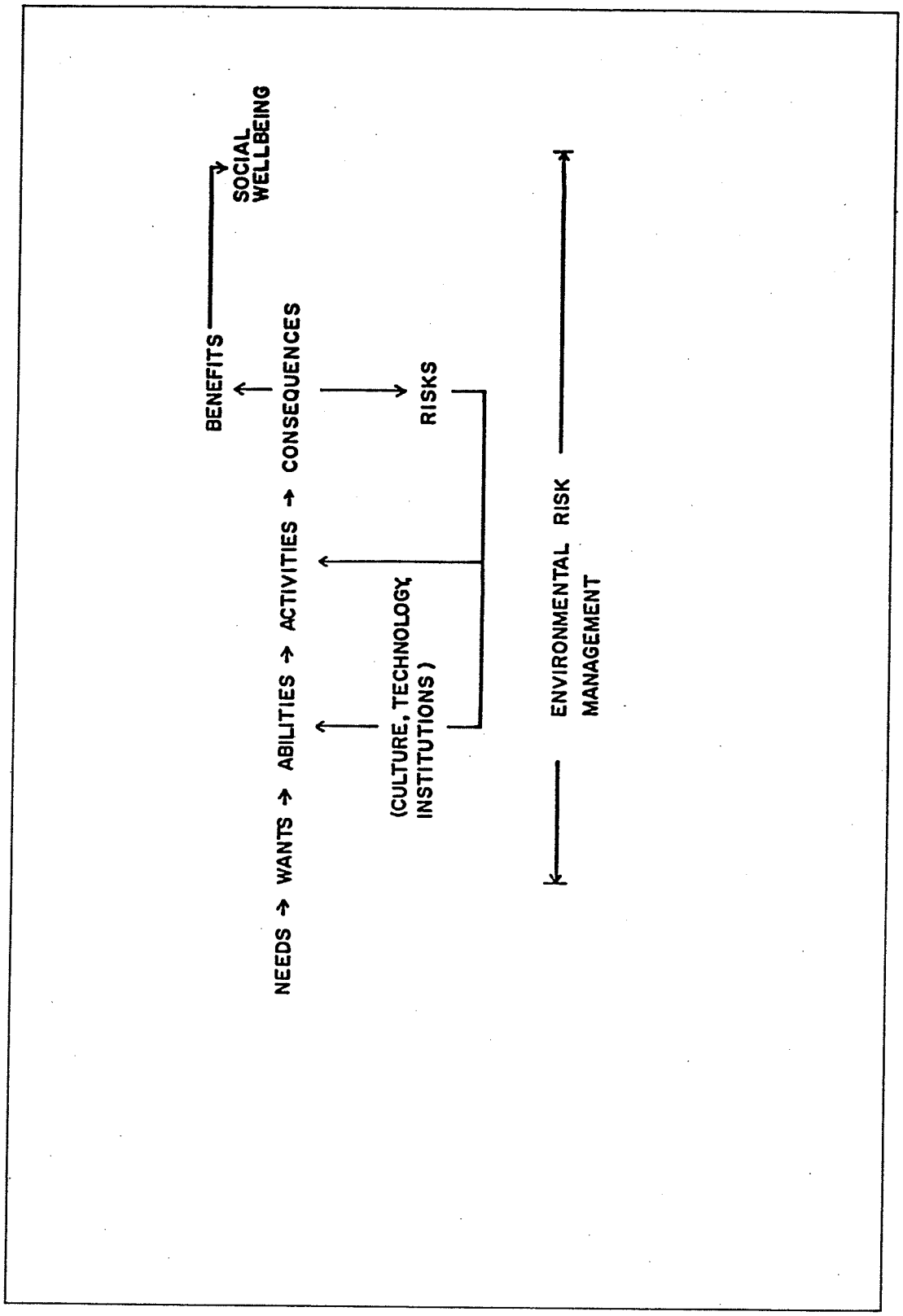

Figure 2: Environmental risk in the context of social gain (From O'Riordan, 1979).

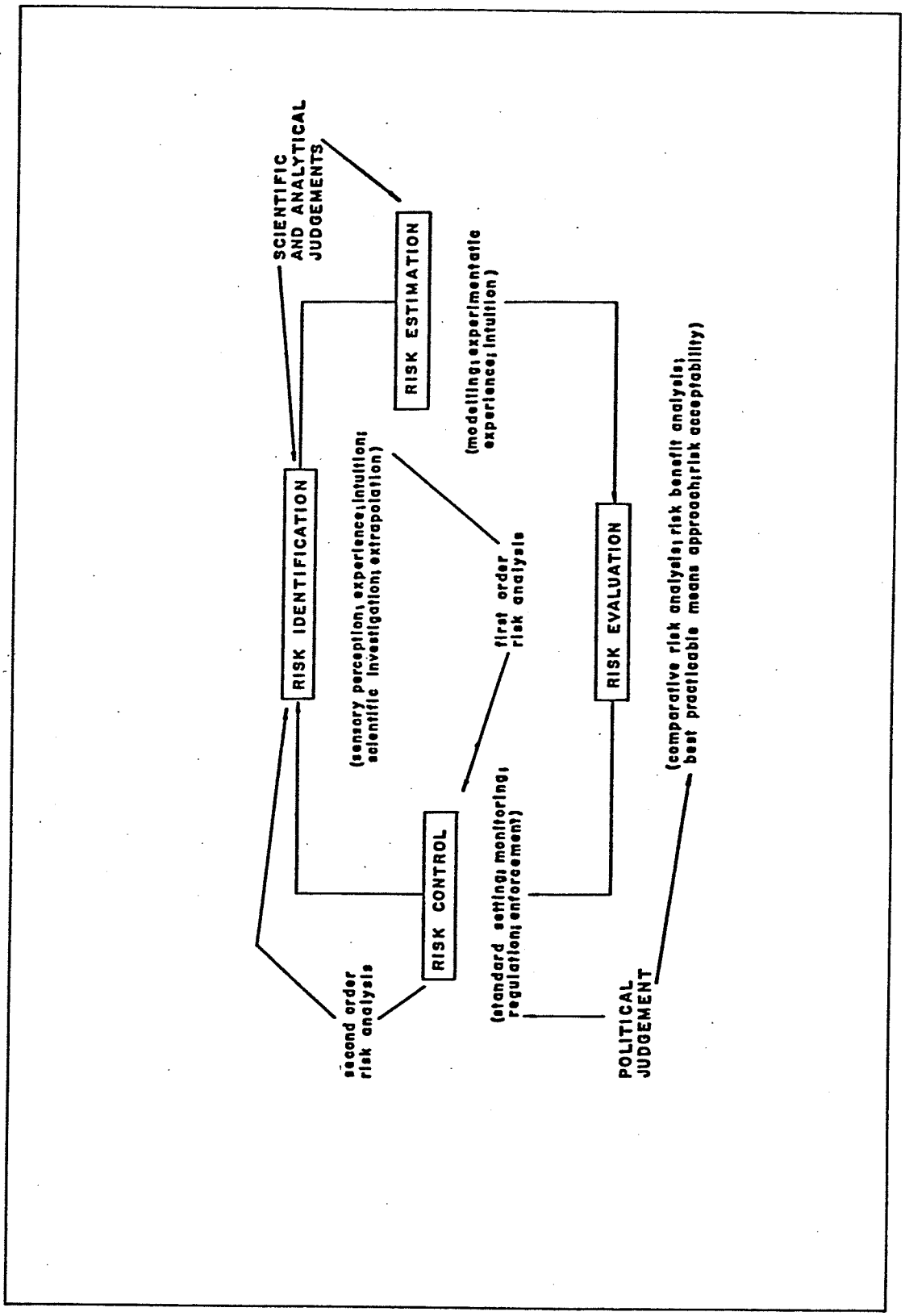

Figure 3: Environmental risk management functions (After O'Riordan, 1979).

3.6 RISK IDENTIFICATION

Risk identification is the activity of recognizing that a specific hazard with definable characteristics exists. Some risks can be reasonably well anticipated, based on experience. In such cases, proceeding to the analysis stage may be straightforward. Other risks, as characterized by the introduction of a new technology, product, chemical or the combination of such variables in a heretofore untested geographical area, for which no long-term record of environment-related data is available, may be initially identified as risks through a formalized process of testing and screening against specific criteria (O'Riordan, 1979).

A brief mention should be made of "scoping" in risk identification. Since risk assessment is an expensive and time consuming process, it is considered important to delineate the important aspects of the analysis, specifying appropriate boundaries to be considered. It is unlikely, however, that even in the most sophisticated studies, all the relevant risks will be identified. O'Riordan (1979) notes that an extremely important feature of the risk identification phase is the search for second order risks, namely the risks associated with the technologies and techniques developed to reduce the first order perceived risks. The fact that risk chains need to be considered, links the four components of risk management in a cyclical manner as portrayed in Figure 3.

3.7 RISK ESTIMATION AND ANALYSIS

Risk estimation involves the modelling of risk causes and pathways, the prediction of likely consequences, and their distribution in space and time. The analysis component is the discipline of the natural scientist. O'Riordan (1979) suggests that as a first step, a concept must be developed for the total environmental system in question, including its components and interrelationships. Scientific information is then used to quantify the concept. O'Riordan (1979) points out that quantification of the concept of the environment is usually achieved via a model, covering the significant aspects of the relevant cause-effect relationships, including those of source, receptor, exposure susceptibility and dose response. Through the application of this model to assumed initial boundary conditions, the risk of alternative actions, or of test scenarios, may be estimated (O'Riordan, 1979). O'Riordan (1979) and Whyte and Burton (1980) note that the validity of this process is dependent upon adequate peer reviews and model validation.

Some components of cause-effect may be understood well enough to be considered deterministic (rendering their modelling straight forward); however, in many cases one is confronted with uncertainties in parameter values, in occurrence of events, or in the presence or absence of specific features (O'Riordan, 1979). Such uncertainties would be incorporated into risk analysis by assigning

probability distributions to them, where these distributions would represent the judgement of individuals knowledgeable regarding the problem. It should be noted that the choice of probability distributions can also introduce error into the analysis. Kahneman et al. (1982) note that there is a growing literature on how one may obtain, and use, judgemental or subjective probability information.

Rowe (1979) identifies the process of risk estimation as being composed of five steps: identification of the cause of the risk; measurement of its effects; determination of risk exposure; definition of the consequences of exposure to the risk and the value of the consequences of exposure to the risk. These five steps are illustrated in Figure 4.

The first step in Rowe's (1979) model is the identification of causative events, or events which create a probability of risk occurrence. Each causative event may lead to several possible outcomes. In the second step, the outcomes of causative events are defined, and their relative probabilities determined. Rowe (1979) notes that the causative event and outcome do not of themselves constitute risk, until the exposure of humans, institutions, and the natural environment is considered. The probabilistic relationships between events and their outcomes can be measured through empirical experiments, statistical design of experiments, and hypothesis testing. Rowe (1979) points out that if such experiments require exposure of humans or

of the environment to risk, then the risk of conducting the experiments must also be evaluated. The third step in risk estimation, as outlined by Rowe (1979), is to define exposure pathways, the means by which risks are transmitted. The probability of various exposure pathways and of resultant exposures are also determined in the third step of risk estimation. Rowe (1979) states that the fourth step in risk estimation is the definition of the possible consequences of risk exposure and the determination for each risk, the probability that such consequences will occur. The fifth and final step in risk estimation (as proposed by Rowe (1979)), is the consideration of the value placed by the affected individuals on the consequences of risk exposure.

The probability of risk occurrence, and the value placed on risk consequences by affected individuals, will determine government and public response to attendant risks. Thus, the process of risk estimation requires two basic determinations: a consequence probability determination and consequence value determination.

Rowe (1979) notes that estimated risk cannot be fully equated with actual risk because probability and consequences may be inexact. The probability that a consequence will occur may be determined by direct observation of repeated trials of a causative event. Rowe (1979) points out that when the number of trials is large,

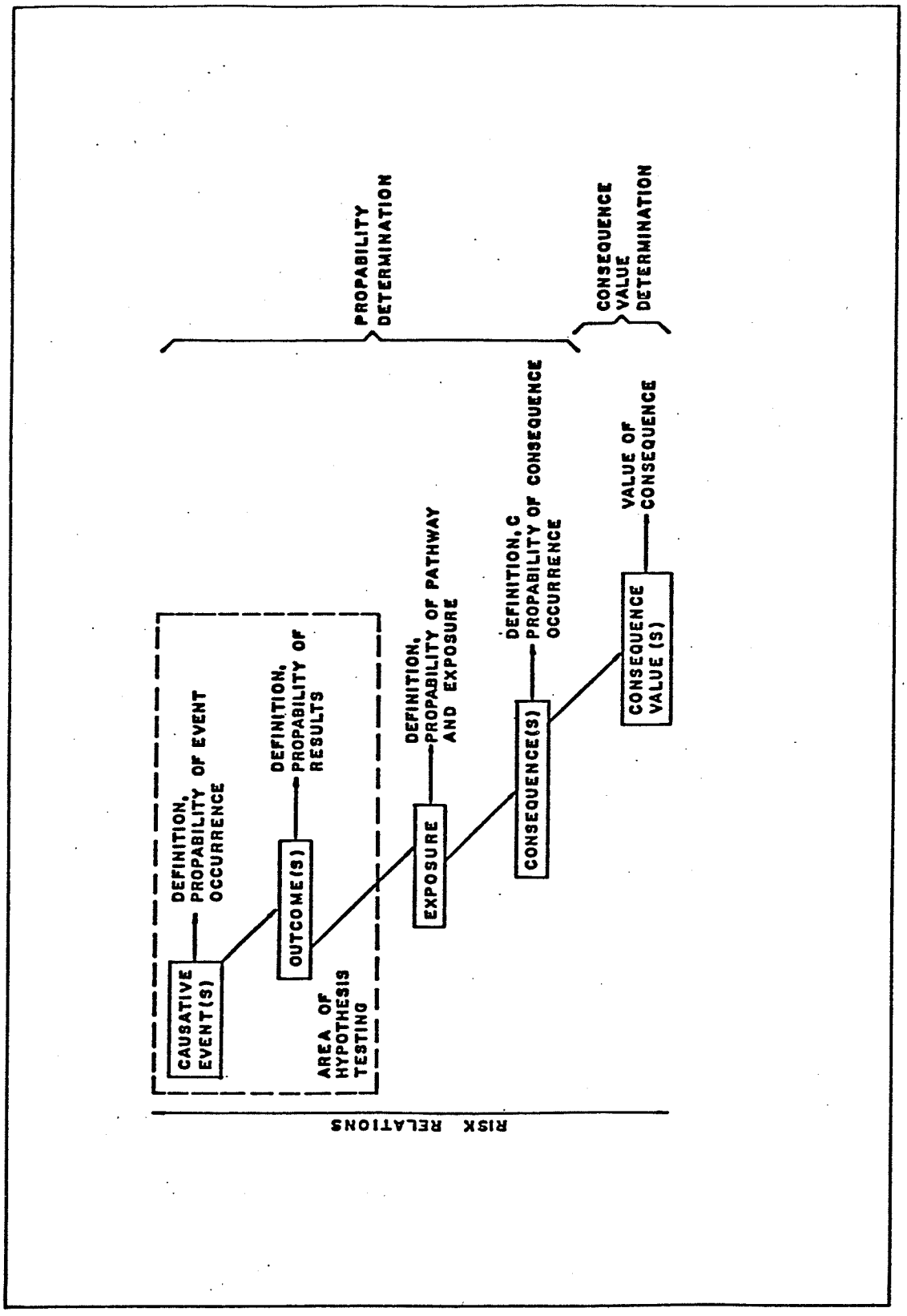

Figure 4: The process of risk estimation (After Rowe, 1979).

the estimate of probability is appropriately termed objective, because it represents an empirical estimation. Alternately, if probability estimates are made on the basis of one or a few trials (or by conjecture), then the resulting probability estimate is subjective. Rowe's (1979) definitions of subjective and objective probability compare with classical definitions recorded by Collocott and Dobson (1974). Collocott and Dobson (1974) define subjective probability as a figure (between zero and one) assigned to an event based on personal views as to whether or not the event will occur. Rowe (1979) points out that between these extremes lies another estimate, synthesized probability. Rowe (1979) defines synthesized probability as that for which the probability of a consequence is not measured directly; rather, it is extrapolated from the objective probabilities of causative systems that are expected to behave similarly.

Rowe (1979) states that a range of certainties also exists in calculating consequence values. Objective estimates of consequence values consist of consequences that are directly observable and measureable, thus enabling the consequence value to be explicitly expressed. Subjective consequence values, on the other hand, are encountered when the consequence value of a particular risk agent depends entirely upon the personal value system and the situation of those affected by the risks. Rowe (1979) notes that between

these two extremes lie value estimates, or observable consequence values. Rowe (1979) describes value estimates as those in which the behavioral responses of groups in society to objective or subjective risk consequences are ascertained and measured by the study of actual behaviors.

The relationships between the nature of probability and the nature of consequence, both of which range from objective to subjective, are illustrated in Figure 5. Probability is diagrammed vertically, and consequence horizontally. Figure 5 illustrates how various combinations of probability and consequence define risk. Thus, the combinations of probability and objective consequence define objective risk. Rowe (1979) notes that most scientific studies of risk have concentrated on objective risks, because such risks are the simplest to define and measure. Rowe (1979) states that synthesized probability and observable risk define an area termed modelled risk. Such risks are neither directly observable nor objective. Thus, the usefulness of computing modelled risk is dependent upon the degree to which the model corresponds to reality. Figure 5 indicates that all other risks are subjective because they are computed on the basis of subjective estimates, subjective valuations, or both. Rowe (1979) sets forth that the science of risk estimation has traditionally used scientific experiments and empirical measurements to compute objective risk. Recently, the concept of

synthesized probability has been developed and utilized extensively (Winkler, 1982).

Rowe (1977) notes that there are sophisticated methods, such as Markov Chain analyses for integrating probabilistic variations into risk modelling. He points out that while such sophisticated modelling tools exist, often, simpler events (fault) tree analyses are used in risk assessment. In event tree analysis, a specified decision, or event is considered to branch out into a finite number of possible outcomes, each with its own probability of occurrence as determined from the subjectively determined probability distributions (Slovic et al., 1980). The likelihood of each hazard is then given by the product of the probabilities along its particular branch.

To summarize: risk estimation is the scientific determination of the characteristics of risks, in as quantitative a fashion as possible. Quantitative risk estimation techniques may include the estimation of the magnitude, spatial scale, duration and intensity of adverse consequences, and their associated probabilities, as well as a description of the cause and effect links of the risks in question. The ultimate goal of risk identification and estimation is to understand the environmental system and its complex pathways and processes through which risks occur.

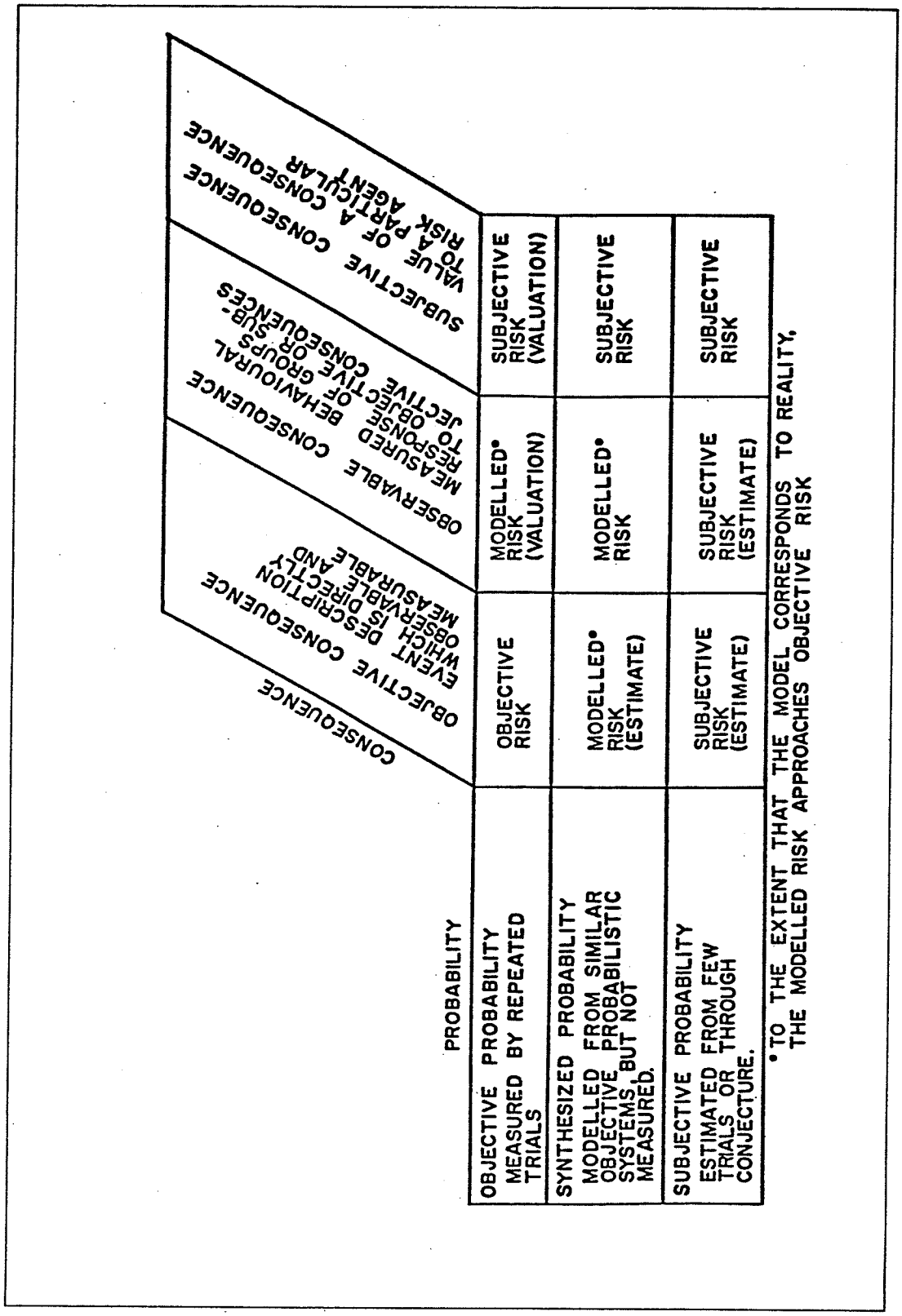

Figure 5: The subjective and objective nature of risk management (From Rowe, 1979).

3.8 RISK EVALUATION

Risk evaluation is the central task of risk management for it involves not only the social judgement of risks as identified and estimated, but the balancing of such risks against perceived and/or estimated, social gains (O'Riordan, 1979). The weighting of alternatives is the heart of the risk evaluation process. One cannot evaluate risk without considering human responses. Man is by nature risk aversive, tending to avoid acts or situations whose consequences may threaten, among other things his health and safety. The risk aversive nature of society, together with an increasing awareness of new risks created by novel technology and development endeavors, have focused attention on technological risk. The growth of public awareness and concern for risk is probably irreversible because the knowledge required for technology assessment and risk identification is now available to all levels of society. Consideration of societal risk is becoming an accepted part of technological decisions. Consequently increased regulatory attention is now focused on risk assessment. Rowe (1979) suggests that a methodological approach which assures a reasonable perspective in evaluating risk is necessary if a government's regulatory apparatus is to operate responsibly and visibly.

Turner (1985) states that a figure representing a quantified risk lacks meaning unless it is compared to a

risk measurement scale. Turner (1985) suggests that such comparisons for the treatment and assessment of environmental hazards may be of four kinds. In the case of elevated risk, the risk value is judged against those which occur naturally in the environment, or those that have been environmentally tolerated for an extended period of time without ill effects. Balanced risk signifies that the risks are compared with those associated with alternative ways to achieve the same objective, or alternately, that the risks associated with an action are balanced against the risks of not taking such action. Comparative risk on the other hand, refers to comparisons with other risks which are not true alternatives, but lend a sense of relative significance. The fourth and most commonly used approach is risk benefit, the comparison of risk with the gain to be made. There are several analytical techniques (such as multi-attribute utility analysis) which have been developed to assist in risk benefit comparisons. Slovic et al. (1981) note that despite the problems inherent in attempting risk benefit comparisons (e.g. difficulty in balancing the units and comprehensiveness of both sides of the comparison, variations in time scales of risk and benefit, social separation of those who are at risk from those who are to benefit, etc.), the process is considered to provide valuable input to decision-making as it provides a summary overview of the issues.

Risk evaluation is central to policy determination; it provides policy-makers with a systematic analysis of the issues and their uncertainties in as quantitative a fashion as possible. Decision-makers must weigh risk evaluation information along with available knowledge respecting economic, social and political factors to reach solutions, and to orchestrate actions.

3.9 RISK CONTROL

Risk control is the implemention phase of risk management, the stage where executive action in the form of regulation, monitoring, enforcement and re-evaluation take place. Ideally, these tasks are undertaken following an extended process of research, consultation and judgement.

In Canada, the Federal Environmental Assessment and Review Process (instituted by Cabinet memorandum in 1973 and subsequently amended) provides for a survey of proposed activities which may impact on the environment. Thus the Federal Environmental Assessment and Review Process serves the function of a federal environmental risk control tool in Canada.

Clearly, oil and gas exploration and development operations, onshore and offshore, and transportation of petroleum products by land or by sea, or by tanker or pipeline fall within the category of proposed development

activities which may impact on the environment. Offshore hydrocarbon development in the Beaufort Sea/ Mackenzie Delta Region was referred to the Federal Environmental Assessment and Review Process (EARP) in 1980 with the establishment of the Beaufort Sea Environmental Assessment Review Panel (BEARP) (Federal Environmental Assessment Review Office, 1984). The purpose of the review was to facilitate a formal public assessment of the possible environmental and socio-economic impacts of the proposed Beaufort Sea/Mackenzie Delta Region oil and gas developments.

3.10 SUMMARY

Individual and societal response to hazards is multi-determined. Political, social, economic and psychological factors all interact with technical feasibility in complex and poorly understood ways. The discipline of environmental risk management through its various processess (risk identification, risk estimation, risk evaluation and risk control) attempts to arrive at a consensus on the best route between social benefit and environmental risk. Environmental risk management is intended to enhance the quality of environmental decision-making through the use of analytical techniques which integrate scientific information with considerations of economic and social values.

Chapter IV

PERCEPTION OF RISK

4.1 PREAMBLE

The ability to sense and avoid harmful environmental conditions is necessary for the survival of all living organisms. Survival is also aided by an ability to codify and learn from past experience. Humans have an additional capability which allows them to alter the environment as well as respond to it. This capacity both creates and reduces risk.

In recent decades, the widespread development of new industrial processes and technologies has been accompanied by the potential to cause catastrophic and long-lasting damage to the earth and its life forms. The mechanisms underlying the complex technologies are unfamiliar and incomprehensible to most citizens. Their most harmful consequences are rare and often delayed, and are hence difficult to assess by statistical analysis, and not well suited to management by trial and error. The elusive and difficult to manage qualities of today's hazards have forced the creation of the discipline termed risk assessment. Risk assessment is intended to aid in the identification, characterization and quantification of risk.

Whereas technologically sophisticated analysts employ risk assessment to evaluate hazards, the majority of citizens rely on intuitive risk judgements, typically referred to as risk perceptions. For these people, experience with hazards tends to come from the news media, which rather thoroughly publicize mishaps and threats occurring worldwide. The dominant perception of most Americans (and one which contrasts sharply with the views of professional risk assessors), is that they face more risk today than in the past, and that future risks will be even greater than today's (Slovic, 1987). Slovic (1987) notes that similar views appear to be held by citizens of many other industrialized nations. Perceptions of enhanced risk, as a consequence of the Proponent's development proposal for the Beaufort Sea/Mackenzie Delta Region were widely held by northern Canadians. These fears, along with many other concerns were repeatedly voiced by representatives of the various stake-holders in the Beaufort Sea Environmental Impact Assessment and Review Process. Slovic (1987) asserts that these perceptions, and the opposition to technology that accompanies them, have puzzled and frustrated industrialists and regulators, and have led numerous observers to argue that the American public's apparent pursuit of a "zero-risk society" threatens the nation's political and economic stability.

During the past decade, a small number of researchers have attempted to examine the opinions of people when asked, in a variety of ways, to evaluate hazardous activities, substances, and technologies. This research has attempted to develop techniques for assessing the complex and subtle opinions which people have about risk. With these techniques, researchers have sought to discover what people mean when they say that something is (or is not) "risky", and to determine what factors underlie those perceptions. The basic assumption underlying these efforts is that those who promote and regulate health and safety require an understanding of the ways in which people think about and respond to risk. If successful, this research should aid policy-makers by improving communications with the public, by directing educational efforts, and by predicting public responses to new technologies, events, and new risk management strategies.

4.2 RISK PERCEPTION RESEARCH

Explicit risk assessments are a fairly new addition to the repertoire of intellectual enterprises. As a result, the risk experts are only beginning to reach a consensus on terminology and methodology. Their communications to the public are only beginning to express a coherent perspective, to help the public understand the variety of meanings that risk can have (Crouch and Wilson, 1981). Experimental

studies (Slovic, 1979; 1980) have indicated that when expert risk assessors are asked to assess the risk of a technology on an undefined scale, they tend to respond with numbers which approximate the numbers of recorded or estimated fatalities in a typical year. When asked to estimate "average year fatalities", laymen produce fairly similar numbers (Fischhoff et al., 1983). When asked to assess "risk", however, laymen produce quite different responses. Fischhoff et al. (1983) note that these estimates seem to be an amalgam of their average year fatality judgements, along with their appraisal of other features, such as a technology's catastrophic potential or the equity with which the risks are distributed.

Important contributions to the current understanding of risk perception have been made by the fields of geography, sociology, political science, anthropology, and psychology. Geographical research originally focused on understanding human behavior in the face of natural hazards, but it has since been broadened to include technological hazards. (Burton et al., 1978). Sociological (Short, 1984) and anthropological studies (Douglas and Wildavsky, 1982) have shown that the perception and acceptance of risk has its roots in social and cultural factors. Short (1984) argues that responses to hazards are mediated by social influences transmitted by friends, family, fellow workers, and respected public officials. Douglas and Wildavsky (1982)

assert that people acting within social groups minimize certain risks and emphasize others, as a means of maintaining and controlling the group. Psychological research on risk perception originated in empirical studies of probability assessment, utility assessment and decision-making processes (Edwards, 1961). A major development in this area has been the discovery of a set of mental strategies, or heuristics, which people employ in order to make sense out of an uncertain world (Kahneman et al., 1982). Although these perceptions may be valid in specific circumstances, they often lead to widely held and persistent biases, with serious implications for risk assessment. In particular, laboratory research on basic perceptions and cognitions has shown that difficulties in understanding probabilistic processes, biased media coverage, misleading personal experiences and the anxieties generated by life's gambles cause uncertainty to be denied, risks to be misjudged (sometimes overestimated and sometimes underestimated) and judgements of fact to be held with unwarranted confidence (Slovic, 1987). Kahneman et al. (1982) note that experts' judgements appear to be prone to many of the same biases as those of the general public, particularly when experts venture beyond the limits of their experiences and of available data and resort to intuition.

Many debates focus on whether the risks associated with a particular configuration of a technology are acceptable.

Slovic et al. (1980) have found substantial disagreements, not only among people belonging to different population groups, but also within groups when questions concerning particular technologies are posed in different ways. Fischhoff et al. (1983) note that although such disagreements are often interpreted as reflecting conflicting social values, or varying individual values, closer examination may suggest that the question of what level of risk is acceptable may not be being addressed adequately.

Fischhoff et al. (1983) state that one does not accept risks. Rather they assert that one (or society as a whole) may accept options which entail adverse risk consequences. Whenever the decision-making process has considered benefits or other (non-risk) costs, the most acceptable option need not be the one with the least risk. Indeed, Fischhoff et al. (1983) note that one might choose (or accept) the option with the highest risk if it has sufficient potential for compensating benefits. Fischhoff et al. (1980) assert that the attractiveness of an option depends on its full set of relevant positive and negative consequences.

People who agree about the facts regarding a technology, and share common values may nevertheless disagree about the acceptability of associated risks because they have different notions about which of those values are relevant to a particular decision problem. Thus, when laymen and

experts disagree about the acceptability of a risk, one must always consider the possibility that they are addressing different problems, with different sets of alternatives, values or a different set of relevant consequences. Stallen (1980) asserts that assuming that both laymen and experts have a full understanding of the implications of favoured problem definitions, the choice among definitions often becomes a political question.

4.3 RISK PERCEPTION VERSUS RISK ANALYSIS

Risk analysis is a formal method for determining the degree of risk. It is concerned with the probability of an event occurring, and with its impacts or consequences. This requires a modelling of the "risk system" from the initiating event (or cause) through to the final outcome or consequence. Risk analysis, so conceived, is intended to be a rational, objective, scientific approach which consciously seeks to exclude emotional biases and value judgements. To critics who assert that risk analysts, being human, are unable to exclude emotions completely and that the mode of analysis itself inevitably expresses a value judgement, the analysis can be defended on the grounds that both emotional biases and value judgements can be observed in the analysis. Formal analysis in which all assumptions are clearly specified provides a manner of showing precisely where and how non-rational considerations intrude. A key argument is

that whatever the shortcoming of the practice, it is the analyst's intention to be objective, and that the degree of objectivity can be enhanced by normal procedures of scientific validation.

The modelling of risk systems always requires explicit assumptions to be made. These always involve a simplification of reality for reasons of data availability, lack of knowledge or ease of calculation. Simplifying assumptions have to be made both in the area of rational or technological processes and in human behavioral variables.

Risk analysis is therefore a technically specialized function which is carried out by trained experts for others. The risk analysts calculate the risks to which others are exposed. The analysts may or may not be exposed to the risk. In any case, the analysts endeavor to exclude personal feelings from the analysis and to think in terms of "target populations" or "those at risk" as being other human beings. The experience suggests that this is successfully achieved in most circumstances. This is the main strength of risk analysis. It is also a weakness, in that risk analysis does not necessarily reflect the emotions or values or preferences of those at risk. Some persons may reject objective findings of a risk analysis on the grounds that it does not reflect their own preferences. The risk analysts can then reply that this is not relevant. On the other hand, the risk analysts may recommend a preferred choice,

which may then be rejected by the public or by decision-makers for reasons which the analysts consider completely irrational, or based on prejudice. Risk analysts who achieve a high degree of objectivity in their work may, however, find it difficult to project that detachment to the public.

Risk analysis is not limited to the estimation of the probability of an event or sequence of events. It can, and usually does extend to the estimation of consequences. However, risk analysis in the strictest sense stops at the boundary where risk acceptability comes into question. A good analyst attempts to describe the risk as precisely as possible. This description can include the levels of comparison of one risk to others, or to benefits or to prior conditions.

Probability and consequences are thus at the heart of the risk analysis process. Total risk may be expressed as:

Risk = Probability (E) X Consequences

When this information is set in a context of comparative risk, costs and benefits, the choices to be made about acceptable levels of risk may seem obvious. Risk perception, however, is not as clearly definable. Perception of risks by an individual, or by a society is quite a different matter from risk analysis. Risk may involve personal threat to life, livelihood or emotional

equilibrium. For any given threat each individual chooses the direction of her/his response. The direction and strength of this response depends on many factors. These can be considered as three sets: factors pertaining to the individual, to the group, and to society. Individual factors include such variables as the size, social, or economic function of the group. The social context refers to broader social and economic dimensions and to the class or group of people at risk, the relationship of risk to economic benefits (such as employment) and the presence or absence of social conflict.

To those studying risk perception there are no correct answers. All perceptions are valid expressions of subjective evaluations of risk. The risk analyst may protest that such perceptions are not valid, and that they result from the distorting influence of emotional and other considerations. This, however, is not how they appear to persons at risk, or to laymen as perceivers of risk. The laymen may well include information and assessments provided by risk analysts in their own perceptions. Laymen typically weigh what the experts say, and add their own ideas based upon the individual, group and social context variables previously discussed.

This does not render the laymen's view invalid or a misconception. It simply recognizes that the mix of variables in the social assessment of risk includes the

intentionally objective analysis of the experts, and the intentionally subjective appraisal of the lay population. The laymen's appraisal is important because it expresses the feelings and values of society (or a segment of society). Feelings and values are an integral part of the manner in which humans relate to one another, and it is reasonable that they should be recognized.

Given the different bases and purposes of risk analysis and risk perceptions, it is not surprising that they are often widely divergent or seem to be fundamentally opposed. Much needless frustration occurs in present-day society because risk analysts tend to expect their conclusions to be accepted, and because laymen reject risk analyses as neglectful of their real fears and concerns. While risk analysis and risk perception are different concepts, societal decisions involving risk are influenced by both.

This conclusion does not mean, however, that risk analysis and risk perception cannot both be improved. While improvements are possible, and some convergence between risk analysis and risk perception may be achieved, differences will remain. For the lay risk-perceiver, the magnitude of the consequences of risks remain larger than the estimates of risk probabilities, while risk analysts tends to avoid preoccupation with the worst case scenario.

4.4 EMPIRICAL INVESTIGATIONS

To date there have been few empirical investigations of the factors affecting risk perception. Clearly, more controlled studies are required. The lack of available data from controlled studies in Canada has meant that it has been necessary in the past to resort to data of a more general nature, as available from public opinion and attitudinal surveys conducted nationally and regionally in Canada over the last ten years. This source of information is supplemented by detailed studies of risk perception for particular locations or groups of people.

4.5 SUMMARY

The presentation to the public of information which is relevant to risk analysis (assessment) is a great impediment to the application of risk analysis to EIA. Grima et al. (1986) note that the uncertain and probabilistic nature of much of the information provided by risk analyses (assessments), as well as the mathematical language used in risk calculations, can render risk analyses (assessments) threatening rather than enlightening to the layman. The perception of the utility of risk analysis in the Federal Environmental Assessment and Review Process can be expected to be enhanced if the findings of risk studies are communicated to laymen in clear, unambiguous and comprehensible terms.

Grima et al. (1986) state that further research into the "perception of risk" should take into account the interweaving of the political and psychological elements of the Federal Environmental Assessment and Review Process, if risk analyses (assessments) are to become worthwhile additions to the EIA process. If risk analyses (assessments) are to become a cornerstone of the Federal Environmental Assessment and Review Process, it is vital that the public have a better understanding of the processes, the methods, the assumptions and the sources of information used in risk analyses. Until this is achieved, there can be no expectation that the public will accept recommendations and conclusions based on risk analyses. The acceptability of the EIA Process itself is an integral part of the acceptability of the results of the process. Grima et al. (1986) note that the process of EIA is one of the best ways of ensuring that risks and benefits are acknowledged. Grima et al. (1986) also assert that the use of risk analysis (assessment) techniques and concepts assist in this by ensuring that uncertainties about future consequences are not ignored, but are specifically considered, clarified and communicated to the stake-holders.

Chapter V

THE BEAUFORT SEA ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS: A CASE STUDY

5.1 PREAMBLE

This chapter will review the Beaufort Sea Environmental Assessment and Review Process, the development Proponents' environmental impact statement, related data-bases and oil spill risk assessment. As well, a critique and commentary respecting risk analysis in the Beaufort Sea/Mackenzie Delta Region hydrocarbon resource development environmental impact statement will be presented. The Beaufort Sea Environmental Assessment Review Panel recommendations and the practical aspects of risk assessment in the Federal Environmental Assessment and Review Process will be reviewed. General guidelines for the conduct of risk assessment in the context of environmental impact assessment will be set forth.

5.2 THE DEVELOPMENT PROPOSAL AND THE REVIEW PROCESS

Based upon successful exploration drilling results in the Beaufort Sea/Mackenzie Delta Region as of 1979, (which indicated recoverable reserves of oil at 120 million cubic metres and gas at 290 billion cubic meters), the oil and gas industry with exploration interests in the Beaufort Sea/Mackenzie Delta Region established that the recoverable reserves of hydrocarbon resources in the Region were sufficient to warrant consideration for production and transport to southern markets (Dome Petroleum Limited et al., 1981). In July, 1980, the Department of Indian Affairs and Northern Development (DIAND) initiated a formal public review of a proposal for production of oil and gas from the Beaufort Sea/Mackenzie Delta Region, and for transport of it to southern markets by pipeline or tanker or both. The Minister of the Environment appointed seven members to the Beaufort Sea Environmental Assessment Panel between January and May, 1981.

An issues seminar was held in Calgary, Alberta by the Federal Environmental Assessment Review Office (FEARO) in November, 1980, to identify preliminary environmental and socio-economic issues associated with the proposal. The seminar was attended by a wide range of potential participants in the Panel's review process, including representatives from the oil and gas industry, the federal and territorial governments, northern communities, native

groups and special interest groups (Federal Environmental Assessment Review Office, 1984). The issues identified at the seminar were useful in the development of the Draft Guidelines released by the Panel in June, 1981, to assist the Proponents in the preparation of an environmental impact statement (EIS). Although over 40 companies held oil and gas leases in the Beaufort Sea/MacKenzie Delta Region at the time of the public review, the companies most active in the exploration program at that time, Dome Petroleum Limited, Esso Resources Canada Limited and Gulf Canada Resources Incorporated acted as Proponents for the purposes of the public review.

Early in the review process, the Panel opened an office in Inuvik and employed a resident of Tuktoyaktuk to coordinate Panel activities in the Western Arctic. The Beaufort Sea Environmental Assessment Review Panel received comments and suggestions on its Draft Guidelines in November and December 1981, at public meetings held in Yukon and Northwest Territories communities and in Calgary. (Federal Environmental Assessment Review Office, 1984). In February, 1982, the Panel issued revised Guidelines for Preparation of an Environmental Impact Statement. These Guidelines contained many changes from the original draft as a result of comments received at the public meetings (Federal Environmental Assessment Review Office, 1982). The Proponents were asked to include in their EIS an analysis of

significant issues, impact predictions, mitigation and compensation measures, enhancement of desirable effects, monitoring, knowledge deficiencies and research needs, relevant to the development proposal. However, no criteria for the treatment and assessment of environmental hazards, upon which the Proponents could have structured their analysis were set forth by the Review Panel. The lack of clarity and definition in the Guidelines caused considerable confusion during the course of actual preparation of the EIA as to what in fact was expected of the Proponents.

At approximately the same time, the Panel presented an Interim Report to the Minister of the Environment. The Report summarized the Panel's progress to date, outlined future plans and provided preliminary comments on the review process. It also recommended amendments to the Panel's Terms of Reference. As a result of the Minister of the Environment's review of the Interim Report, and after consultation with the Minister of Indian Affairs and Northern Development, amendments were made to the Panel's Terms of Reference. The amendments provided for a review of all possible onshore and offshore oil and gas production facilities in the Canadian Beaufort Sea/Mackenzie Delta Region and of transportation options for oil and gas to southern markets. The Panel was instructed to ask for preliminary design information on production concepts, and for a statement of the premises upon which designs were

based. The Terms of Reference explicitly stated that information submitted by the Proponents should describe and justify any statements involving concept viability or risk analysis of possible failure. Thus, from the inception of the environmental review it was an accepted fact that risk analysis (assessment) was to play a pivotal role in the delineation of environmental hazards.

The Panel was instructed in its Terms of Reference to take into consideration previous and possible future northern activities which would be relevant to the development proposal submitted by the Proponents (e.g. the Mackenzie Valley Pipeline Inquiry, the Norman Wells Oil Expansion Project, the Arctic Pilot Project, Lancaster Sound Exploratory Drilling, the Alaska Highway Gas Pipeline, and the Senate Committee Report on Northern Pipelines). Furthermore, the Panel was instructed to consider the capacity of governments to control Beaufort Sea oil and gas development. The Panel was also instructed to make recommendations respecting the need for subsequent public reviews of any aspects of the proposed development (Federal Environmental Assessment Review Office, 1984).

In November, 1982, the Beaufort Sea Environmental Assessment Review Panel received the Proponent's EIS. Subsequent to a 90 day formal public review period, during which the advice and comments of 36 Intervenors and Technical Specialists were considered, the Panel determined

that additional information was required. The Panel issued a Deficiency Statement through DIAND to the Proponents in March, 1983. The Proponent's response to the Deficiency Statement, the EIS Supplementary Information, was submitted to the Panel in June, 1983. In August, 1983, after reviewing the EIS Supplementary Information and 20 interventions, the Panel established that the Proponent's submissions contained sufficient information to proceed with public sessions. The public sessions were to be forums held in northern and southern communities to discuss and consider the environmental and socio-economic effects of the proposal.

The public sessions were completed in December, 1983, after which the Panel deliberated on all matters brought before it. The Beaufort Sea Environmental Assessment Review Panel published its final report titled "Beaufort Sea Hydrocarbon Production and Transportation Proposal" in July, 1984. The Report discussed potential effects, both positive and negative, upon the physical, biological, and socio-economic environments likely to be affected by the Proponent's proposed developments. The Panel's Report recommended how adverse effects of the proposed development could be controlled or avoided. The Report also included comments on the capability of governments to control Beaufort Sea hydrocarbon development, such as environmental regulation and on the need for subsequent reviews (Federal Environmental Assessment Review Office, 1984).

5.3 THE ENVIRONMENTAL IMPACT STATEMENT

The Proponent's environmental impact statement, along with the 37 support documents and the EIS supplementary information, constitute one of the most complete environmental and socio-economic reviews compiled in Canada. The EIS consists of approximately 2,000 pages in seven volumes.

In response to the Review Panel's EIS Guidelines, the development plans described in the EIS forecast a possible range of events to the year 2000. The Proponents, in submissions to the Beaufort Sea Environmental Assessment Review Panel, described a range of options and scenarios for oil and gas production and transport for the Beaufort Sea/Mackenzie Delta Region. The options presented were: transport of hydrocarbons to southern markets by an overland pipeline along the Mackenzie Valley from Richards Island in the Mackenzie Delta to Edmonton, Alberta (both small and large diameter pipelines, partially elevated or buried were considered); or transport of hydrocarbons via icebreaking tankers through Parry Channel and Davis Strait to eastern Canada; or a combination of the above transport options (Figure 1). The number of tankers and/or the diameter of a pipeline would be determined by the rate of production of hydrocarbon resources achieved in the Beaufort Sea/Mackenzie Delta Region. In addition to the transportation systems, man-made offshore islands, or other types of platforms were

presented as options to provide the foundations for drilling systems, production wells and associated processing facilities offshore. Onshore production methods would be similar to those used in southern Canada. Production estimates by the Proponents ranged from oil production levels of about 15,000 cubic metres/day to 200,000 cubic metres/day (Federal Environmental Assessment Review Office, 1984). The Federal Environmental Assessment Review Office (1984) report notes that exploration results obtained by the Proponents suggest that production rates towards the lower end of the above range could be expected.

The environmental impact statement prepared by the Proponents concentrated on the first five years of development, rather than on long term plans, because such plans are more susceptible to external factors such as government policy, community impacts and the results of monitoring programs (Dome Petroleum Limited et al., 1982). The Proponents' 37 EIS support documents provide relevant information in support of the EIS.

Pursuant to the Guidelines for Preparation of an EIS published by the Beaufort Sea Environmental Assessment Review Panel for use by the Proponents, the Proponents undertook extensive research on oil spills and risk as a consequence of the proposed development activities in the Beaufort Sea Region. The entire contents of Volume 6 of the EIS titled Accidental Spills is devoted to the examination

of the occurrence, prevention and behavior of oil spills in the arctic environment. Oil spill risk assessment (analysis) is discussed throughout the Proponents' EIS in various contexts.

5.4 RELATED DATA-BASES

The need for increased knowledge regarding Canada's Arctic has been enunciated for more than a century. To mention a few advancements, the Franklin Expeditions, the Canadian Arctic Expeditions 1913-18, the Geological Survey of Canada's Operation Franklin, and the recent government and petroleum industry's environmental baseline studies have each contributed to the Arctic knowledge data base. However, in consideration of the size and complexity of this vast region, much remains to be learned.

In recent years, several proposals have been advanced for delivery of arctic oil and gas to southern markets. These include the transport of oil and liquefied natural gas from the Alaskan North Slope, the transport of oil and liquefied natural gas from the Lancaster Sound Region, and, the delivery of liquefied natural gas and methanol from the High Arctic Islands. Further proposals can be expected, as prevalent economic and political conditions favour exploration and development in arctic regions. Although the proposed projects vary in mode (tanker vs. pipeline), cargo (oil vs. LNG or methanol), point of origin (Alaskan North

Slope vs. High Arctic Islands) (Mackenzie Valley pipelines vs. Northwest Passage Tanker) each raises similar issues. These include the exercise of sovereignty in the Arctic, the development of a merchant marine, the protection of environmentally significant areas, the thrust of energy policy and the impact on native peoples, etc. The implications of each of these projects transcend their mere function, the production and transport of hydrocarbon resources to market, to assume national importance.

Development proposals such as the Mackenzie Valley Pipeline, the Arctic Pilot Project, the Norman Wells Pipeline, the Alaska Highway Gas Pipeline and the Lancaster Sound Regional Study have each included a consideration of risk assessment (analysis). None of the proposals, however, has achieved the level of formalized risk assessment (analysis) as it was presented in the Beaufort Sea/Mackenzie Delta Development Proposal. Thus, although much useful information has been assembled concerning the risks inherent to the development of the North's hydrocarbon potential, much of the information is of minimal relevance to the case at hand, except as background information.

5.5 OIL SPILL RISK ASSESSMENT

The purpose of oil spill risk assessment for the Beaufort Sea/Mackenzie Delta Region Environmental Assessment and Review, as set forth by the Federal Environmental Assessment Review Office was two-fold. Risk assessment studies were to provide numerical estimates of the risk of an oil spill associated with each component of any proposed production and transport system. Such numerical estimates were to provide an indication of the types of accidental spills which would be most likely to have potentially serious environmental effects.

The assessment of oil spill risks for the Beaufort Sea/Mackenzie Delta production and transport proposal involved the use of analogous historical data obtained from other oil producing regions of the world. The Beaufort Sea Environmental Assessment Review Panel Report (1984) notes that in many cases, the historical data was derived from data bases which included production and transport facility data which differed in age, design, size and cause of accidents from those assumed for the Proponents' proposal. The data were modified (extrapolated) to reflect the conditions prevalent in the arctic environment, and the engineering technologies the Proponents stated they would employ.

The Beaufort Sea Environmental Assessment Review Panel Report (1984), points out that during the risk assessment studies conducted for the Beaufort Sea Environmental Assessment Review, much of the discussion focused on methodological issues, such as the merits of various statistical techniques and data bases. Technical experts (on behalf of both the Proponents and the Beaufort Sea Environmental Assessment Review Panel) recognized the limitations of available methods and data for oil spill risk assessments of the development proposal. Nonetheless, it was concluded that such methods could be used to provide reasonable bounds for assessment of spill frequency and size (Federal Environmental Assessment Review Office, 1984).

The Panel concluded that the analyses presented were valid only in describing risk within the range of possibilities assumed for the particular analyses, and that even then, other factors such as human error, enhanced awareness of risk, and unforseen circumstances could significantly alter the actual risk from the projected risk. In addition, the Beaufort Sea Environmental Assessment Review Panel report (1984) notes that as a result of the conceptual nature of the Proponents' proposal, assumptions were made as to the location of production facilities. The Proponents, therefore, had to base their risk estimates on hypothetical scenarios. While the Panel accepted these scenarios as reasonable, changes in concept could

substantially alter the risk estimates presented by the Proponents.

5.6 CRITIQUE AND COMMENTARY ON THE RISK ANALYSIS DONE IN THE BEAUFORT SEA/MACKENZIE DELTA REGION HYDROCARBON RESOURCE DEVELOPMENT ENVIRONMENTAL ASSESSMENT AND REVIEW

It is clear from the review of available data that the Beaufort Sea/Mackenzie Delta Region development Proponents were conscientious in identifying and trying to understand the risks that could result from oil spills in the Beaufort Sea/Mackenzie Delta Region as a consequence of hydrocarbon resource development and transport. However, in light of publicly available information, the evidence presented by the Proponents in the environmental impact statement was insufficient, and tended to gloss over or avoid providing the public with quantitative estimates of the probability and location of various projected spills.

In theory, mathematical risk analysis (assessment) is an ideal tool in the evaluation of losses associated with alternative solutions to environmental decision problems. In practice, however, the complexities of even the simplest problems are such that at best, the results are only approximate estimates of the risks that are anticipated. Ideally, in the case of the Beaufort Sea/Mackenzie Delta Region development, the public would want to know the probability of spills of various sizes at all the points

along all possible transportation routes, along with the present and future socio-economic impacts associated with each of these spills.

In practice, however, it is impossible to adequately quantify socio-economic impacts and it would take several lifetimes to begin to measure the probability of all the significant outcomes. In addition to these problems, there remains the practical problem that not all important risks can be anticipated.

The question then arises as to why risk analyses (assessments) should be conducted in environmental impact assessments. For example, why not simply allow those concerned with the environmental impacts of a proposed development to vote on the choices before them. The complications with such a solution are that the voting public would not be cognizant of the relevant technical complexities inherent to development. The compromise solution to this problem is that there is a pragmatic balance which can be struck between these two extremes which is neither purely subjective nor purely objective.

The public's understanding and acceptance of risk analyses (assessments) associated with environmental assessment and reviews are of vital importance. Therefore, it is crucial that risk analyses (assessments) conducted for environmental impact assessments be supported by the

assumptions and analyses which are used to derive risk estimates.

Thus, in the case of estimating and comparing the risks inherent to northern hydrocarbon resource development, there is a place for risk analysis (assessment). It must be noted however, that risk analysis (assessment), is merely a tool which can be used in support of the far more complex and irreplaceable process of human judgement.

5.7 BEAUFORT SEA ENVIRONMENTAL ASSESSMENT REVIEW PANEL RECOMMENDATIONS

The Beaufort Sea Environmental Assessment Review Panel concluded that the risk of an oil spill as a consequence of hydrocarbon resource development activities in the Beaufort Sea/Mackenzie Delta Region would not be appreciably higher than for other parts of North America and abroad. The Panel advocated a phased approach to hydrocarbon resource production and transport in the Beaufort Sea/Mackenzie Delta Region. The Panel concluded that a small diameter (e.g. 400mm) buried pipeline through the Mackenzie Valley would be the most acceptable alternative for transport of oil from the Beaufort Sea/Mackenzie Delta Region. In its 1984 report, the Beaufort Sea Environmental Assessment Review Panel stated that a small buried pipeline would be the most acceptable transport alternative because the drilling and production activities to justify such a pipeline would

provide benefits to the North, while imposing only minimal negative impacts. There was wide consensus among federal and territorial government departments that a small diameter pipeline could be built in an environmentally acceptable manner, given appropriate regulations, regulatory enforcement and monitoring procedures (Federal Environmental Assessment Review Office, 1984).

When the Panel published its report in July, 1984, it was estimated that the earliest possible date for commercial shipments of hydrocarbon resources from the Beaufort Sea/Mackenzie Delta Region would be 1988. The Panel suggested that the interval between the publication of its report and the estimated commercial start-up date be used to allow governments and the Proponents sufficient time to take steps to permit orderly, safe production and transport of hydrocarbon resources in the North. While five years have passed since the Beaufort Sea Environmental Assessment Review Panel published its report, production and transport of hydrocarbons from the Beaufort Sea/Mackenzie Delta Region have not proceeded.

5.8 PRACTICAL ASPECTS OF RISK ASSESSMENT IN THE FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS

Throughout human history, people have always attempted to avoid inordinately high risks to their health, safety, property and environment. As such, humans have survived and adapted to a changing, and often turbulent environment.

Therefore, there is nothing novel in the attempt of individuals to recognize and mitigate risks to their everyday lives. While rigorous risk analysis (assessment) has been used for many years in fields such as actuarial science, it is only recently that risk analysis has been identified as a specific concept and tool, to be studied as a discipline in and of itself, and interdisciplinarily in the context of inquiries into environmental hazards. The main impetus for the increasing attention paid to risk as a concept in Environmental Assessments and Reviews, has been the enhanced political and social concern over the administration of a growing collection of potentially hazardous products, technologies and projects. Wolf (1983) notes that the history of risk analysis (assessment) as used in the study of environmental problems runs parallel to that of environmental impact assessment. He also notes that some of the factors responsible for the new interest in risk are similar to those which influenced the initiation of environmental impact assessment. Risk analysis (assessment) as conducted in environmental impact assessment provides a framework for information collection, and the identification of gaps in knowledge.

Grima et al. (1986) note that the United States National Research Council (NRC) 1982 Committee on Risk and Decision-making states that there is no easily available information on comparative and aggregate risks. Yet, the

NRC asserts that the comparative assessment of risks is a vital and compelling component of environmental impact assessment. Thus, while it is understood that the Federal Environmental Assessment and Review Process is, in its own right a significant institutional arrangement for monitoring, reducing or containing risk, it is not clear as to how risk analysis (assessment) is to be accomplished in the context of EIA.

Grima et al. (1986) assert that to conduct a competent risk analysis there must be an adequate information base. Paradoxically, the most interesting and controversial environmental impact assessments often deal with projects which require the application of new and unproven technologies (e.g. high temperature incinerators), which propose to move into previously forbidden territory (e.g. Arctic development), or which otherwise go beyond existing practice (Grima et al., 1986). Risk analysis, therefore, is plagued with the use of information originally collected for other purposes, coping with disparate quantities and qualities of available data, and the need to extrapolate beyond the range of existing observations (Grima et al., 1986). The application of risk analysis techniques to a situation such as that investigated by the Beaufort Environmental Assessment Review Panel exemplifies these complications. Indeed it may be viewed as a worst case scenario in light of the fact that the entire risk analysis

process respecting Beaufort Sea hydrocarbon resource development (as conducted by the development Proponents and the Intervenors) concerned new and unproven technologies, proposed for use in hitherto forbidden territories. Further, the entire risk analysis was based upon extrapolated and analogous data.

In addition, the question arises as to whether risk analysis (assessment) is a valid or sufficiently sensitive technique to use in the evaluation of development proposals for the fragile physical and socio-economic arctic environment. That is, are risk analyses (assessments) as they are currently designed and conducted, adequately responsive to the subtle nuances that must be considered when discussing arctic development?

Further, there remains the more complex question of who should decide what levels of risks are acceptable for the North? That is, what is the role of social consensus in determining a morally justifiable and equitable balance among risks, costs and benefits?

All these questions deal, in one way or another, with a problem that is difficult to pose meaningfully and even more difficult to resolve - the philosophical problem of risk and consent. Perhaps a partial answer to these most difficult questions lies in the fact that tommorrow's society is shaped by today's decisions. The inclusion of risk analysis

(assessment) as part of the Federal Environmental Assessment and Review Process provides a forum for the expression of what society (through its designates in the EIA process) believe are at stake in a proposed development or project. Risk analysis (assessment), like other techniques of policy analysis used in the past (e.g. benefit - cost analysis) is largely an analytical tool, and can be used by different interest groups to further their own particular purposes. Grima et al. (1986) state that risk assessment should not be expected to resolve value questions, but rather to clarify the implications of various alternative decisions for value groups. Fundamental to the inclusion of risk as a concept to be studied as part of an environmental impact assessment, is the recognition of its limitations. Therefore, in the conduct of risk analysis (assessment) prudent caution must be exercised in ascribing validity to risk estimates and to subsequent conclusions.

5.9 GUIDELINES FOR THE CONDUCT OF RISK ASSESSMENTS IN ENVIRONMENTAL ASSESSMENTS AND REVIEWS

Every risk assessment is unique in its own right, and can be Herculean in its complexity. This is particularly true because of the oft encountered difficulties due to lack of data, uncertainties, and public involvement.

Whyte and Burton (1982) assert that risk analyses (assessments) in environmental impact assessments would be more acceptable and persuasive if:

- the assumptions adopted in any particular analysis are realistic;
- the analysis is seen to be objective and is not suspected of being biased in favor of a particular outcome;
- the analysis has a specific purpose (e.g. to detect and reduce risks) and is not simply an attempt to influence public opinion;
- the analysis is not based on classified data or reports that are confidential;
- the analysis is presented in language that is as clear as possible, that recognizes and does not attempt to conceal uncertainty and divergence of expert opinion;
- the results are presented in an unambiguous fashion with explicit recommendations on action to be taken.

Grima et al. (1986) note that because the literature on risk assessment has expanded so rapidly in the last few years, it may be helpful to practitioners to develop generic guidelines on risk assessment. Further, they note that such guidelines would make risk assessments more consistent across various environmental impact assessments.

Guidelines could be developed for various issues such as:

- when risk assessment is necessary;
- what information on risks should be provided;

- the use, adequacy, and admissibility of data respecting risks;
- the mode of presentation of risk related data.

Grima et al. (1986) note that even if guidelines for the conduct of risk assessment in environmental impact assessments were initially very general, they could be of immediate use. The exercise of writing guidelines would aid in the identification of gaps in the practice and understanding of risk assessment's role in the Federal Environmental Assessment and Review Process. While generic guidelines could be of use to those conducting risk assessments, it would nevertheless be vital that each case be considered on its own merit.

5.10 SUMMARY

This case study of the Beaufort Sea/Mackenzie Delta Region Environmental Assessment and Review Process serves to demonstrate some of the strengths and weaknesses of approaches and techniques used for long term decision-making requirements in resource development. It is anticipated that as a consequence of the examination of case studies such as the Beaufort Sea example discussed in this Chapter and the incorporation of relevant solutions from this, as well as other case studies, in the future, the Environmental Impact Assessment Review Process will become a more efficient and viable framework for resource development not

only for the North, but for where ever environmental assessment reviews are conducted.

Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

Since 1965, over 150 exploratory wells for oil and gas have been drilled, both onshore and offshore in the Beaufort Sea/Mackenzie Delta Region. As a result of this exploration work, sufficient reserves of hydrocarbon resources were discovered to warrant consideration of production and transport of oil and gas from the Beaufort Sea Region to southern markets. In July, 1980, the Minister of Indian Affairs and Northern Development initiated a formal public review of oil and gas production and transport the Beaufort Sea, by asking the Minister of the Environment for a Panel review under the auspices of the Environmental Assessment and Review Process (EARP). On behalf of over 40 companies holding exploration permits in the Region, the three companies (Dome Petroleum Limited, Esso Resources Canada Limited and Gulf Canada Resources Incorporated) (the Proponents) with the largest interest in the Region prepared and submitted a detailed environmental impact statement concerning the production and transport of oil and gas from the Region to the Beaufort Sea Environmental Assessment Review Panel in November, 1982. At the request of the Environmental Review Panel, the Proponents also submitted additional background and supplementary information in June,

1983. As part of the environmental impact statement prepared by the Proponents, assessment studies respecting environmental risk were conducted.

The primary objective of this practicum was to examine risk assessment as it is included in the Federal Environmental Assessment and Review Process. The Beaufort Sea/Mackenzie Delta Region Environmental Assessment and Review was used as a case study in the examination of how risk assessments are undertaken in environmental assessments and reviews. The following conclusions are based on a review of related literature and consultation with industry, research and government representatives involved with risk assessment in the Federal Environmental Assessment and Review Process:

1. Risk assessment as it was conducted in the context of the Beaufort Sea/Mackenzie Delta Region Environmental Assessment and Review Process was not adequately structured to contend with the paucity of data relevant to environmental hazards.
2. Data bases concerning northern hydrocarbon resource development currently available, upon which risk assessment studies can be based, are incomplete. Risk assessments which are prepared utilizing analogous and extrapolated data are of limited reliability, and are largely unacceptable for decisions regarding northern hydrocarbon resource development.

3. In cases where formal risk assessment is not possible because of a lack of reliable data, the procedure of risk assessment may provide a useful framework for the organization of available data and for the identification of deficiencies.
4. Generic guidelines should be developed respecting risk analysis in the context of environmental assessment and reviews. Such guidelines would assist in the delineation of gaps in the practice and understanding of the role of risk analysis in the Federal Environmental Assessment and Review Process.
5. Guidelines which require risk analysis (assessment) in the context of environmental assessment and reviews should include criteria for validation of data and scientific understanding and should include recommendations on how to contend with scenarios where these criteria cannot be met.
6. Formal risk assessment of the Beaufort Sea/Mackenzie Delta Region hydrocarbon resource development proposal was limited to environmental risk assessment. Future environmental assessments and reviews should also encompass risk assessments respecting economic and socio-economic concerns.
7. Research should be conducted into when, during the Federal Environmental Assessment and Review Process, the explicit public focus on risk should take place. Two principal types of public participation in the

Federal Environmental Assessment and Review Process respecting risk assessment are required. These are: public forums at which the public and its representatives can articulate their own priorities and concerns; and public scrutiny of the adequacy of the technical risk analyses. The practice of soliciting public input before guidelines for the preparation of environmental impact statements are prepared, would increase the effectiveness of public participation in the Federal Environmental Assessment and Review Process.

8. While much of the work in current environmental assessment and review includes risk analysis (assessment), the explicit treatment of risk concepts in environmental assessment would assist in the clarification and codification of the process. Risk analysis (assessment) could thereby provide the stimulus for specific explicit questions about acceptable risk. This in turn would lead to better informed decisions based on the results of environmental assessments and reviews.

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