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MACKENZIE VALLEY-NORTHERN YUKON PIPELINES

SOCIO-ECONOMIC AND ENVIRONMENTAL ASPECTS

Environmental·Social
Committee Northern Pipelines

CORRIGENDUM

74-17 Mackenzie Valley and Northern Yukon Pipelines -- Socio-economic and Environmental Aspects (Report to the Task Force on Northern Oil Development

(i) remove the words "on wildlife" from the title for Figure F-5 on Page 11 and on Page 137;

(ii) substitute "environmental" for "wildlife" in line 6 of F.2.8 on Page 138.

A-27292

Mackenzie Valley and Northern Yukon Pipelines

Socio-economic and Environmental Aspects

A Report to the Task Force on Northern Oil Development, Government of Canada

respectfully submitted by the
Environment-Social Committee,
Northern Pipelines
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Environmental-Social Committee,
Northern Pipelines,
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Preface

This report is concerned with the people, the natural environment and resource use in the Mackenzie valley and the northern Yukon and how these aspects might be affected if pipelines were built to move natural gas or oil to southern markets. It is based on studies for the Environmental-Social Committee of the Task Force on Northern Oil Development since 1971, together with related information from other government and non-government studies, papers and reports.

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A

Initial Reactions and Responses to Proposed Northern Pipelines

A.1 Introduction

A.1.1 This report is concerned with the people, the natural environment and resource use in the Mackenzie valley and the northern Yukon and how these aspects might be affected if pipelines are built to move natural gas or oil to southern markets. The form of the report was shaped in large part by the temper of the times while the background studies for the Environmental-Social Committee of the Task Force on Northern Oil Development were being conducted since 1971.

A.1.2 The early 1970's were marked by increased public demand for some direct voice in important decisions made by Government and industry concerning proposals for large industrial developments. Well-organized members of the public encouraged governments to consider carefully the social and environmental effects of major development projects. At the same time these segments of the public pressed for more access to information on proposed developments and more opportunities to be 'heard' and 'listened to' before important decisions were made. Also during this period northern natives stated firmly that they had a legal claim to the land and its resources and should participate in decisions on resource development activities.

A.1.3 The proponents of northern pipelines contributed to heightened public interest in the proposed developments in many ways. First, publicity on the size and cost of a northern pipeline could not help but attract attention. Secondly, at an early date industry recognized the need for detailed data for design purposes and to support any future application. Concurrent with industry's mounting of a comprehensive research program which included environmental and socio-economic studies, Government was in the process of reviewing its regulatory legislation and its information base. Mainly for these reasons several government departments were restructured in order to deal with complex environmental questions in an integrated manner. New environmental protection legislation which emphasized the regulatory approach, was enacted. This in turn created a strong demand for background information as well as for data that would contribute to setting standards for environmental protection.

A.1.4 At the international level the early 1970's were characterized both by intensified demand for energy resources, including those from the Canadian North, and an awareness of the importance of long term controls over the quality of air and water and the productive capacity of life support systems. These differing interests ranging from individual to international, have resulted in a situation in which the emphasis has fluctuated across a broad spectrum of concerns. The studies and research conducted for the Environmental-Social Committee of the Task Force on Northern Oil Development have not only been influenced by this dynamic setting, but also are part of it.

A.1.5 As a result of the diverse concerns during the early 1970's, proposals for specific large industrial projects have received high research priority. The approach has been to investigate environmental and social problems that either have already occurred or are thought likely to occur; however some of the more important problems may not be identified during the early phases of the research. The first step, then, is to continue to refine the research goals, and to obtain a better understanding of the present setting and existing trends. This report summarizes the present environmental, socio-economic and resource use setting of the study area, identifies major areas of concern, and then goes on to examine these areas in relation to proposed northern pipelines.

A.1.6 The succeeding sections of this chapter describe the general concept of northern pipelines, some specific pipeline proposals, initial public reaction to these proposals and the resulting actions by Government.

A.2 The Concept of Northern Pipelines

A.2.1 Oil and gas production in the Canadian Arctic dates back to Norman Wells in the 1920's but the significant increase in activities was triggered by the major petroleum discovery in Alaska in 1968. The Prudhoe Bay oil and gas discoveries are the largest in Northern America and rank among the first ten in the world.

A.2.2 Public concern about northern petroleum development was focussed initially on exploration and development rather than on pipelines. The broad issue of extracting oil from the north slope of the Brooks Range received its first full scale review in August 1969, at the 20th Alaska Science Conference in Fairbanks, when conservationists expressed their concern about arctic development. This meeting was followed in October 1969, by the Tundra Conference in Edmonton, which dealt with petroleum exploration and development, and also gave scientists an opportunity to respond to proposed northern land use regulations. In addition, a brief concerning the claims of northern indigenous people was presented; this was probably the first public statement on this issue by native inhabitants of the western Arctic (Usher and Beakhust, 1973). However, public and scientific concern over northern petroleum development soon became focussed on pipelines. In the exchange between the United States Department of the Interior and Trans Alaska Pipeline Systems (TAPS) in the summer of 1969, many pipeline related environmental questions were raised that could not be answered at that time. These various expressions of public concern were part of the background for the first Canadian northern pipeline guidelines in 1970 and for initiating a program of environmental and socio-economic studies by the Task Force on Northern Oil Development in 1971.

A.3 Proposals to Move Petroleum to Market

A.3.1 The Prudhoe Bay discovery raised the question of the best method for moving Alaskan oil to southern markets. There appeared to be three main possibilities: (i) by pipeline across the state to a port on the Gulf of Alaska and then by tanker down the west coast; (ii) by tanker either westward through the Bering Strait or eastward through the Northwest Passage; and (iii) by pipeline across the northern Yukon and then southward through the Mackenzie valley. The experimental voyages of the *Manhattan* confirmed that a tanker system using the Northwest Passage was feasible but transport by pipeline appeared to have economic advantages. A pipeline route through Canada was apparently considered only for any *second* pipeline required to bring Alaskan oil to market; the American petroleum interests at Prudhoe Bay favored the Alaska pipeline and tanker system.

A.3.2 There has been Canadian opposition to the tanker portion of the Alaska pipeline system. The general concern has been the pollution problems that could occur on the Canadian west coast in case of a major oil spill.

A.3.3 In contrast to oil, it was initially generally accepted that a pipeline through Canada was the preferred method and route for transporting *natural gas* from Prudhoe Bay. More recently however, a proposal to construct a pipeline across Alaska to a port on the Gulf where the gas would be liquefied and transported by supertankers has been under consideration.

A.3.4 Both oil and natural gas have been discovered in the western Canadian Arctic, particularly in and around the Mackenzie delta since the Prudhoe Bay discovery in 1968, but to date it appears that only *gas* has been discovered in sufficient quantities to warrant consideration of a pipeline. Industry's present planning for a 48 inch gas pipline anticipates that about half of the gas would come from Prudhoe Bay and half from the Mackenzie delta (Canadian Arctic Gas Study Limited, 1973).

A.3.5 Several groups from industry have been promoting pipelines to bring oil and natural gas from the Alaska north slope and the Mackenzie delta area to southern markets. At various times these included: the Alyeska Pipeline Service Company, El Paso Natural Gas Company, Mountain Pacific Pipeline Limited, Mackenzie Valley Pipe Line Research Limited, Gas Arctic Systems Study Group, The Northwest Project Study Group, and Canadian Arctic Gas Study Limited.

A.3.6 Alyeska Pipeline Service Company is the proponent of a pipeline from Prudhoe Bay to Valdez, Alaska coupled with a tanker system for transporting the oil down the west coast. This group had hoped to start construction about 1970 but various legal problems have delayed it into 1974.

A.3.7 El Paso Natural Gas Company is reported to be carrying out an $11 million study of a proposal to move Prudhoe Bay natural gas to U.S. markets by way of a pipeline across Alaska to Seward, where the gas would be liquefied for shipment by tanker to California (Canadian Arctic Gas Study Limited, 1973).

A.3.8 Mackenzie Valley Pipe Line Research Limited was formed early in 1969 to investigate the technical feasibility of an oil pipeline from Prudhoe Bay to Edmonton, Alberta. In a report released in December 1972 the consortium concluded that: (i) construction and operation of a 48 inch crude oil pipeline from the arctic coasts of Alaska or Canada to Edmonton was technically feasible; (ii) such a pipeline could be built and operated without major or irreparable damage to the arctic environment; and (iii) it could be designed, built and in operation within four years after a final decision to proceed providing final governmental approvals were granted within the first year.

A.3.9 Mountain Pacific Pipeline Limited was active in the early phases of feasibility studies for proposed gas pipelines from Prudhoe Bay to southern markets. This consortium is relatively inactive at present.

A.3.10 In 1969 The Northwest Project Study Group began research and feasibility studies on the construction and operation of a large diameter natural gas transmission system from the north slope of Alaska and northern Canada to markets in the midwestern United States and eastern Canada. Similar work was initiated by Gas Arctic Systems Study Limited late in 1969. These groups amalgamated in 1972 to form Canadian Arctic Gas Study Limited, the current major proponent of a pipeline in the Mackenzie valley and the northern Yukon. Canadian Arctic Gas Study Limited would be responsible for the Canadian portion of the proposed gas pipeline; a parallel company, Alaska Arctic Gas Study Company, would be responsible for the Alaska segment.

A.3.11 Late in 1973, Canadian Arctic Gas Study Limited officials stated that if 18 months were required for processing their application after it was filed, the consortium would have spent about seven years and $60 million on feasibility studies, regulatory proceedings and detailed preconstruction engineering. (Applications were actually filed with Indian and Northern Affairs and the National Energy Board on March 21, 1974.) They proposed to start construction in the winter of 1976-77, with Mackenzie delta gas being onstream by the end of 1978, and Prudhoe Bay gas coming onstream by the fall of 1979 (Canadian Arctic Gas Study Limited, 1973). More recent statements have proposed a start on construction in the fall of 1977.

A.3.12 Although industry has concentrated mainly on the pipeline alternative, other methods of transporting oil and gas from the North have been considered. The *Manhattan* tanker test runs through the Northwest Passage in 1969 and 1970 were a well-publicized alternative. Recently, attention has been focussed on a railroad alternative. Proponents claim it would be competitive because it would create more permanent employment, cause less environmental damage, and be more versatile than a pipeline system. Proposals to move oil and liquefied natural gas by rail have included a route from Prudhoe Bay across the northern Yukon and through the Mackenzie valley (Law et al., 1972) and a route from Prudhoe Bay through the southern Yukon into British Columbia (British Columbia, 1973). At present, the Ministry of Transport is investigating the feasibility of the railway alternative.

A.3.13 There have been at least three proposals for airborne movement of oil and liquefied natural gas using: (i) large air tankers which would be at least three times the size of a Boeing 747; (ii) very large tri-wing helicopters; or (iii) dirigibles. Prototypes of these alternatives do not presently exist. Although proponents of all three claim that they have potential, the petroleum industry has not appeared very enthusiastic about any of them as an alternative to pipelines.

A.4 Some Public Reactions

A.4.1 The native people of the Canadian North have expressed their interests in and concerns about northern pipelines through their various associations. The concerns of the individual associations are exemplified in the following statement of the President of the Federation of Natives North of Sixty:

"Mr. Chairman, ladies and gentlemen: I am speaking to you as a representative of the Federation of Natives North of Sixty. We are a group representing all indigenous people of the Canadian North and we have some international affiliations.

We would like to thank the meeting and especially Professor Malaurie for the time that has been granted to us. We believe that we have a valid contribution to make here just as you have in our North.

We came here, as did the rest of you, to learn. For three days we have listened to your thinking concerning our ancestral home and how you are planning to exploit it. Now we feel the time has come for us to tell you of our hopes and plans so that we all might understand each other completely.

As you know, we are the indigenous people of the Canadian North. As the indigenous population we believe that we have certain rights both moral and legal. We claim aboriginal rights, a legal concept that has been recognized for centuries in the Western World. These rights consist of land, hunting, fishing, trapping, resources and other rights. These rights are based on our use and occupancy of the land from time immemorial and certain other more contemporary legal decisions.

Most of you have been in the North and know first hand of the appalling economic, social and cultural situation our people are enduring. We did not choose to live this way but through white migration to our areas it has become difficult for us to follow our traditional life styles. Now with the spectre of a pipeline, a road and all the attendant services it is apparent that for most of our people it will be impossible to live from the land any longer. So we are faced with the future. Many people have told us that our future includes oil and a pipeline. Perhaps, but we believe that it will hold these things only if we have settled all our land claims satisfactorily.

We say this because we believe that the aboriginal rights that I outlined a moment ago are strong enough for us to delay indefinitely, through the judicial system, any proposed development.

You see, we cannot allow any more development in the North until we are assured that it will benefit us for many years to come. We are the owners of the land and we believe that we have this right.

Until now much of what we have presented must sound sinister and familiar to you. This need not be so, for we are a reasonable people. We believe that the extraction of our northern mineral resources are perhaps in the best interest of the native people and the developers, if the native people are assured that our share of the wealth will allow our people to compete as equals with the rest of society.

For a pipeline to benefit us in the long run we must be employers as well as employees from the outset. We must be assured not only of enough royalties from resource extraction to guarantee a better life, but we also require direct participation in the planning and decisions of developments. This will ensure an active and not passive role for our children in our North.

To be more specific, the monies from a land claim settlement will enable us to take up for ourselves the development of a different economic system more in tune with our values and culture. We could also then assume responsibility for many of the services now being run by others, such as education, social assistance, and many other programs. Another and very important aspect of land settlement would be the exclusive parcels of land that we would control. We could use this land to ensure to some degree that our people will be able, now and in future generations, to still practice our hunting traditions. These lands could also serve to ensure the protection of many now endangered species of wildlife which we are concerned about.

To be blunt, a satisfactory land settlement would allow us to again become our own masters.

When our land claims are settled the question of title to land would be resolved and the developers could then move ahead assured of proper ownership and free from legal action. We also think that a satisfactory land settlement would allow us to cooperate and assist the developers in their planning.

In conclusion, we believe that successful land settlements could lead to a development of the North that would benefit us all. But we need our claims recognized and settled by our Government. We think that unless the oil companies wish to be caught in the middle of protracted court proceedings between ourselves and the Government, they should begin to meet with us. There is no question in our minds that with the moral, economic, and political support of the oil companies, our claims would be soon recognized and settled.

We propose then that the representatives of the oil companies present tell their companies that we are quite ready and willing to meet with them and perhaps even form some kind of committee to discuss all our mutual concerns.

We think that this kind of coalition would be to the benefit of everyone and would do much to make the dream of the North a reality.

Again, we thank you for the opportunity to speak to such a distinguished assembly". (Wah-shee, 1973)

A.4.2 Other organizations have expressed their environmental and social concerns regarding northern pipeline proposals through public statements, seminars and various publications. These organizations include: (i) the Agassiz Centre for Water Studies; (ii) the Canadian Arctic Resources Committee; (iii) the Canadian Nature Federation; (iv) the Canadian Society of Environmental Biologists; (v) the Canadian Wildlife Federation;

(vi) the Environment Protection Board; (vii) Pollution Probe; and (viii) the Society for Pollution and Environmental Control.

A.4.3 The social concerns expressed by the people living in the Mackenzie valley and the northern Yukon and their organizations, by various national organizations, by the pipeline consortia and by Government have covered a broad range of subjects. Those most commonly voiced include: (i) preservation of the traditional way of life for those who desire it; (ii) preservation of wildlife and fish resources in the interests of the local economy; (iii) encouragement of employment opportunities to meet the needs of a growing labour force; (iv) avoidance of family and cultural disruption in the settlements; (v) training of Northerners for employment in skilled positions; and (vi) preservation of cultural, archaeological, and historical resources.

A.4.4 Expressed concerns about adverse effects on the environment have included: oil spills; earthquakes; degradation of the permafrost; changes to the terrain, including slope instability and erosion; damage to vegetation; conservation of caribou herds, fur bearers, fish and birds; apprehension for rare and endangered species; and wilderness preservation.

A.4.5 These general public reactions together with Government's concern over many of the same social and environmental questions, have led to a number of specific responses by Government from 1969 to the present. One of the more important responses is outlined in the next section.

A.5 Government's Response to Pipeline Proposals

A.5.1 Accepting the possibility of a northern oil discovery comparable to Prudhoe Bay, Canada made preparations to respond to public and industry concerns about northern petroleum development, and, as one step, the Task Force on Northern Oil Development was established in 1968. In announcing its establishment, the Hon. Jean-Luc Pepin stated, "this is a governmental task force and its purpose will be to bring together all information on the existing oil situation in the North, on transportation routes that might be used, and to coordinate all available information from all federal agencies and departments, and then report and make proposals to the Government" (Hansard, 20 Dec., 1968).

A.5.2 Six committees have been established under the Task Force on Northern Oil Development. The members of each of these interdepartmental committees have been drawn from the various interested federal departments.

A.5.3 The *Pipeline Committee* appraises all technical and engineering matters related to the construction and operation of proposed oil and gas pipelines in the North, with emphasis on construction procedures and on design and operational criteria. The Committee maintains close contact with the oil and gas industry and with such organizations as the Canadian Standards Association.

A.5.4 The *Economic Impact Committee* carries out studies on the anticipated national economic impact of the construction and operation of northern pipelines using such criteria as: benefits, regional impacts, effects on balance of payments and exchange rates, investment impacts, and availability of finances. The Committee is concerned with whether a northern pipeline would be an overall benefit or cost to the national economy, and with the nature and the scale of the cost-benefit balance.

A.5.5 The *Transport Committee* advises on the transportation services that would be specifically required to support development of the petroleum industry in northern Canada and on matters relating to transporting oil and gas by means other than pipelines.

A.5.6 The *Marketing Committee* assesses the probable impact of northern oil and gas on energy supply and demand patterns of North America.

A.5.7 The *Industrial Supply Committee* assesses the capability of Canadian industry to supply goods and services for the design, construction and operation of proposed northern pipelines. One objective of the Committee is to determine appropriate levels of Canadian content for proposed pipeline construction.

A.5.8 The *Environmental-Social Committee* develops and coordinates environmental and socio-economic studies and research programs related to various aspects of proposed pipeline construction in the northern Yukon and the Mackenzie valley. The goals of these research programs are: (i) to ensure that Government possesses adequate information for a balanced assessment of applications to build pipelines and for making decisions that inevitably involve trade-offs among economic, environmental and social factors; (ii) to provide the additional technical and scientific information necessary to assess the probable environmental impacts of building and operating pipelines in the North; (iii) to provide the additional socio-economic information needed to assess the probable impact of building and operating pipelines in the North; (iv) to gain adequate information to enable Government to set terms and conditions for the land tenure agreement and the permit to build the proposed pipeline with a view to minimizing social disruption and adverse environmental effects; and (v) to provide further detailed renewable resource data in order to develop an understanding of the northern environment and to assess the problems of resource harvesting and other possible developments.

A.5.9 The Environmental-Social Committee has more staff and more funding than the other committees because of the nature of its responsibilities. Since field work and research were required, a small directorate was set up under this Committee to assess specific pipeline related research needs. To further these objectives, coordinators were appointed from the Departments of Energy, Mines and Resources; Environment; and Indian and Northern Affairs; and from the governments of the Yukon and the Northwest Territories. In addition, because of the close association of their work, formal liaison was established with the National Energy Board and the Ministry of Transport.

A.5.10 While planning an accelerated program of pipeline related research in 1971, the Environmental-Social Committee asked the obvious question whether knowledge available from pipeline projects in northern Alberta and British Columbia could be applied to proposed pipelines north of 60°. A related question was whether Canadians could learn about the social and environmental side effects of northern pipeline projects from experience gained in the USSR and Alaska, or from previous northern Canadian projects such as the Distant Early Warning (DEW) Line, the Great Slave Lake Railway, mineral development, or oil and gas exploration. At an early date the Committee determined that while some information was available, it was very limited in nature, and that Government required specific research in order to properly assess any applications that might be received. Therefore, Government decided in 1971 that funding for Mackenzie valley-northern Yukon pipeline studies should be increased from about $1.5 million to about $4.5 million for that year and that an accelerated research program should continue for a further three years with the funding up to $5 million per year.

A.5.11 Over 100 reports have been published from the studies and research projects carried out for the Environmental-Social Committee. Most have been published as Environmental-Social Committee reports, but some have been published by other government agencies, as papers in various journals, or in the proceedings of conferences. (For a current listing of publications resulting from work for the Environmental-Social Committee see Appendix II.)

A.5.12 As industry had already begun planning and research on the proposed pipeline at least as early as 1970, it was necessary to provide some guidance on Government's anticipated requirements. Moreover, it was vital to Canadian economic growth and the protection of the northern environment that Government's policies related to this major economic development be stated publicly. Therefore, on August 13, 1970, government guidelines for the construction and operation of northern oil and gas pipelines were announced jointly by the Hon. J. J. Greene, then Minister of Energy, Mines and Resources, and the Hon. Jean Chrétien, Minister of Indian and Northern Affairs.

A.5.13 The 1970 Pipeline Guidelines established requirements related to environmental protection, pollution control, Canadian ownership and participation, and the training and employment of northern residents. These 1970 Guidelines are reproduced in Appendix III of this report.

A.5.14 It was clear by 1971 that some aspects of the 1970 Guidelines should be presented in more detail. Therefore, the Expanded Guidelines were announced on June 28, 1972. They dealt with the corridor concept and the environmental and social implications of northern pipelines; and provided further direction to companies engaged in research and planning for northern pipelines. They are also included in Appendix III of this report.

A.5.15 The March 28, 1972 report by the Hon. Jean Chrétien to the Standing Committee on Indian Affairs and Northern Development is of special importance as far as overall oil and gas development in the North is concerned. This report on the Government's northern objectives, priorities and strategies for the 1970's was based on the conviction that: "The needs of the people in the North are more important than resource development and that the maintenance of ecological balance is essential."

A.5.16 The 1972 report to the Standing Committee stated that Government's national objectives in the North were: "(i) to provide for a higher standard of living, quality of life and equality of opportunity for northern residents by methods which are compatible with their own preferences and aspirations; (ii) to maintain and enhance the northern environment with due consideration to economic and social development; (iii) to encourage viable economic development within regions of the northern territories so as to realize their potential contribution to the national economy and the material well-being of Canadians; (iv) to realize the potential contribution of the northern territories to the social and cultural development of Canada; (v) to further the evolution of self-government in the northern territories; (vi) to maintain Canadian sovereignty and security in the North; and (vii) to develop fully the leisure and recreational opportunities in the northern territories."

A.5.17 These seven national objectives present the setting for future northern development projects. In addition, the Council of the Northwest Territories expressed its views on a Mackenzie valley pipeline in passing the following motion on February 1, 1973: "Now therefore, I move that the Council of the Northwest Territories formally recommend and support the construction of a pipeline or a systems corridor development through the Mackenzie Valley provided there is: (i) optimum participation and involvement of the Government of the Northwest Territories and territorial residents in the planning, route selection, financing and policies pertaining to the construction and operation of the pipelines; (ii) optimum employment of Northerners during the planning, construction and operation of the pipelines; (iii) provision for just and equitable compensation of any person or persons adversely affected as a direct result of the pipeline construction; and (iv) adequate provision for the protection of the environment along the pipeline route with minimum disturbance to wildlife and persons living off the land."

A.5.18 In summary, Government's responses to proposed northern pipelines have been guided by the principle that an applicant would be required to show that any proposed pipeline system would be 'acceptable' from socio-economic and environmental points of view. Even though this responsibility would rest with any applicant, Government was aware of the need to assemble its own information on socio-economic and environmental concerns so that it could adequately assess any application to construct a Mackenzie valley-northern Yukon pipeline from a position of independence.

B

The Work of the Environmental-Social Committee

B.1 Organization and Scope of this Report

B.1.1 There are four main parts to this report. The first is an outline of proposals for developing northern pipelines and the study program that resulted from of these proposals (Chapters A and B). Next is a description of the current setting of the natural environment (Chapter C), the people (Chapter D) and resource use (Chapter E) in the study area. The third main section discusses the implications for the study area of a decision to construct a gas or oil pipeline in the Mackenzie valley and northern Yukon (Chapter F). The final part (Chapter G) summarizes the main conclusions and recommendations from studies carried out under the Environmental-Social Program.

B.1.2 The discussion of socio-economic and environmental implications of proposed northern pipelines concentrates upon *what* is considered to be important. *Where* the effects might be greatest must also be identified. Socio-economic or environmental concerns occurring in just one place must be distinguished from those occurring either at various locations or throughout the study area. This geographic identification requires fairly detailed discussion and is therefore considered beyond the scope of this report. (More detailed discussions of the environmental and socio-economic implications are found in reports of the studies and research carried out for the Environmental-Social Committee listed in Appendix II.)

B.1.3 The subject of alternative routes or methods of moving oil and gas from the Canadian North was beyond the scope of the Environmental-Social Committee. In addition, it was not within the terms of reference of this Committee to select a route for proposed pipelines that appeared most suitable from environmental or socio-economic points of view. However, several individual reports prepared for the Environmental-Social Committee do contain recommendations concerning alternative areas that appear suitable for locating pipeline routes, and areas to be avoided.

B.1.4 Environmental and socio-economic implications are viewed differently depending on whether one is a proponent of the project, someone personally affected by its execution, or the Government (Benn, 1973). For the proponent of a project, such assessments are an integral part of corporate planning, as exemplified by the environmental and socio-economic reports prepared to accompany a northern pipeline application. For those affected by a project, personal interests must be safeguarded. In contrast, Government must view the entire proposal and all of its implications more broadly. To accomplish this purpose, Government has had to gather much of its own information for use in decision making. This type of information is outlined in this report in relation to proposals to develop northern pipelines.

B.1.5 This report refers to environmental and socio-economic *influences* or *implications* rather than *impacts* because they allow consideration of both good and bad effects, whereas the term *impact* usually implies consideration of only the negative effects. Furthermore, *environmental impact* is now associated with very specific United States legal and administrative requirements which have no precise Canadian counterpart. The approach in this report is to present and discuss the general environmental and socio-economic implications of a gas or oil pipeline in the North. If a northern pipeline project is approved, many of these points could serve as the bases for recommending practices to reduce the undesirable influences of such a development.

B.2 Definition of the Study Area

B.2.1 An initial assumption in defining the study area was that proposed pipeline routes would have to satisfy the following criteria: (i) they would originate at a proven source of oil or gas and (ii) they would pass through or near areas potentially rich in hydrocarbons. Prudhoe Bay met the first criterion, and the Mackenzie delta also appears likely to meet it. The north slope (in Alaska and in Canada) and the Mackenzie delta would meet the second criterion. On this basis, the 1970 Pipeline Guidelines provided for the establishment of a 'corridor' to enclose trunk oil and gas pipelines. The following broad 'corridors' were identified in the 1972 Expanded Guidelines: "(i) along the Mackenzie Valley region (in a broad sense) from the arctic coast to the provincial boundary; and (ii) across the northern part of the Yukon Territory either adjacent to the arctic coast or through the northern interior region from the boundary of Alaska to the general vicinity of Fort McPherson, and thus to join the Mackenzie 'corridor'" (Appendix III). These broadly defined 'corridors', plus all the routes proposed by the various pipeline consortia, were the main criteria in defining the area of study.

B.2.2 The general area covered by studies under the Environmental-Social Program are shown diagramatically in Fig. B-1.

B.2.3 The area covered by the survey and mapping projects was sufficiently broad to include the proposed alternative routes through the northern Yukon and up the Mackenzie valley. The geographic area for the mapping projects was also determined by the official boundaries of map sheets within the National Topographic Series because an entire area was mapped even if one segment was some distance from a proposed route. In general, studies under the Environmental-Social Program

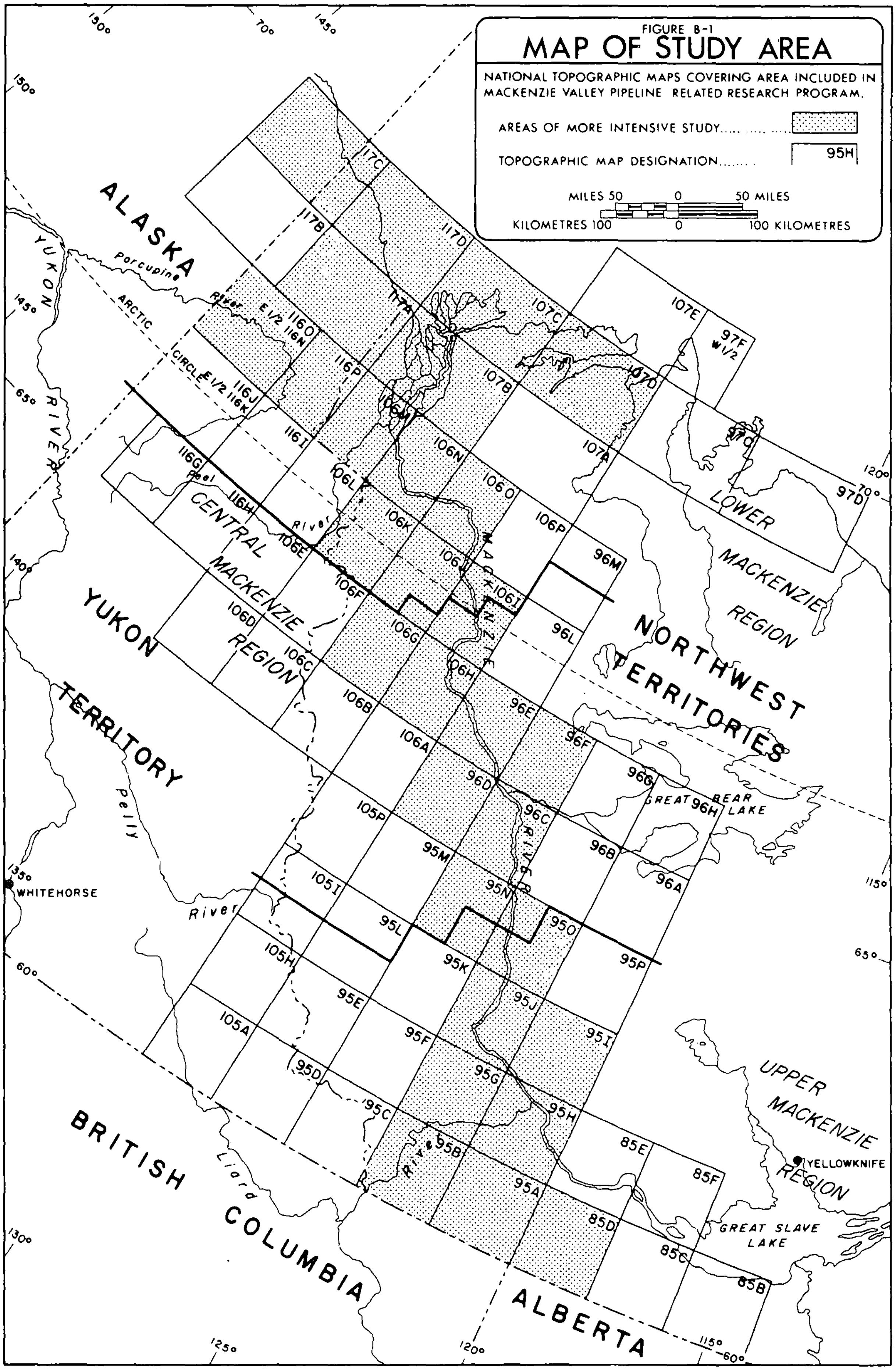


FIGURE B-1
MAP OF STUDY AREA
NATIONAL TOPOGRAPHIC MAPS COVERING AREA INCLUDED IN MACKENZIE VALLEY PIPELINE RELATED RESEARCH PROGRAM.
AREAS OF MORE INTENSIVE STUDY
TOPOGRAPHIC MAP DESIGNATION
95H
MILES 50 0 50 MILES
KILOMETRES 100 0 100 KILOMETRES
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
CENTRAL MACKENZIE REGION
LOWER MACKENZIE REGION
UPPER MACKENZIE REGION
GREAT BEAR LAKE
GREAT SLAVE LAKE
WHITEHORSE
YELLOWKNIFE
ARCTIC CIRCLE
YUKON RIVER
Porcupine River
Peel River
Pelly River
Liard River
MACKENZIE RIVER

became more restricted geographically once the original survey and mapping phases were completed and once some route alternatives were no longer being considered by the pipeline consortia.

B.2.4 It was impossible to define the study area precisely using a single geographic boundary for all socio-economic and environmental studies. For example, environmental studies concerned with the relationship between vegetation, soils and proposed construction activities could be confined to an area within a few miles of possible pipeline route alternatives. In contrast, things moving in or on the water required broad geographic coverage. For example, floods or ice jams which are a concern for proposed stream crossings, might be triggered by events in a watershed 100 miles or more away; if a man made structure interrupted the passage of fish through a stream, the effects might be felt in a domestic fishery many miles away; and oil spilled in the Mackenzie River near its delta could affect not only the delta but also marine mammals and waterfowl in near-shore areas of the Beaufort Sea. The barren-ground caribou in the northern Yukon provide a different kind of example since the area of concern is defined by their natural range, which includes virtually all of the Yukon north of the latitude of Dawson City. It is possible therefore to show two things on the map of the study area: (i) the broad area that includes all subjects under investigations; and (ii) the narrower band in which most investigations were concentrated (Fig. B-1).

B.2.5 The geographic area for socio-economic investigations is also rather broad. All northern communities would be influenced to some extent by a pipeline construction program in the Mackenzie valley and northern Yukon. However, an area extending about 50 miles on either side of proposed pipeline routes encompasses most of the communities that would be directly influenced by proposed pipelines. Some additional communities outside the 50 mile limit were included because of such considerations as transportation, traditional land use and employment.

B.2.6 Eighteen communities are grouped into regions within this zone of influence. The *lower Mackenzie region* includes Fort McPherson, Aklavik, Tuktoyaktuk, Inuvik and Arctic Red River. The *central Mackenzie* includes Fort Good Hope, Colville Lake, Norman Wells, Fort Norman and Fort Franklin. The *upper Mackenzie* includes Wrigley, Fort Simpson, Nahanni Butte, Fort Liard, Jean Marie River, Trout Lake, Fort Providence, Hay River and Enterprise. The *northern Yukon*, including the settlement of Old Crow, is discussed separately.

B.2.7 The routes of proposed pipelines from the Arctic Islands or the marine areas between these islands are not included in the study area. Marine offshore areas were not covered by research under the Environmental-Social Program except in relation to such questions as the effects of pipeline related oil spills in the Mackenzie River and its delta on migrating waterfowl, marine animals or fish in the near-shore areas.

B.2.8 The specific areas studied in each research project under the Environmental-Social Program are indicated in Fig. B-2.

Figure B-2 Research Projects under the Environmental – Social Program

Project	Agency	Objectives	Duration	Location
Environmental Studies				
Meteorological aspects of site selection and snow road construction	Atmospheric Environment Service, Environment Canada	With respect to weather around settlements to: (i) define the critical factors in ice fog occurrence; and (ii) develop methods for predicting meteorological problems arising from locations of various exhaust producing facilities. Regarding snow roads – to obtain information on snowfall and patterns of snow cover to determine potential for snow road construction.	1972-75	Norman Wells (some information from other locations included)
Hazards associated with gas pipeline breaks	ALUR Program, Indian and Northern Affairs	To assess the possibilities of gas pipeline breaks and the hazards that would result from such breaks. Particular attention was given to explosion and fire harzards and to identification of precautionary measures.	1973	Study area
Energy budget components in the arctic environment	ALUR Program, Indian and Northern Affairs	To determine the effect of surface disturbance on the amount of solar energy absorbed at the earth's surface. The results can be used to assist in predicting the extent of permafrost degradation and in selecting construction procedures to minimize degradation.	1971-74[1]	Tuktoyaktuk and sites in the Mackenzie delta

Figure B-2 Research Projects under the Environmental – Social Program *(continued)*

Project	Agency	Objectives	Duration	Location
Stream flow surveys	Water Survey of Canada, Environment Canada	Metering and sampling of various watercourses to: (i) obtain hydrometric discharge data for estimating river levels and flood magnitudes; and (ii) sample sediment conditions in areas important to fish.	1971-75[1,2]	Mackenzie River, some tributaries, and rivers in northern Yukon
Water quality surveys	Water Quality Division, Environment Canada, Regina	Sampling survey to: (i) determine water quality; (ii) relate water quality to identifiable disturbances; and (iii) determine nutrient content of freshwater for fish from aquatic ecology studies.	1971-75[2]	Mackenzie River and major tributaries
Hydrologic aspects of northern pipeline development	Glaciology Division, Water Resources Branch, Environment Canada	A series of studies designed to: (i) study sedimentation and erosion with respect to river beds and banks; (ii) determine the form, character and stability of lakes and their shores; (iii) determine location and severity of ice jamming on river banks and ice scour on river beds; (iv) relate snow cover to spring floods; (v) evaluate freeze-up and breakup data regarding travel on rivers or on the thawed tundra; (vi) estimate the likelihood, severity and location of extreme events in rivers; (vii) develop methods for flow estimation in ungauged streams; (viii) identify areas of groundwater recharge and discharge; and (ix) study the behavior of oil in mixture with ice and water.	1971-75 (some earlier data incorporated)	Mackenzie River and rivers in northern Yukon
Aquatic ecological studies	Freshwater Institute, Fisheries Research Board, Environment Canada, Winnipeg	Basic studies to: (i) obtain predisturbance data on aquatic life in lakes, streams and rivers; (ii) determine biological effects of silt, oil and industrial chemicals likely to be used in pipeline development; and (iii) assess stream crossing disturbances, especially for organisms found at the bottom of lakes and streams because of their 'early warning' capabilities, and because they are basic to the food chain for fish.	1971-75	Mackenzie River and rivers in northern Yukon
Fishery surveys in the Mackenzie valley and northern Yukon	Fisheries Service, Environment Canada	Generally to provide a qualitative and quantitative assessment of fish stocks so that predisturbance productivity levels can be protected. More specifically to: (i) determine species composition, distribution, age size relationships, growth and feeding characteristics; (ii) compile stream catalogues that identify chemical and physical features of streams important to fish spawning, rearing, feeding, migration and overwintering; (iii) assess the importance of fish resources for native use and for sport and commercial fishing; and (iv) define areas of particular sensitivity because of their importance for spawning, migration or human use.	1971-75	Entire length of Mackenzie River and all tributaries that could be crossed by pipeline; and rivers in northern Yukon
Marine ecology of the Mackenzie delta region	Arctic Biological Station, Fisheries Research Board, Environment Canada, Ste. Anne de Bellevue	A study of oil on the northern shoreline environment to examine: (i) the direct effects on near-shore marine life; (ii) the ability of bacteria and marine invertebrates to degrade oil in an arctic marine shoreline environment; and (iii) the effects of sublethal concentrations of oil upon the growth and reproduction of invertebrates.	1973-75	Beaufort Sea, Liverpool Bay and Eskimo Lakes

Figure B-2 Research Projects under the Environmental – Social Program *(continued)*

Project	Agency	Objectives	Duration	Location
Terrain surveys	Geological Survey of Canada, Energy, Mines and Resources	A general survey to provide information on surface materials and formations including ground ice, river banks, coastal and near-shore conditions. Maps were prepared at 1:125,000 scale. The survey included two specific investigations noted below:	1971-75	Study area
1. Physical characteristics of the arctic coast		An onshore and coastal study to: (i) obtain information on coastal retreat, sedimentation and erosion and the processes involved, distribution of marine sediments, and position of frost table on these sediment bodies; and (ii) prepare an inventory of coastal conditions.	1972-74	Yukon coast and Tuktoyaktuk peninsula
2. Sediments and seabed conditions, Mackenzie Bay and continental shelf		An offshore and continental shelf study to: (i) inventory seabed materials and distribution, describe landforms, and characteristics of ground ice; and (ii) document nature and rate of sedimentary and erosion processes in the shelf, and particularly all aspects of ice scouring.	1971-75[1]	Mackenzie Bay and continental shelf
Geothermal properties of near-surface materials	Earth Physics Branch, Energy, Mines and Resources	To determine heat flow, surface ground temperatures, and thermal properties of frozen materials in areas that could be subject to disturbance and thaw.	1972-75	Study area
Topographic mapping and air photography	Surveys and Mapping Branch, Energy, Mines and Resources	A new coverage of air photography was flown to aid in map preparation and interpretation of terrain conditions, hydrology, vegetation and wildlife. Topographic maps at 1:50,000 scale were prepared for the proposed pipeline corridor areas of the Mackenzie valley and northern Yukon to serve as a base for various environmental and social studies and other aspects of pipeline planning.	1971-73	Study area
Earthquake hazard	Seismology Division, Earth Physics Branch, Energy, Mines and Resources	Seismic studies supplementing the National Seismological Program were undertaken to: (i) provide an inventory of variations in the magnitude of earthquake hazard throughout Mackenzie valley, northern Yukon and adjacent Alaska; and (ii) locate areas of highest seismic risk.	1971-75[1,2]	Study area
Properties and performance of permafrost terrain	Geological Survey of Canada, Energy, Mines and Resources	Comprehensive permafrost studies to: (i) determine nature and extent of ground ice, develop ground temperatures profiles, determine thermal properties of frozen materials and their influence on terrain performance; (ii) determine the characteristics of the 'active layer', and its influence on terrain performance and movement of surface water; (iii) provide information on engineering properties of frozen and thawed materials, on slope stability and other terrain hazards of importance in land use planning and designing safe pipelines; (iv) document changes in permafrost resulting from man made disturbances to predict possible effects of pipeline development; and (v) develop geophysical methods for delineating ground ice and permafrost.	1971-75	Study area

Figure B-2 Research Projects under the Environmental – Social Program *(continued)*

Project	Agency	Objectives	Duration	Location
Terrain inventory, sensitivity rating and mapping	Geological Survey of Canada, Energy, Mines and Resources and ALUR Program, Indian and Northern Affairs	A mapping project of the Mackenzie valley and northern Yukon to show surface and surficial materials, landforms, permafrost and ground ice, muskeg, soils, and terrain vegetation conditions. Maps and accompanying reports designed to serve as a basis for other environmental research – such as granular survey and terrain sensitivity ratings; and to aid in assessment of pipeline routing and design.	1971-75	Study area
Vegetation and disturbance studies and vegetation mapping	Northern Forest Research Centre, Forest Management Institute, Canadian Forestry Service, Environment Canada	A mapping exercise to: (i) determine relationship between vegetation, landforms, and soil characteristics and ice content; (ii) record reaction of soils and vegetation to man made disturbances with emphasis on restoration of active layer; and (iii) map and describe forest and non-forest vegetation and locate recent burns.	1971-75	Study area
Disturbance studies in the Mackenzie River region	ALUR Program, Indian and Northern Affairs	Studies designed to develop guidelines for procedures to reduce damage to various kinds of vegetation and terrain during pipeline construction. The studies consisted of documenting: (i) the effects of heavy vehicle traffic and other man made disturbances in permafrost areas (such as winter roads, seismic lines, drill sites, etc.) to determine the effects on vegetation and terrain; (ii) similar disturbances in the forested area of the Mackenzie valley, with emphasis on erosion hazards created by major surface disturbances – particularly the removal of the vegetation cover.	1972-74	Mackenzie delta region
Soils, vegetation, landform relationships in boreal forest region of Mackenzie River valley	ALUR Program, Indian and Northern Affairs	To appraise vegetation, soils and landform relationships with particular reference to erosion hazard created by removal of forest cover and construction.	1971-72	Wrigley area
Vegetation studies in the Mackenzie delta region	ALUR Program, Indian and Northern Affairs	The study generally investigated revegetation problems in permafrost areas through use of experimental plots. Specifically the study sought to: (i) determine how assisted revegetation restores stability to disturbed areas in the permafrost zones; (ii) evaluate the overwintering capability of various species, and the use of mulches, fertilizers, transplants and various horticultural techniques; and (iii) investigate the special problems of re-establishing vegetation on burned areas.	1973-74 (some earlier data incorporated)	Lower Mackenzie valley
Land based oil spills	ALUR Program, Indian and Northern Affairs	Studies of the effects of summer and winter oil spills of northern crude oil on the physical, biological and microbiological environment were carried out to investigate: (i) the ecological consequences; (ii) techniques of ecological restoration after oil spills; and (iii) methods of prevention, containment and recovery of oil spills.	1972-75	Norman Wells and northern Alberta

Figure B-2 Research Projects under the Environmental – Social Program *(continued)*

Project	Agency	Objectives	Duration	Location
Waste disposal study	ALUR Program, Indian and Northern Affairs	To investigate the various methods of sewage disposal (lagoons, biological and physiochemical treatment plants) and solid waste disposal (land fill, shredding, incineration) with particular reference to their applicability to northern climatic conditions. This project was designed to establish standards, and to obtain information that could be used to set terms and conditions for waste disposal during construction and operation of possible pipelines.	1972-75 (some earlier data incorporated)	Study area
Wildlife ecological studies	Special Habitat Evaluation Group, Canadian Wildlife Service, Environment Canada	Generally to map all proposed pipeline routes to show locations of habitat and areas used by: waterfowl, fur bearers, barren-ground caribou (including migration routes), moose, grizzly bear, arctic fox and Dall sheep. Other specific objectives were to: (i) collect distributional data for raptorial birds; (ii) prepare qualitative ratings of habitat units for various wildlife species; and (iii) determine tolerance levels of various wildlife species to disturbances from aircraft.	1971-75	Study area
Pipeline regulations	National Energy Board	To develop appropriate regulations and control measures concerning: (i) the design, construction and operation of any pipelines to minimize erosion; (ii) drainage along pipeline ditches to prevent washouts; and (iii) construction methods in permafrost with different types of soil. Much of this work involved translation of the findings of other investigations into actual technical requirements for proposed pipeline construction and operation.	1971-74	Ottawa
Evaluation of line pipe and pipeline steel	Physical Metallurgy Division, Mines Branch, Energy, Mines and Resources	To evaluate the suitability of large diameter line pipe available from commercial sources for use under arctic conditions and to develop weldable pipe steel of improved strength and toughness adapted to northern conditions.	1971-75	Ottawa
Contingency planning	ALUR Program, Indian and Northern Affairs	To define the requirements for a contingency plan that could deal with pipeline breaks or other pipeline related accidents.	1973-74	Calgary
Socio-Economic Studies				
Archaeological and historic sites	Northern Affairs Program, Indian and Northern Affairs; National Museum of Man; and governments of the Yukon and the Northwest Territories	Reconnaissance surveys: (i) the *archaeological survey* was to identify principal areas of archaeological and historical interest along the proposed pipeline routes, and to establish procedures for preservation and/or recovery of the resource;	1972-75	Study area

Figure B-2 Research Projects under the Environmental – Social Program *(continued)*

Project	Agency	Objectives	Duration	Location
		(ii) the *historical survey* was to identify principal sites such as old trading posts that are of potential recreational or tourism interest for avoidance in route selection.		
Sociological overview studies	Governments of the Yukon and the Northwest Territories	Surveys conducted in both territories were designed to: (i) examine the pertinent socio-economic research of each area; (ii) review and analyze the applications of present government social programs and to identify problems; and (iii) provide current data on certain social factors for communities along the route of the proposed pipeline.	1973-74	Study area
Labour force information and status study	Northern Affairs Program, Indian and Northern Affairs and government of the Northwest Territories	The initial study was designed to develop and test an information system for ascertaining the status of labour force with respect to availability, skills and training requirements on a continuous basis. A further study evaluated the progress being made by adult education and training programs in placement and employment of graduates, particularly from the Northwest Territories vocational training centre at Fort Smith.	1973-75	Mackenzie valley communities
Regional impact of a northern gas pipeline	Northern Affairs Program, Indian and Northern Affairs and MPS Associates Ltd., Winnipeg	An omnibus work covering the socio-economic impact of a gas pipeline on the Mackenzie valley area. Objectives of the studies were as follows:	1972-73	Study area
1. Relevant aspects of pipeline construction and operation in the territories and impact on local petroleum resources		To provide the background information on pipeline location, materials and labour requirements, scheduling of work, etc., and an assessment of impact on territorial employment.		
2. Impact of a pipeline on territorial transportation facilities, resource output and industrial development		(i) To project future employment statistics from present trends; (ii) to project future employment statistics in terms of additional requirements related to pipeline development; (iii) to examine the relationship of the proposed pipeline to mineral development; and (iv) to review the present status and likely future for renewable resources, utilities and industrial development.		
3. Impact of pipelines on selected territorial communities		To comment on the practicality of siting pipeline operation and maintenance centres in certain communities and to discuss the overall implications of the proposed pipeline development on a number of Mackenzie valley communities.		
4. Impact of pipelines on traditional activities of hunter/trappers in the territories		To present background and baseline data on the traditional activities (hunting, trapping and fishing) of northern people; and to comment on the economic importance of the traditional base and the possible impacts of a northern gas pipeline in the Mackenzie valley.		

Figure B-2 Research Projects under the Environmental – Social Program *(continued)*

Project	Agency	Objectives	Duration	Location
5. Impact of pipelines on territorial population, labour force, employment and income		To provide data on population, labour force, incomes and work patterns in order to project the effects of the proposed pipeline on: (i) the demand for pipeline workers by numbers and occupation groupings; (ii) labour requirements during impact period; (iii) potential supply of Northerners based on present and projected training and experience; and (iv) the influence of proposed pipeline development on the work patterns and incomes of Northerners.		
6. Analysis of overall territorial impact of a through gas pipeline		To assess the overall impact of a pipeline by: (i) evaluating the current population, labour force, occupational experience and cash incomes in the territories; (ii) projecting population, labour force by occupation, and anticipated income for various stages of construction and operation; and (iii) estimating the net benefits of a gas pipeline to the Northwest Territories.		
Old Crow community impact study	Northern Affairs Program, Indian and Northern Affairs	To consolidate and bring up to date information related to local economy, resource base and land use, and the social organization of the community. To estimate the probable effects of a Porcupine River routing versus a coastal routing with reference to both construction activity and establishment of a maintenance centre in the community.	1973-74	Old Crow
Potential social and psychological effects of pipeline development on native people	Northern Affairs Program, Indian and Northern Affairs	To assess the implications of pipeline construction and operation on the social structures of the communities; and the problems of native people of psychological adaptation to such change. Attention is given to the effects of new employment opportunities, changing life styles, the growth of non-native population and the adaptation of native people to geographic relocation.	1973-74	Selected communities in the study area
Ethnic relations in the North	Northern Affairs Program, Indian and Northern Affairs	To examine the effect on ethnic relations of the rising expectations of native people brought about by recent increased development in some communities and their limited realization of these expectations due to certain barriers. From this analysis a projection is made of the likely effects of the proposed pipeline development on inter-group tensions, and the main issues are discussed.	1973-74	Selected communities in the study area
Studies related to monitoring and assessment of the socio-economic effects of pipeline development	Northern Affairs Program, Indian and Northern Affairs and government of the Northwest Territories	Initial study designed an information system to gather and measure certain socio-economic parameters considered important to local communities. The second phase consists of field checking the validity of the variables in the settlements, and assuring that the system would be useful for future monitoring of changes caused by the pipeline development.	1973-75	Selected communities in the study area

Figure B-2 Research Projects under the Environmental – Social Program *(continued)*

Project	Agency	Objectives	Duration	Location
Housing and community development study	Department of Local Government, Northwest Territories	A series of studies designed to: (i) inventory present housing and estimate future requirements related to proposed pipeline development; (ii) assess the potential of selected communities to provide land and service facilities required for future housing developments; and (iii) develop a series of community development plans for those centres requiring immediate action.	1973-75	Mackenzie valley communities
Northwest Territories' corridor development plan	Government of the Northwest Territories	Planning and work programs to: (i) develop policies for recommendations to the federal government concerning the proposed pipeline; (ii) develop policies and programs for implementation by the Northwest Territories government; and (iii) develop a comprehensive and integrated plan to ensure maximum benefit and minimum disruption to the Northwest Territories as a result of the proposed pipeline.	1972-75	Study area in the Northwest Territories
Dissemination of pipeline and highway information	Indian and Eskimo Affairs Program, Indian and Northern Affairs	To improve the native people's understanding of what a pipeline development would involve, the benefits that could accrue to individuals and the group, and how Natives might go about preparing themselves to realize these benefits. In addition, the project sought to improve their understanding of the adverse consequences of pipeline development and how such harmful effects might be countered. The project was initiated on agreement of several native associations, the communities, and both levels of government who then acted jointly in the dissemination of basic information to the native people in the study area.	1972-74	Communities in the study area
Entrepreneurial opportunities studies	Department of Industry and Economic Development, Northwest Territories	First order feasibility investigations to: (i) project opportunities arising from proposed pipeline development; (ii) forecast the likelihood of Northwest Territories residents capitalizing on these opportunities; and (iii) make recommendations on how to maximize the participation of Northwest Territories residents, and particularly native people, in pipeline related opportunities.	1974-75	Mackenzie valley communities
Resource Use Studies				
Land use information map series	Land Use Planning Branch, Environment Canada and ALUR Program, Indian and Northern Affairs	To produce a series of 44 land use maps (1:250,000 scale) that show current land uses and a wide range of data on renewable resources including: wildlife, hunting and trapping areas; fish resources and fishing; areas of recreational interest; archaeological and historical sites; extent of Development Control Zones; locations of proposed ecological reserves; water survey and water quality sampling stations; capped gas and oil wells; climatic data; fur statistics; community information; and transportation networks.	1971-72	Study area

Figure B-2 Research Projects under the Environmental – Social Program

Project	Agency	Objectives	Duration	Location
Porcupine caribou population study	Game Division, Northwest Territories	To develop information on the seasonal distribution and migration pattern of the herd from the standpoint of: (i) forecasting their continued importance to certain northern communities; and (ii) management considerations for appropriate harvesting.	1972-75	Richardson Mountains
Evaluation of fur resources along the proposed pipeline route, Northwest Territories.	Game Division, Northwest Territories	Consolidation of statistics and mapping to: (i) evaluate fur resources along the proposed route for management purposes because of increased accessibility and disturbance from proposed highway/pipeline development; and (ii) provide detailed maps of traplines and hunting and fishing areas for use by Government and industry in route selection.	1973-75	Study area in Northwest Territories
Economic and social significance of renewable resource harvesting for native people	Northern Affairs Program, Indian and Northern Affairs and government of the Northwest Territories	To examine and analyze the traditional activity base of hunting, trapping and fishing; and to estimate the contemporary significance of the renewable resources.	1973-74	Mackenzie valley communities

[1] Indicates work being carried on by the responsible department prior to commencement of research under the Environmental-Social Program

[2] Indicates work to be continued indefinitely by the responsible department after completion of research under the Environmental-Social Program

B.3 Definition of the Research Objectives

B.3.1 The specific objectives of studies for the Environmental-Social Committee are summarized in tabular form in Fig. B-2 above. These reflect several broad purposes, the most important being to: (i) predict specific interactions with proposed pipeline developments; (ii) describe and map the current environmental, socio-economic and resource use setting in the study area; and (iii) provide support, in the form of baseline data, for other pipeline related studies and for assessment of actual side effects during the life of proposed pipeline projects. Fig. B-2 also identifies the agency or contractor responsible for each project and the duration of each study. Appendix II lists studies and reports published under the Environmental-Social Program; reports prepared under the Program and published by other government agencies; and reports based on work conducted under the Program and published by non-government agencies.

B.4 Present State of Knowledge

B.4.1 Most of the reports prepared for the Environmental-Social Committee contain sections summarizing the current state of knowledge and report on and discuss current investigations. For details on any given subject the interested reader is referred to these sections in the appropriate reports listed in Appendix II.

B.4.2 Apart from use of the study results during assessment of any pipeline application, the Environmental-Social Committee reports and maps have added greatly to understanding the northern environment and its renewable resources. The knowledge gained is equally useful for planning and assessing highways and other development projects.

B.4.3 On the social side, this Program has provided baseline information on such subjects as: population and labour force trends; local economy and standard of living; sources of income and employment; and resource use practices; as well as information on trends in social change and archaeological resources. It should therefore be possible to measure future social and economic changes in the study area.

B.4.4 Environmentally, this Program has provided a baseline of current data against which future conditions can be compared for a wide variety of subjects. These include: surface terrain conditions; vegetation; productivity and distribution of the fish resource; distribution of wildlife and their habitats; quality of water; and some information on rates and magnitudes of various physical and biological processes on land and water.

B.4.5 The broad environmental subject area most in need of additional information is how various ecological factors interact to produce secondary effects, which are often either some distance from observable primary effects or considerably delayed in time. Such information cannot be obtained from a three or four year program. Long term site specific studies of environmental processes will eventually be needed to determine the *actual effects* of such projects as proposed pipelines and to develop ecologically sound methods for managing renewable resources. Concerning the abiotic environment, many of the unanswered questions of the physical sciences result from the absence of techniques that allow accurate prediction of the existence or thickness of ground ice. Turning to the biotic environment, the physical, chemical and biological characteristics of northern freshwater systems under *winter* conditions are generally poorly documented. Fishery, wildlife and vegetation inventory studies under the Environmental-Social Program have identified various habitats that might be adversely influenced by proposed pipeline construction and operation. However, on the basis of present knowledge, it is not generally possible to state with precision the degree of adverse effects that proposed pipeline activities would have on fish and wildlife populations or habitats.

B.4.6 On the socio-economic side, the subject area most in need of further investigation is the cultural survival or revival of the native groups along the Mackenzie valley. Although sudden economic development has previously occurred in the region, the proposed pipeline development is of a scale never before experienced and there is concern regarding the effects of the rate of social and economic change on the native people. Recent hydro electric development projects in the northern area of the provinces are only roughly analogous to a pipeline; and before and after studies documenting the effects of these developments on nearby native settlements are largely non-existent. Nevertheless, systematic study of one or two recent developments in the provinces would be useful in identifying more precisely the key cultural elements most likely to be affected by the socio-economic changes usually associated with large scale construction projects. On the economic side, it would be extremely useful to undertake some pilot employment projects to find out if Natives' work adjustment improved when the usual work routine was modified.

C

The Natural Environmental Setting of the Study Area

C.1 The Northern Environment – How Different Is It?

C.1.1 The observation that pipelines have operated in northern Alberta and British Columbia for a considerable time without noteworthy environmental disturbances and without much apparent public concern leads to an obvious question: How is the northern environment different from areas now traversed by pipelines in the higher latitudes of the western provinces? Another practical question is: How far down the Mackenzie valley can we say that conditions are 'about the same' as they are in the northern part of the provinces where pipelines already exist?

C.1.2 This chapter describes the natural environmental setting of the study area giving particular attention to processes and features that make 'the North' ecologically different from 'the South'. This raises such questions as: Why is permafrost of such concern? Why is the North described as fragile? How do we differentiate among natural cycles, fluctuations, and man made disturbances? And how does the North compare to more temperate latitudes in its ability to recover from disturbances?

C.1.3 This chapter examines these questions through detailed discussions of the climate, physiography and drainage, geology and glacial history, hydrology and permafrost, soils, vegetation, wildlife and aquatic ecology of the study area.

C.2 Climate

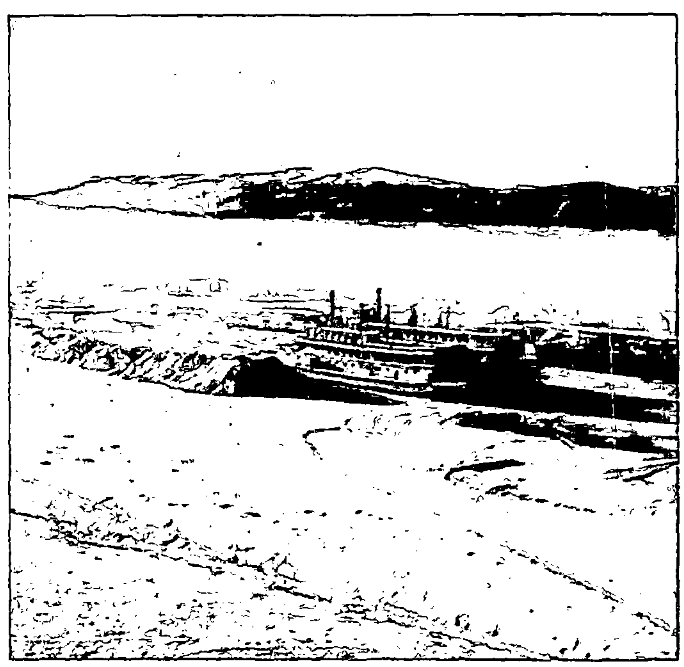
C.2.1 *General*

C.2.1.1 The climate, above all else, gives the study area its appearance of harshness. Even though adapted to survival in the harsh environment, all plant and animal life, including man, reach their limits of climatic tolerance in the Arctic. Climate gives a region its character when one climatic factor dominates all others, or when a combination of climatic factors is clearly unique. The *critical climatic factor* in the Arctic is the low temperature resulting from low solar radiation during ten months of the year, which affects all natural processes and completely dominates some. An example of a process *affected* by low temperatures is the recycling of nutrient chemicals. This process is slow because dead plant and animal materials decompose slowly at low temperatures. An example of a process *dominated* by the cold is the effect of permafrost which creates an impermeable layer that causes groundwater to remain at or near the surface. In an area that has low annual precipitation the abundant surface water creates a unique landscape in the tundra portion of the study area.

C.2.2 *Solar Radiation and Air Masses*

C.2.2.1 The long periods of daylight in summer and darkness in winter are also distinctive features of the arctic climate. The seasonal swing in length of daylight is more and more exaggerated the farther north one goes, so that Inuvik, near the northern end of the study area experiences 56 days of continuous daylight, in contrast to Toronto's longest day of 15 hours 27 minutes. This long period of daylight compensates in part for the shortness of the northern summer and permits rapid plant growth during the short growing period.

C.2.2.2 The long period of darkness, on the other hand, is particularly depressing to people who are restricted to northern settlements during the winter. All outdoor activities, especially construction work, are complicated by darkness. The winter night also contributes to temperature inversions which are common and more persistent in the North than elsewhere (Burns, 1973). These temperature inversions, with the coldest air at ground level, are mainly due to heat loss from the ground when the sun is either low or below the horizon. When the temperature falls below -34°C (-30°F) under inversion conditions, excess moisture in the air forms ice fog which greatly limits visibility (Fig. C-1).



R.S. Finnie

Fig. C-1(a) Ice fog effects, Whitehorse, Yukon. Some topography shows above ice fog which has formed in an inversion layer where a temperature of -36°C (-32°F) was recorded.

J.G. Holty

Fig. C-1(b) Ice fog effects, Fairbanks, Alaska. There is good visibility at -18°C (-1°F), but it is greatly reduced by ice fog at -44°C (-47°F).

C.2.2.3 Northward retreat of the Polar continental air mass in spring coincides generally with snowmelt and river ice breakup and the consequent increase in the land's ability to absorb heat from the sun. That is, the land's reflecting capability decreases when snow melts so that the earth's surface is warmed rapidly as the days of continuous sunlight commence (Fig. C-2). The usual spring flooding from snowmelt is aggravated by ice jams and by the persistence of ice cover in the lower reaches of major northward flowing rivers.

W.H. Prescott

Fig. C-3 Vegetation differences on north and south facing slopes. Black spruce are found on south facing side of valley near Sitidgi Lake (25 miles east of Inuvik, NWT). The colder north facing slope supports only tundra-like vegetation.

C.2.2.4 South facing slopes receive more heat than other slopes or flat surfaces. As a result soil and vegetation differences distinguish south facing from north facing slopes (Fig. C-3).

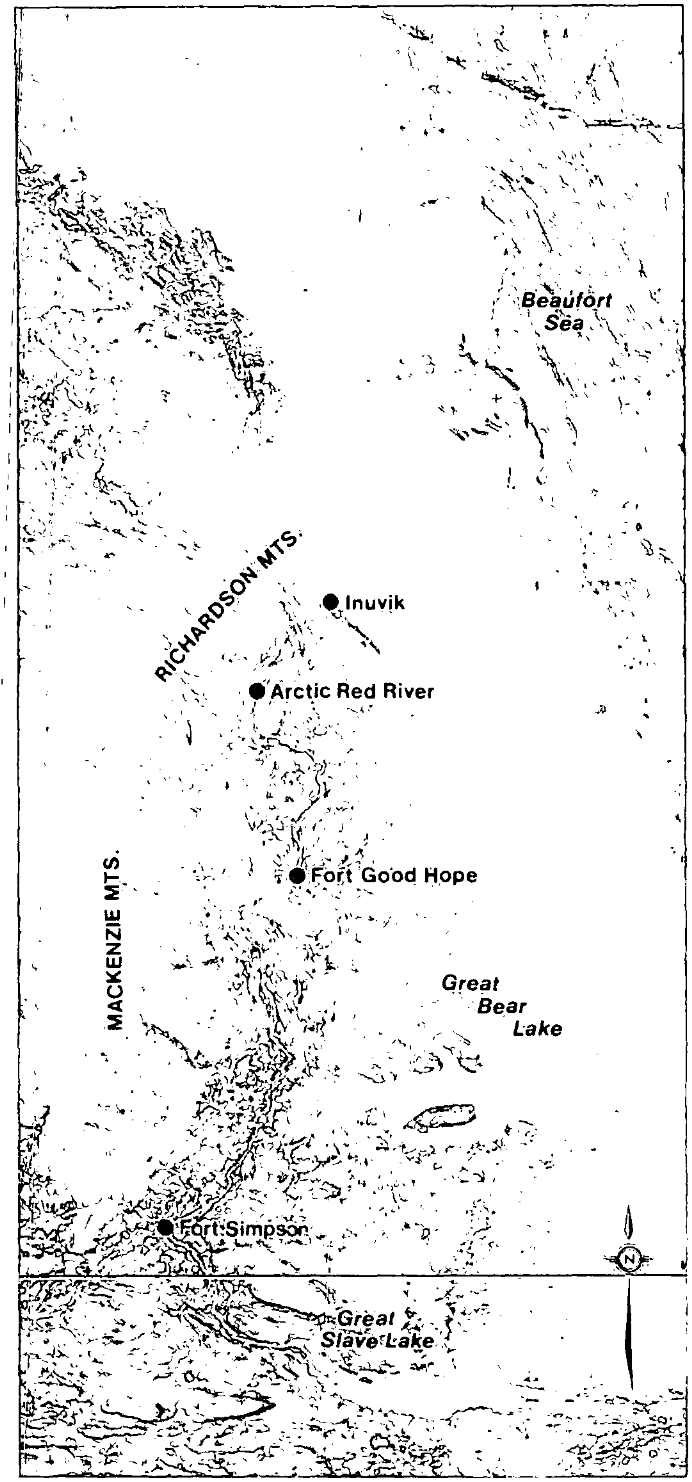
C.2.3 *Temperature*

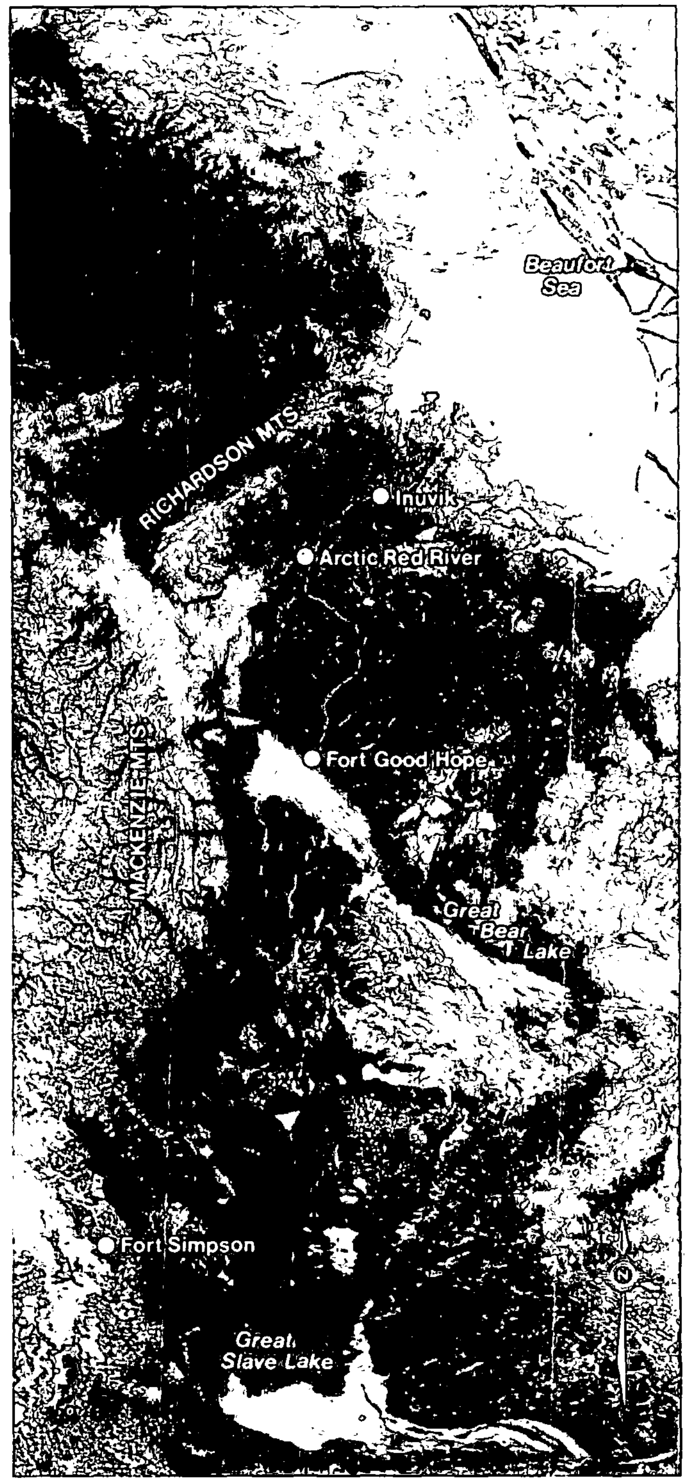
C.2.3.1 Permanently frozen ground (permafrost), a characteristic of northern latitudes, results in very different conditions from those in the South. Permafrost owes its persistence and, in some places, its recent formation to the low average annual temperature.

C.2.3.2 Winter, which is defined by the number of days with daily average temperatures below 0°C (32°F), varies from about 200 days at Fort Simpson in the NWT to over 250 days at Komakuk Beach in the Yukon. There are 230 and 300 days with frost at these locations respectively (Burns, 1973). This extended period of below freezing temperatures explains why over vast areas, only the few inches of soil near the surface thaw during the summer.

C.2.3.3 Meteorologists have identified six threshold daily average temperatures that usefully describe the climate of a region, both for understanding the significance of temperature in ecological processes and for planning purposes. These range from 18°C (65°F) below which indoor heating is required, to -40°C (-40°F), below which outdoor activities are severely limited. Fig. C-4 provides the percentage probabilities of daily average temperatures falling below these six thresholds for selected settlements in the study area. Some areas in southern Canada are also shown for comparison.

C.2.3.4 Although the climate in the study area is cold in comparison to southern Canada, the Mackenzie lowlands are significantly warmer than areas at the same latitude farther east. For example, there are between 35 and 135 per cent more frost





National Environment Satellite Service, NOAA

Fig. C-2 NOAA 3 weather satellite photographs of Mackenzie valley. Note snow covered landscape on April 16, 1974 (on left). Right hand photograph taken on May 20, 1974, shows relatively snow-free valley with snow persisting at higher altitudes, especially in the Mackenzie and Richardson Mountains. Ice cover still remains on all large lakes and along the arctic coast. Some open water exists at the mouth of the Mackenzie delta.

free days in the Mackenzie lowlands than in the uplands of the Keewatin. Expressed another way, the 'degree growing days' (the number of days above 6°C (42°F) multiplied by the number of degrees that the average daily temperature exceeds 6°C (42°F)) are between 10 and 100 per cent greater in the Mackenzie lowlands than farther east.

C.2.4 *Wind*

C.2.4.1 Popularization of the wind chill index has made Canadians well aware of the effect of wind on comfort and heating costs during the winter. Wind is another environmental factor of greater significance in the study area than in most settled parts of southern Canada. "Wind is a dominant factor of the tundra environment. It may force the fauna to take cover,

Figure C-4 Percentage Probability of Mean Daily Temperatures Falling Below Specified Temperatures *(Temperatures in Fahrenheit)*

Specified Temperatures	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15	July 15	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15
Tuktoyaktuk												
65°[1]	100	100	100	100	100	100	100	86	100	100	100	100
42°[2]	100	100	100	100	100	29	0	57	71	100	100	100
32°[3]	100	100	100	100	100	0	0	0	14	100	100	100
0°[4]	100*	100	86	57	0	0	0	0	0	0	43	71
−20°[5]	71	86	43	14	0	0	0	0	0	0	0	29
−40°[6]	14	0	0	0	0	0	0	0	0	0	0	0
Fort Simpson												
65°	100	100	100	100	100	89	49	73	100	100	100	100
42°	100	100	100	97	26	0	0	0	22	89	100	100
32°	100	100	100	58	0	0	0	0	0	54	97	100
0°	97	67	36	0	0	0	0	0	0	0	39	78
−20°	44	19	0	0	0	0	0	0	0	0	6	14
−40°	6	0	0	0	0	0	0	0	0	0	0	0
Vancouver												
65°	100	100	100	100	100	92	64	61	97	100	100	100
42°	81	61	33	3	0	0	0	0	0	0	39	56
32°	17	3	0	0	0	0	0	0	0	0	6	19
0°	0*	0	0	0	0	0	0	0	0	0	0	0
−20°	0	0	0	0	0	0	0	0	0	0	0	0
−40°	0	0	0	0	0	0	0	0	0	0	0	0
Winnipeg												
65°	100	100	100	100	94	63	26	37	91	100	100	100
42°	100	100	100	51	11	0	0	0	3	31	94	100
32°	100	100	83	11	0	0	0	0	0	3	71	100
0°	65	35	6	0	0	0	0	0	0	0	0	40
−20°	9	3	0	0	0	0	0	0	0	0	0	0
−40°	0	0	0	0	0	0	0	0	0	0	0	0
Toronto												
65°	100	100	100	97	91	60	20	26	68	100	100	100
42°	97	97	89	43	3	0	0	0	0	12	71	100
32°	80	89	40	6	0	0	0	0	0	0	31	77
0°	3*	3	0	0	0	0	0	0	0	0	0	0
−20°	0	0	0	0	0	0	0	0	0	0	0	0
−40°	0	0	0	0	0	0	0	0	0	0	0	0

[1] Below 65°F indoor heating is required
[2] Below 42°F vegetative activity is greatly reduced
[3] Below 32°F freezing of water occurs
[4] Below 0°F operation and maintenance problems become serious
[5] Below −20°F efficiency of outdoor labour is less than 25 per cent of that at 70°F
[6] Below −40°F northern native people generally become inactive outdoors
* For example, on January 15 there is a 100 per cent chance of the mean daily temperature being less than 0°F at Tuktoyaktuk, a nil chance at Vancouver and a 3 per cent chance at Toronto

Source of Data: Burns, 1973; Atmospheric Environment Service, Environment Canada, 1974

while being abrasive to the flora; rearrange the snow, either covering or exposing food; and create barriers to travel or provide a snow cover (crust) sufficiently hard to facilitate animal and, in extreme cases, heavy vehicle traffic. Thus, of major importance is the severe restriction on winter activities imposed by the combination of strong winds, blowing snow and low air temperatures" (Burns, 1973, p. 175; Fig. C-5).

C.2.4.2 The north coast of the study area, with its marked temperature contrasts between land and ice covered sea in summer, is characterized by intense winds. Wind velocity is generally much greater over water than over land; therefore, when cold fronts move over the coast winds may be two to four times as strong over the Beaufort Sea as over land (Burns, 1973). Strong winds also result from air flow over the Yukon mountain ranges, which create turbulence and very high velocity on the ridge crests, as well as strong downslope winds.

C.2.4.3 Such localized factors as valley direction (Norman Wells) or lake breeze effect (Hay River in summer) determine the direction of prevailing winds in the study area.

C.2.4.4 In summary, the study area is characterized by extremes in wind velocity; the unusual calms associated with prolonged temperature inversions and the unusually strong winds off the sea or in the vicinity of mountain ranges are sources of problems and discomfort in the Arctic.

Division of Building Research, NRC

Fig. C-5 Wind shaped spruce. The abrasive effect of wind driven snow is easily seen. Top of low spruce mat indicates protective winter snow depth. Note lack of branches in zone of maximum abrasion.

C.2.5 *Precipitation and Evaporation*

C.2.5.1 Geographers have long referred to the most northerly parts of Canada as a 'cold desert' because rainfall and snowfall are so light. Even along the forested southern boundary of the study area, annual precipitation is *less* than over much of the Prairies. Both rain and snowfall generally decrease northward down the Mackenzie valley with heavier and more variable precipitation occurring in the mountains to the west. The table below provides precipitation data for selected Mackenzie valley stations and for several cities in southern Canada for comparison.

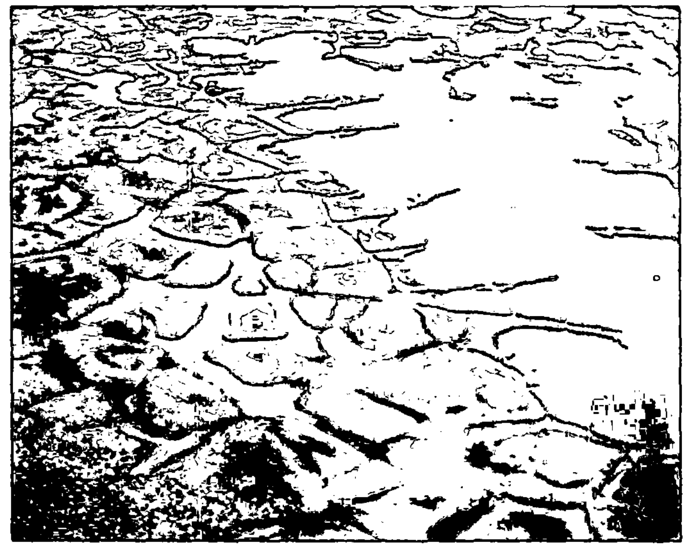
Average Annual Precipitation for Selected Stations

	Rain	Snow*	Total
	inches	*inches*	*inches*
Tuktoyaktuk	2.9	21.9	5.1
Fort Simpson	8.3	52.6	13.6
Winnipeg	12.2	51.3	20.4
Toronto	25.5	54.6	30.9
Vancouver	58.4	21.4	60.5

*10 inches of snow equals 1 inch of water
Burns, 1973

C.2.5.2 Despite the meagre rainfall, there are vast tracts of wetland in the study area. Retention of surface and near-surface waters are favored by low evaporation rates, topographic depressions, fine textured soils, and permafrost (Fig. C-6).

C.2.5.3 Drought is not unknown even though wet surface conditions prevail in many parts of the study area. The occasional outbreaks of serious fires are often associated with drought. However, drought is less important as a short term *climatic* condition than as a long term *site* condition, such as in coarse textured soils on dry, south facing slopes. Physiological drought may occur where strong winds dry out growing plant tissues while moisture remains either unavailable in the frozen soil or in short supply in the thin active layer.



W.W. Pettapiece

Fig. C-6 Polygonal ground. Note abundant standing water in tundra region of very low precipitation.

C.2.5.4 Snow cover is of great importance in the whole study area. It protects low lying vegetation from the drying, abrasive winds. Its absence or persistent deep accumulation provides unfavorable habitats for most plants, yet minimal snow cover is preferred by grazing animals because it facilitates access to food.

C.2.5.5 At least one half of the annual snowfall occurs during the first two and one half months of winter providing sufficient snow for building winter roads. Accumulated snow cover does not necessarily reflect local snowfall, but is highly dependent on topography, forest cover and wind. Snow cover is relatively uniform over gentle terrain with continuous forest cover. The more dissected or irregular the terrain and the sparser the vegetation, the more uneven the snow distribution. Long, sinuous drifts are commonly found in shallow valleys while circular drifts occur around pingos and knolls which are often blown bare of snow.

C.2.5.6 Because snow generally drifts close to the ground, local snow cover patterns are often consistent for certain landform-vegetation types. Snow cover variability generally increases down the Mackenzie valley. Towards the tundra, the greater wind effect packs the snow increasing its density compared to the forested parts of the study area.

C.3 Physiography and Drainage

C.3.1 The main part of the study area coincides with the downstream half of the Mackenzie-Slave-Athabasca drainage system (Fig. C-7). The Mackenzie lowlands, at the northern extremity of the Interior Plains region, consist of the Great Slave, Great Bear, Mackenzie, Peel and Anderson Plains (Bostock, 1970). There are also minor uplands and plateaus, but the most important anomaly is the Franklin Mountain Range through which the Mackenzie River has cut a narrow course. The Mackenzie delta forms part of the Arctic Coastal Plain region north of these interior plains. The Yukon Coastal Plain division, that portion of the Arctic Coastal Plain north of the Cordilleran region, drains directly into the Beaufort Sea through many parallel streams.

C.3.2 The remainder of the study area lies in the Cordilleran region. In the northern Yukon this includes: the east-west trending British Mountains which rise steeply from the coastal plain; part of the Porcupine Plateau, notably the Old Crow flats; and, the north-south trending Richardson Mountains along the Yukon's eastern border. Other plateaus and plains are found in the northern Yukon; and most of them have escaped glaciation. Because most of Canada was glaciated, this unusual feature gives the natural environmental setting of the northern Yukon particular scientific importance.

C.3.3 The Cordilleran region in the Northwest Territories is represented by the Mackenzie Mountains which, along with the Richardson Mountains, define the western boundary of the Mackenzie River drainage basin.

C.3.4 The Mackenzie River system which drains most of the study area, is North America's longest northward flowing river. Its discharge of fresh water, along with that of several major Russian rivers, contributes to the lower salinity and consequently higher freezing point of the Arctic Ocean.

C.3.5 In the portion of the Mackenzie basin lying downstream of Great Slave Lake, most tributaries, including the largest, enter from the west (Fig. C-8). The flow of the Mackenzie doubles from its junction with the Liard downstream to its mouth. This fact, coupled with the *south* to *north* melting of ice cover, results in frequent spring ice jams. In contrast to the Liard River which has no lakes along its length, the flow in the Mackenzie River is stabilized somewhat by the reservoir effect of Great Slave and Great Bear Lakes.

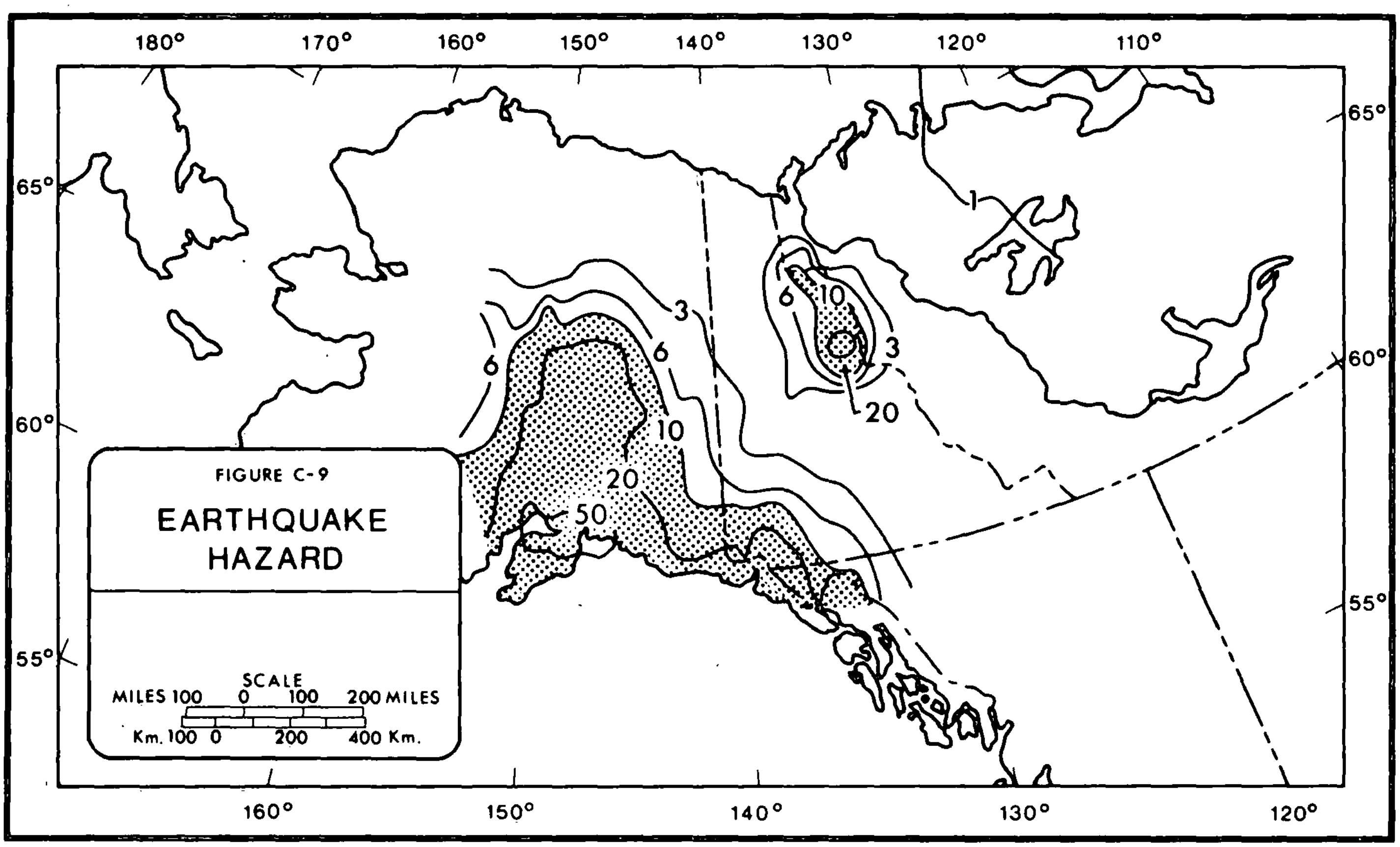
C.3.6 Much of the northern Yukon is drained by the westward flowing Porcupine River and its tributaries. This drainage is part of the Yukon River system which ultimately empties into the Bering Sea.

C.4 Geology and Glacial History

C.4.1 *Earthquakes*

C.4.1.1 Worldwide earthquake activity is concentrated in linear zones along which movements of the earth's crust occur. These zones are recognizable by the presence of young mountain ranges and volcanic belts. The Aleutian-California earthquake belt, from the Aleutian Islands south along the west coast of North America, is the site of most of this continent's major earthquakes.

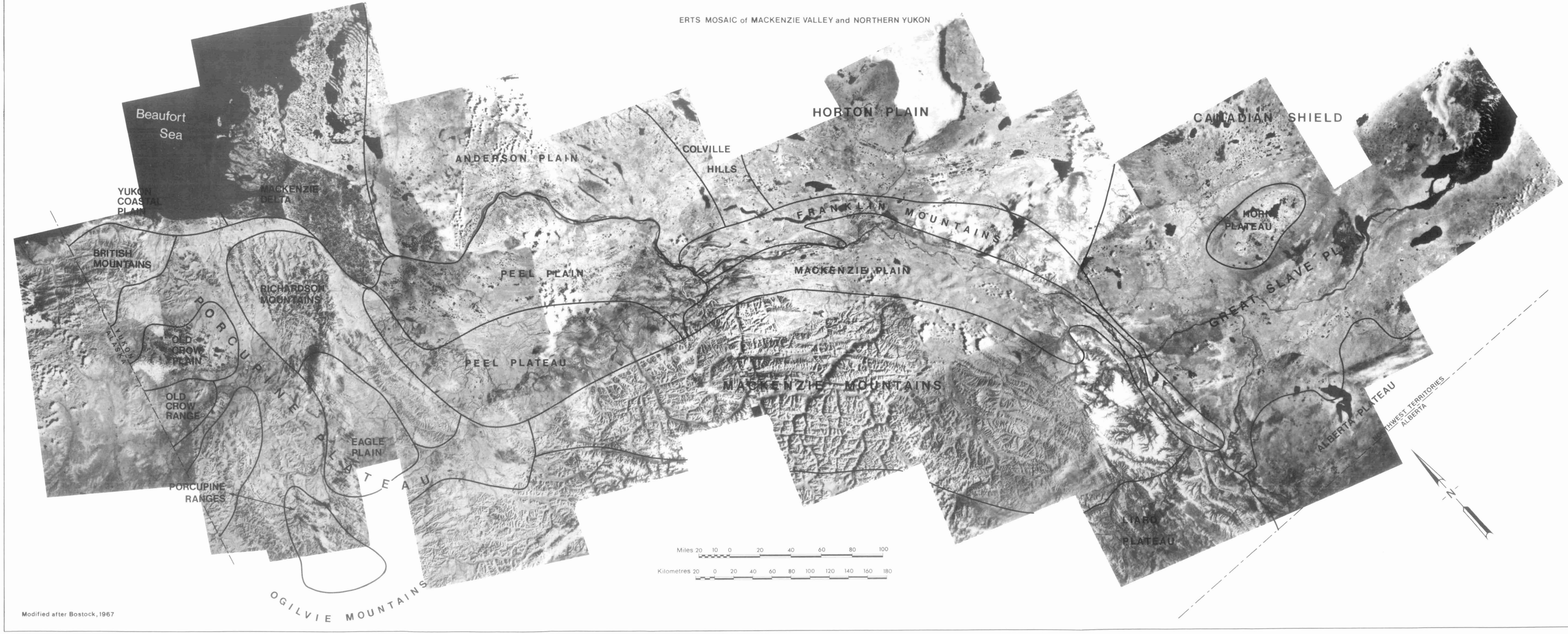
C.4.1.2 The Fort McPherson-Peel River region, lying east of this belt is a comparatively small zone of earthquake activity (Fig. C-9). This region coincides generally with the interception of the north-south trends of the Richardson and northwest trends of the Mackenzie Mountains. The remainder of the study area which comprises most of it, has a low earthquake hazard.



The map shows relative earthquake hazards near proposed pipeline routes in northwest Canada and eastern Alaska. The one per cent g contour represents ground motion just large enough to be felt. Potentially damaging ground motions are usually associated with accelerations of 10 per cent g or higher. Such accelerations have a probability of occurrence of 1 in 50 each year within the shaded area.

FIGURE C-7 PHYSIOGRAPHIC REGIONS

ERTS MOSAIC of MACKENZIE VALLEY and NORTHERN YUKON



Modified after Bostock, 1967

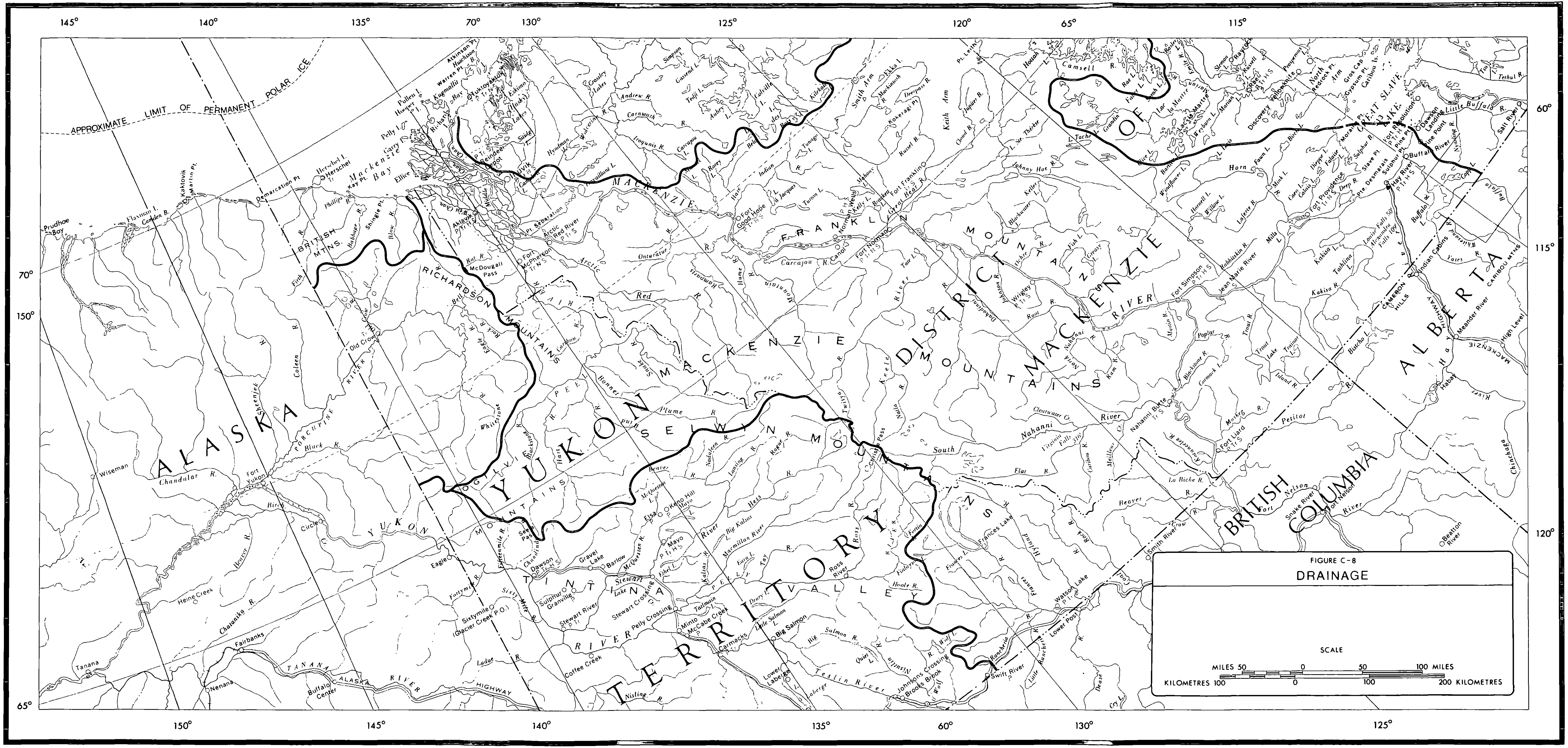
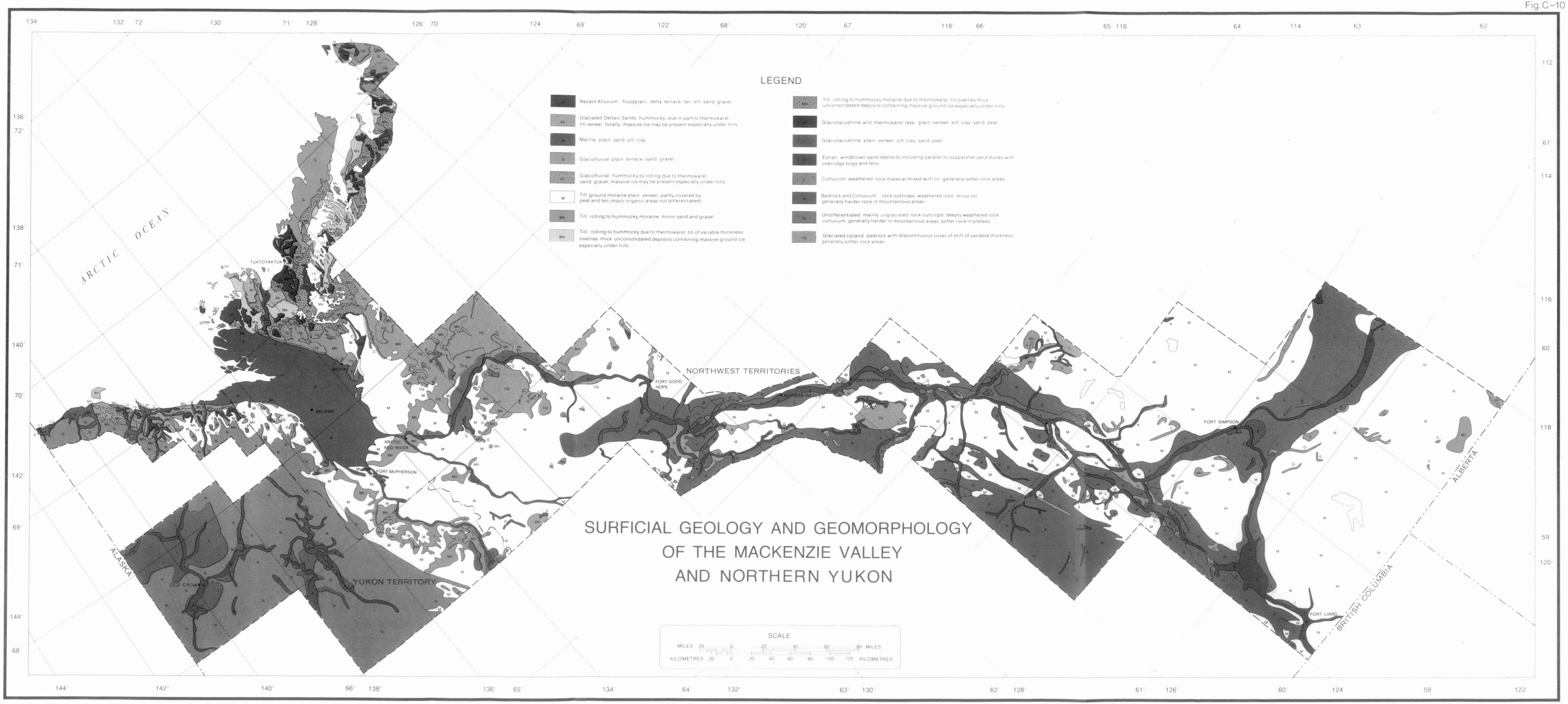


FIGURE C-8
DRAINAGE



SURFICIAL GEOLOGY AND GEOMORPHOLOGY OF THE MACKENZIE VALLEY AND NORTHERN YUKON
LEGEND
A Recent Alluvium floodplain delta terrace fan silt sand gravel
Ah Glaciated Deltaic Sands hummocky due in part to thermokarst till veneer locally massive ice may be present expecially under hills
M Marine plain sand silt clay
G Glaciofluvial plain terrace sand gravel
Gi Glaciofluvial hummocky to rolling due to thermokarst sand gravel massive ice may be present especially under hills
M Till ground moraine plain veneer partly covered by peat and fen (major organic areas not differentiated)
Mh Till rolling to hummocky moraine minor sand and gravel
Mx Till: rolling to hummocky due to thermokarst till of variable thickness overlies thick unconsolidated deposits containing massive ground ice especially under hills
Mhi Till rolling to hummocky moraine due to thermokarst till overlies thick unconsolidated deposits containing massive ground ice especially under hills
Lk Glaciolacustrine and thermokarst lake plain veneer silt clay sand peat
L Glaciolacustrine plain veneer silt clay sand peat
E Eolian windblown sand deposits including parallel to subparallel sand dunes with interridge bogs and fens
C Colluvium weathered rock material mixed with till generally softer rock areas
R Bedrock and Colluvium rock outcrops weathered rock minor till generally harder rock in mountainous areas
N Undifferentiated mainly *unglaciated* rock outcrops deeply weathered rock colluvium generally harder in mountainous areas softer rock in plateau
Ug Glaciated Upland bedrock with discontinuous cover of drift of variable thickness generally softer rock areas
ARCTIC OCEAN
TUKTOYAKTUK
INUVIK
AKLAVIK
ARCTIC RED RIVER
FORT McPHERSON
OLD CROW
YUKON TERRITORY
ALASKA
NORTHWEST TERRITORIES
FORT GOOD HOPE
FORT NORMAN
NORMAN WELLS
FORT SIMPSON
FORT LIARD
BRITISH COLUMBIA
ALBERTA
SCALE
MILES 20 0 20 40 60 80 MILES
KILOMETRES 20 0 20 40 60 80 100 120 KILOMETRES

C.4.2 *Bedrock Geology*

C.4.2.1 Virtually all minerals and hydrocarbons are found in bedrock. In addition, the nature of the bedrock governs the availability and types of gravel and other aggregate materials and greatly influences the character of parent materials from which soils are developed. Bedrock also affects surface flow of water and the availability and quality of groundwater.

C.4.2.2 Three types and three ages of bedrock are found extensively in the Mackenzie valley and the northern Yukon. The mountain ranges are formed mainly of old, resistant Paleozoic limestones and dolomites. Oil and gas have been discovered in these rocks in the southwestern part of the Northwest Territories. The British and Richardson Mountains have many older, more folded and altered rocks in which no oil or gas reserves exist.

C.4.2.3 Devonian shales are widespread in the Mackenzie lowlands where they are locally overlain by Mesozoic (Cretaceous) shales which are much younger geologically. Both types of shale are unstable, easily weathered, have poor engineering characteristics, and have been the cause of many stream bank failures. Nonetheless, since these shales, like other bedrock materials contain little ground ice, they are being used extensively as a source of borrow material in the northern part of the study area where glacial and other unconsolidated materials contain much ground ice. Moreover, they are the source of various overlying clay rich glacial deposits which exhibit ice rich permafrost and poor drainage properties.

C.4.2.4 Sandstone is the third type of rock commonly occuring in the study area. Early Paleozoic sandstones form erosion resistant beds in the British and Richardson Mountains; and sandstones are a widespread but minor component of Cretaceous sediments. Younger, Quaternary sands and gravels which are common on the coastal plain, sometimes contain interbedded silts and clays with high ice content.

C.4.3 *Surficial and Glacial Geology*

C.4.3.1 The glacial history of the study area is as complex as any area in Canada and is still only known in a general way. The northern Yukon was apparently never glaciated because of the dryness of the local Pleistocene climate. The remainder of the study area was almost completely covered by two westward advances of the continental Laurentide ice sheet. The earlier, more extensive one covered the Mackenzie Mountains up to a height of 5,000 feet (1,500 metres) (Hughes et al., 1973). The second Laurentide ice sheet abutted the Richardson Mountains on the east. In addition, there were at least three advances of mountain glaciers in the Mackenzies; however, minimal glacier development occurred in the Richardson Mountains (Hughes et al., 1973).

C.4.3.2 Glacial till plains form the most extensive terrain unit in the region (Fig. C-10). The till is typically rich in silt and clay, although sand or gravel texture is locally extensive. In the southern part of the study area, where permafrost is thin and discontinuous, the till contains a relatively small amount of ground ice. Farther north, layers of ice in the till become thicker and larger; and in some areas the overall ground ice content is high enough to be of substantial engineering concern. Extensive areas of rolling to hummocky moraine occur in the Fort Good Hope-Fort McPherson portion of the Mackenzie lowlands (Fig. C-10). Unlike till plains, moraines usually contain large, irregular and erratically distributed masses of ground ice.

C.4.3.3 Silt and clay, overlain by sand, were deposited in glacial lakes along the Mackenzie valley, and now occupy a belt of variable width almost continuously along the valley from near Fort Simpson to Arctic Red River. In the unglaciated region west of the Richardson Mountains, large lakes occupied portions of the present Porcupine drainage system including the Old Crow flats during the period of glaciation farther east.

C.4.3.4 Ground ice, in the form of thin lenses, reticulate networks or thick tabular layers, occurs in silt and clay sediments (Fig. C-16). Therefore, these soils are potentially highly unstable when thawed, creating thermokarst lakes and depressions which characterize the Old Crow flats and most other glacial lake beds. There is widespread evidence of continuing collapse in these areas. Sand and gravel deposited by glacial meltwater streams occur as deltas along the margins of former glacial lakes, as outwash plains, and as irregular knolls and ridges. These deposits which occupy only a small part of the land area, constitute the main source of granular material for construction and provide stable locations for airfields, camps, pumping stations, etc.

C.4.3.5 Much of the Mackenzie River and the lower reaches of many of its tributaries cut into the glacial lake sediments and hence have unstable valley walls. Since the end of the Ice Age, alluvium has been deposited along the lower reaches of river courses; the most spectacular, the Mackenzie delta, is composed of silts and clays, at least in the top layers (Fig. C-11).

C.4.3.6 Glacial tills, lake bottom sediments and moraines comprise most of the glacial deposits and frequently contain large amounts of ice. As a result, they possess poor engineering properties. Extensive peat deposits, which have been formed since the end of glaciation, overlie the poorly drained till and lake deposits and further detract from their value as potential construction sites.

C.4.3.7 Three types of slope failures are common within the study area: (i) *active layer detachment slides* – the vegetation and material of the active layer, at most about one metre (3 feet) thick, separate from the underlying material and slide down the slope (Fig. C-12(a)). These slides typically develop in shale on slopes greater than 10° and are particularly common on freshly burned areas. They are frequently initiated by heavy rains. (ii) *retrogressive thaw flowslides* – most common in glacial lake sediments, frequently develop by slow melting of a nearly vertical headwall that is usually 6 to 12 metres (20 to 40 feet) high, but may be 30 metres (100 feet) high in some cases. The headwall gradually erodes until the sloping floor on the flowslide intersects the ground surface (Fig. C-12(b)). The flowslide area, exclusive of the outflow beyond, may be 150 to 800 metres (500 to 2,500 feet) wide and 600 to 900 metres (2,000 to 3,000 feet) long. Most

Canada Centre for Remote Sensing, EMR

Fig. C-11(a) ERTS mosaic of Mackenzie delta. Light blue depicts silt load of Mackenzie River and its distribution in the delta.

R.D. Muir

Fig. C-11(b) Aerial oblique of Mackenzie delta. Lakes, ponds, distributary channel and levees are shown.

retrogressive thaw flowslides are initiated when active layer detachment slides expose ice rich sediments. However, they could be initiated just as readily by mechanical removal of vegetation from slopes. Unlike the catastrophic slides in marine clays in parts of southern Canada, where the period of main activity is measured in minutes, large retrogressive thaw flowslides require decades to develop (Fig. C-30). (iii) *rotational slides* – typically involve a backward rotation of slumped material with the result that the surface of the slumped block often has a reversed slope. These slides often occur in glacial lake silt or clay, with an embedded network of ice and overlay of sand. They are often found adjacent to streams where the current has undercut a steep slope face (Hughes et al., 1973). The oversteepening of river banks by the eroding action of river ice during spring breakup is also a major cause of such slope failures (Fig. C-12(c); Code, 1973).

C.5 Hydrology and Permafrost

C.5.1 The normal groundwater occurrence and movement found in southern Canada, is replaced in much of the study area by ground ice. Because permafrost and ground ice exert a great influence upon drainage, hydrology and permafrost are discussed together.

C.5.2 *Permafrost* is the condition of the ground when its temperature is continuously below 0°C (32°F) for more than one year. The ground is frozen to a maximum depth of about 300 metres (1,000 feet) in the northern part of the study area. Around Fort Simpson, it is locally frozen in scattered patches up to two metres (6.5 feet) thick.

C.5.3 Another point of contrast is that in southern Canada the earth *freezes* to a maximum depth of about one metre (3 feet), whereas in the study area the frozen earth *thaws* to approximately the same depth. This thin layer which thaws annually is known as the *active layer* and sets the limit of rooting depth (Fig. C-13).

C.5.4 The northern part of the study area lies in the Continuous Permafrost Zone where permafrost underlies all landforms and is thought to be present at some depth under many water bodies including part of the Beaufort Sea. (Fig. C-14 outlines the Zones of Continuous and Discontinuous Permafrost in northwestern Canada.) The active layer is thinnest in the Continuous Permafrost Zone, being less than 0.3 metres (1 foot) in fine grained or organic soils. However, even along the arctic coast, gravel soils with south facing aspects may thaw to about one metre (3 feet) each summer. Permafrost in this zone is at a lower temperature than farther south and is less susceptible to degradation through surface disturbance.

LANDSLIDE TYPES OF THE MACKENZIE CORRIDOR

FIG. C-12 (a) *ACTIVE LAYER DETACHMENT SLIDE*

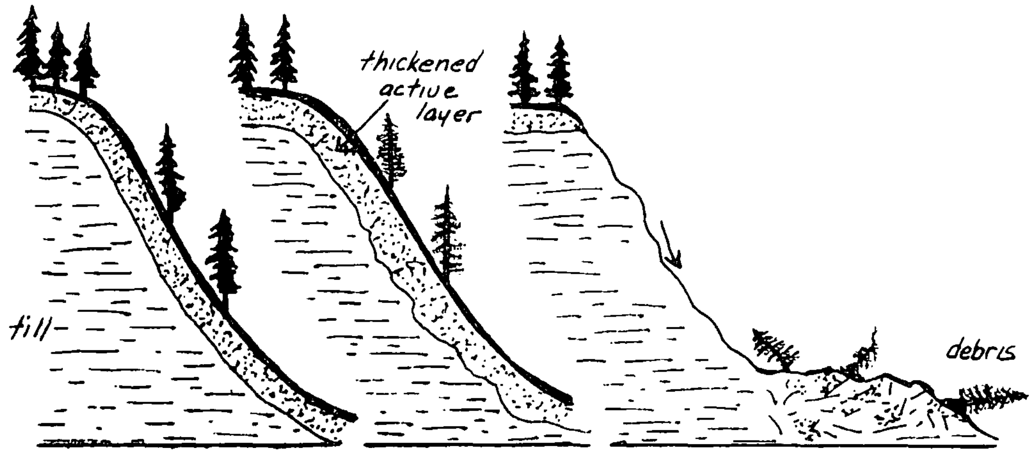


FIG. C-12 (b) *RETROGRESSIVE THAW FLOW SLIDE*

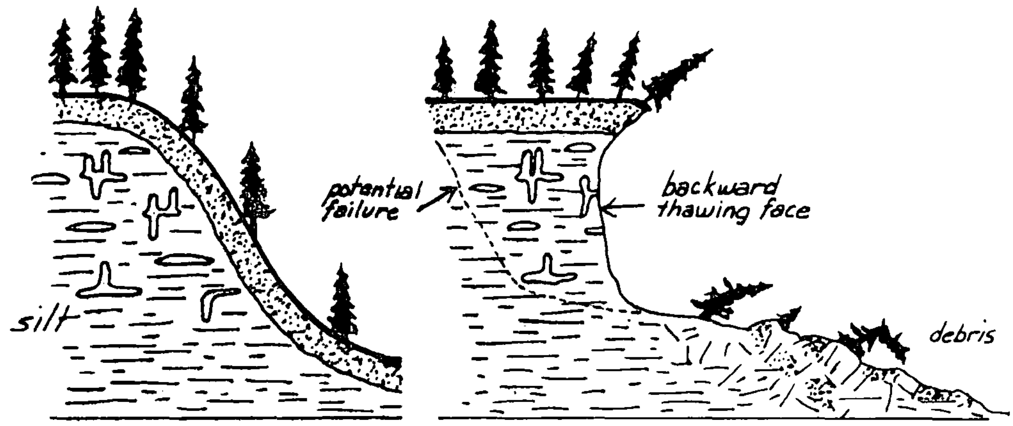
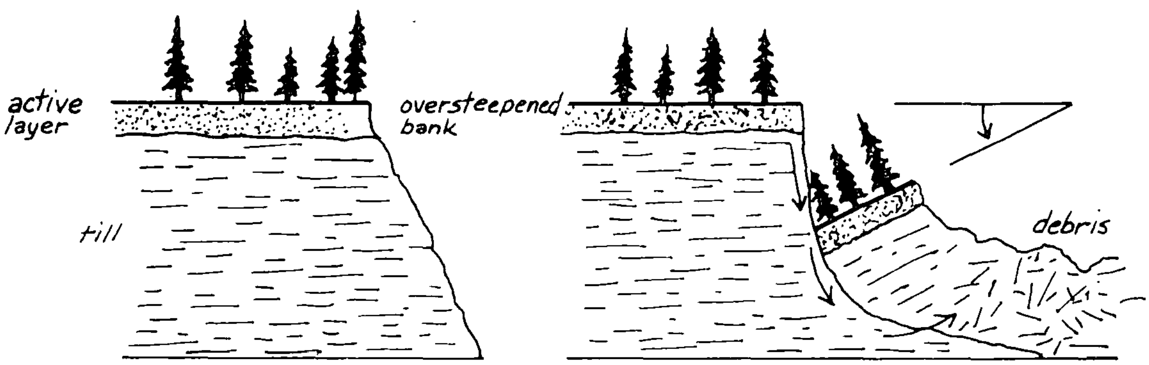


FIG. C-12 (c) *ROTATIONAL SLUMP*



W.L. Wallace

Fig. C-13 Recent burn with exposed tree roots. Roots are mainly restricted to the former organic layer in the top few centimetres of soil, termed the biologically active layer. Summer thaw produces a thermal active layer that is about 60 centimetres (2 feet) thick in this forested area but it develops too late for root penetration which takes place during the June growing season.

C.5.5 The southern portion of the study area is transitional between the Continuous Permafrost Zone and the situation in southern Canada where only winter freezing occurs. In the Discontinuous Permafrost Zone permafrost may be absent, as under lakes or terrain lacking an insulating organic layer, or the top of the permafrost layer may be well below the maximum depth of winter freezing (Fig. C-15). In the southern parts of this zone, permafrost is only slightly below 0°C (32°F) and consequently is sensitive to slight temperature changes resulting from physical surface disturbances, fire and short term climatic trends.

C.5.6 The importance of permafrost is determined by its depth and distribution, the amount and type of ground ice, and the texture, structure and spatial relationships of the frozen material. For instance, "a permafrost site can be ice free bedrock near Inuvik, or in nearly pure ice at Tuktoyaktuk, or in soft muddy sea bottom sediments, cooled below 0°C by the saline waters of the Beaufort Sea" (Mackay, 1972). These factors determine the amount of water more or less permanently withheld from the water cycle in the form of ground ice, as well as the quantity and speed of water moving through springs or cracks in bedrock. Very high ice content is common in silt and clay sediments, and particularly in lake silts. Ground ice may be finely spread throughout the sediment or it may occur as innumerable lenses or massive beds (Fig. C-16).

C.5.7 Although snowfall is light to moderate in the study area, spring snowmelt produces high runoff because the frozen surface prevents significant infiltration. Snowmelt moves progressively northward with the rapid advance of spring, but breakup of river ice proceeds less quickly with resulting ice jams and flooding in most rivers.

C.5.8 The Mackenzie basin is so large that different climates prevail in upstream and downstream segments. Thus while the time differential between snowmelt in a watershed and ice breakup in most streams and rivers is only a few days, it takes a matter of weeks in the Mackenzie River. Furthermore, the Mackenzie does not break up sequentially from south to north with spring's advance. It breaks up almost simultaneously from Fort Simpson at the mouth of the Liard River to Fort Good Hope, while both the upstream and the downstream reaches break up two weeks later. The upstream portion between Fort Providence and Fort Simpson is delayed because of the stabilizing effects of Great Slave Lake on the discharge. Breakup in the section downstream from Fort Good Hope is delayed because of its more northerly location, disruption of flow by upstream ice jams, and the absence of major tributaries. The early breakup of the middle portion is caused by the high spring inflow from the Liard River. Ice is shoved up on river banks as much as 15 metres (49 feet) above summer water levels downstream from Fort Simpson, but ice shove is much less pronounced upstream where the flow is more stable. Even greater ice jams occur on the lower reaches of the Liard where ice shove has been recorded at 17 metres (55 feet) above the summer water level.

C.5.9 Ice jams recur regularly at some sites such as at or directly below major tributary junctions (for example, Liard, Nahanni and Great Bear Rivers), at sharp bends in the channel, or along gravel bars and rock ledges (Fig. C-17). However, locations of some ice jams are totally unpredictable. Ice jams may be largest in high water years, but they occur relatively infrequently. In low water years, jams increase in number, but their size is diminished (MacKay, 1973).

C.5.10 Ice jams are a major factor in bank erosion through ice shove and bank saturation at high water levels. Most tributaries are subject to water backing up in spring because runoff is impeded by either Mackenzie River ice or high water. Ice jams and breakup characteristics are factors in the dynamic hydrology of the Mackenzie delta where channels are constantly being formed and abandoned. Winter ice formation and ice cover are also important here, causing the distribution of channel flow to be radically altered.

C.5.11 Channel alternation causes changed frequency and length of inundation of portions of the delta during annual floods, with the result that delta lakes may shrink or become filled with sediment. Permafrost may then encroach into previously unfrozen lake bed sediments from the bottom, sides and surface. Concentrations of ground ice and increasing hydrostatic pressure in the unfrozen portion, forces the surface upward to form the well-known ice centred *pingos* of the Mackenzie delta (Fig. C-18).

C.5.12 Groundwater, rain and thaws are sources of *winter* stream discharge in southern Canada. In contrast, deep groundwater springs, with a great enough flow to prevent freezing, are the only contributors to winter flow in streams in much of the study area. Furthermore, the highly permeable coarse sands and gravels in many stream beds often channel the movement of water flows. In other situations, rivers may freeze to the bottom, forcing upstream flow out of the river bed where it freezes. These surface accumulations of ice which may last all summer, are called *icings* or *aufeis* (Fig. C-19).

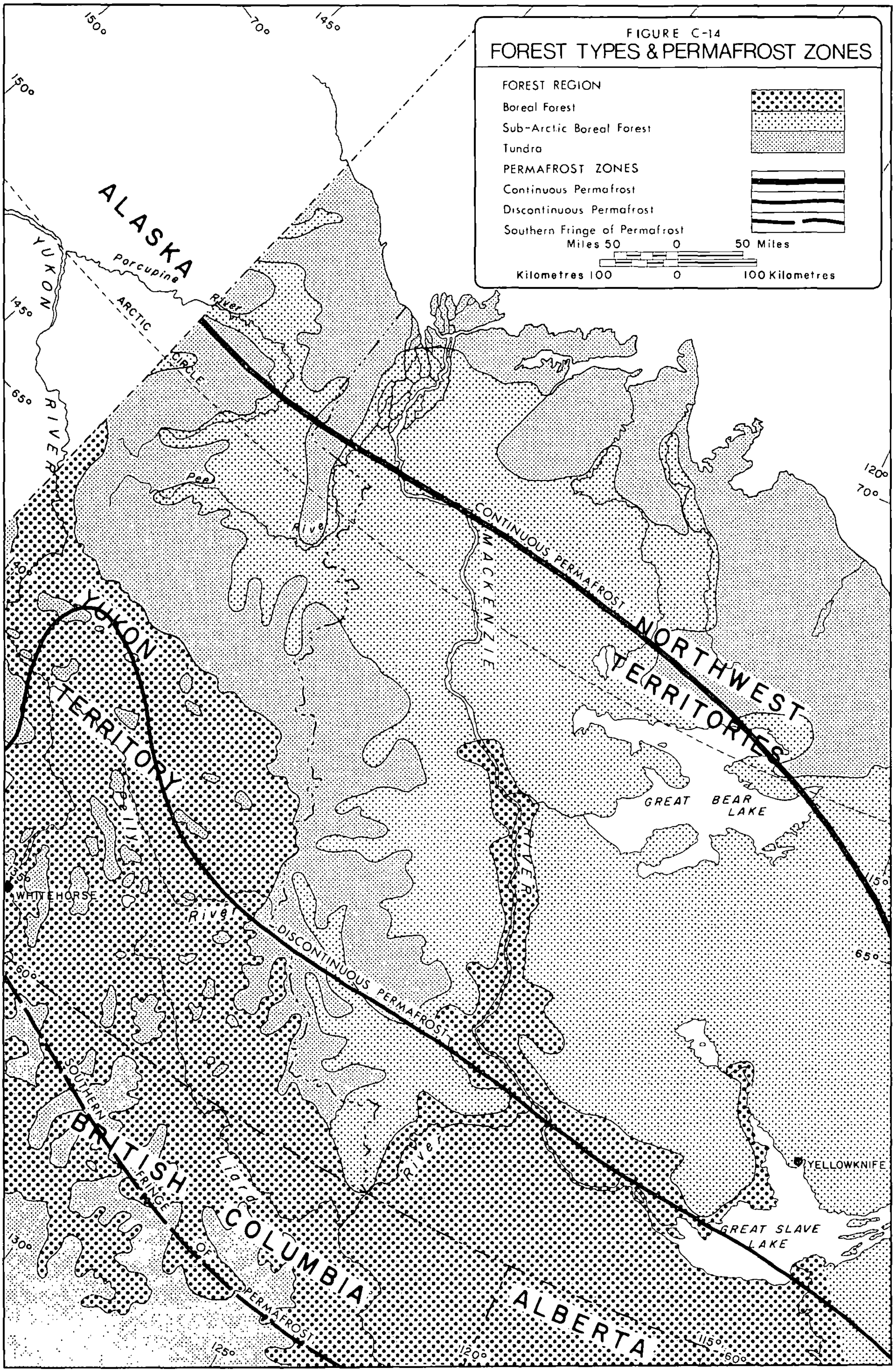
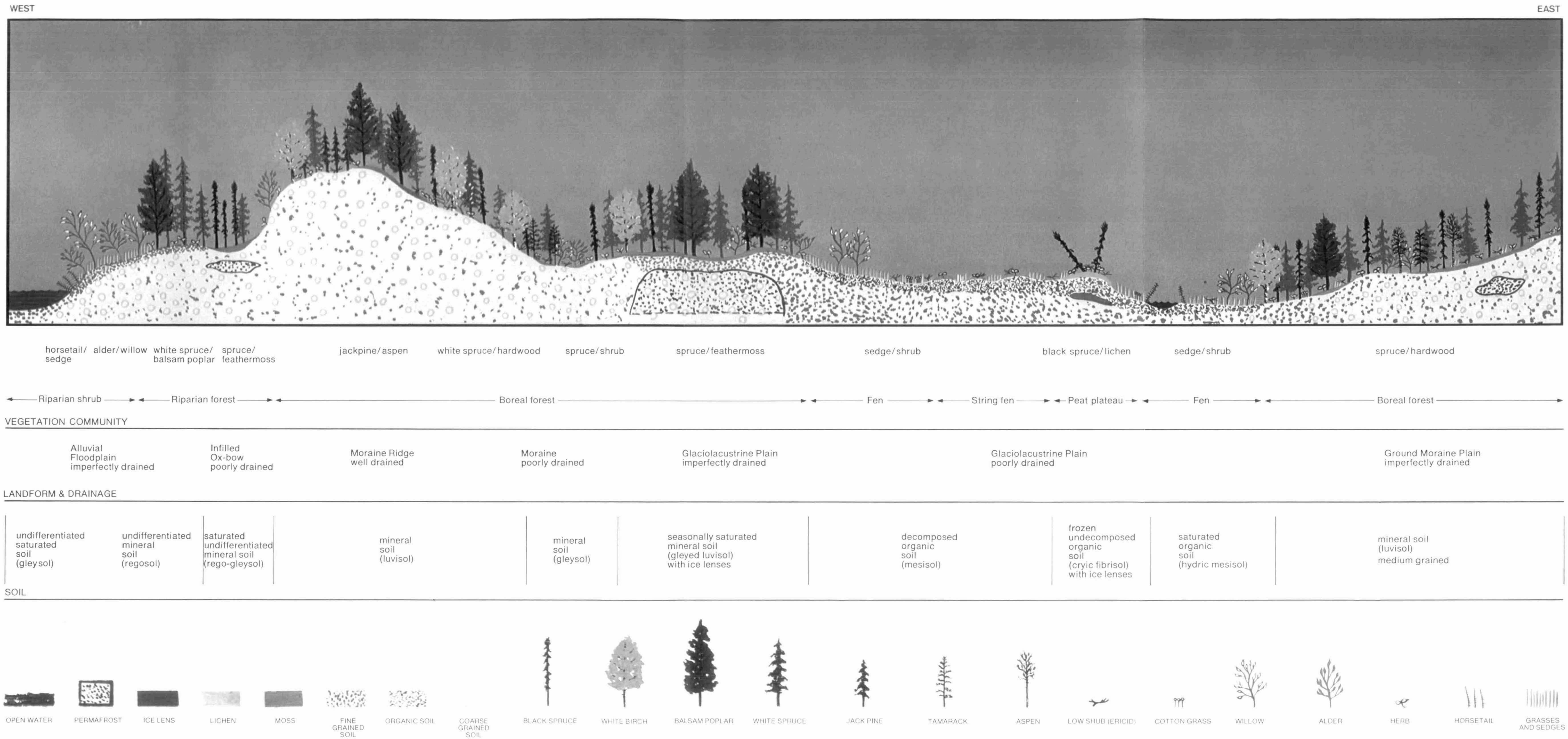


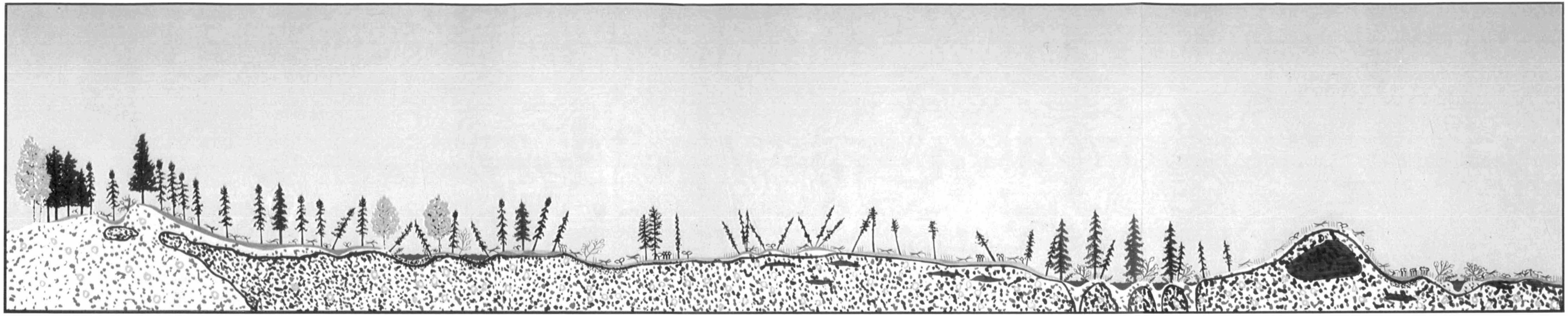
FIGURE C-14
FOREST TYPES & PERMAFROST ZONES
FOREST REGION
Boreal Forest
Sub-Arctic Boreal Forest
Tundra
PERMAFROST ZONES
Continuous Permafrost
Discontinuous Permafrost
Southern Fringe of Permafrost
Miles 50 0 50 Miles
Kilometres 100 0 100 Kilometres
ALASKA
YUKON RIVER
Porcupine River
ARCTIC CIRCLE
Peel River
CONTINUOUS PERMAFROST
MACKENZIE RIVER
NORTHWEST TERRITORIES
GREAT BEAR LAKE
YUKON TERRITORY
Pelly River
WHITEHORSE
DISCONTINUOUS PERMAFROST
YELLOWKNIFE
GREAT SLAVE LAKE
SOUTHERN FRINGE OF PERMAFROST
BRITISH COLUMBIA
Liard River
ALBERTA



Diagrammatic cross-section, illustrating landform — permafrost — vegetation relationships.

Figure C-15a: EAST-WEST CROSS-SECTION IN THE UPPER MACKENZIE REGION

SOUTH NORTH



spruce/hardwood | black spruce/feathermoss | sphagnum/heath | black spruce hummocks (drunken forest) | stunted black spruce/lichen | white spruce/shrub | shrub/sedge | sedge/moss | willow/sedge | shrub/sedge patterned ground

← Boreal forest → ← Subarctic boreal forest → ← Riparian forest → ← Tundra →

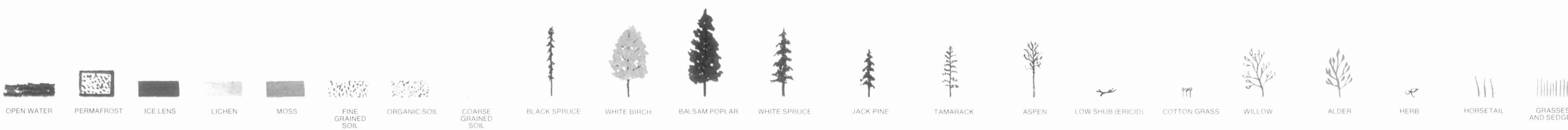
VEGETATION COMMUNITY

Hummocky Moraine imperfectly drained	Glaciolacustrine Plain imperfectly drained	Thermokarst Pools poorly drained	Moraine Plain poorly drained	Mackenzie Delta imperfectly drained	Hummocky Moraine with thermokarst ice cored hill well drained	Moraine Plain imperfectly drained

LANDFORM & DRAINAGE

mineral soil (brunisolic) medium grained	frozen saturated mineral soil (cryic gleysol) with ice lenses fine grained	frozen, semi-decomposed organic soil (organo-cryosol)	frozen mineral soil (cryosol)	frozen organic soil (organo-cryosol)	frozen mineral soil (cryosol)	frost-churned mineral soil with organic inclusions (turbic cryosol)	frozen semi-decomposed organic soil (cryosol)	undifferentiated frozen mineral soil (rego-cryosol)	frozen mineral soil (cryosol)	frozen saturated organic soil (organo-cryosol)	undifferentiated frozen mineral soil (rego-cryosol)	frozen mineral soil (cryosol)

SOILS



Diagrammatic cross-section, illustrating landform—permafrost—vegetation relationships.

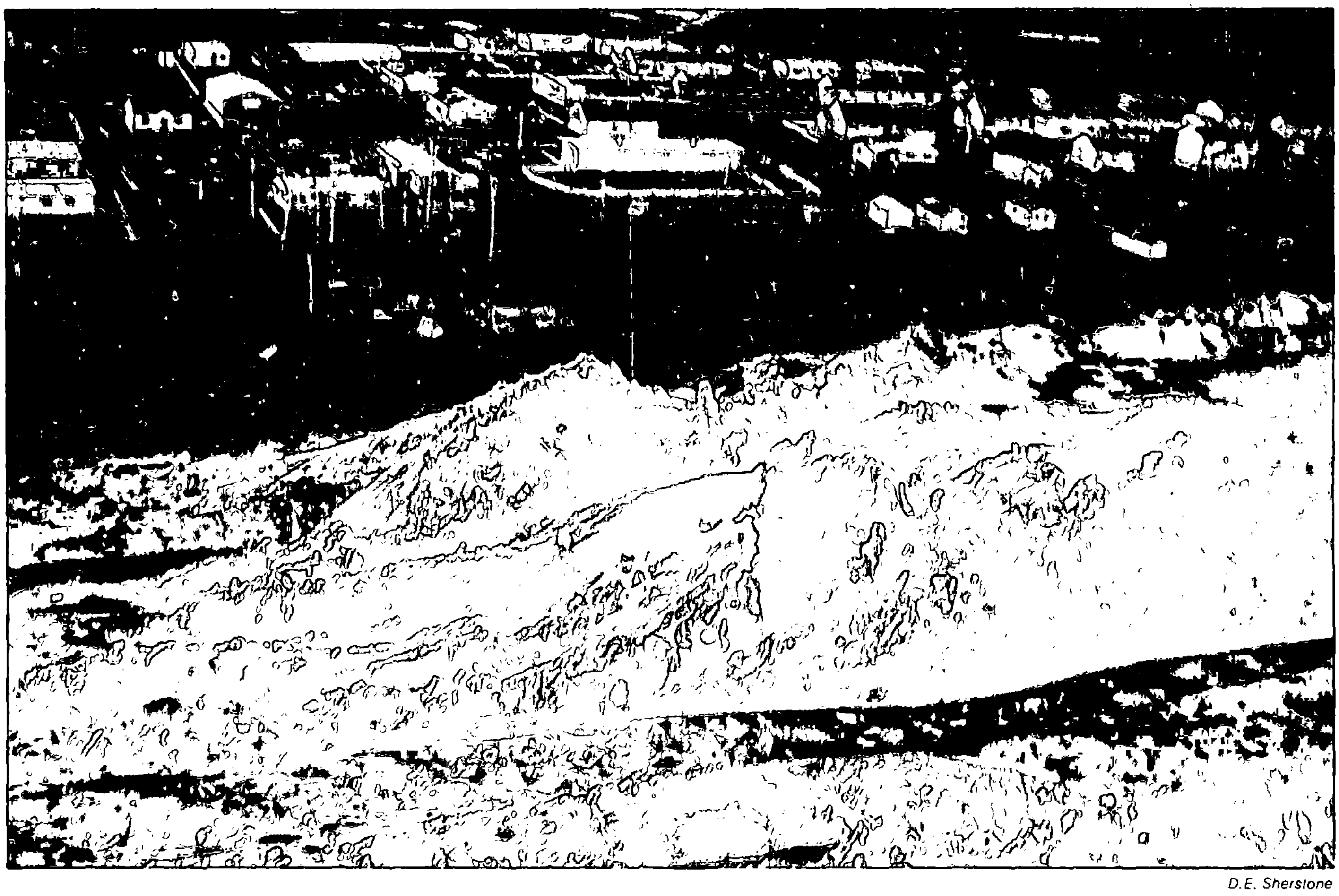
Figure C-15b: NORTH-SOUTH CROSS-SECTION OF MACKENZIE VALLEY

S.C. Zoltai

Fig. C-16(a) Massive ground ice, Yukon north slope. Visible thickness at head of retrogressive flow slide is 2.5 metres (8 feet).

N.W. Rutter

Fig. C-16(b) Fine network of ground ice. Ice lenses in this vertical soil cut would be measured in centimetres.



D.E. Sherstone

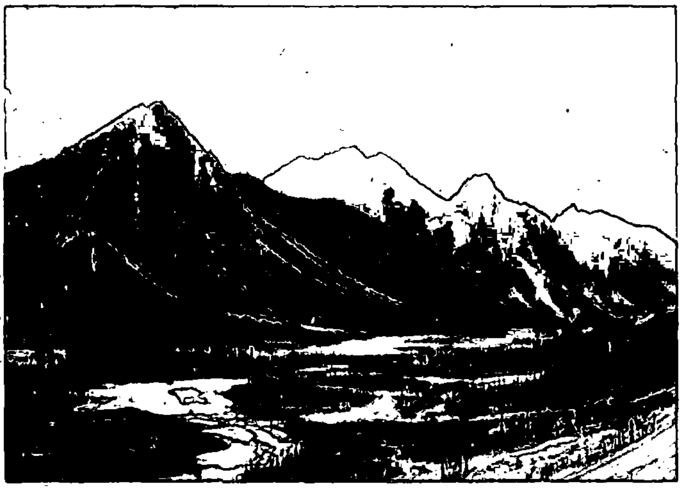
Fig. C-17 Ice jamming adjacent to Norman Wells, NWT – May 13, 1973

C.5.13 Icings are not numerous within the study area. Some occur on Yukon coastal rivers, in streams of the Richardson Mountains and the Porcupine drainage, and around Norman Wells (MacKay, 1973). In extreme cases, icings in the study area may build up to about three metres (10 feet) in thickness and a kilometre (0.67 miles) in length. Thus, they may tie up a significant portion of winter stream flow in the form of ice and correspondingly increase summer flow (Brown, 1970; Fig. C-19).

C.5.14 The eastern tributary watersheds of the Mackenzie River have smaller drainage areas, lower mean elevations and gentler slopes than west side tributaries. Low drainage density values and a high proportion of lakes and swamps in the

R.D. Muir

Fig. C-18 Pingos on the Tuktoyaktuk peninsula, NWT. These commonly develop in the fine grained sediments.

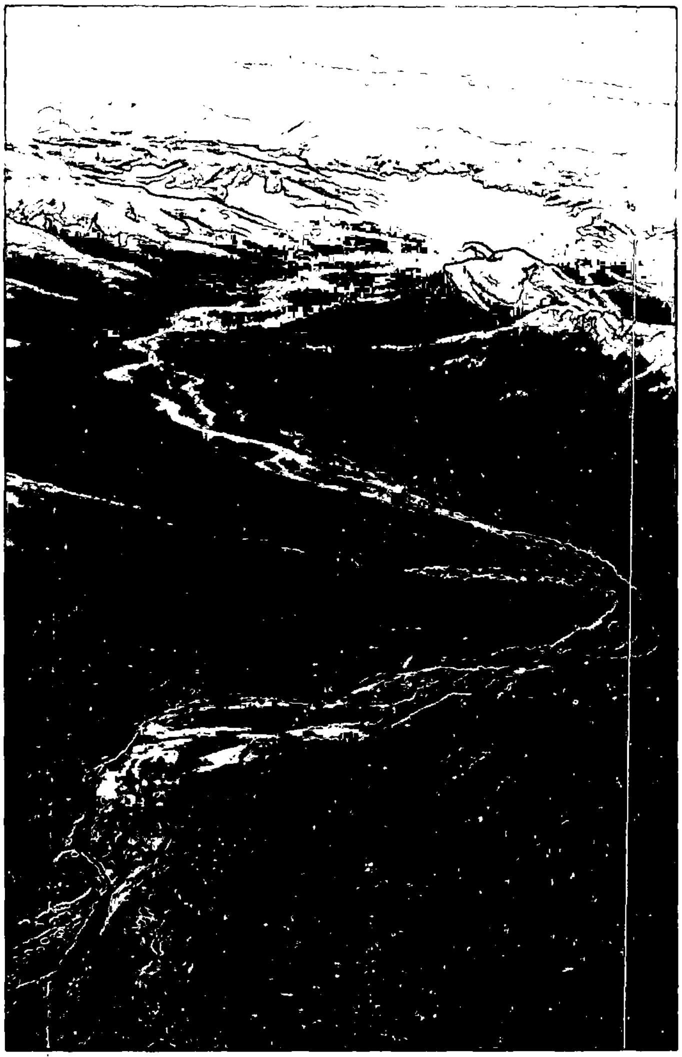


D.K. MacKay

Fig. C-19(a) Icings on Mountain River, west of Norman Wells, NWT – July, 1971.

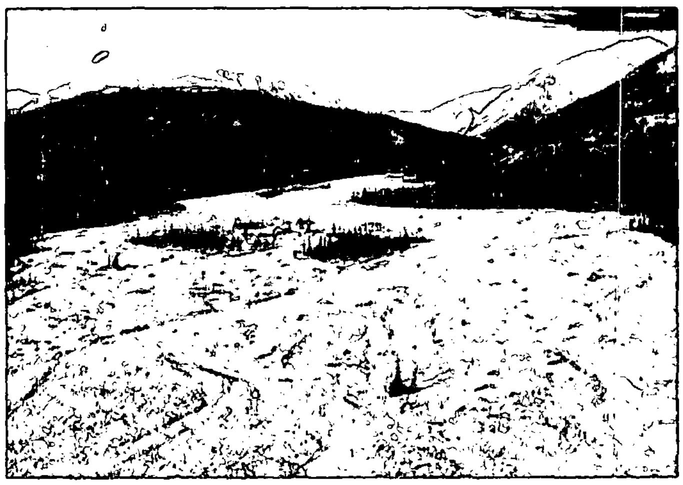
S.C. Zoltai

Fig. C-19(b) Icings on Carcajou River, west of Norman Wells, NWT - late June, 1973.



Canadian Wildlife Service, DOE

Fig. C-20(a) Aerial oblique of braided Bell River, Rat Pass area. Note the multiple channels which are subject to rapid shifting under the variable discharge regime characteristic of such streams.

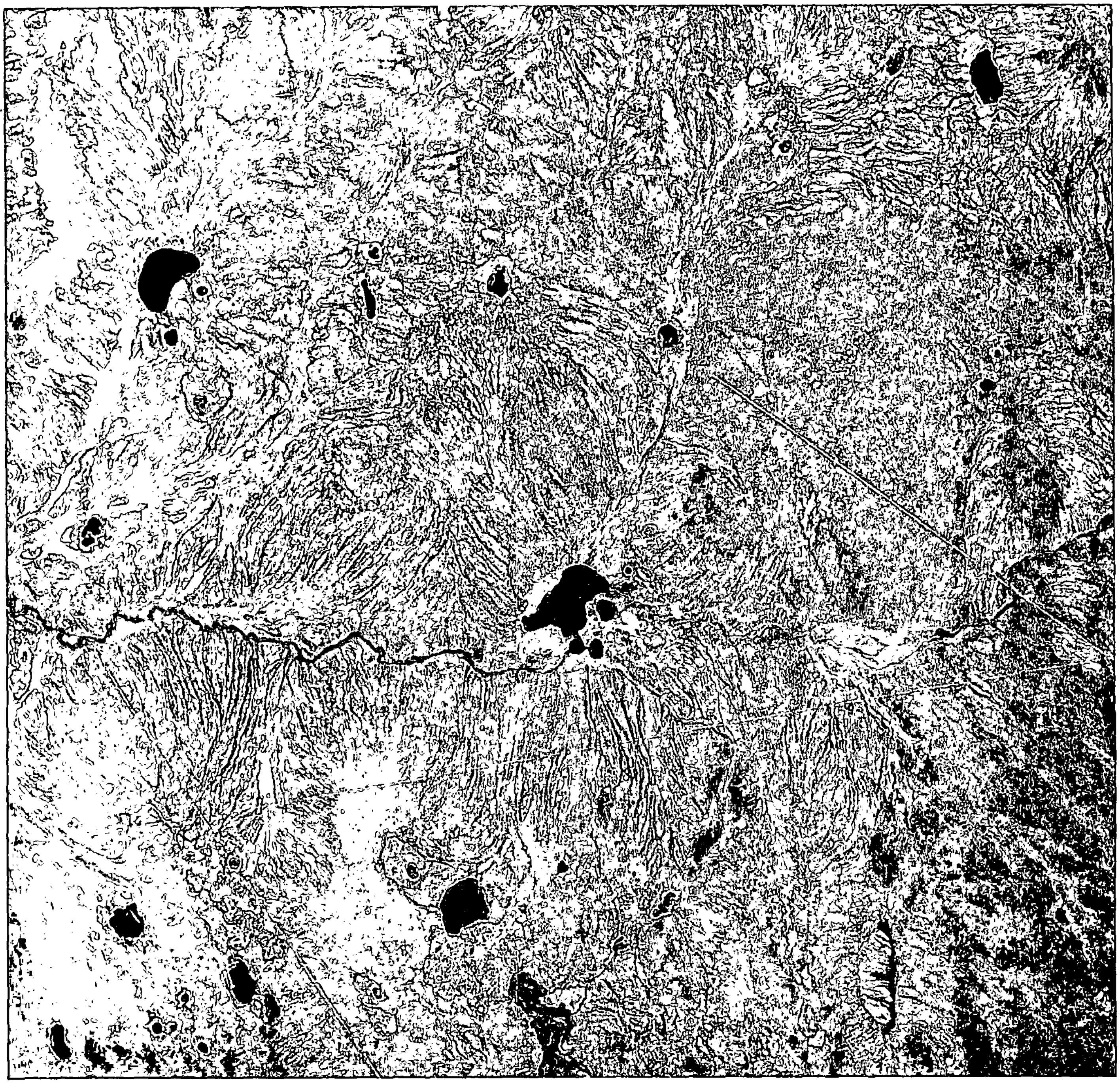


Canadian Wildlife Service, DOE

Fig. C-20(b) Heavily braided Keele River. The characteristic coarseness of the water-borne material is apparent.

landscape on the east side reflect poor drainage – a consequence of Laurentide glaciation. Tributary basins on the west side of the Mackenzie are larger, have higher mean elevations – 800 metres (2,600 feet) compared to 300 metres (1,000 feet) on the east side, and higher drainage density (Thakur and Lindeijer, 1973).

C.5.15 The flood hazard of west side Mackenzie tributaries is greater than for east side streams because those on the west



NFB

Fig. C-21 Horsetail drainage. The fine linear drainage pattern reflects near-surface seepage perpendicular to the slopes. Note the thin white seismic lines, and the contrasting grey tones, some of which reflect vegetation burn patterns. Scale: 1:36,000.

side have higher elevations, generally heavier precipitation, more violent summer thunderstorms, steeper gradients, few large lakes to act as natural reservoirs, and highly variable discharge from melting mountain snow. Rivers flowing north from the British Mountains over the Yukon Coastal Plain also exhibit the last three characteristics and have broad, shallow, *braided* shifting channels as do west side tributaries of the Mackenzie River (Fig. C-20).

C.5.16 Another aspect of surface water hydrology contrasting markedly to southern Canada is the presence of permafrost close to the surface. This prevents the entry of water into the soil and causes near-surface lateral movement, even on very gentle slopes. As a result, the active layer is saturated for a longer period of time than the equivalent soil layers in southern regions and soil temperatures are held down. The concentration of groundwater near the surface also creates numerous localized springs and abundant signs of near-surface seepage, even on convex slopes (Fig. C-21).

C.5.17 At the southern fringe of the Discontinuous Permafrost Zone the permafrost becomes more localized until it occurs only sporadically in peatlands. Although much of the perennially frozen ground is thought to be a remnant of continental glaciation, it may presently be forming in some localities. For example, permafrost may often be found under localized peat deposits on floodplains and be underlain by unfrozen materials, indicating recent permafrost development. A delicate balance exists in many areas where average ground temperature hovers near 0°C (32°F). This is less common farther north where permafrost is colder and there is less chance of its degradation.

C.5.18 Striking landscape features such as *collapse scars* (Fig. C-22) and *thermokarst lakes* (Fig. C-23) result from widespread surface thaw in fine grained deposits. Thermokarst lakes increase in size as melting continues and tend to have characteristic rectangular shapes as a result of wind and wave action. These lakes are abundant in the northern and central Mackenzie basin where they are associated with lake bottom and delta silts and clays. Indeed, they are a reliable indicator of generally ice rich, fine grained deposits with poor engineering properties. *Beaded streams* are also a good indicator of high ice content near the surface (MacKay, 1973).

C.P. Lewis

Fig. C-22(a) Babbage River delta, Yukon north slope. Circular, regularly spaced ponds near the end of the delta have been interpreted as thermokarst collapse scars.

S.C. Zoltai

Fig. C-22(b) Thermokarst pond, southern Mackenzie delta. Active enlargement of pond is indicated by the progression from straight to leaning and fallen white spruce.

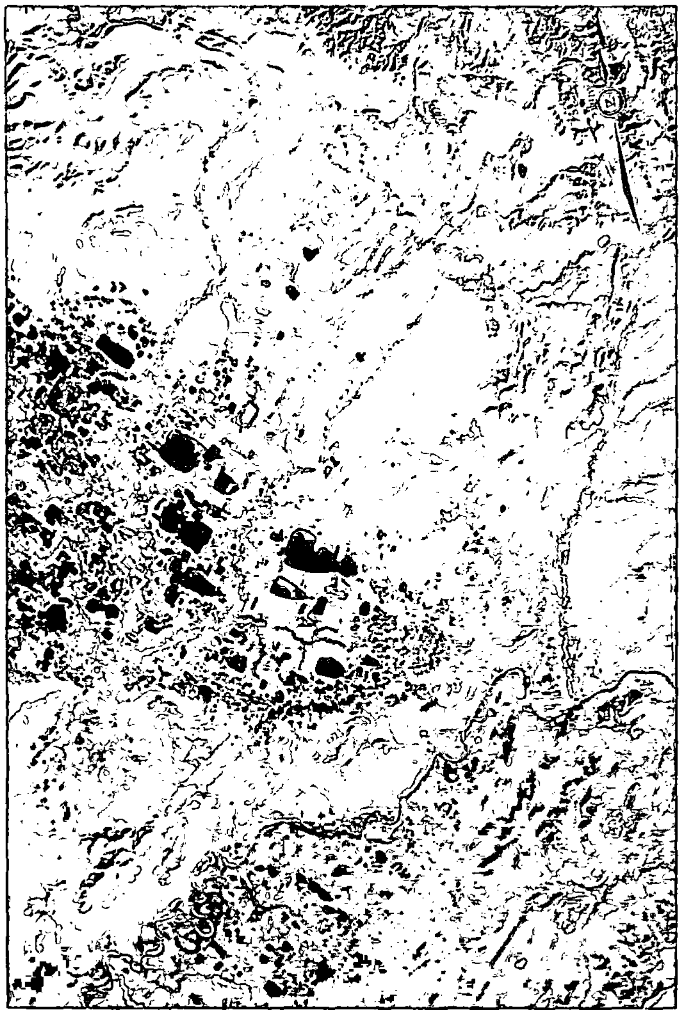
C.6 Soils

C.6.1 There is a wide range of variations in soil properties in a region as large as the study area, reflecting differences in climate, bedrock, landforms, surface deposits and vegetation. All soils in the study area are influenced by low temperatures, either from ground ice contained within their profile or from being underlain by permafrost near the surface. Soil development in mineral soils of the southern part of the study area, is the same as in other areas in the boreal forest (Tarnocai, 1973). Near-surface permafrost is first encountered in fine textured materials in shaded, moist locations. As the climate becomes more severe farther north, permafrost spreads into medium textured, better drained, more exposed landscapes and only the very coarse textured, rapidly drained sites are not affected. All land surfaces in the northernmost part of the study area are underlain by perennially frozen materials.

C.6.2 In addition to being colder than soils in southern Canada, those of the study area generally lack well developed soil horizons. Organic soils (peats) are more widespread than in agriculturally developed parts of Canada; and effective soil depth is less than in most soils in southern Canada because permafrost limits root depth (Fig. C-13).

C.6.3 The greatest changes from southern conditions in terms of soil development and soil environment are noted in the northern part of the study area, particularly in the subarctic forest region (Zoltai and Pettapiece, 1974). The soils consisting of coarse textured sands and gravels without permafrost, are similar to those in the South, but are of very limited extent. The majority of upland soils are silts and clays with hummocky surfaces due to freezing processes over the permafrost table. These hummocks may be regarded as *permanent frost boils*; they average one to two metres (3 to 7 feet) in diameter and may be up to 60 centimetres (2 feet) high. Permafrost generally lies within one metre (3 feet) of the surface, so drainage is impeded. The usual soil forming processes may be present, but are weakly expressed because of low biological and chemical activity in this cold climate. In addition, *frost churning*, a major process in soils of the northern part of the study area, causes physical disruption of the soil materials.

C.6.4 Many northern soils are susceptible to erosion once the protective organic layer is removed because of their high ice content. These soils may form a *slurry* as the contained ice melts, with *gullies* being formed in some cases (Fig. C-24). The excess moisture can drain away on slightly sloping land, resulting in a relatively stable land surface. Later, however, as the vegetation and organic layers are again developed, the permafrost table rises and ice accumulates in the soil. It is common to find a very icy layer just beneath the permafrost table in hummocky areas. This icy layer, though usually less than one metre (3 feet) thick, often consists of nearly pure ice with only a few streaks of soil (Zoltai and Pettapiece, 1974).

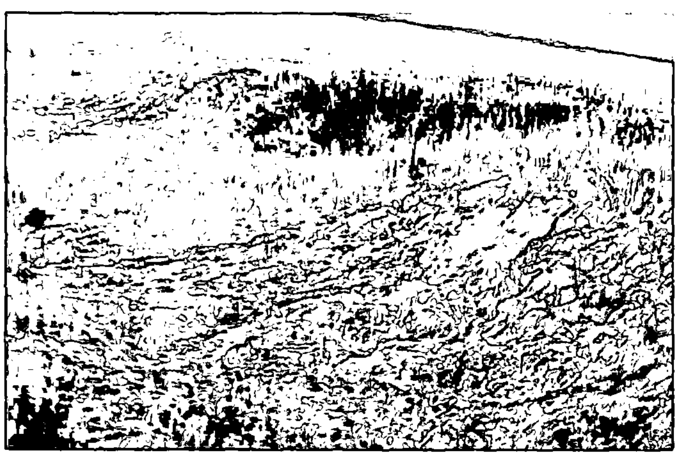


Canada Centre for Remote Sensing, EMR

Fig. C-23 ERTS photograph of rectangular thermokarst lakes on Old Crow flats, Yukon. Scale: 1:1,000,000.

W.L. Wallace

Fig. C-24(b) Erosion along seismic line in Norman Wells area. Large silty delta is built into lake in the foreground.

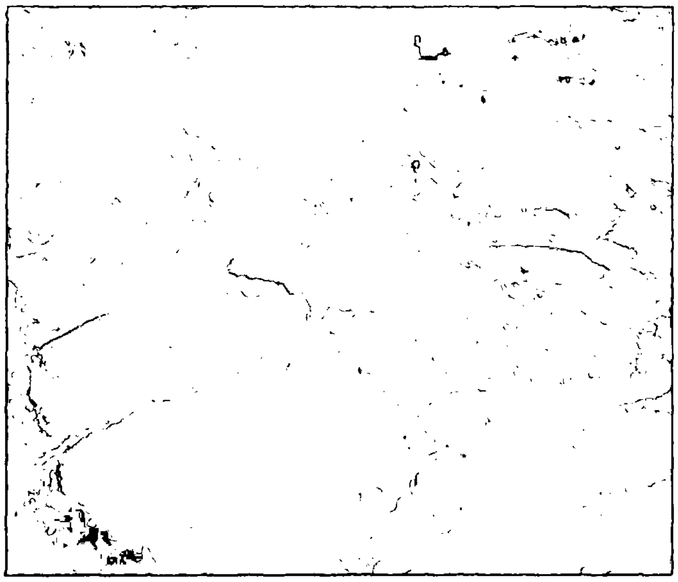


S.C. Zoltai

Fig. C-24(a) Earth flow and gullying in ice rich soil two years after forest fire.

C. Tarnocai

Fig. C-24(c) Seismic line erosion. Seismic line has eroded to a depth of about five metres (16 feet). Note black spruce falling into gully as permafrost melting and erosion proceeds.



V.N. Rampton

Fig. C-24(d) Melted out ice wedges resulting from clearing of DEW Line site, Anderson River area.

C.6.5 Organic soils occur where poor drainage, high water table or seepage have resulted in the accumulation of more than 60 centimetres (2 feet) of peat. These soils are generally located in the flat depressions of former lakes or ponds. The average thickness of the peat about is 2.5 metres (8 feet); the greatest observed thickness was six metres (20 feet). Peat is derived mainly from sedges and mosses, or more commonly a mixture of the two, often in alternating layers. These soils cover about one quarter of the study area, decreasing in extent in the tundra and the unglaciated regions of the northern Yukon.

C.6.6 The most southerly extent of permafrost is found in sphagnum moss covered *bogs*. The associated landforms (peat plateaus) rise about one metre (3 feet) above the water table, and therefore have a relatively dry surface covered with an abundant growth of lichen. The active layer is only about half as thick as in nearby mineral soils, because the dry peat has better insulating qualities.

C.6.7 Where the water table is at the surface, and particularly in seepage areas, the peat is less acidic and contains more nutrients. Sedges and shrubs predominate on these very wet *fens* (Tarnocai, 1970). Fens are not affected by permafrost, except in the northernmost part of the study area.

C.6.8 Such factors as drainage, formation of hummocks, and suitability for tree growth are all partially determined by the rate of accumulation of peat. Sphagnum peat accumulates at three to seven centimetres (1 to 3 inches) per 100 years while fen peats and forest peats accumulate at 1.5 and 2.5 centimetres (0.6 and 1.0 inches) per 100 years respectively (Tarnocai, 1973). This rate of accumulation is sufficiently rapid to provide an insulating mat under which permafrost may develop.

C.7 Vegetation

C.7.1 Vegetation is intimately related to the climate, landforms, permafrost, drainage and substrate characteristics described in the preceding sections.

C.7.2 Vegetation in the study area ranges from merchantable stands of white spruce and jack pine in the southern Boreal Zone through open subarctic boreal forests of stunted black spruce to dwarf shrub-heath communities of the treeless tundra (Fig. C-14). (Scientific names of plants used to identify these various zones are given in Appendix IV, Part 1.) These vegetation zones, however, do not appear in orderly parallel bands corresponding to climatic zones, but in localized mosaic patterns, according to differences in soil, drainage, aspect, elevation and fire history.

C.7.3 On the rich alluvial soils of the Mackenzie delta, tall white spruce provide a northern extension of a boreal-like forest into an area that is otherwise considered part of the tundra region. Likewise, under adverse conditions created by exposure to strong winds that strip away protective snow cover, outliers of tundra vegetation occur hundreds of miles south of the main tundra region (Fig. C-14).

C.7.4 The boreal forests in the southern part of the study area are characterized by tall, closely spaced trees. South facing slopes usually support a mixed wood forest, with black spruce on the north facing slopes. The first forests after a fire on well-drained uplands usually consist of trembling aspen and a few white spruce or black spruce. In the absence of fires, nearly pure black spruce and white spruce stands develop, with a characteristic thick carpet of feather mosses. On stabilized dunes or old beach ridges ravaged by forest fires, pure stands of jack pine and trembling aspen are common.

C.7.5 Farther north in the Wrigley area, the boreal forest becomes thinner and the trees shorter. Permafrost occurs within one metre (3 feet) of the surface impeding the internal drainage. Slopes which would be well-drained farther south now support open stands of black spruce with a thick moss carpet and abundant Labrador tea. White birch and white spruce form the first forest following a fire, but black spruce gradually becomes dominant.

C.7.6 Progressing northward, the subarctic boreal forest begins in the vicinity of Norman Wells, although outliers occur south of Norman Wells at higher elevations. Southern species such as jack pine no longer grow and others such as trembling aspen, are restricted to sunny gravel ridges. Forests consist of widely spaced black spruce, with ground vegetation of mosses and lichens if undisturbed for at least 100 years. Open black spruce forests occupied about 50 per cent of the entire area mapped during vegetation surveys under the Environmental-Social Program (Forest Management Institute, 1974). The well-drained, sunny slopes also support tall white spruce, and balsam poplar is common near river banks.

C.7.7 As noted in paragraph C.7.5 relatively dense white birch and white spruce stands may be established after a fire. These first stands usually grow well, but good growth is not sustained as moss cover develops and permafrost rises. If left undisturbed for more than 150 years, an open black spruce forest will become a community of dwarf shrubs since rising permafrost reduces the depth of the rooting zone (Fig. C-13).

C.7.8 Farther north in the Fort Good Hope area, trees become more widely spaced and ground lichens replace the moss carpet. Hummocky areas, formed by heaving soils underlain by

D.K. MacKay

Fig. C-25(a) Panoramic view of 'drunken' open black spruce forest.

S.C. Zoltai

Fig. C-25(b) Close-up view of 'drunken' black spruce-lichen forest. Hummocky microtopography caused by frost heaving of the soil and resultant leaning trees is shown.

permafrost near the surface, indicate an unstable substrate. As the soil churns, trees which are rooted on the sides of the hummocks and in the depressions between them, are tipped haphazardly creating a 'drunken' forest (Fig. C-25).

C.7.9 Near the arctic tree line spruce trees, predominantly black spruce, are stunted (2-3 metres, 6-10 feet) and widely spaced (Fig. C-26). Low shrubs, including Labrador tea and cranberry, and abundant lichens grow between the trees. After a fire, black spruce and white spruce usually regenerate, with some white birch common on steep slopes. However, repeated fire damage may result in willow and alder shrubs replacing the trees and forming the main stands. In extreme cases, even the shrubs may fail and a sedge-cottongrass community develop, as in the tundra region.

S.C. Zoltai

Fig. C-26 Scattered stunted black spruce near arctic tree line. Note the white blooms of the cotton grass and the typical hummocky ground of the tundra.

C.7.10 The unifying characteristic of *tundra* is the low, ground hugging growth habit of vegetation, an adaptation to the severe climate. Dwarf birch-heath shrub communities predominate on the coastal plain near the Mackenzie delta as well as in the peat areas of Old Crow flats. Mosses, lichens and sedges comprise a virtually continuous understory; and scrub willow, birch and alder border the streambanks. Much of the coastal plain and the foothills of the Richardson Mountains support tussock cottongrass and sedge meadows. Large areas of frost patterned ground are common on the Tuktoyaktuk peninsula and the plains bordering the Eskimo Lakes.

C.7.11 Wetlands, covering about one quarter of the area studied, have a distinctive vegetation sequence which is closely tied to the development of permafrost (Zoltai and Pettapiece, 1974). The dominant vegetation on the unfrozen wetlands or fens is sedge with aquatic mosses and scattered heath shrubs. Sphagnum moss and shrubs may occur in low, narrow ridges at right angles to the direction of seepage, forming string or ribbed fens (Fig. C-27). Extensive fens exist on the flats between upland forests in the undulating topography south of Fort Simpson; and they occur in pockets all along the Mackenzie River.

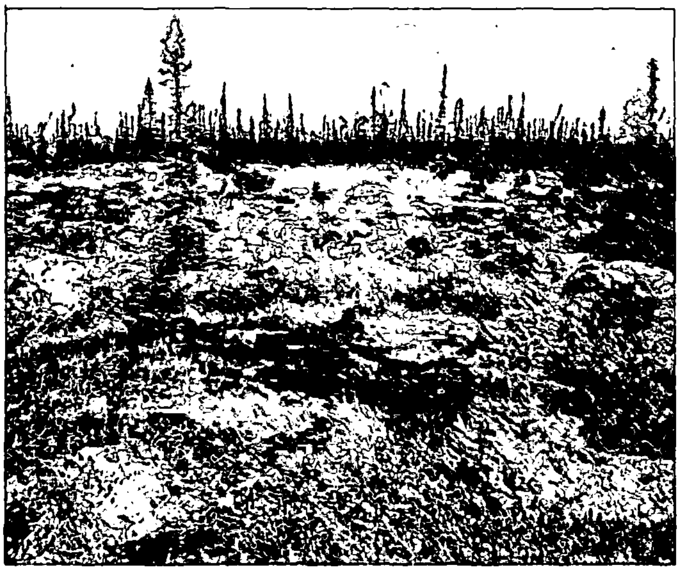
C.7.12 In time, the accumulation of organic material permits cushions of sphagnum to grow in the fens. Eventually, black spruce trees become established on the sphagnum cushions, shading the ground and intercepting snowfall. The better insulation, shading and thinner snow cover combine to preserve seasonal frost in the ground beneath the spruce trees, creating local areas of permafrost. The ground surface is then elevated by the expansion of water turning to ice, forming a peat plateau which is better drained than the surrounding fen permitting stands of black spruce to grow to maturity. In the southern part of the study area, around Fort Simpson, dense black spruce, Labrador tea and lichens occur on these peat plateaus. Farther north, the black spruce becomes more widely spaced and lichen cover dominates on peat plateaus.

C. Tarnocai

Fig. C-27(a) Aerial oblique of string fens, Bulmer Lake area. Water seepage is perpendicular to direction of vegetation lines. Fens are usually not underlain by permafrost.

Canadian Wildlife Service, DOE

Fig. C-28(a) Frozen peat plateaus and wet unfrozen fens, Caribou River area. The light coloured bogs have a thin cover of trees, while the fens are treeless.



W.W. Pettapiece

Fig. C-27(b) Peat plateau complex. These landforms may become underlain by permafrost as the moss cover thickens.

S.C. Zoltai

Fig. C-28(b) Ice cored palsa. This palsa stands 2.5 metres (8 feet) high above the unfrozen bog in the foreground.

C.7.13 The peatlands appear as a mosaic of *peat plateaus* or *ice cored palsas* and adjacent unfrozen fens as far north as Arctic Red River (Fig. C-28). Changes in water circulation patterns may result in development of a sphagnum cover with subsequent development of permafrost in some fens. If frozen wetlands eventually melt, collapse scars may remain. These collapse scars are common in the southern part of the study area but become scarce north of Fort Good Hope.

C.7.14 Perennially frozen treeless peatlands occur in the lower Mackenzie valley and the coastal plains. These exhibit a polygonal pattern due to ice wedge development. All frozen peat plateaus in these areas are interspersed with small water filled thaw pockets or collapse scars which are eventually filled in with peat (Fig. C-16).

C.7.15 All peatlands in the tundra region are perennially frozen and show a polygon pattern (Fig. C-6). Polygons are a visual manifestation of permafrost control of a landscape. The low centred polygons are surrounded by a low ridge, resulting in a wet centre. Sedges and some aquatic mosses grow in the centre, while the shoulders support sphagnum moss and dwarf shrubs (Fig. C-27). High centred polygons are surrounded by a shallow trench, which leaves the centre high and well-drained. The centres are often eroded by the wind, but are usually covered by dwarf birch and ground lichen.

C.7.16 Alpine regions consist of a complex of plant communities. The influence of permafrost is reduced and exposure becomes a critical factor. On exposed sites gnarled, dwarf spruce provide visual evidence of the harsh environment

(Fig. C-5). In drier areas, protected mountain river valleys provide a suitable climate for the growth of trees or high shrubs. Meadows, in poorly drained depressions and on gentle slopes, support lush sedge and grass-moss communities. Dwarf willow, mountain avens and lingonberry may grow in longitudinal stripes; moss campion, lichen, cassiope and mountain avens occur in pockets of soil on rocky slopes and ridges.

C.7.17 Along the floodplains of the larger rivers vegetation is zoned in bands which reflect a chronological succession of plant communities invading different levels above the average water line. Regularly flooded areas support little vegetation except sedges, horsetails and willows. On somewhat higher ground, alder and balsam poplar thrive in the rich alluvial soil. Flooding deposits periodic increment of silts, suppresses growth of mosses and lichens, and promotes a relatively thick active layer. White spruce grows with a thick carpet of feather mosses, that allows the development of permafrost on floodplains which flood less frequently. If a river channel shifts and an area escapes regular flooding, black spruce-lichen stands will develop (Fig. C-29).

C.7.18 Fire is probably the main factor altering the vegetation cover throughout the study area. Most forest cover reflects past fires by a mixture of stands in various stages of succession (Rowe and Scotter, 1973; Watson et al., 1973). Intense fires destroy vegetation and damage the organic layer, thus increasing thaw depth in summer and releasing the moisture locked in the soil by permafrost. General subsidence occurs on flat sites, accented by the development of wet depressions. Landslides may occur on slopes during periods of heavy rains. If such slides expose lenses of ground ice, serious erosion will follow as a retrogressive flow slide develops (Fig. C-30). Gullying is often initiated even on gently sloping areas.

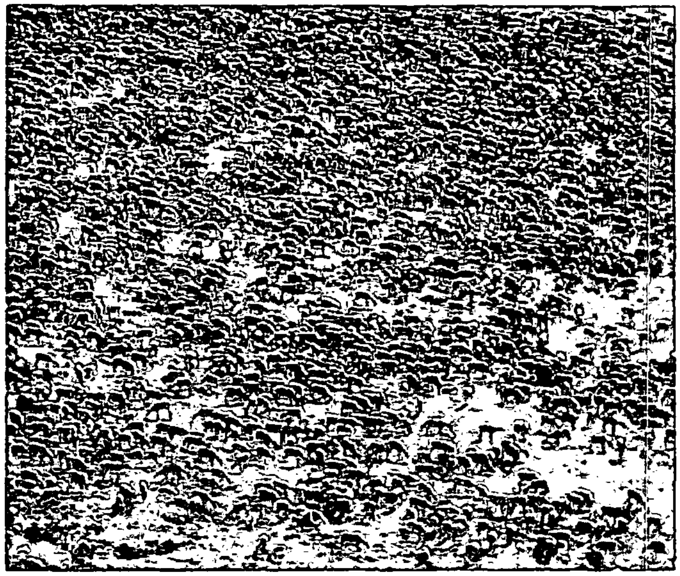
C.7.19 The rehabilitation of a burned area begins soon after the fire. In areas that have escaped serious erosion, the insulating organic mat is built up in about 100 years, allowing the permafrost table to rise to its former level. Retrogressive flow slides may remain active for scores of years after they become activated; often they stop only when ground ice lenses have melted completely.

S.C. Zoltai

Fig. C-29 Snake River floodplain and terraces. Vegetation types provide distinct wildlife habitats and reflect flood and scour hazard. Maximum flood and scour hazard is indicated by the linear pattern of willow and alder in the foreground which also forms prime moose habitat. Light green toned balsam poplar on the extensive low terrace is rarely flooded; while the dark green toned higher terrace in the background which is covered with white spruce, is free of flooding.

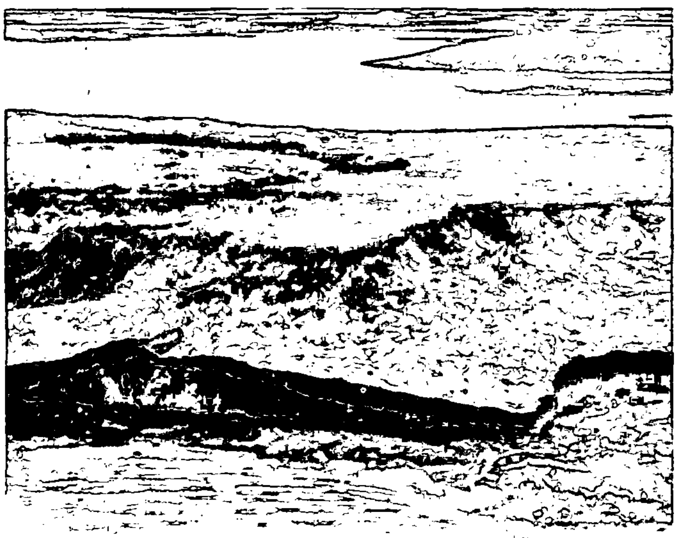
J.N. Stein

Fig. C-30(a) Retrogressive flow slide, North Nahanni River.



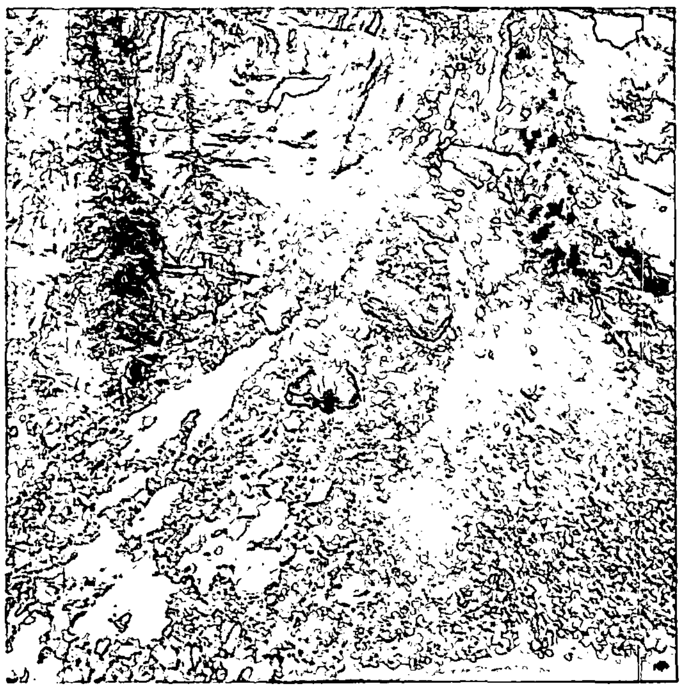
E.A de Bock

Fig. C-32 Portion of Porcupine caribou herd.



V.N Rampton

Fig. C-30(b) Re-activated flow slide. Note massive bed of ice at shallow depth.



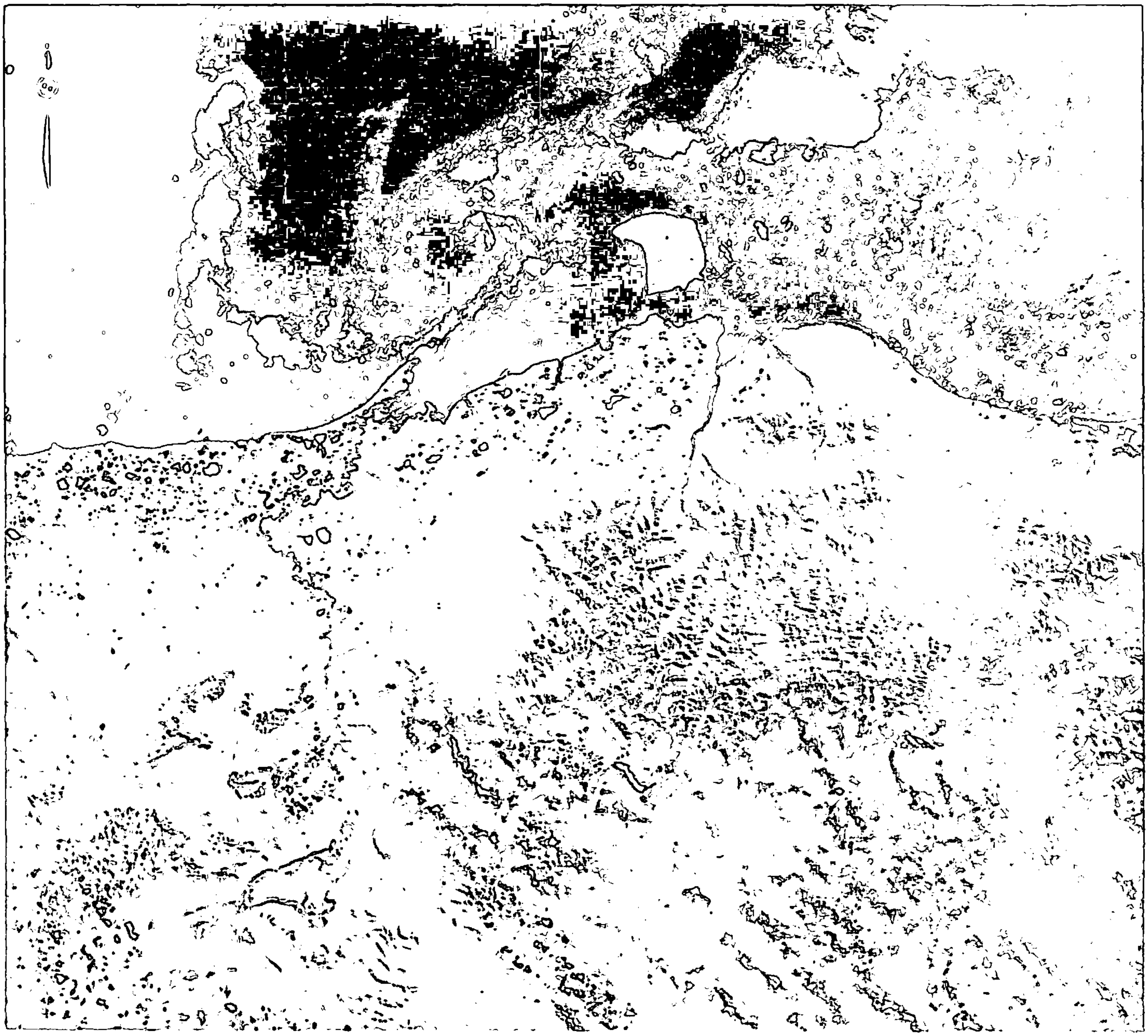
B. Goski

Fig. C-31 Grizzly bear in typical rough terrain.

C.8 Wildlife

C.8.1 *General Wildlife and Habitat Relationships*

C.8.1.1 The term *wildlife* encompasses a large variety of animals, each with its own distinctive life cycle and habitat requirements. It is difficult to imagine a greater contrast than that between the sedentary beaver, living in its own small aquatic habitat, and the migratory birds, travelling thousands of miles twice each year to reach their nesting sites in the Arctic and then to return to their wintering areas far south of the Canadian border. Equally great contrasts exist between the solitary grizzly bears, with territories of hundreds of square miles (Fig. C-31), and the dense herds of barren-ground caribou which travel shoulder to shoulder in tens of thousands at certain points of concentration (Fig. C-32). And yet, beneath these obvious differences is a common bond that unifies these animals – the use of the same ecosystem. Although their life cycles are very different, beaver and waterfowl occupy the same aquatic habitat; the relationship of the grizzly bear and the barren-ground caribou is that of predator to prey and they likewise occupy the same general area (Watson et al., 1973). (Scientific names of the wildlife species discussed in the following sections are listed in Appendix IV, Part 2.)



Canada Centre for Remote Sensing, EMR

Fig. C-33(a) ERTS photograph of Yukon north slope, August 16, 1973. Scale: 1:1,000,000

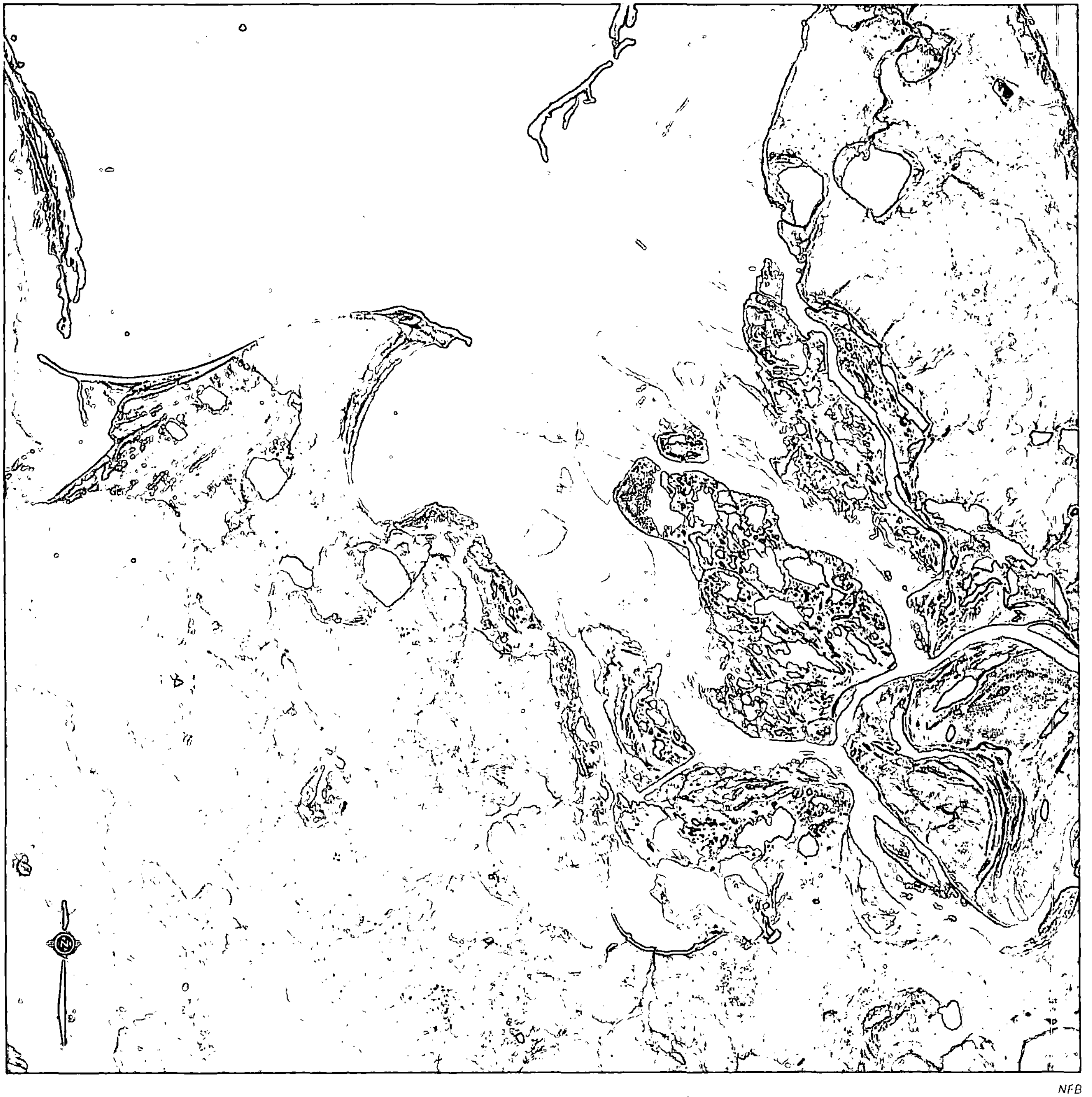
C.8.1.2 The land is as complex as the wildlife it supports. The low shelving coast of the Arctic Ocean which is frequented by polar bears in the winter, grades gently into the undulating tundra hills of the north slope where the greatest concentrations of arctic fox occur (Fig. C-33).

C.8.1.3 Offshore gravel and sandbars, and sheltered bays and lagoons provide nesting sites and moulting and staging areas for waterfowl, and ideal habitat for shorebirds (Fig. C-34).

C.8.1.4 South from the coastal zone, the treeless, gently rolling hills of the north slope merge with the slopes of the British Mountains where golden eagles are numerous and where the most northerly Canadian herd of Dall sheep is found. Farther south, the Old Crow flats, a dense wetland complex developed through the melting of ground ice in a glacial lake bed, forms a unique landscape rich in waterfowl and muskrat habitat (Fig. C-35).

C.8.1.5 The valley of the Mackenzie is far from uniform as a habitat for wildlife. Distinctive features include its delta, by far the largest in Canada, which supports a productive array of plant and animal life because of its dynamic hydrologic regime and fertile silt deposits. Some 5,000 square miles of estuarine flats, levees, channels, lakes, marshes and meadows support large populations of muskrat, beaver and waterfowl (Fig. C-11). The delta is frequented by arctic fox and grizzly bears and is a major staging area for migrating waterfowl.

C.8.1.6 Another distinctive feature farther upstream is the Mackenzie's many islands, which are densely covered by spruce and willow. Willow is particularly important as winter food for moose. The bars serve as resting areas for as many as 100,000 migrating geese and swans in the spring (Fig. C-36).



NFB

Fig. C-34 Aerial photograph of Phillips Bay, Yukon north slope. Coastal lagoon waterfowl staging and nesting habitat is shown. Scale: 1:70,000

B. Goski

Fig. C-33(b) Arctic fox denning site, Yukon north slope. View looking towards British Mountains (typical arctic fox habitat).

W.W. Pettapiece

Fig. C-35 Aerial oblique of Old Crow flats, Yukon. The extensive productive wetlands utilized by large numbers of breeding waterfowl of many species are shown.

C.8.1.7 The numerous large lakes on the Mackenzie floodplain are important to waterfowl, especially since abandoned channel lakes are the first to open in the spring. There are cliffs, river banks, terraces and valley edges where falcons and eagles nest. Winter habitat for moose is found along the stream edges where willow and alder grow abundantly.

C.8.2 *Some Characteristics of Northern Wildlife Species*

C.8.2.1 Northern ecosystems are populated by fewer species than their southern equivalents. Nature seems to have compensated for the smaller number of species by increasing the members of a particular species; and no one who has been in Canada's North during the summer needs to be reminded of the insects that bear painful testimony to this maxim. Adequate

S.O. Barber

Fig. C-36 Spring migration of snow geese – Fort Norman, NWT on the Mackenzie River. River bars and willow covered alluvial deposits such as this provide critical stopping areas for migrating waterfowl.

aquatic and terrestrial plants are produced during the brief summer not only to feed the abundant bird and insect life but also to sustain food chains on which year round residents depend. However, the migratory habit of the barren-ground caribou is undoubtedly a survival mechanism developed in response to the low net productivity of any one area.

C.8.2.2 In response to the short and cool summers, many arctic plants reproduce vegetatively rather than through seed production since the latter takes more time than is available. Animals do not have a similar biologic alternative, and late springs, severe weather conditions, or early autumns can disrupt the reproductive success of waterfowl and various mammals. Second nesting which often helps prairie waterfowl populations overcome adverse weather conditions, is not possible during the short arctic summer.

C.8.2.3 The seasonal concentrations of waterfowl, shore birds, Dall sheep, moose, caribou, fish and coastal dwelling whales further increases their 'species' sensitivity to environmental stresses because even local adverse conditions can affect a high percentage of the population at one time.

C.8.2.4 The long, cold winter in the northern Mackenzie valley and along the arctic coast places greater physiological stress on populations than in the South. Northern ecosystems are characterized by the high proportion of species which hibernate or migrate out of the ecosystem for the winter.

C.8.2.5 Certain ecological principles apply to all ecosystems. For example, a series of plant communities replacing each other over a period of time – a process known as *succession* – is characteristic of all ecosystems, especially after disturbances such as fire. Each successional stage has a distinct wildlife carrying capacity. The fact that such general relationships are common to ecosystems everywhere suggests that knowledge from more intensively studied areas should be applicable in the subarctic and arctic regions. However, this transfer of knowledge is deterred by two factors: (i) the relationships between the ecosystem and wildlife are so complex that much remains unknown even in the most intensively studied areas; and (ii) much present understanding of arctic wildlife problems is already derived from work carried on outside the Arctic. General principles are transferable, but not details. For example, ecological 'laws' related to tolerance can be applied to northern moose populations where scarce overwintering habitat is known to put absolute limits on populations. But this knowledge does not help answer questions regarding what *level* of disturbance would reduce moose survival.

C.8.2.6 Various *waterfowl*, that are highly dependent on weather conditions at nesting time, and such small *herbivores* as lemmings, and arctic and snowshoe hares, that are subject to epidemics and changes in food supply, are most subject to wide population fluctuations. Predators that feed on these animals are similarly subject to major population changes because there are few alternate prey to which such animals as fox and snowy owls can turn, although in bad years the latter periodically move southward in search of prey. Longer living, wider ranging herbivores such as Dall sheep and caribou are much less prone to large fluctuations in numbers.

C.8.2.7 Even though populations of some species remain relatively constant from year to year, apparent changes in numbers may result from variations in migratory patterns. This is particularly true of barren-ground caribou that have traditional migration patterns within which a significant degree of variability occurs. The causes of these variations within the broader scale traditional patterns are unknown although food supply, weather, and perhaps predation are factors. The migration patterns of waterfowl, on the other hand, are much more predictable, and the time, location and size of flocks can be estimated reasonably accurately.

C.8.3 *Characteristics of Particular Wildlife Species*

C.8.3.1 Although the broad principles discussed in the previous section are generally applicable to wildlife in the study area, there are certain key points to be noted for the more important species. Such species as lynx and wolverine are not discussed and only a general statement is provided on other species such as black bear, wolf, otter and mink. These omissions and brief statements are not intended to minimize the importance of these species in the environmental setting. However, studies could not be undertaken on all wildlife species and greatest emphasis was placed upon those thought to be most susceptible to proposed engineering projects.

C.8.3.2 *Moose*

C.8.3.2.1 Moose are widespread throughout the Mackenzie valley and northern Yukon and are a modest, reliable food resource, locally utilized by the native population. In winter they are severely restricted to three main habitat types: river valleys; wetland complexes and upland slopes. Moose depend upon browse species of vegetation such as willow, dogwood, alder and balsam poplar whose growth is encouraged by local habitat disturbances such as fire and flooding.

C.8.3.2.2 Development of any kind in or around critical river valleys will inevitably lead to population reductions. The river valley sites are particularly critical in the more northern regions where riverside vegetation is confined to a narrow band and where moose populations tend to be local and isolated in nature (Watson et al., 1973).

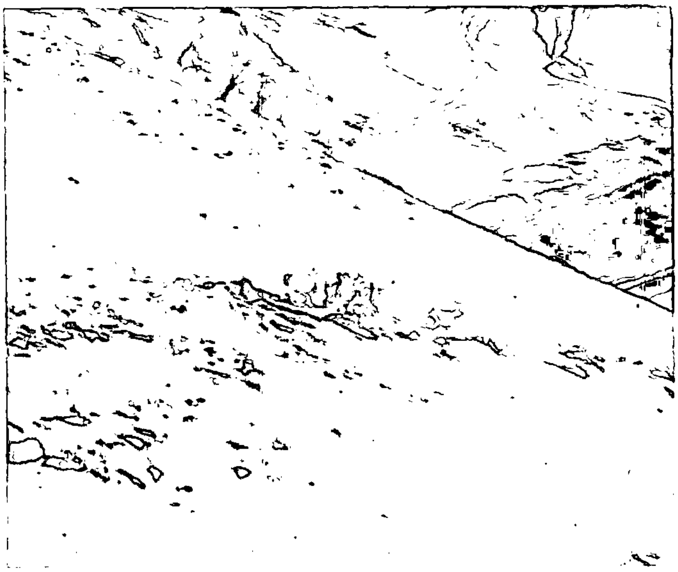
C.8.3.2.3 In the more northern areas growth of browse shrubs is limited to locations near river channel banks where the active layer is deeper and where browsing keeps the vegetation permanently in an early successional stage. Predation, and especially hunting, is an important factor controlling moose population size and distribution, though not nearly as critical as the availability of winter habitat.

C.8.3.3 *Caribou*

C.8.3.3.1 The three subspecies of caribou in the study area (woodland caribou, barren-ground caribou and reindeer) are more important to the native people than moose. Woodland caribou, perhaps the most widespread, are essentially non-migratory. They are found on both sides of the Mackenzie River as far north as the tree line; in summer they appear to use highland ranges which provide lichens, mosses and herbs for forage, relative freedom from insects, and some protection from predators. All three subspecies of caribou use open black spruce-lichen forests at lower elevations for their winter range.

C.8.3.3.2 There are two major groups of barren-ground caribou in the study area: the Bluenose herd which is found east of the Mackenzie River; and the larger Porcupine or International herd, consisting of between 70,000 and 140,000 animals, which has its summer range in northeastern Alaska. Although they are typically found south of the tree line in winter, movements of the Porcupine herd are not wholly predictable and most of the Yukon and northeastern Alaska may be considered as their winter range. Generally, this herd winters in the foothills and valleys of the Ogilvie and Selwyn Mountains and moves north and west in the spring via the Richardson, Old Crow, and western migratory routes. The herd groups loosely on the Yukon Coastal Plain and then proceeds westward into Alaska toward the summer range.

C.8.3.3.3 Four particular habitats are significant for barren-ground caribou: *staging areas; calving areas; mineral licks*; and *river crossings*. Although staging areas are used for premigratory grouping at approximately the same time and for the same length of time each year, their importance is not at all well understood. Mineral licks are important as sources of scarce minerals to which caribou are highly attracted. Calving areas are characterized by snow free, gently rolling, well-drained and fairly well-sheltered valleys. River crossings appear to be used consistently since Natives have harvested caribou at these points for untold generations. These sites, like the staging areas, have several common attributes: they have gentle slopes with good footing and are normally located at the apex of river bends. Caribou often follow a river bank for several miles before crossing at such sites. Some rivers, such as the Firth, have deep canyons which force the caribou to cross under extremely perilous conditions. Caribou patterns of movement appear relatively stable over long periods of time; in fact, hunting camps and settlements such as Old Crow exist because of the long term dependability of the migration routes.



J.W Nolan

Fig. C-37(a) High elevation Dall sheep winter range. This windblown talus slope is unstable and has sparse vegetative cover. This type of winter range supports only small herds of sheep.

J W. Nolan

Fig. C-37(b) Large band of Dall sheep on 'plateau and gentle slope' winter range in Mackenzie Mountains. Well-vegetated windblown slopes are heavily utilized by sheep. Precipitous escape terrain lies at background left.

C.8.3.3.4 The third subspecies of caribou in the study area is a small herd of about 2,000 Eurasian reindeer, which were originally introduced from Alaska, and have excaped over the years from the Canada Reindeer Project. Their range is east of the Mackenzie delta in which local north-south movement of the herd occurs.

C.8.3.4 *Dall Sheep*

C.8.3.4.1 There are four major populations of Dall sheep, a northern subspecies of the more widespread bighorn sheep, located west of the Mackenzie River – in the Mackenzie, the Richardson and the British Mountains and in the Nahanni-Liard region.

C.8.3.4.2 Winter habitat which is crucial to the sheep, is probably the prime limiting factor. Good wintering habitat consists of abundant food, limited snow cover and scattered areas of precipitous escape terrain (Fig. C-37). Since wintering areas occupy only a small fraction of the herd's home range, the ridges, slopes and plateaus take on great importance. Mineral licks and lambing areas are other critical elements in sheep habitat. An absolute necessity of suitable summer range is proximity to *escape terrain* which emphasizes the sensitivity of these animals to disturbances, either through sight or sound.

C.8.3.4.3 Sheep habitat does not decrease in quality in more northern latitudes, and is only limited in extent by topography. For example, in the Richardson Mountains, lack of precipitous escape terrain restricts summer range.

C.8.3.5 *Grizzly Bear*

C.8.3.5.1 Grizzly bear distribution in the study area ranges from nil in some southern regions to relatively high densities in northern and mountainous areas; the species seems more dependent upon food supply than on specific habitat types. Adult male bears have a very large home range averaging 160 square miles; females appear to range within a more constricted area. However, they all seem to prefer rough, broken terrain where maximum diversity of landforms and vegetation occurs. As a consequence, there is a rather close coincidence of favorable Dall sheep and grizzly bear habitat on a regional basis, although the bears are also quite common in the tundra region of the Yukon north slope. Denning sites are an important factor in considering grizzly bear habitat. Records indicate long term use of individual dens which are usually found on mountain slopes, hillsides and stream banks. Grizzly bears retreat from disturbance, preferring remote areas and relative isolation even from their own species.

C.8.3.6 *Black Bear*

C.8.3.6.1 Black bears are common throughout the forested areas of the Mackenzie valley. They range widely and are frequently attracted to sources of abundant food. Although berries and other vegetation form the bulk of their food, they are omnivorous and often become nuisances around camps and garbage dumps. Denning sites are an important feature, but there is no indication that potential sites are in short supply or that any particular landscape feature is utilized more than others.

C.8.3.7 *Arctic Fox*

C.8.3.7.1 Arctic foxes are restricted to the tundra regions of the study area where their dependence on the cyclic lemming population for food in turn subjects them to cyclic fluctuations in numbers. Denning sites are located in dry, unfrozen sand dunes and on the banks of water bodies – all in low relief areas. Arctic foxes could be adversely affected by exploitation of the well-drained granular materials in which they make their dens because these sites are used for many years.

C.8.3.8 *Wolf*

C.8.3.8.1 Wolves are found throughout the study area, generally associated with their major prey – caribou and moose. Wolf denning sites are important especially in the northern tundra areas where burrowing possibilities are limited by the permafrost. Some dens are used year after year.

C.8.3.9 *Muskrat and Beaver*

C.8.3.9.1 Extensive areas of good quality beaver and muskrat habitat occur in the biologically rich Mackenzie delta and in the thermokarst ponds of old glacial lakes in the Fort Good Hope, Fort Norman, Camsell Bend and Old Crow areas. The relative value of muskrat and beaver habitat within the study area is dependent on a variety of physical and vegetational features. These features are a reflection of interacting and continuing geological processes such as thermokarst development, sedimentation, erosion and drainage.

C.8.3.9.2 While muskrats are generally restricted to standing water, beaver are equally at home in standing water of suitable depth and in running water where the depth can be manipulated. Much habitat may be favorable for both muskrat and beaver, but the same habitat is rarely optimum for both.

C.8.3.9.3 The best muskrat habitat usually coincides with the best duck breeding grounds because the abundant food produced in waters rich in nutrients makes prime habitat for both. However, high quality waterfowl habitat is more abundant than high quality muskrat habitat because ducks are only dependent upon summer food production and can utilize smaller, less productive areas than those needed to maintain overwintering muskrats.

C.8.3.10 *Otter and Mink*

C.8.3.10. Otters are not common in the Mackenzie valley since they are restricted in winter to areas with open water primarily in fast flowing streams and rivers. Any disturbances that would eliminate either open water areas or the fish species that serve as prey for otters would also threaten otter populations. Mink, although not abundant, are widespread throughout the Mackenzie valley. Mink, like otter, prefer open water. They feed on fish, small mammals and birds, and any disturbance affecting their prey species would ultimately affect them.

C.8.3.11 *Waterfowl*

C.8.3.11. Many species of ducks nest in the study area. Greater scaup are particularly abundant in the wooded portions of the Mackenzie delta, and pintails in the unwooded portions. Several thousand snow geese and more than 2,000 whistling swans nest on the outer Mackenzie delta.

C.8.3.11. White winged scoter, scaup and pintails are the most abundant species in the Old Crow flats. Although other widespread, but less dense wetlands are important on a per acre basis, the Tuktoyaktuk peninsula and the Kakisa River area are the other main areas of good waterfowl habitat.

C.8.3.11. These main areas are important because hundreds of thousands of birds regularly breed there; this breeding density creates a sensitivity to disturbance. The less concentrated wetlands scattered throughout the study area have the added importance of providing spillover habitat which is heavily utilized during recurrent prairie droughts.

C.8.3.11. Equally important as the breeding areas are waterfowl staging and nesting areas which are frequently located in close proximity to the breeding habitat.

C.8.3.11. The Mackenzie River, with its islands, is a critical spring migration route where tens of thousands of ducks, geese and swans congregate, and gradually move northward with the spring breakup. On arrival at their destination, pairs disperse to breed on the countless lakes, ponds and streams. By midsummer, large flocks of moulting, flightless birds have congregated along coastal and large inland waters. With the approach of fall, large and small concentrations of waterfowl prepare for the long flight southward. The most spectacular concentrations form on the Yukon north slope and estuarine areas of the Mackenzie delta where several hundred thousand birds (mainly snow geese, but also swans, scaup, scoters and old squaws) condition themselves until they leave at freeze-up.

C.8.3.12 *Rare and Endangered Species*

C.8.3.12. Several rare and endangered species occur in the study area. Polar bears are found along the coast from west of Herschel Island to Baillie Island, just east of the Anderson River. During winter and spring these bears tend to concentrate near islands because the open leads in the offshore ice are used by seals, their main food source. Polar bears are rarely found on the mainland during the summer when open water separates the coast from the pack ice. Little maternal denning occurs on the mainland coast; polar bears frequenting the study area apparently den elsewhere on the arctic coast.

C.8.3.12. The cliff nesting gyrfalcon, peregrine falcon and golden eagle are highly sensitive to disturbance and are restricted in distribution by available nesting sites. In contrast to waterfowl, these birds have a very low reproductive potential, and the peregrine falcon population is declining in response to pesticides which have been concentrated in its prey species. There is no experience to indicate that abandoned peregrine falcon nesting sites will ever be occupied again.

C.8.3.12. The osprey and bald eagle are dependent upon water and fish and their distribution is controlled by the availability of large trees in proximity to productive fresh or salt waters. They, too, are at the top of the food chain and are highly susceptible to pesticides.

C.9 Aquatic Ecology and Fish

C.9.1 *General Features of Northern Freshwater Ecosystems*

C.9.1.1 Any discussion of fish resources must focus first on the aquatic habitats on which fish depend. Even in the last century it was understood that many close relationships exist between the terrestrial and aquatic environments; also it was pointed out that a river channel at a given point reflects the geology, biology, climate and hydrology of a drainage basin which may extend many hundreds of miles upstream. This is a useful way to think of the Mackenzie valley and the northern

Yukon, for what happens in the watersheds and in the tributaries will surely be reflected in downstream channels, water quality and fish resources. Standing water habitats are perhaps less obviously related to the many dynamic characteristics of a drainage basin and more related to the geologic and vegetational history.

C.9.1.2 Productivity of both standing and running water environments is dependent upon three main factors: nutrient supply; water clarity which permits photosynthesis; and temperature. Arctic lakes are young and poor in nutrients. Dunbar (1973) has pointed out that the low nutrient capital invites experimentation in fertilization; in fact, up to a certain point, the dangers of nutrient enrichment (eutrophication) in the Arctic may be less than elsewhere. (Scientific names of the fish species discussed in the following sections are listed in Appendix IV, Part 3.)

C.9.1.3 For organisms in clear streams and lakes of the Mackenzie valley and northern Yukon, the biologically critical level for suspended sediments appears to be 10 to 15 milligrams of suspended sediment per litre of water (Brunskill et al., 1973).

C.9.1.4 The generally high rate of transport of nutrients in waters of the west side tributaries of the Mackenzie River is probably of small importance to aquatic biological communities, since extreme turbidity (reduced light penetration necessary for algae growth) and abrasion limit biological growth. The generally lower rate of transport of nutrients in the clearer waters of the east side tributaries of the Mackenzie River is probably more important to aquatic biological communities, since these systems are less controlled by the effect of suspended sediments (Hatfield et al., 1972; Brunskill et al., 1973).

C.9.1.5 Since there is evidence of *winter* biological activities in lakes and channels of the Mackenzie delta, both by algae under the ice and by bottom dwelling organisms, winter disturbances to these delta water areas may be critical. The organisms of the delta channels can tolerate large amounts of silt during the spring flood stage, but the effects of silt in their environment during the winter is not known (Brunskill et al., 1973). Even without the influence of man's activities, concentration of dissolved oxygen in northern waters may fall to less than one milligram per litre under the winter ice; this is well below the figure of four milligrams per litre considered critical for fish in more temperate waters (Greenwood and Murphy, 1972).

C.9.1.6 Cold dominates arctic aquatic systems as well as terrestrial ones by slowing chemical and bacterial activity, so that aquatic systems which depend on nutrient leaching and decomposition of plant debris tend to be nutrient poor. As a consequence of the low nutrient content and the low temperatures, growth rates for fish are slow. There is a high proportion of large fish in these waters because low nutrient status and limited food supply prevent overpopulation and consequent stunting, and because the waters are unfished.

C.9.1.7 Winter ice conditions in streams and ponds are so severe that many species of fish are limited in their winter distribution to lakes, large rivers, or local areas of open water in streams. Low oxygen content is characteristic in the winter; and the fact that some small streams run dry, others freeze to the bottom, and larger ones are mainly fed by upwellings of oxygen deficient groundwater compounds the problem. Rapid oxygenation of upwelling groundwater takes place if its volume is sufficient to keep ice from forming; such areas are critical overwintering habitats for many species of fish. Although fish are relatively inactive during the winter, they may be particularly sensitive to other stresses such as turbidity caused by siltation.

C.9.1.8 The abundance of bottom dwelling organisms in streams, rivers and delta channels decreases as one moves northward within the study area. There are 5,000 to 50,000 bottom dwelling organisms per square metre of sediment surface area in the upper Mackenzie valley around Fort Simpson, but there are only between 100 and 400 such organisms per square metre in the Mackenzie delta channels. However, clear lakes in the southern part of the Mackenzie delta are oases of aquatic plant and animal growth – they have standing crops several times greater than nearby silty delta channels. In the northern Yukon, there were a few hundred to a few thousand bottom dwelling organisms per square metre of surface. Headwater sections of streams generally have a greater abundance of bottom dwelling organisms per unit area than the lower sections of streams (Brunskill et al., 1973). In these sparsely populated freshwater systems, a breakdown in the food webs can have serious ecological effects. Therefore, Dunbar (1973) has stressed that arctic lakes, especially small ones, are probably the most vulnerable part of the landscape.

C.9.1.9 In summary, the hydrology of arctic streams is unique since there may be no flow throughout the winter. Another special feature is that, along with breakup and a period of several weeks following breakup, the waters carry an enormous suspended sediment load which has been largely scoured from the river bed and banks. The ecological significance of these environmental features is clear. If organisms spend the entire year in the arctic streams, they must be able to survive with very low dissolved oxygen levels for several months; they must continue to metabolize, though slowly at 0°C (32°F); and they must survive high sediment loads and tremendous scouring of the river bed in spring (Greenwood and Murphy, 1972).

C.9.2 *Fish Resources*

C.9.2.1 Thirty-four species of fish have been identified in the Mackenzie drainage, sixteen in the Porcupine River system (including three not found in the Mackenzie), and seven have been identified in the Yukon north slope rivers (including one unique to the area), for a total of thirty-eight species (Bryan, 1973; Stein et al., 1973).

C.9.2.2 Numerous types of aquatic habitat exist within a geographic region such as the Arctic. Each has its own unique physical and chemical properties. The species developing within a particular habitat have become genetically tied to conditions there. For example, the interrelationships of some species of fish with their habitat have become so intense that they could not tolerate a change in conditions or displacement to another area. Salmon species provide good examples. If a population specific to one unique set of habitat conditions is lost, no other population of the same species can fill the void.

C.9.2.3 The ability of a species to survive adverse conditions is thought to depend on: (i) the number of subpopulations within the geographic range; (ii) the genetic variability of the subpopulation; and (iii) the severity, extent and timing of the disturbance.

C.9.2.4 Although life histories of some very widespread species such as northern pike are known, it has not yet been determined where other species in the study area spend certain phases of their life cycles. The complexities of the life histories of many fish species, the seemingly erratic distribution of some, and the vastness of the study area make it difficult, if not impossible, to delineate the environment they utilize. Nonetheless, there is a considerable amount of knowledge about many species, including population estimates for some tributary water systems. As one example, tag returns from arctic grayling in the Norman Wells area indicate that some populations may use tributary systems on opposite sides of the Mackenzie River during different phases of their life cycle. Therefore, in order to safeguard a particular population of fish, several river systems may have to be considered (Stein et al., 1973). Present data indicate that main stems of such large rivers as the Mackenzie, Peel or Liard, serve mainly as migration routes; spawning, rearing and summer feeding habitats are usually found in small tributaries or back eddies of large streams (Stein et al., 1973).

C.9.2.5 Some species including the arctic grayling, yellow walleye, northern pike and white and longnose suckers, spawn in spring soon after breakup, and usually have completed their outward migrations and egg incubation by late June. However, in the northern Yukon, grayling egg incubation is not complete until mid July and sucker egg incubation extends into August. Many other species, including arctic char, inconnu, humpback and broad whitefish, and ciscos spawn from late summer to late fall. Salmon, some whitefish and arctic char are migratory, returning from the sea in the fall to spawn and overwinter in the rivers. However, the timing of these movements is not well-known.

C.9.2.6 Although data on locations are scarce, non-migratory fish species are thought to overwinter in deep tributary pools, large river systems, or suitable connecting lakes (Stein et al., 1973). Critical areas for the fish resource, particularly in the northern Yukon but also in the Mackenzie basin, are those sections of rivers that remain unfrozen throughout the winter and are near flowing springs (Fig. C-38). Char and probably grayling overwinter in these groundwater discharge areas in the Beaufort drainage. Similarly, in the Porcupine drainage, some young fish apparently overwinter in the open water of the Fishing Branch River, but many also overwinter in the mainstream of the Porcupine River (Bryan, 1973). In the northern Yukon, groundwater is particularly important to overwintering fish populations because its discharge provides the main source of streamflow during winter (Harlan, 1973). In the Porcupine River system, bottom dwelling organisms that are important as food for fish are ten times more abundant near springs and groundwater discharge areas than elsewhere. These discharge areas are essential for the recolonization of large portions of rivers following spring floods (Brunskill et al., 1973).

C.9.2.7 Fish may be thought of collectively, but there are some very distinct differences in the potential of fish species to withstand disturbances. Some of these differences are outlined in the paragraphs that follow.

C.9.2.8 *Arctic grayling* populations may have low resistance to environmental disruptions. Their growth rates are slow and catches of adults in the Mackenzie system are spread over relatively few age classes. Thus, even if no further environmental disruptions or stress occurred, a significant reduction in numbers of an age class would require a long recovery period. The major dependence of grayling on terrestrial and aquatic insects for food also makes this species particularly vulnerable to insecticides and chemical spills which could reduce or contaminate their source of food (Stein et al., 1973).

C.9.2.9 Since at least one life history stage of *arctic char* is present in a stream system at all times, they are especially vulnerable to silt or chemical pollution throughout the year. Char are found in only a few areas of the Mackenzie valley; and where significant number are present, a substantial domestic fishery exists (Stein et al., 1973; Fig. C-39).

C.9.2.10 The preservation of *inconnu* is important because its distribution in North America is restricted to the northwest and it is significant to the domestic fisheries. A wide age class distribution theoretically makes this species better able to withstand isolated short term environmental disruption. However, the inconnu is vulnerable to physical environmental disruptions and stress because it requires clear water and clean gravel for spawning and does not feed during spawning migrations (Stein et al., 1973).

C.9.2.11 The *humpback whitefish* is probably quite resilient because of its wide geographic distribution, a broad age class distribution, a tolerance for a wide range of turbidity and high numbers. Since it depends on bottom dwelling organisms for food, particularly in the Mackenzie delta region, it would be adversely affected by any chemical contamination of its environment (Stein et al., 1973).

C.9.2.12 The degree of resilience and the required spawning conditions of the *broad whitefish* are not known. Since only limited feeding occurs during spawning migrations, added stress at this point in the life cycle might be harmful (Stein et al., 1973).

J.N. Stein

Fig.. C-38 Fish overwintering area on Hodgson Creek, Mackenzie Highway.

W. MacCallum

Fig. C-39 Arctic char spawning in Char Lake, Cornwallis Island.

C.9.2.13 *Arctic* and *least cisco* have good potential for commercial fishery development but are quite vulnerable to environment disruptions. Since the bulk of the spawning migrations are made up of only three or four age classes, a major reduction of them could mean a long recovery time for the population. These species are particularly susceptible to overfishing with nets because of their tendency to congregate in small back eddies, and the relatively uniform size of the spawning population. They are particularly vulnerable to added stress during spawning migration since neither species appears to feed at that time (Stein et al., 1973).

C.9.2.14 *Northern pike, yellow walleye, longnose* and *white sucker, lake* and *flathead chub, trout-perch* and *burbot* have a high resilience because of wide habitat tolerance, high numbers and extensive distribution. Trout-perch, suckers and chub are forage fish for other species and are very important to the food chain of inconnu, lake trout, pike and walleye. Modest reduction in numbers of these species would probably be compensated by repopulation from other areas if environmental conditions returned to normal (Stein et al., 1973).

C.9.2.15 *Lake trout, dolly varden, chum salmon, round* and *mountain whitefish, least cisco, longnose* and *redbelly dace, spottail* and *emerald shiner, brook* and *ninespine stickleback, slimy* and *spoonhead sculpin, boreal* and *pond smelt, goldeye* and *arctic lamprey* were not caught in sufficient numbers to warrant speculation on their resilience. However, their apparent existence in small numbers in the areas sampled in the Mackenzie basin indicates that the local environment is probably not suited to supporting them in large numbers (Stein et al., 1973).

C.9.2.16 There are substantial *chinook* and *chum salmon* populations, each consisting largely of one subpopulation, in the Porcupine River of the northern Yukon. They spawn in the Miner and Fishing Branch Rivers respectively. Destruction of these single spawning areas would mean elimination of the salmon species in the Porcupine River. Salmon are also vulnerable to damage because migration times are short – six weeks in spring for juveniles and six weeks in fall for adults – and the pathways are narrow, consisting of the Porcupine River and one tributary stream. Available evidence indicates that arctic char and inconnu may be as vulnerable to damage as salmon and for much the same reasons.

C.9.2.17 In summary, the extreme cold of the study area imposes severe time and place constraints on all fish species because of ice cover, complete freeze-up and breakup. Water temperatures and falling spring flood levels appear to govern timing of spring migration and spawning. Many important species rely on silt free gravel for spawning. This basic requirement can be threatened by siltation from stream bank failure induced by natural stream processes, by fire induced erosion, or by thermal erosion following other kinds of disruptions to the thermal regime over land surfaces. The land, the water, and the related organisms, and man's treatment of them are all closely interrelated.

D

The Local Social and Economic Setting

D.1 Introduction

D.1.1 In the past Canada has tended to stress investment, exports and employment objectives when evaluating large development projects. However, in assessing the probable effects of northern pipelines, Government has made it clear that local social and economic matters, including employment, are to be of primary importance. In this chapter the attention devoted to the background setting is brief; the main emphasis is on the *present situation*, and particularly on those factors affecting the native people of the study area.

D.1.2 The brief archaeological and historical background sections provide a time perspective, and the reader who is interested in these subjects is referred to general works providing more detail. However, the main themes throughout the chapter are the trends in and the pace of social and economic change. Thus considerable attention is devoted to the evolution of local government and to the life styles of the native people. Likewise, some aspects of population and labour force receive considerable attention since the study area is sparsely populated and could be more profoundly affected by a large development than a more populated area. Also since unemployment, underemployment, and low incomes have been problems in the study area in the recent past, the local economy and transportation and communication are examined.

D.2 Archaeological Considerations

D.2.1 Anthropologists generally agree that the ancestors of Indians and Eskimos migrated from Asia to America across the Bering Strait or possibly over an isthmus joining the two continents much farther back in time. They came as primitive hunters seeking game without realizing they had crossed onto another continent. The earliest migrants who were probably the ancestors of the Indians, came to North America about 40,000 years ago. There were apparently succeeding waves of these people, who rarely settled north of the tree line. The Eskimos who inhabited the bleak arctic tundra, seem to have a shorter past of some 4,000 to 6,000 years. Artifacts and other evidence found recently, suggest that the culture dates back to 3500 B.C. and is the primary source from which Eskimo culture developed (Cinq-Mars, 1973).

D.2.2 The study area has always been considered archaeologically important, primarily because it corresponds more or less to the so-called Mackenzie 'migration corridor' which is assumed to have been one of the major routes during the aboriginal peopling of the new world. However, intensive archaeological research in the study area is a relatively recent phenomenon. Survey and excavation work have been concentrated mainly in the northern Yukon, the Mackenzie delta and the lower Liard valley (Fig. D-1). However, field teams have recently conducted further surveys in selected areas throughout the middle section of the Mackenzie River valley (Cinq-Mars, 1974). Most proposed archaeological sequences, explanations, and speculations are derived from these regional centres and a few scattered intermediate sites far removed from proposed pipeline routings. (The locations of known archaeological and historical sites are shown in Fig. E-5.)

B. Gordon

Fig. D-1(a) Archaeological site at Whirl Lake, east of Arctic Red River, NWT.

D.2.3 Archaeological reconnaissance and excavation were carried out in several key regions within the study area during the summer of 1972. Work in the Porcupine River drainage and the western half of the Yukon Coastal Plain was continued in 1973; and new surveys were commenced along the east bank of the Mackenzie River from Fort Simpson to Fort Good Hope, and in the Travaillant Lake area at the southwestern tip of the Anderson Plain (Cinq-Mars, 1974). Preliminary steps have been taken to reconstruct the prehistoric cultural sequence of the

J. Cinq-Mars

Fig. D-1(b) Archaeological site at Old Chief Creek overlooking the Porcupine River, northern Yukon.

Mackenzie corridor by comparing artifacts from the intermediate regions and from Indian sites in the delta and southern regions.

D.2.4 The near void in the intermediate regions can be explained in terms of the quantity of field work performed and the limited regional synthesis formulated. In light of recent work these areas must be considered as archaeological regions in their own right, having definite affinities in terms of cultural continuity with areas to the north and south (Gordon, B., 1974, personal communication).

D.2.5 Most of the sites in the Mackenzie corridor are located on well-drained high ridges or terraces, on ancient beaches, or on the high banks of present day rivers. The sites are rarely stratified; they are usually shallow and could be disturbed by minor construction procedures.

D.2.6 For the moment it appears that a greater variety of sites exists in the northern Yukon, the delta, and the Fisherman Lake areas than in the intermediate regions, primarily due to the addition of Eskimo cultures and the dual maritime and land adaptation of prehistoric peoples. Proposed pipeline routes in the northern portion of the study area cut across a relatively large number of ecological zones which were systematically exploited by a wide variety of cultural groups over a long period of time.

D.2.7 Present archaeological and ethnographic evidence suggests that major prehistoric human distribution was perpendicular to the Mackenzie River system, parallel to the caribou herd areas which extended into the barrenlands. The Mackenzie River does not appear to have been the prehistoric communication link or 'highway' that it became in historic times (Gordon, B., 1974, personal communication). Many sites or clusters of sites will probably be found near caribou water crossings and fishing areas along the tributaries of the Mackenzie River. These would represent transient populations moving back and forth across the intermediate regions.

D.3 Historical Considerations

D.3.1 At the time of Champlain and Cartier, 50 Indian tribes consisting of approximately 220,000 people roamed four million square miles of Canada (Jenness, 1932). During the same period the Eskimo population probably numbered about 25,000. Both the Indians and Eskimos of the study area had well developed cultures involving seasonal nomadism based on the hunting and fishing resources of the region. Although their hunting grounds were adjacent and their ways of life similar, the Indians and Eskimos remained apart and seldom met. As a result there was little or no cultural exchange and no intermarriage between the two groups. Thus for many centuries prior to contact with the white man, the Eskimos inhabited the arctic coastal areas and the tundra region of the study area, and the Indians roamed the subarctic taiga and the boreal forests of the river valleys.

D.3.2 The Indian bands of the Mackenzie and northern Yukon were of Athapaskan linguistic stock. Each band occupied a fairly distinct area and their distribution about 1789, the year Mackenzie canoed down the river now bearing his name, can be delineated fairly well from the records of early explorers. The Loucheux-Kutchin extended along the Porcupine River and over its northern tributaries into the Peel River and lower reaches of the Mackenzie. The bands located in succession from there towards distant Lake Athabasca were: the Hare and Bear Lake, the Dogrib and Yellowknife, the Slave, and the Chipewyan. (For further discussion of the Indian tribes of the Mackenzie watershed see Jenness, 1932.)

D.3.3 The native people roamed their traditional areas to utilize the seasonal food resources. Thus the migration patterns of caribou and the cyclic fluctuations of animal populations seriously affected the area's food potential. The native people congregated at the best fishing locations in spring and autumn; but during the winter they usually divided into smaller groups to facilitate living off the land. Since they were continually on the move, the material culture of the native people in the Mackenzie was limited.

D.3.4 The coming of the white man caused changes in the territorial boundaries of the native groups; and the establishment of trading posts changed their ways of living. The groups that first secured firearms upset the balance of power and drove the weaker bands before them. For example, the Cree brought pressure on the Chipewyan, who pushed northward against the Slave. The Slave in turn brought pressure on the Dogrib and Yellowknife producing succeeding shifts.

D.3.5 Early trading posts were often built at the best fishing sites, forming the initial and primary stimulus for change and cultural convergence in the area. Their location provided a food resource for the trader and gave him ready access to large numbers of Indians. The native people increasingly used the trading posts as a focus for land based pursuits and when fur prices were high they acquired a wide variety of outside goods. The white man's technology was readily accepted; the bow and arrow and native traps were soon replaced by rifles and steel traps. The introduction of firearms was especially significant and resulted in the rapid depletion of game in some areas. The Natives had more furs to barter and more meat to use when fur bearers and game were plentiful because they had more efficient tools; and when cycles were at a low ebb or areas overharvested, they had less. In both instances the Natives became increasingly involved with the trading posts for materials and food.

D.3.6 The missionaries who usually arrived soon after the trading posts were established, represented a different type of cultural contact. They were concerned with the spiritual and physical well-being of the people and believed that achievement of these goals required a literate *resident* community. Thus the interests of the traders and the missionaries conflicted to some extent. The missionaries encouraged the Indians to return to the 'settlements' frequently, whereas the traders urged them to spend as much time as possible on the land harvesting furs.

D.3.7 The missions expanded their services by providing frontier hospitals and schools to meet the pressing needs around the trading posts. This further encouraged the development of permanent settlements and population growth. The hospitals developed by the religious orders have gradually been replaced by public institutions but a few still remain. For over a century the only schools in the Northwest Territories were those operated by Roman Catholic and Church of England missions with some financial assistance from Government. The change to a government operated school system was only begun in 1949 (Chart I, Appendix D).

D.3.8 High fur prices and new mineral and petroleum activities continued to attract non-native entrepreneurs to the Mackenzie valley during the first two decades of the twentieth century. Interest in the Mackenzie watershed's mineral resources increased with the discovery of oil at Norman Wells and the identification of valuable deposits of uranium, gold, silver and subsequently base metals.

D.3.9 In addition to trapping and mineral exploration, the annual resupply of trading posts in the western Arctic via the Mackenzie River system grew in economic importance and brought with it more outsiders. The trading posts demanded better services and soon bush pilots were flying mail, trappers and prospectors into largely unmapped areas. Small commercial fishing and lumbering ventures were started around Great Slave Lake and the Slave River; this further stimulated river transportation in the late 1920's and 1930's and increased contact between outsiders and the native people.

D.3.10 By 1920 the influx of prospectors, trappers, traders and settlers was so great that a treaty with the Indians of the area seemed necessary. Treaty 11, dated June 27, 1921, was signed by the Canadian Government and the Indians from Fort Simpson, Fort Norman, Fort Good Hope, Fort McPherson, Fort Rae, Wrigley, Arctic Red River, Fort Providence and Fort Liard.

D.3.11 The validity of Treaty 11 "...which extinguished the Indian title to the lands covered by it...", was recently challenged by the Indian Brotherhood of the Northwest Territories. This challenge took the form of an application to the Supreme Court of the Northwest Territories to lodge a caveat under the Land Titles Act with the Registrar of Titles of the Land Titles Office for the Northwest Territories. The caveat claimed an interest in part of the land covered by the Treaty and certain adjacent lands in the Mackenzie District "by virtue of aboriginal rights". Judgement was pronounced on September 6, 1973 holding that the Registrar of Land Titles had a duty to lodge the caveat presented to him. He was directed to do so when all appeals had been completed or the time for launching the same had expired. This judgement was entered in the Supreme Court of the Northwest Territories on October 2, 1973. The Deputy Attorney General of Canada filed a Notice of Appeal, dated November 30, 1973, in the Court of Appeal of the Northwest Territories. At the time of writing the Court had not set a date for hearing the appeal.

D.3.12 Government is presently negotiating with the Indians of the Yukon Territory with regard to their land claims and has declared its intention to begin negotiations on land claims with the native people of the Northwest Territories as soon as possible.

D.4 Community Organization and Evolution of Local Government

D.4.1 *Organization Prior to World War II*

D.4.1.1 Prior to the arrival of the white man the Indian bands and the Eskimos had little need for formalized social organization. Populations were small, intergroup trading was minimal and the location of habitation was governed mainly by proximity to seasonal food sources.

D.4.1.2 Unlike the Plains Indians, the Indians in the Mackenzie valley rarely had a formalized authority structure with powerful chiefs. A hunting party consisted of a family or a loose association of family groups led by the best hunter. Where, for example, hunting areas were threatened by other bands, groups with affinities of language, interfamily ties or traditional use of the land often grouped together under the best warrior for purposes of defence or attack.

D.4.1.3 The formalized structures of local government were unnecessary principally because there were no large permanent settlements. Cooperation in providing food, shelter and protection created the foundation on which modern local government could develop. Problems in adapting to modern structured communities stemmed more from difficulties in understanding the *institutions* and *mechanisms* of cooperation than in understanding the *need* for it.

D.4.1.4 After acquiring Rupert's Land from the Hudson's Bay Company in 1870, the federal government had direct control over what are now the two northern territories. However, this control and administrative responsibility had little direct application until American whaling activities in the Beaufort Sea and the Yukon gold rush in 1898 challenged Canadian sovereignty. The gold rush and the need for a Canadian presence in the Beaufort Sea led to the appointment of direct agents of the Government – the RCMP. They were sent first to Dawson in 1898, and then to Fort McPherson and Herschel Island in 1903. From that point on the RCMP performed many of Government's northern administrative functions; whereas the missionaries, in addition to their religious functions, provided such programs as education and hospital services; and the Hudson's Bay Company took care of commerce and transportation.

D.4.1.5 As a result of mining developments and rapid population growth, the Yukon has had a territorial government with a federally appointed resident Commissioner since 1898. Council members were appointed at first, but since 1908 the Commissioner has been advised by a wholly elected council.

More recently, the council has elected a speaker from among its own members. Whitehorse, the capital and administrative centre, is also the main business and population centre.

D.4.1.6 Government in the Northwest Territories has progressed more slowly and somewhat differently from that in the Yukon. Prior to 1967 there was neither a resident Commissioner nor a capital. As recommended by the Carrothers' Commission report on the development of territorial government, there is now a resident Commissioner, a capital in Yellowknife and a territorial civil service administering all 'provincial type' programs other than those concerning crown lands and mineral and forest resources (Carrothers, 1966, V.1). The majority of the council members are elected, but a small number have been appointed by the federal government.

D.4.1.7 The Yukon Act and the Northwest Territories Act were amended by Parliament early in 1974. The major changes were to increase the Yukon Territorial Council from 7 to 12 members and the NWT Council from 14 to 15 members, with all members to be elected in the future.

D.4.1.8 In both the Yukon and the Northwest Territories, the Commissioner is the chief administrative officer and the executive branch is not legally responsible to the legislature. In the Yukon, the Commissioner frequently visits the council but does not participate in its deliberations. In contrast, in the NWT the Commissioner has had a dual role, acting as head of the council in its sessions and as head of the territorial administration.

D.4.2 *Postwar Organization*

D.4.2.1 The recurring demand for more responsible government in the Yukon and the Northwest Territories has been largely a postwar phenomenon. Prior to that there was relatively little federal activity in the North both because of its remoteness and because of more immediate, pressing demands in southern Canada. In addition, matters such as education, health, welfare, and community planning were constitutionally provincial or local responsibilities; and until the advent of cost-sharing programs and different national priorities, the federal government had little interest in these fields.

D.4.2.2 In the late 1940's and the 1950's there was a marked increase in the number of social programs and in federal participation in such areas as health, welfare and education. In the North, where isolated cases of starvation continued to occur, where the incidence of tuberculosis and infant mortality were multiples of the same indices in the rest of Canada, and where the availability of education for children was negligible, these programs had direct relevance. There was also a concurrent gearing up of government machinery to deliver these new programs to the people.

D.4.2.3 In 1953 an existing federal government department was reorganized to become the Department of Northern Affairs and National Resources. Its personnel increased rapidly and it became the largest single employer of federal personnel in the North (Carrothers, 1966, V.1). Its responsibilities included: administration of crown lands and forests; management of fur and mineral resources; promotion of education, social welfare and industrial development; and provision of engineering services for departmental use and a number of other needs. By 1965 the Department was the most influential in the Northwest Territories because its policies and programs affected the lives of the majority of the population. In the Yukon the Department's functions and responsibilities were not as far reaching but nevertheless were still substantial.

D.4.2.4 The Department accomplished a great deal between 1955 and 1965 as indicated by increased school enrolment, construction of over 1,000 houses, and improved welfare programs, local utilities and other services. It also replaced the former community leaders such as the Hudson's Bay manager, the missionary and the RCMP officer in the power structure of the settlements. The native people began to regard the area administrator as their representative from Ottawa. Therefore, when more administrative responsibility was granted to the Northwest Territories and the Yukon in the mid 1960's, the native people, particularly those in the Northwest Territories, were unwilling to sever their relationship with the Department.

D.4.2.5 As a result of important base metal discoveries and renewed interest in petroleum exploration during this period, economic development accelerated in both the Yukon and the Northwest Territories. Social programs contributed to increased population growth as birth rates rose and mortality rates declined. The influx of teachers, nurses, social workers, administrators, and other personnel also added to the population. These factors, together with improved economic conditions, resulted in a marked population increase, especially in the Northwest Territories. As a result the two territorial administrations needed a government structure suitable for implementing public programs and services.

D.4.2.6 The slow development of self-government in the North, particularly in the Northwest Territories, is understandable in light of the history, low taxation base and delayed development of modern institutions. There was little interest in gaining local control in the settlements. For example, Yellowknife, the first municipality in the NWT, was not incorporated until 1939; and it remained alone until 1949 when it was joined by Hay River.

D.4.2.7 This lack of political development was recognized by various commissioners. In 1965, the NWT Commissioner outlined his administration's objectives for fostering local government. He called for the decentralization of government activity so that, wherever possible, community services could be provided by elected local governments and community institutions (Carrothers, 1966, V.1). This basic policy was further strengthened in 1967 by the establishment of the Department of Local Government.

D.4.2.8 The growth of local government in the Northwest Territories has been most apparent in the Mackenzie watershed communities. Twenty of the 30 communities which in 1973 included approximately 96 per cent of the area's population, have some form of self-government. Eight of the 20 organized communities are fully incorporated municipalities accounting for roughly 78 per cent of the total population. The remaining 12 communities have elected settlement councils and local settlement managers, who are appointed by the territorial government in consultation with the settlement councils.

D.4.2.9 Natives are well represented on the elected settlement councils and their participation is increasing steadily. This reflects the increasing number of young native people who have acquired substantial formal education in schools with mixed ethnic populations, who lack the inhibitions of their elders, and who are taking an active role in the social and political institutions in the North. This local participation is paralleled at the national and territorial levels; there is a native Member of Parliament from the Northwest Territories and five Natives serve on the territorial council.

D.4.2.10 In most communities, there is a band council representing members of the local Indian band in addition to the settlement council. The band councils are primarily oriented towards the Department of Indian and Northern Affairs, whereas the settlement councils are primarily oriented towards the territorial government. Membership on the two councils frequently overlaps.

D.4.2.11 Further evidence of the growing political and cultural awareness on the part of indigenous people in the two territories is the creation and growth of a number of native associations in recent years. The Indian Brotherhood of the Northwest Territories, representing 16 bands, was established in 1968. The Committee for Original Peoples Entitlement (COPE), started in Inuvik in 1970, now embraces people in the delta communities and some western arctic coastal settlements. The Métis Association of the Northwest Territories, organized in 1972, is confined mainly to the Mackenzie valley. In the Yukon, the Yukon Native Brotherhood for Status Indians was established in 1970 and the Yukon Association for Non-status Indians in 1972. Finally, to achieve some measure of uniformity of objectives and coordination in efforts, the Federation of Natives North of Sixty was created in September 1972. All these native groups belong to the Federation; and Inuit Tapirisat of Canada (ITC) was invited to join. ITC, the national association for Eskimos, operates chiefly in the eastern Arctic. COPE is directly affiliated with Inuit Tapirisat and purports to represent Eskimos in the western Arctic.

D.4.2.12 Generally, these native associations list high among their concerns such topics as: aboriginal claims; treaty rights; land claims and present use of land, particularly with respect to hunting, trapping and fishing; preservation of their culture; and betterment of their economic and social position. The associations receive some funding from Government for organizational purposes and some have obtained funds for research or specific program activities. As noted in paragraph D.3.11, the Indian Brotherhood of the Northwest Territories has challenged the validity of Treaty 11 in the courts, and it is assumed that aboriginal claims, treaty rights and other land claim issues will be their main concern until a settlement is achieved.

D.5 Socio-Economic Change Among Native People

D.5.1 *Renewed Interest in the North*

D.5.1.1 Development in the North subsided with the outbreak of World War II, but resumed after 1942 with the building of the Canol pipeline and interest in uranium ore from Great Bear Lake. Construction of the pipeline and development of the oil field at Norman Wells were accomplished in less than two years. The thousands of workers and equipment involved in pipeline construction greatly increased industrial activity in the upper Mackenzie (Imperial Oil, 1970). The effects of uranium mining at Great Bear Lake were less dramatic but also served to stimulate the growth of the river transportation system. (For a brief outline of the major historical developments in the communities in the study area see Chart I, Appendix D.)

D.5.1.2 In the late 1940's and early 1950's the pace of social and economic change increased. The principal initiating forces were new government programs, defence projects, mineral development and the accompanying transportation, communication and service support. Many new health and welfare programs were introduced; and the school system was upgraded and became non-denominational. The native people were exposed to a much greater variety of professional and administrative personnel.

D.5.1.3 The construction of the DEW Line in the 1950's initiated construction and development activity that in some respects complemented industries' interest in base metals in the upper Mackenzie and renewed petroleum exploration in the lower Mackenzie and northern Yukon. New government programs and large defence or mining construction projects meant better services and alternate forms of employment and income for Northerners. For the Natives it also meant dealing with an increasing array of specialists from the outside, and working for large corporations where the pace of activity and the type of equipment were comparable to those found in southern Canada.

D.5.1.4 These programs and development activities were the forerunners of the significant social and economic interactions between Natives and Non-natives that have continued up to the present. The casual economic and social relationships of the fur trade era were replaced by more deliberate and purposeful interactions. Docks, schools, hospitals, airfields and other facilities were built at intervals along the valley; Inuvik was established as an 'instant' settlement; the DEW Line sites were erected at strategic locations across the northern fringe of the continent; and the Great Slave Lake Railway joined northern Alberta to the Pine Point lead-zinc mine and to Hay River, the new centre of the upper Mackenzie water transportation system.

D.5.1.5 Development brought native and non-native workers, and to some extent their families, into closer and more complex contact. People mingled together in schools, hospitals, on the job, in beer parlors, and in supermarkets as never before. Residential segregation continued in the established settlements and was created in the newer ones. But on the whole, the amount and depth of inter-ethnic contact increased and the differences between the various groups tended to blur.

D.5.2 *Traditional Pursuits*

D.5.2.1 In the study area the once characteristic differences between the land based and settlement based native populations are less discernible (Fried, 1964; Vallee, 1967). Nevertheless, the attractions of the land based pursuits remain. In addition to providing food and cash income, just being out on the land seems to fill a psychological and cultural need for the native people.

D.5.2.2 Approximately 130 native hunters and trappers in the area are considered fully dependent on the renewable resource base for their livelihood (paragraph D.7.4.2). The majority are in their 40's and 50's and the rate of recruiting young native people into these traditional pursuits is low.

D.5.2.3 However, upwards of 1,000 hunter/trappers sell furs or engage in big game hunting (INA/MPS, 1973, V.5). Game meat and fish are the main food sources for the majority of native people (Fig. D-2). In six sample communities in the study area, an average of about 55-70 per cent of annual meat consumption consisted of game meat and fish. It is estimated that in recent years an annual average of about 0.2 million pounds of meat and almost one million pounds of fish have been harvested in study area communities for local consumption (INA/MPS, 1973, V.5).

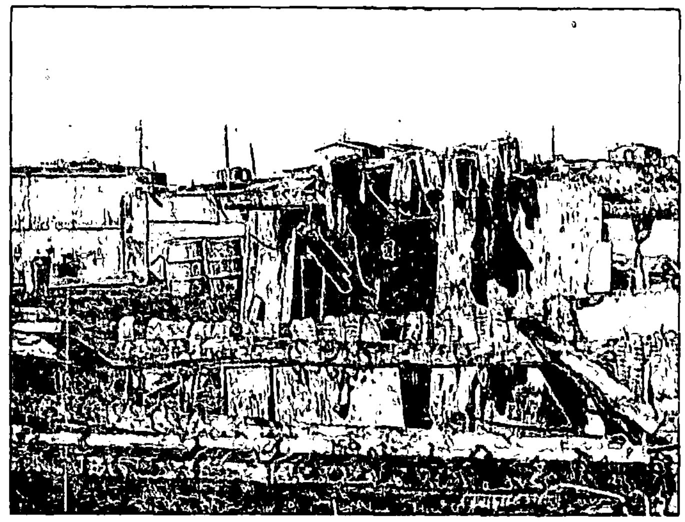
D.5.2.4 The game harvest has fluctuated recently, particularly in the lower Mackenzie region. Wage employment opportunities have also increased in this area. When a margin of income above subsistence level exists, imported foods seem to replace local foods. However, decreased reliance on local foods might not reflect changing preferences but rather lack of equipment, depletion of game populations near large settlements, or other factors.

D.5.2.5 The importance of local foods is well understood by both the native people and the two territorial governments. Game management officials now encourage and facilitate caribou hunts. Hunters from Old Crow and the delta communities receive assistance in intercepting the Porcupine caribou herd and those from some communities in the central and upper Mackenzie regions are sometimes assisted in hunting the Bluenose herd.

D.5.2.6 Trapping continues to provide ready cash income to a considerable number of part-time and full-time trappers. It is a seasonal activity and over the years the fur harvest has fluctuated considerably due to prices, population cycles of the animals, weather conditions and, more recently, the competition from wage employment. While the returns from trapping formed a significant part of the Natives' cash income in the 1960's, trapping is gradually losing its economic importance (Abrahamson, 1962; Anders, 1966; Bissett, 1967; Makale, 1967; Villiers, 1967; Higgins, 1969; Makale, 1970).

D.5.2.7 Few improvements have been made in trapping technology over the years and knowledge of the skills and the folklore associated with trapping has declined. Government, for its part, has contributed little to research and development in a sustained manner as it has in many other industries. Like other marginal industries, the equipment is often inadequate or, if in good repair, it is unsuited to specific local conditions. Furthermore, the quality of pelts is often poor either because of adverse weather conditions or damage caused by improper harvesting techniques – for example, the shooting of muskrats (INA/MPS, 1973, V. 5).

D.5.2.8 The meaning of traditional pursuits to native groups for determining roles and status in communities has been altered by wage employment. The effects of DEW Line employment and its resultant income upon the Eskimos of the arctic coast provides one example (Stevenson, 1968). Prior to DEW Line construction, successful hunters and trappers in the Eskimo communities were accorded high status and, as a result, were often expected to provide leadership. The DEW Line brought wage employment and a different status scale based on the values of a monetary economy. The proficient hunters and trappers could only maintain their positions in the community by participating in construction employment and competing as wage earners. Many, however, were unable to do so effectively since the required skills were different and judgement based on long experience out on the land was not applicable. The results were often confusing and traumatic. On a less dramatic scale a similar situation exists among native groups in the study area as participation in traditional activities declines and wage employment becomes more universal.



B.E. Darling

Fig. D-2 Fish drying, Tuktoyaktuk, NWT.

D.5.3 *Other Resources*

D.5.3.1 *Renewable Resources*

D.5.3.1.1 While use of renewable resources for hunting, trapping and fishing remains significant for the native people, the other renewable resources in the study area are less important. The native people, and particularly the Indians, have traditionally used forest resources for shelter and heating, and for a variety of tools and materials. Water, of course is important for direct use by consumers and, in addition, is of paramount importance since it provides fish and wildlife habitat and a means of transportation.

D.5.3.1.2 Milled lumber has replaced poles for building materials and furniture. Heating oil is gradually replacing fuel wood in all but the most isolated settlements. The few scattered attempts to establish small lumber mills in the delta or along the Mackenzie valley have had mixed results. The operations were generally marginal and faced a range of problems including inexperienced management; lack of sustained demand; difficulty in gaining access to better logging areas; and a labour force unfamiliar with commercial logging or millwork.

D.5.3.1.3 Nevertheless, there are isolated examples of cooperatively owned and operated lumber mills such as the one at Jean Marie River which provide a substantial portion of the income of community residents and give them a sense of purpose and identity that is invaluable. Moreover, as noted in paragraph E.3.1, the timber resources of the Mackenzie watershed are sufficient to meet local lumber needs for the foreseeable future, as well as the anticipated requirements of the proposed pipeline.

D.5.3.2 *Non-renewable Resources*

D.5.3.2.1 Natives have little background in the use of non-renewable resources, or employment experience related to their development. In recent years native workers from the study area have become involved in petroleum exploration work and road construction and maintenance. They seem to have some affinity to working outdoors with equipment but show little interest in underground mining or inside work in mills. Thus close confines and a structured work setting may be the operative factors. In the eastern Arctic some Eskimos adapted reasonably well to mining occupations at Rankin Inlet; and when that mine was closed a few continued in mining in northern Manitoba. There are no examples of native people in the western Arctic exhibiting a sustained interest in underground mining activities. However, the natives at Fort Resolution assert that a greater number of them would be interested in employment in the open pit mine at Pine Point if special arrangements were made to accommodate them (Deprez, 1972).

D.5.4 *Attachment to the Land*

D.5.4.1 Prior to the coming of the white man, the various native groups' definitions of territorial boundaries were more precise than they are now. However, even today, their attachment to an area is very apparent at the emotional level. For example, it is now acceptable for Indians from the delta to work alongside Eskimos, but the demarcation lines between them for hunting, trapping and fishing remain more or less intact.

D.5.4.2 The boundaries of hunting areas are *not* specifically defined since the caribou migration routes tend to vary. Trapline areas are less flexible since each species has a specific habitat, but a trapper may shift to an area favorable for a particular species as prices fluctuate. Fish campsites are more specifically located and many have been used for generations. Nevertheless, the Natives, like other rural people, strongly resist moving outside their traditional areas.

D.5.4.3 Delta Eskimos appear apprehensive if they wander into areas frequented by Indians from Arctic Red River or Fort McPherson and the feuds of ancient times appear to be well remembered (Honigmann and Honigmann, 1970). Indians also seem apprehensive when leaving the boreal forest or taiga to go out onto the tundra while hunting (Helm and Lurie, 1961).

D.5.5 *Economic Integration*

D.5.5.1 Economic circumstances are an important influence on the social attitudes and cultural integrity of subsistence groups and satisfaction of physical needs is of primary importance. Only a rich cultural heritage or a religion which incorporates the promise of identity or later reward for enduring privation can retain a competitive position with the physical needs of life.

D.5.5.2 Steadily increasing wage employment opportunities for Natives during recent years, particularly at the extremities of the Mackenzie valley, have resulted from increased government presence and development activity by both industry and Government. The native people continue to concentrate in settlements, pulled by the availability of government services and facilities such as housing, and by their attraction to the Non-natives' life style.

D.5.5.3 During the late 1950's and early 1960's the pull of settlement living versus the continued reliance on the traditional land based pursuits was typified as 'dual allegiance' or 'economic dualism' (Wolforth, 1971). However, settlement living now appears to predominate in most valley communities, particularly among the young, more educated native population.

D.5.5.4 Opportunities for full-time wage employment have not kept pace with the growing supply of native labour in the settlements. Employment in many sectors such as construction and transportation is seasonal. In addition, the qualifications for many administrative and personal service jobs are often too high for native people at the present time.

D.5.5.5 Therefore, Natives are employed mainly in seasonal work and generally have less skilled, lower paying jobs than Non-natives. The resultant vertical stratification of employment along ethnic lines is a widespread source of frustration. Natives can supplement their incomes by part-time involvement in the traditional pursuits and some do, but there are seasonal conflicts between wage employment and fall hunting and fishing. There is also the realization that life on the land is arduous and provides few comforts.

D.5.5.6 Natives have been drawn increasingly into the economic activities of the Non-natives. This economic integration which began with the fur trade and continues in such activities as petroleum exploration and heightened transportation developments, has led to some common economic goals on the part of all ethnic groups. To a lesser extent, it has meant cultural convergence – first *between* native groups, and secondly the native people's adoption of many norms and values of the predominant southern Canadian culture. As might be expected, this social and cultural integration on the behavioral level has resulted in some assimilation and some cultural loss by the native groups.

D.5.5.7 Some observers contend that the native people's adaptation has been mainly at the aspirational level. They aspire to many of the Non-natives' economic and social goals, such as higher incomes, better housing and improved social and health services. But they do not appear to be fully aware of the institutionalized steps leading to the fulfilment of these goals such as long employment preparation.

D.5.5.8 Property ownership, industrial organization, education and training, health services, and other programs and institutions in the North are largely duplicates of those in southern Canada. For the native people, the process of adapting to these programs and institutions has been primarily one way until recently. However, definite steps are now being taken by territorial government personnel to make these programs and institutions more responsive to the needs of all northern residents and thus eliminate this one way process.

D.5.6 *Significant Areas of Adaptation*

D.5.6.1 A few of the more significant areas of native adaptation to the predominant socio-economic system have been selected for consideration. These are: choice of occupation, preference for land or settlement living; inclination to relocate; attachment to family; and unique personal or group characteristics.

D.5.6.2 As previously indicated, the educational and occupational achievements of native youths are low and improving slowly. The low level of achievement is often explained away by shortcomings of the system such as inappropriate curricula, language difficulties, boarding school environments, teachers from the South, and by problems inherent in bridging the cultural gap. However, a preliminary study of occupational preferences of native and non-native youths found many similarities at least at the aspiration level (Smith, 1974).

D.5.6.3 Smith (1974) also indicates that native youths tend to prefer living in urban centres. However, this would frequently require relocation of the family and it appears that families of all native groups are not inclined to move from their local community.

D.5.6.4 For example, a number of Natives were employed during the construction of the Great Slave Lake Railway with mixed results. Those with a good command of English, wage employment experience, and a good understanding of the work and living conditions adjusted reasonably well. Workers who brought their families along generally had more problems resulting from the lack of suitable housing, the lack of preparation of wives and families for life in a different environment, and the families' difficulties in operating as an independent social unit away from their kin (Stevenson, 1968).

D.5.6.5 Other examples of relocation include moving Eskimo workers with previous wage employment experience and their families from Rankin Inlet to Yellowknife and to Lynn Lake, Manitoba, to work in the mines. The Yellowknife venture was a failure for many of the reasons mentioned above. Additional problems included the greater degree of visibility and the increased opportunities for social interaction between ethnic groups in the larger and more sophisticated centre (Stevenson, 1968).

D.5.6.6 Limited success was achieved at Lynn Lake probably because the candidates were selected more carefully. Also the home situation was structured so that the Eskimo women obtained a greater sense of achievement from performing household tasks. The need for easy communication and travel between Lynn Lake and Rankin Inlet to forestall loneliness was recognized early and was facilitated (Stevenson, 1968).

D.5.6.7 In contrast to Non-natives' emphasis on individualism, Natives generally have strong ties to their immediate and extended families. This strong family orientation partially explains their tendency towards homesickness and their need for group support and comfort. Non-natives are preoccupied with individual achievement whereas Natives emphasize equality and not outstripping or surpassing others; sanctions are often applied to those who do not 'share' their better fortune. Despite this preoccupation with equality, they have a great respect for independence. This is particularly noticeable with respect to the native children who are allowed considerable self-determination.

D.5.6.8 In addition to differences in orientation, there are differences in personality characteristics between Natives and Non-natives. Many observers note the Natives' tendency to think in concrete terms and their difficulty in dealing with abstractions. Somewhat related is their preoccupation with the *present* in contrast to Non-natives' concern with the *future*. Their tendency to taciturnity and unwillingness to reveal their feelings are more subtle differences. For example, a worker who feels cheated may quit his job rather than discuss the problem with his supervisor. Finally, Natives have a tendency to be passive and stoic in response to life's vicissitudes, perhaps as a result of the ancient struggle with the forces of nature. All these characteristics and others result in a tendency towards self-control, patience and lack of direct action in interpersonal relationships.

D.5.7 *Social Interaction*

D.5.7.1 Social relationships depend to a considerable extent on social distinctions and the roles ascribed to the principal participants. Major social distinctions related to occupational status are still evident between Natives and Non-natives. In addition to the residential segregation found in small and large settlements (paragraph D.5.1.5), there is considerable occupational segregation and generally little social interaction between Natives and Non-natives.

D.5.7.2 The Non-natives generally hold the best jobs, live in the best housing, and dominate most communities economically and socially. Thus when interaction takes place, it is often on a superior/inferior basis such as teacher/student or employer/employee. These meetings frequently take place with the aid of or in the presence of intermediaries (that is, spokesmen or interpreters) who are often acculturated Natives or those with steady jobs in the settlements. It appears that Non-natives are fairly uncertain when interacting with Natives on an interpersonal basis and are prone to accept the stereotypes passed on by 'old northern hands' (Cohen, 1962).

D.5.7.3 Traders were important interacting individuals when credit was required and furs were sold; they were in a dominant position because they controlled valued goods. Stores are now more impersonal and the trader's role is overlain by the complexity of the supermarket type of enterprise. There is less change in the Natives' relationships with the RCMP; they interact mainly on regulatory grounds. The RCMP are generally respected and sometimes feared since the policing function often involves misuse of alcohol. The missionaries' importance appears to be declining and, as in the past, Natives respond to them as individuals, albeit operating within a stereotyped tradition.

D.5.7.4 Nurses, teachers and social workers are important interactors with native people in the settlements. The role of the nurse is well understood and the quality of interaction between the nurse and the people depends largely on her ability to relate to the community on a person to person basis. Where nurses' aides are employed, the prestige of the settlement nurse can be enhanced by imparting a measure of her skill to her native helper.

D.5.7.5 Although the secular teacher is a relative newcomer to the North, the role appears well understood. This, together with the completeness of the new education program and perhaps careful teacher selection, seems to ensure that the Natives view the teachers as friendly and potentially cooperative. In many instances they are looked to for leadership by the native people. On the other hand, the role of social worker is not well understood in settlements. In the past, granting of financial allowances was handled by the RCMP, the Indian agent or the settlement manager on a rather personal basis and such services as child protection were non-existent. Now, the social worker's adherence to eligibility rules for granting assistance may be considered insensitive; the removal of a neglected child from a family an act of persecution.

D.5.7.6 In the industrial workplace first line supervisors are liked and respected by native workers for much the same reasons as elsewhere – that is, for clear direction, patience, fairness, firmness with a touch of humor, etc. Foremen who are Northerners or who have considerable experience with native people may achieve better labour relations than outsiders because they have some knowledge of a native language or some awareness of certain sensitivities of native people. On the other hand, because they are 'old hands' they may consider it unnecessary to learn or apply modern labour management practices. Foremen brought in from the outside who have a record of good work relations seldom have problems with native workers on the job as long as they do not have preconceived ideas about native workers. Notwithstanding the relatively good foreman/native worker relations, both the high absenteeism of native workers and their poor continuity of work suggest that all is not well. Not only do the foreman/worker relationships need to be examined with an eye to improving them, but also the relationships between native and non-native workers.

D.6 Present Demographic Aspects

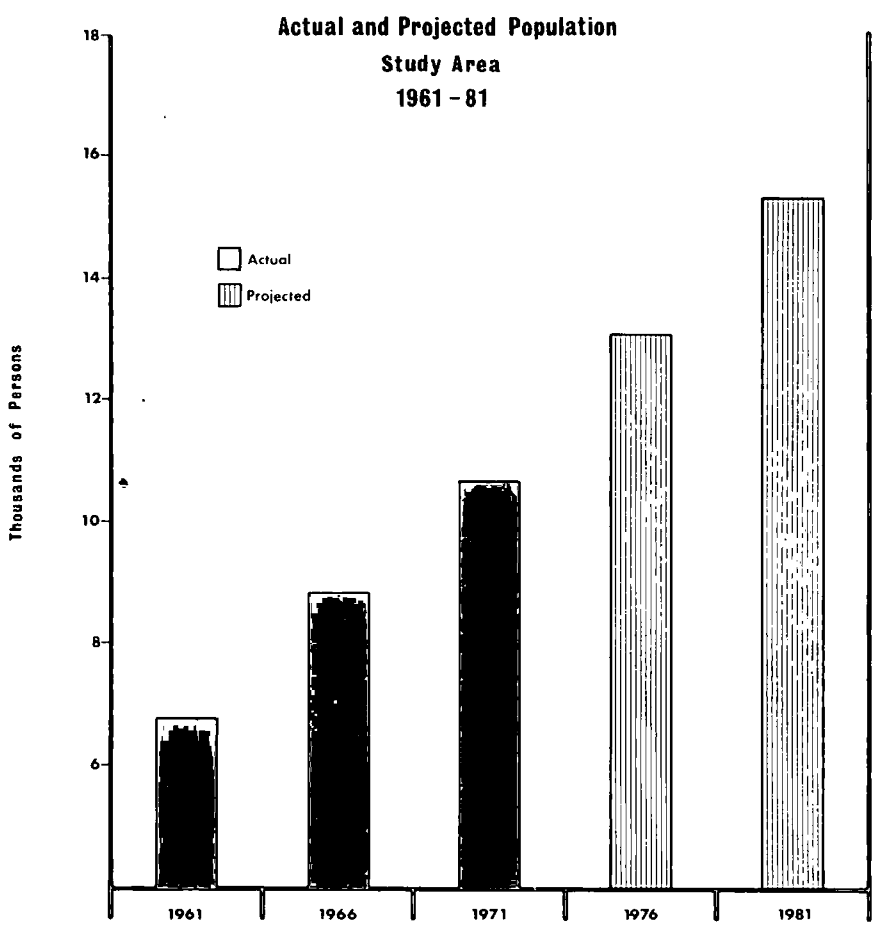
D.6.1 *Population*

D.6.1.1 The population of the study area has increased rapidly in recent years and this trend is expected to continue at an increasing rate. All ethnic groups are expected to participate in this population growth. However, Non-natives are likely to increase more rapidly than Natives because of their expanding migration into the Northwest Territories. The population is expected to continue to be concentrated in the younger age ranges with a slight surplus of males.

D.6.1.2 The population of the study area increased steadily from 1961-71, rising from 6,771 in 1961 to 10,670 persons in 1971. It is expected that this population will continue growing at an increasing rate reaching approximately 15,311 by 1981, for a ten year increase of 43 per cent (Fig. D-3). The population of the entire Northwest Territories is also expected to increase by about 45 per cent from 34,630 in 1971 to 50,078 in 1981 (Table I, Appendix D).

D.6.1.3 The most striking aspect of this growth is that the native population of the study area is expected to undergo a marked change in status. The Natives are expected to move from about 53 per cent of the area's population in 1971 to somewhat of a minority position in 1981, when they would likely account for only 47 per cent (Fig. D-4; Table I, Appendix D).

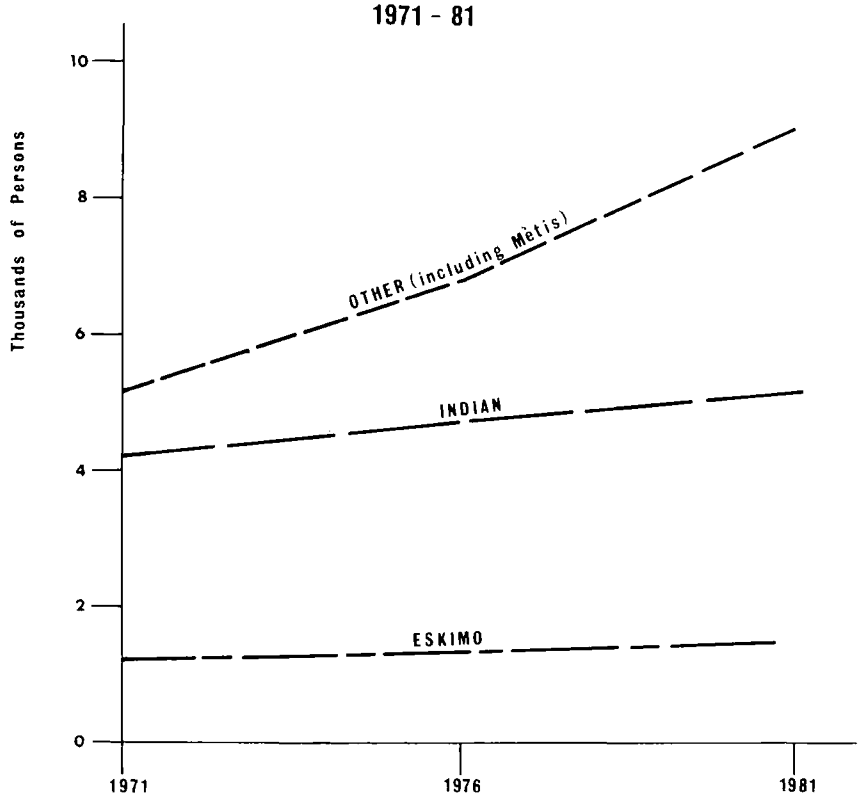
FIGURE D-3



SOURCE OF DATA:
Lu and Mathurin, 1973
Based on Table I, Appendix D

FIGURE D-4

Actual and Projected Population by Ethnic Group
Study Area
1971 - 81



SOURCE OF DATA:
Lu and Mathurin, 1973
Based on Table II, Appendix D

D.6.1.4 Major changes in ethnic balance are also expected to occur on a regional basis within the study area. In the lower Mackenzie region the Natives' share of the total population would decrease from 52 per cent in 1971 to 46 per cent in 1981. The proportion of native people in the upper Mackenzie region is expected to decline from 43 per cent of the total population to 37 per cent. The position of the native population is expected to remain strong only in the central Mackenzie, although even here some erosion is likely (Table I, Appendix D).

D.6.1.5 Because of the small numbers involved, it is estimated that, under normal conditions, the present distribution of total population in the lower, central and upper Mackenzie regions will be approximately maintained between 1971 and 1981: and the study area is expected to retain approximately the same proportion of the population of the entire Northwest Territories during the same period. However, if there is at least one major development project in the Mackenzie valley in the decade 1971-81, it is likely that population growth would occur mainly at the two extremities of the valley. In addition, such development would likely result in the Mackenzie District's accounting for a higher proportion of the Northwest Territories' population than at present (Table I, Appendix D).

D.6.2 *Vital Statistics*

D.6.2.1 *Birth Rate*

Although the birth rate among Indians, Eskimos and 'Others' in the study area appears to be decreasing somewhat, particularly among the Indians, it is still much higher than that of Canada as a whole. In 1971 the birth rates per thousand population were as follows: 34.1 for Indians; 36.6 for Eskimos; and 33.5 for 'Others' compared to 16.8 for Canada as a whole (Table III, Appendix D; Lu, 1972, Table 3).

D.6.2.2 *Death Rate*

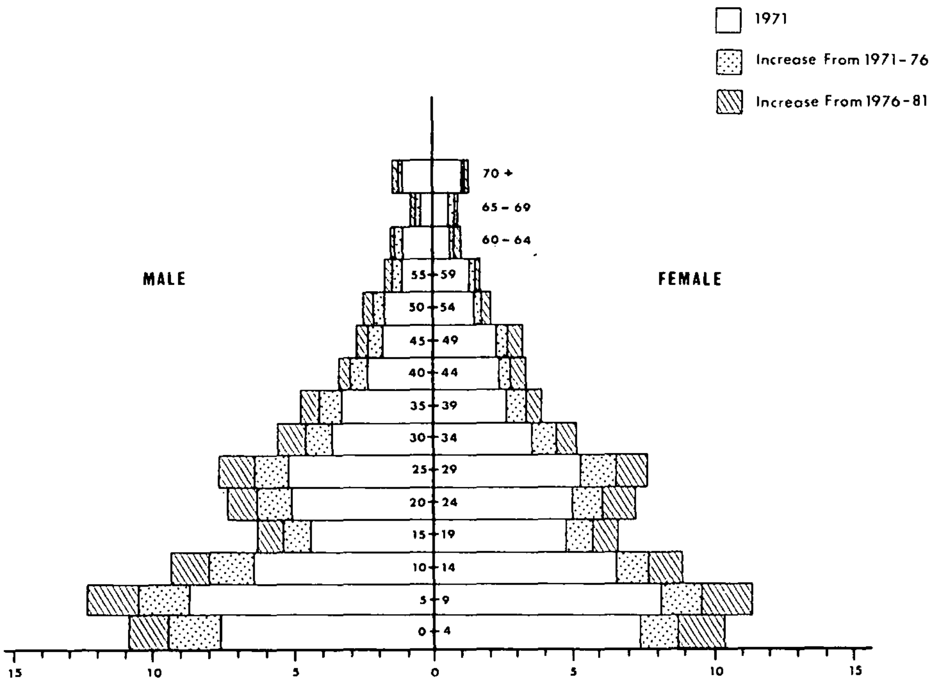
The death rate for Indians approximates fairly closely that of Canada as a whole; however, it is somewhat higher among Eskimos, reflecting a high proportion of infant deaths, and lower for 'Others'. In 1971, the death rates per thousand population were as follows: 6.6 for Indians; 9.6 for Eskimos; and 4.5 for 'Others' compared to 7.3 for Canada as a whole (Table III, Appendix D).

D.6.2.3 *Rate of Natural Increase*

Although the death rate in the study area is relatively low, the birth rate is very high. Thus the rate of natural increase is much higher than that for all of Canada. In 1971, the rates of natural increase per thousand population in the study area were as

FIGURE D-5

Actual and Projected Age – Sex Distribution of Population
Study Area
1971 – 81



SOURCE OF DATA:
Lu and Mathurin,1973

follows: 27.5 for Indians; 27.0 for Eskimos; and 24.0 for 'Others', compared to 9.5 for Canada (Table III, Appendix D).

D.6.2.4 *Sex Distribution*

From 1961-71 there was a slight imbalance in the sex distribution of the population in the study area; that is, there were slightly more males than females. This imbalance is expected to continue through 1981 (Fig. D-5).

D.6.2.5 *Age Distribution*

D.6.2.5.1 Reflecting at least in part the high rate of natural increase, the population in the study area has been concentrated largely in the younger age groupings; and the trend appears likely to continue through 1981.

D.6.2.5.2 At present the 25-39 year olds, the main source of labour force recruitment, are the largest segment of the working age population among both males and females. Again, this trend is likely to continue, reflecting natural increase and migration from the rest of the Northwest Territories, the Yukon and southern Canada (Table VI, Appendix D; Lu and Mathurin, 1973).

D.6.3 ***Trends in School Enrolment***

D.6.3.1 School enrolment in the study area has shown a marked increase, from approximorely 1,868 in 1961 to 3,444 in 1971; approximately 84 per cent over the ten year period. And it is estimated that enrolment will climb to about 5,700 in 1976, for an increase of 66 per cent over the five year period (Table IV, Appendix D).

D.6.3.2 Examination of school enrolment by ethnic origin indicates that while attendance of Indian children *increased* by about 33 per cent between 1961 and 1971, it has lagged behind that of Eskimo children which increased about 56 per cent. However, both native groups are far behind 'other' children whose enrolment increased by 144 per cent from 1961-71 (Table IV, Appendix D).

D.6.3.3 Retention of those pupils already in the school system might be considered an important contributor to the marked increase noted above. Examination of enrolment figures by grade indicates that the proportion of students in secondary school (grades 9-12) has increased slightly, from 7 per cent in 1961 to 13 per cent in 1971. However, the magnitude of the change in the secondary schools was *not* large enough to have contributed significantly to the apparent increase. It appears therefore that retention of Natives at the primary level and migration of Non-natives into the area are the operating factors.

School Enrolment by Grade

	1961		1966		1971	
	#	%	#	%	#	%
Elementary Grades (1-8)	1,661	*93*	2,169	*90*	2,898	*87*
Secondary Grades (9-12)	123	*7*	243	*10*	447	*13*
Total	1,784	*100*	2,412	*100*	3,345	*100*

D.6.4 *Trends in Vocational Training*

D.6.4.1 A large and increasing number of residents of the Northwest Territories have received vocational training at facilities either within or outside the region. Between 1953 and 1962, 1,696 residents received training; and the number increased to 6,878 from 1962-69 (INA/MPS, 1974, V.6, Table 9, p. 3-19).

D.6.4.2 Of the 8,574 who received training between 1953 and 1969, 2,120 (25 per cent) were Indian and 3,904 (45 per cent) Eskimo; that is, 70 per cent of the trainees were native people (INA/MPS, 1974, V.6, Table 9, p. 3-19).

Vocational Training

	1953-62		1962-69		Total Receiving Training	
	#	%	#	%	#	%
Indian	515	*30*	1,605	*23*	2,120	*25*
Eskimo	731	*43*	3,173	*46*	3,904	*45*
Other*	450	*27*	2,100	*31*	2,550	*30*
All Groups	1,696	*100*	6,878	*100*	8,574	*100*

*Including Métis
Derived from INA/MPS, 1974, V. 6, Table 9, p. 3-19

D.6.4.3 At the time of the Mackenzie manpower survey in 1969-70, there were about 200 Natives and 700 Non-natives with training and experience in occupations similar to the types of jobs involved in pipeline construction (INA/MPS, 1974, V.6, Table 2, p. 2-13). However, many typical pipeline occupations such as vehicle driver and catering staff, require relatively short training courses; and many Northerners have taken various vocational and trade courses between 1969 and 1973. In addition, because of publicity regarding petroleum and pipeline development, an increasing number of native youths are expected to take training in pipeline related skills or trades.

D.6.5 *Labour Force Trends*

D.6.5.1 Approximately 54 per cent of the potential labour force in the study area was actually employed when the manpower survey was conducted in 1969-70. By 1971, 56 per cent of the men and women between 15 and 64 years of age, were employed either full-time or part-time (Table V, Appendix D).

D.6.5.2 As expected, 'Others' have the highest rate of labour force involvement. In 1971 about 66 per cent of 'Others' aged 15-64, were employed. Indians and Eskimos have lower, fairly similar rates of involvement in wage employment – about 45 per cent and 46 per cent respectively were employed in 1971 in the study area (Table V, Appendix D).

D.6.5.3 There are differences in labour force participation by sex regardless of ethnic origin. That is, a relatively high proportion of males and a relatively low proportion of females of active working age actually participate in the labour force. However, there is some variation by ethnic origin with a larger proportion of 'other' males and females participating than either Indians and Eskimos.

Labour Force (October 1970)

	Indian	Eskimo	Other*	All Groups
	%	%	%	%
Population aged 15-64				
Male	73	73	88	81
Female	17	17	41	30

*Including Métis
Based on INA/MPS, 1974, V. 6

D.6.5.4 The labour force in the study area is young. In 1969-70, roughly two-thirds (68 per cent) of the labour force were between 14 and 39 years of age. The largest segment (41 per cent) was 25-39 years of age (Table VI, Appendix D).

D.6.5.5 Labour force participation is expected to increase for both native males and females; the rate of 'Others' is now high and is expected to level off. A contributing factor for both Natives and Others is the continued concentration of population in the 15-39 year age range, since most new labour force entrants will come from this group (Fig. D-5).

D.6.5.6 The size of the active working age population, that is the *potential labour force* in the study area, is expected to increase rapidly from about 5,840 in 1971 to 7,276 by 1976 and to 8,551 by 1981 (Table V, Appendix D). It is not surprising that the 'other' segment is expected to account for approximately 60 per cent of the potential labour force in 1981, with Indians contributing 30 per cent and Eskimos, 10 per cent (Figs. D-6, D-7, D-8).

D.7 Local Economy

D.7.1 *Income from Resource Sectors*

D.7.1.1 In the Mackenzie District, the total gross cash value derived from the renewable and non-renewable resource sectors has increased steadily from roughly $9.5 million in 1951 to $101.7 million in 1971 (Table VII, Appendix D). From 1951-71 the contribution of the non-renewable resource sector to the regional economy increased much more rapidly than that of the renewable resources. In 1951 non-renewable resources accounted for 87 per cent of the gross value of the region's economy; by 1971 this increased to 98 per cent (Fig. D-9; Table VII, Appendix D).

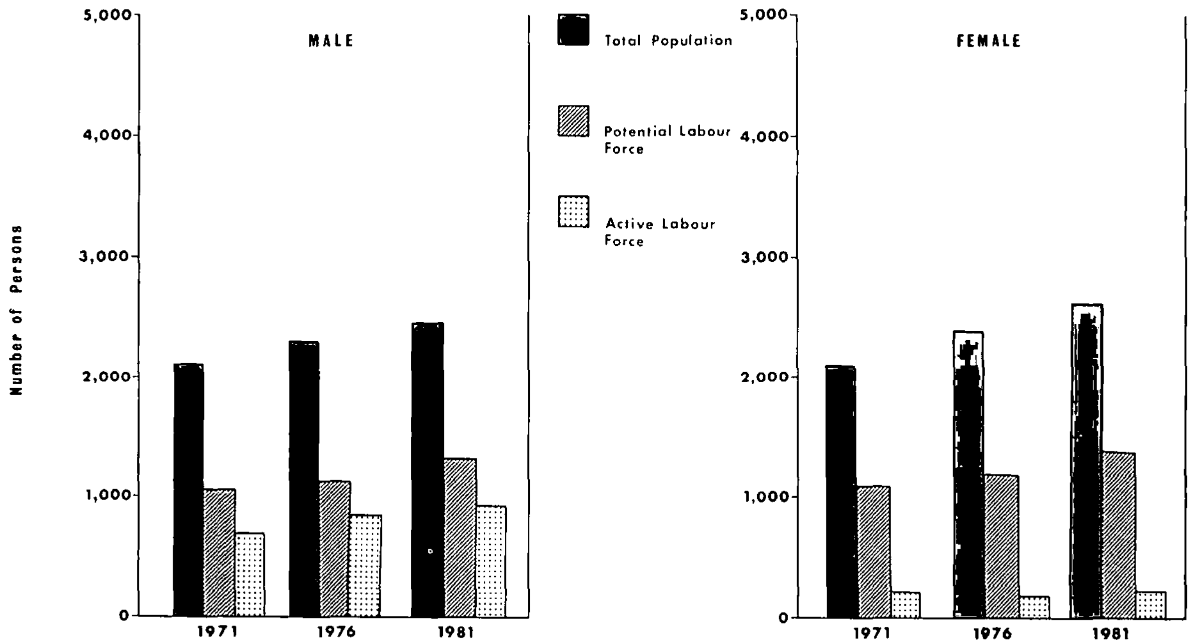
D.7.2 *Personal Income*

D.7.2.1 Wages and salaries are the main sources of income in the study area. In 1969-70 they accounted for 67 per cent of native and 92 per cent of non-native earned income (Table VIII, Appendix D).

D.7.2.2 In 1969-70, government activities and services provided the major share of earned income in the Northwest Territories contributing roughly 42 per cent of total income. The non-renewable resource, communication and transportation sectors were much smaller but still important factors, accounting for 18, 14 and 13 per cent respectively (Table IX, Appendix D).

FIGURE D-6

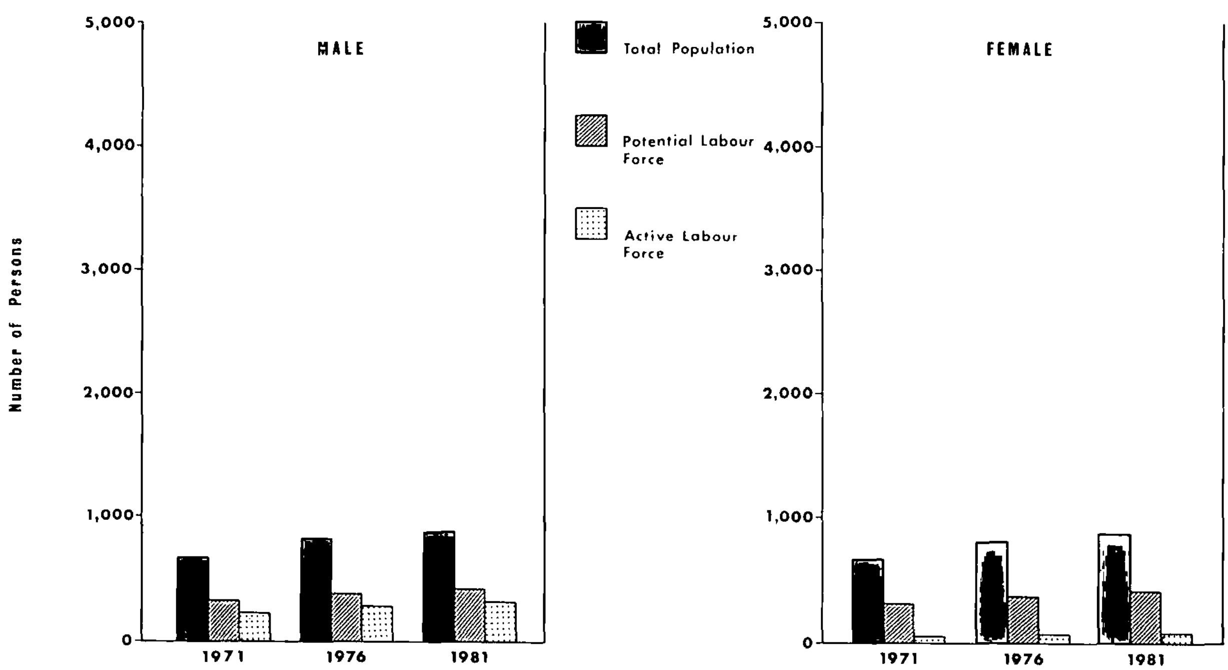
Actual and Projected Indian Potential and Active Labour Force by Sex Study Area 1971 - 81



SOURCE OF DATA:
Lu and Mathurin, 1973

FIGURE D-7

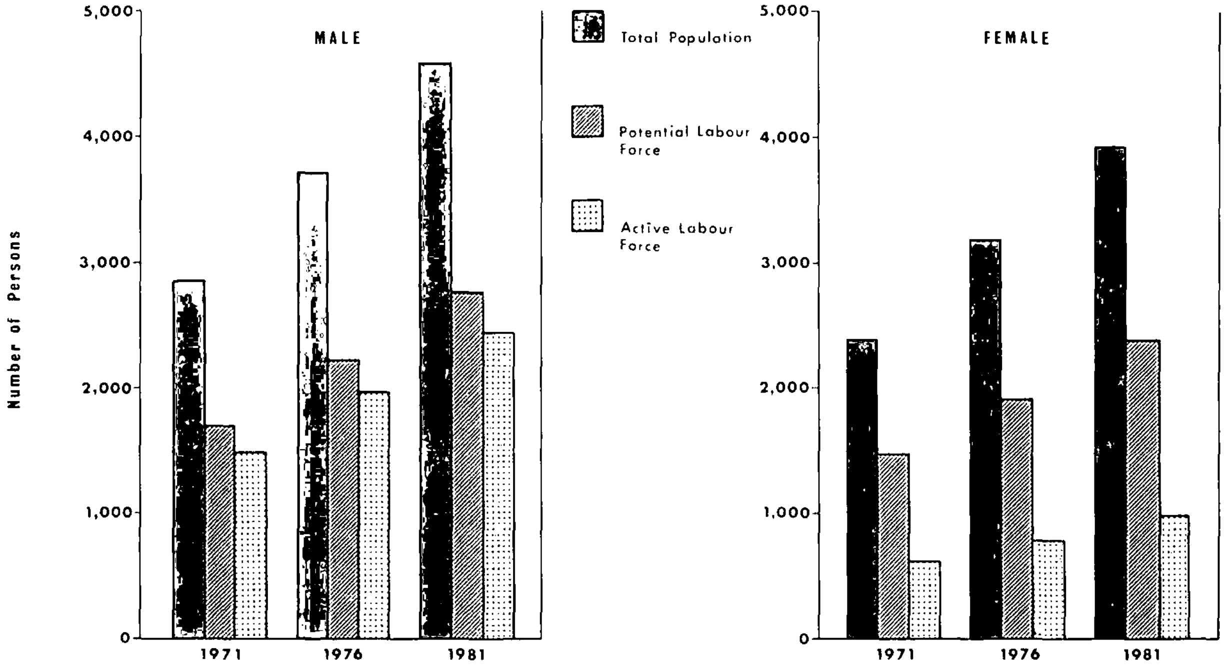
Actual and Projected Eskimo Potential and Active Labour Force by Sex Study Area 1971 - 81



SOURCE OF DATA:
Lu and Mathurin, 1973

FIGURE D-8

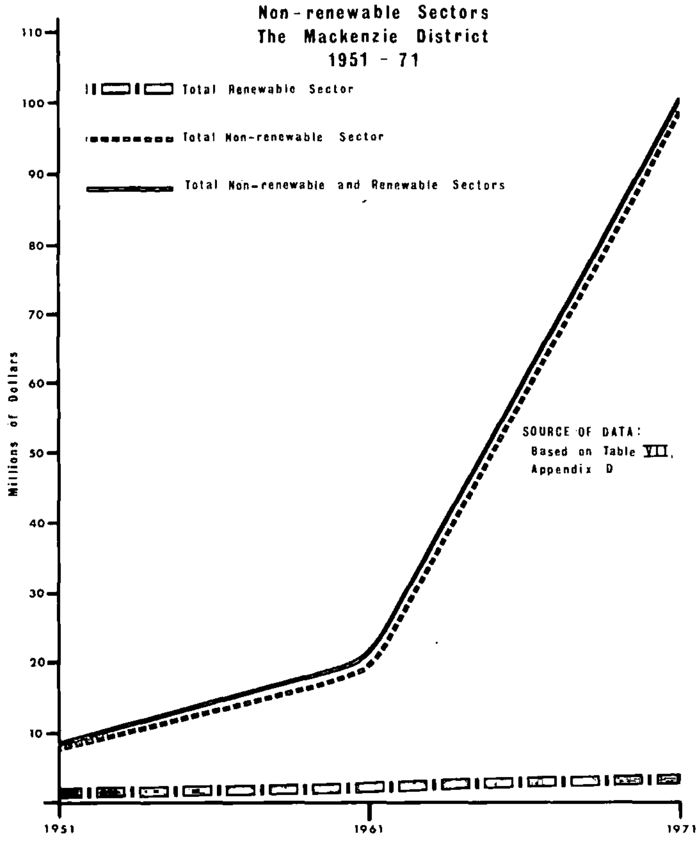
Actual and Projected "Other" Potential and Active Labour Force by Sex Study Area 1971 - 81



SOURCE OF DATA:
Lu and Mathurin, 1973

FIGURE D-9

Gross Value of Renewable and Non-renewable Sectors The Mackenzie District 1951 - 71



D.7.2.3 Income from self-employment is not significant for native people in the study area, and even among Non-natives it accounted for only about 6 per cent of earned income in 1969-70 (Table VIII, Appendix D). Income from trapping accounts for most of the income from self-employment; in 1969-70 it made up between 2 and 40 per cent of total earned income in selected settlements in the study area.

	1969-70 Trapping Income (nearest $100)	Percentage of Total Earned Income
	$	%
Aklavik	65,900	*21*
Arctic Red River	1,400	*2*
Fort Good Hope	9,000	*10*
Fort McPherson	20,200	*8*
Fort Norman	10,900	*8*
Fort Providence	19,300	*17*
Fort Simpson	24,100	*13*
Inuvik	86,400	*12*
Jean Marie River	2,900	*40*
Tuktoyaktuk	9,500	*3*
Wrigley	8,600	*20*

INA/MPS. 1973, V. 5, Table 11, p. 22

D.7.2.4 In 1969-70 sales from hunting and trapping accounted for 9 per cent of native income in the study area (Table VIII, Appendix D). On a regional basis, these sales accounted for approximately 9 per cent in the lower, 10 per cent in the central and 8 per cent in the upper Mackenzie regions (INA/MPS, 1974, V.6, Table 11, p. 1-23).

D.7.2.5 If a nominal value is imputed for game meat and hides, it is estimated that hunting, trapping and fishing accounted for about 20-30 per cent of total native income in cash and kind in 1972 (Palmer, 1973, p.14). Data from the 1969-70 manpower survey corroborate this estimate to some extent as illustrated in the table that follows.

Main Sources of Income

	Wage Employment		Self-employment		Hunting/trapping	
	Native	Other*	Native	Other*	Native	Other*
	%	%	%	%	%	%
Lower Mackenzie	80	94	3	4	17	2
Central Mackenzie	61	98	5	1	34	1
Upper Mackenzie	68	89	2	10	30	1

*Including Métis
INA/MPS, 1974, V. 6, Table 16, p.1-35

D.7.2.6 Native people in the Northwest Territories depend on transfer payments and social assistance to a much greater extent than do 'Others'. (*Transfer payments* include: Old Age Pension, Disabled Person's Allowance, Blind Person's Allowance, Family Allowance, Unemployment Insurance and the Canada Pension Plan. They do not *include* Social Assistance or other provisions under the Canada Assistance Plan.) In 1969-70 these payments accounted for approximately 23 per cent of native family income compared to only 2 per cent for 'Others' (Table VIII, Appendix D). Thus, in 1969-70 at least, transfer payments and social assistance were the second largest source of income for native people. Steady increases in the numbers eligible for the various transfer payments and benefits, and the associated costs, appear directly related to population growth and the steadily increasing level of these benefits. In the case of social assistance a further factor seems to be operating. It appears that some of the increase in the cost of social assistance is due to moving from a subsistence level of living in the recent past to a level more in keeping with modern times. (See Table X, Appendix D for details on the various types of transfer payments and social assistance.)

D.7.2.7 There are regional differences in levels of native income along the Mackenzie valley; and the proportion of total income assumed by social assistance is likewise different in each region (INA/MPS, 1974, V.6, pp. 1-27 to 1-39). Generally, average earned income by Natives (and indeed total income) was highest in the lower Mackenzie region, and lowest in the central Mackenzie — with the upper Mackenzie holding an intermediate position. The regional picture of the proportion of Natives' total income contributed by social assistance, is not quite what might be expected; at the time of the manpower survey in 1969-70, it was about 10 per cent in the upper Mackenzie, about 5 per cent in the lower Mackenzie, and about 3 per cent in the middle Mackenzie (where native incomes are lowest) (INA/MPS, 1974, V.6). This somewhat outdated income picture indicates, however, that while participation in wage income was highest in the two extremities of the valley, and indeed general native incomes were highest in these two regions, it did not follow that there was less reliance on social assistance. Generally, while wage employment generates higher average incomes, it also results in a higher standard of living and greater reliance on store food, oil heat, etc. Therefore, when social assistance is required, the higher standard of living results in higher assistance costs.

D.7.3 *Distribution of Income*

D.7.3.1 As expected, native workers have lower incomes than 'other' workers. For example, in the study area in 1969-70 approximately 78 per cent of the Natives included in the Mackenzie manpower survey had incomes of less than $4,000 compared to only 29 per cent of the Others. Also, of those reporting their incomes, 63 per cent of the 'Others' surveyed received over $4,000, with roughly 22 per cent earning $10,000 or more. By comparison only 16 per cent of the Natives surveyed received more than $4,000 and only about 1 per cent reported incomes of $10,000 or more (Fig. D-10; Table XI, Appendix D).

D.7.3.2 Average *family* income for labour force participants included in the manpower survey in 1969-70 is a further indication of the income disparity among ethnic groups. The average reported income for Indians was $2,568, for Eskimos $4,643, for Métis $5,136 and for Non-natives $9,748 (Kuo, 1973, p.7).

D.7.4 *Main Sources of Employment*

D.7.4.1 In the North the extractive industries, principally mining and petroleum exploration and development, provided the majority of jobs in 1969-70 and continue to maintain this position due to heightened activity. This type of employment has been mainly related to exploration and is consequently seasonal in nature and susceptible to decline if subsequent development does not occur. Within the public sector, the Northwest Territories' government has become a large and growing employer since the mid 1960's when it began assuming federal responsibilities and expanding its services. There has also been moderate growth in the transportation and service sectors.

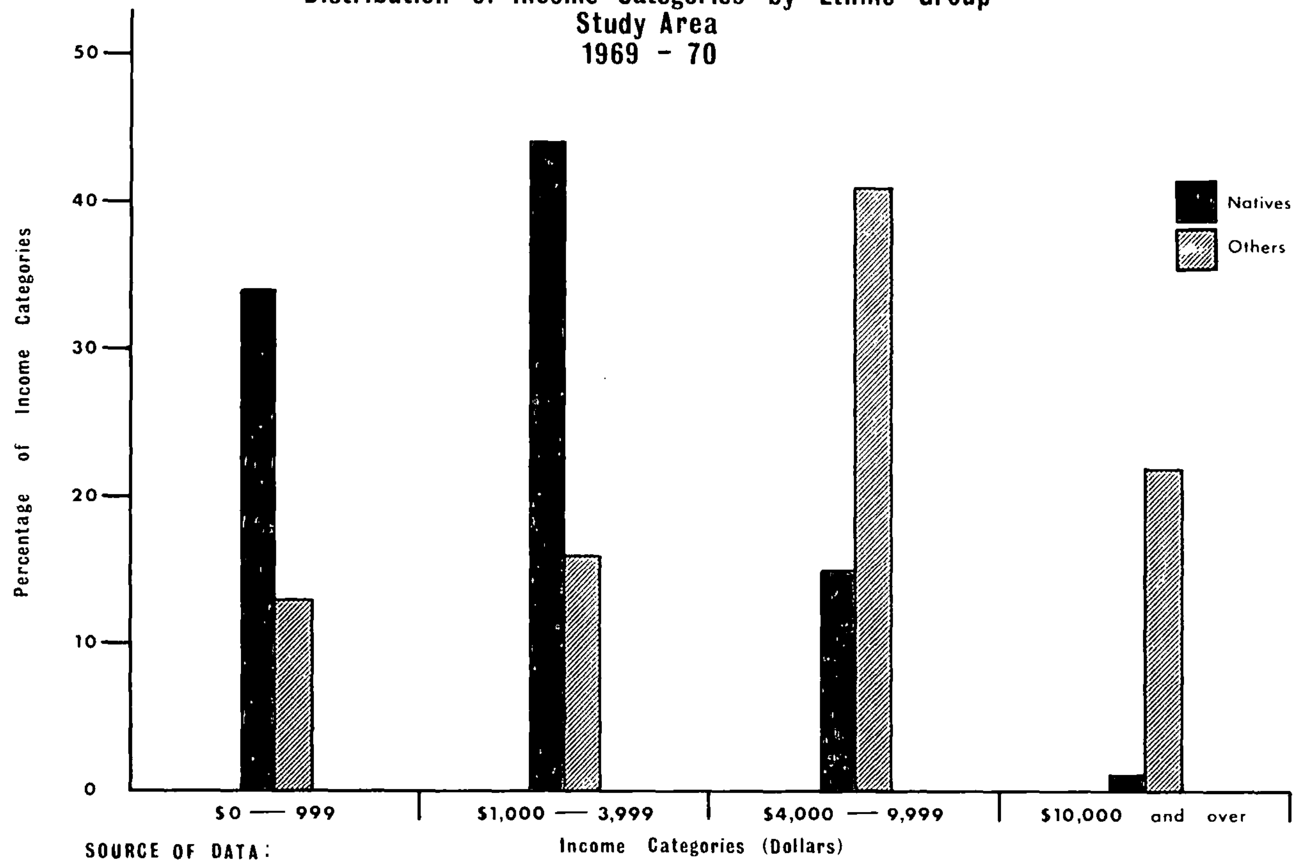
D.7.4.2 Few trappers are considered fully dependent upon trapping today and there are relatively few *active* trappers (arbitrarily defined as those earning at least $1,000 per year or spending at least two months on the trapline). The table below indicates the distribution of active trappers in communities in the study area:

	Active Trappers
	#
Aklavik	16
Arctic Red River	4
Fort Good Hope	5
Fort McPherson	10
Fort Norman	15
Fort Providence	7
Fort Simpson	17
Inuvik	30
Trout Lake	9
Tuktoyaktuk	6
Wrigley	11
Total	*130*

NWT Game Division, 1973

FIGURE D-10

Distribution of Income Categories by Ethnic Group
Study Area
1969 - 70



SOURCE OF DATA:
Based on Table XI, Appendix D

D.7.5 *Continuity of Employment*

D.7.5.1 At the time of the Mackenzie manpower survey in 1969-70 approximately 48 per cent of the *native* population involved in wage employment in the study area worked from 4-24 weeks, about 15 per cent from 25-45 weeks, and about 31 per cent from 46-52 weeks. The remaining six per cent worked less than four weeks. Therefore, wage employment for Natives in 1969-70 generally involved reliance on seasonal work or irregular attachment to wage employment. In contrast, roughly 71 per cent of the non-native labour force were employed from 46-52 weeks (INA/MPS, 1974, V.6, Table 17, p. 1-37).

D.7.5.2 Regional employment in the study area at the time of the manpower survey in terms of continuity of work for *Natives* was highest in the lower Mackenzie communities and lowest in the central Mackenzie. Continuity of employment for *Non-natives* was highest in the central Mackenzie reflecting the stable employment situation at Norman Wells and the influence of the public sector in other communities (INA/MPS, 1974, V.6, Table 17, p. 1-37).

D.7.5.3 In summary then, according to such informants as Manpower, settlement managers, employment liaison officers and construction contractors, the demand for labour during seasons of high employment activity has increased substantially since 1969-70. The lower Mackenzie now appears to have a high demand for male workers for the less skilled occupations in the construction industry in summer and for seismic and drilling crews in winter. In the upper Mackenzie there is fairly brisk demand for workers for the construction and transportation industries in summer, and moderate demand in the winter due in part to the Mackenzie Highway construction program. In the central Mackenzie, where unemployment and underemployment are quite high, the effects of increased demand for labour at the two extremeties of the valley is scarcely noticeable.

D.8 Transportation

D.8.1 The four main means of transportation, that is water, railway, road and air, operate in the study area (Table XII, Appendix D). However, the number of roads is still limited and the railway reaches only as far north as Hay River. Historically, the Athabasca, Slave and Mackenzie Rivers filled the transportation needs of the Mackenzie District and western points in the high Arctic. The river system downstream from Hay River continues to be very important, particularly for moving construction material, heavy equipment, and such cargoes as bulk fuel. In recent years, railway and roads, to the extent that they exist, have been competitive with and complementary to the river system. At the same time air transport has graduated from the bush flying days to a sophisticated and efficient interlacing of scheduled and charter services (Tables XVIII and XIX, Appendix D).

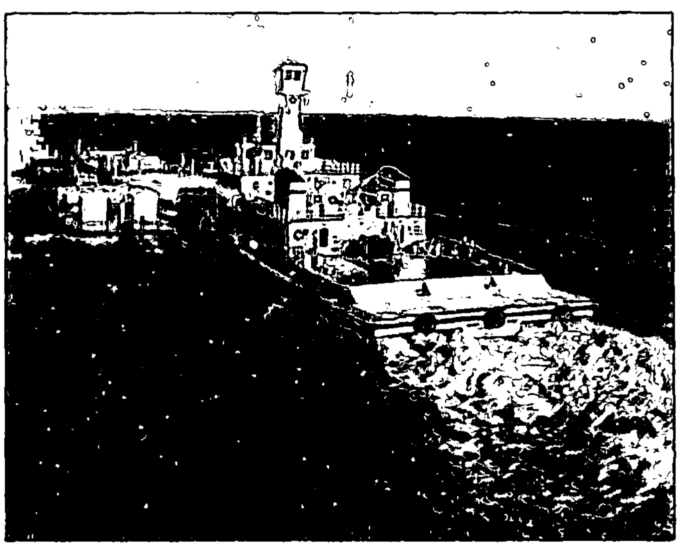
D.8.2 *Water*

D.8.2.1 The Mackenzie River is the only commercial inland water route in the Canadian Arctic. In addition to serving the study area, it is the main freight route to the western Arctic. The distance from Hay River, the principal southern terminus of the Mackenzie River system, to Tuktoyaktuk on the Beaufort Sea near the mouth of the Mackenzie River, is 1,122 miles (Table XIII, Appendix D). It takes 5-6 days of continuous sailing for a 'barge train' to travel from Hay River to Tuktoyaktuk (Fig. D-11). The river transportation season lasts for about four months (Table XV, Appendix D).

D.8.2.2 The two major water carriers are Northern Transportation Company Limited (NTCL) and Kaps Transport Limited. Of a total of 460,000 tons moved by barge in the study area during 1972, NTCL moved about 370,000 tons (81 per cent); Kaps accounted for approximately 70,000 tons (15 per cent); and the remaining 20,000 tons (4 per cent) were moved by other companies.

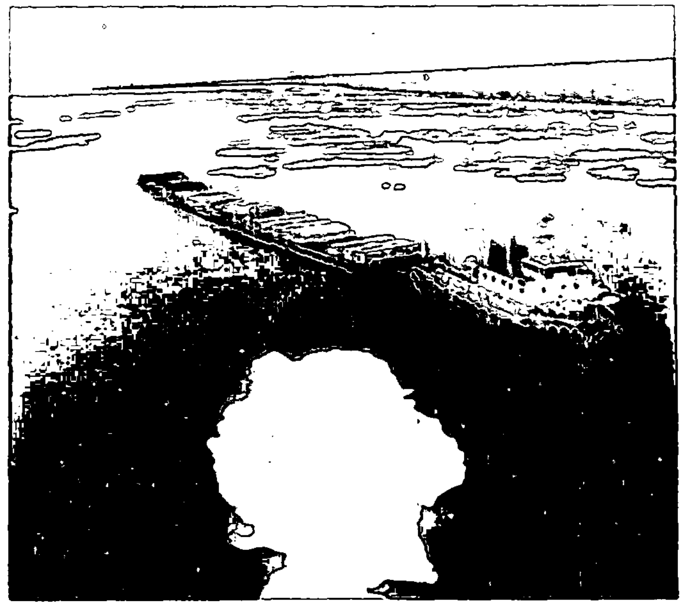
D.8.2.3 NTCL, a crown corporation, is a common carrier, licensed to carry a wide range of goods over the entire Mackenzie system and certain stretches of the arctic seas. Kaps is licensed to transport goods to and from exploration drilling sites, pipeline rights of way, and building and construction sites in the Mackenzie watershed (Canadian Transport Commission, Water Transport Committee: NTCL licence dated May 18, 1973; Kaps licence dated May 18, 1973).

D.8.2.4 In 1972 NTCL had a fleet of 28 diesel tugs, 145 steel dual purpose barges ranging up to 1,500 tons capacity, and three ocean-going cargo ships. Four mainliner tugs, one yarding tug and 20 barges of 1,500 ton capacity were delivered in 1973 (NTCL, 1972). The Kaps fleet, according to its 1973 licence, consisted of three tugs, one ocean-going cargo vessel and 21 barges.



NTCL

Fig. D-11(a) 'Barge train' on the Mackenzie River, approaching Tuktoyaktuk, NWT.



NTCL

Fig. D-11(b) 'Barge train' along the arctic coast.

D.8.2.5 At present surface transportation of cargo north of Fort Simpson consists almost entirely of barge service, which enjoys a competitive advantage over air service. While air transport cannot compete with barge service in handling bulk commodities because of the substantially higher costs, it is the main means of transporting passengers. Likewise, because of its speed and flexibility, air transport is the preferred mode for transporting perishable, fragile or emergency supplies. For most general cargo over a 1,000 mile haul, the average charge by barge in 1970 was 6.7 cents per ton-mile; by comparison costs per ton-mile by air transport ran in the order of 54 cents (Table XVI, Appendix D). Significant inventory costs must be added to the ton-mile rate because of the seasonality of barge service. These charges could run in the order of 25 per cent of the value of the goods, reflecting capital costs, insurance, and other associated costs of ownership. The charges for air service are very much higher than for barge transport for storable, low value commodities (Traffic World, 1972).

D.8.2.6 In 1972 460,000 tons of cargo were transported by *water* in the study area as compared to approximately 32,000 tons carried by *air*. Bulk fuel constituted about 60 per cent of the barged tonnage; the remainder included a considerable proportion of low value cargo.

D.8.2.7 Constraints on water transportation on the Mackenzie River include: its short season; its relative inflexibility of capacity – it is difficult to move tugs or barges in or out of the system; its slowness; and its service which is restricted to river communities unless complemented by plane or truck. Nevertheless, water transportation is likely to retain a major role in the study area particularly with respect to heavy or bulky cargo (Table XVII, Appendix D).

D.8.2.8 The vast majority of resupply requirements north of Fort Simpson are handled by air and water. Bulk fuel is supplied almost exclusively by barge to the river communities and by ocean-going vessels to communities along the arctic coast. However, in 1970 55 per cent of perishable foods, 43 per cent of clothing and 20 per cent of miscellaneous manufactured goods were moved by air (Travacon, 1972, V.1).

D.8.3 *Railway*

D.8.3.1 Rail transport to the study region is provided by the Great Slave Lake Railway, a division of Canadian National Railway. It runs 377 miles from Grimshaw, Alberta, to its northern terminus at Hay River in the Northwest Territories, with a 55 mile branch to Pine Point, for a total of 432 miles.

D.8.3.2 The railroad was built primarily to provide access to market for the mineral deposits at Pine Point. It was also required to move resupply freight quickly to the Mackenzie barge terminus at Hay River, thus avoiding the costs of transshipment and the time involved on the Northern Alberta Railway and the Athabasca and Slave Rivers legs of the system. Owing to the recent upsurge in economic activity in the Mackenzie District related mainly to petroleum development, the importance of freight other than ore and resupply has increased. Although substantial increases in freight might necessitate additions to terminal facilities, the railway is expected to remain a necessary and flexible component of the entire Mackenzie River transportation system.

D.8.4 *Road*

D.8.4.1 The Mackenzie Highway extends from the Alberta-Northwest Territories border northward to Fort Simpson with branches first to Hay River, Pine Point, Fort Resolution and Fort Smith, and secondly to Fort Providence, Rae and Yellowknife.

D.8.4.2 This network has a gravel surface and is classed as a main trunk highway. The distances by road from the Alberta border to selected communities in the study area are as follows:

Alberta Border to	Miles
Hay River	81
Fort Providence	140
Yellowknife	332
Fort Simpson	296

D.8.4.3 Although classed as an all-weather road, traffic to Fort Providence and Yellowknife is disrupted annually because of the river crossing at Fort Providence. The highway is closed approximately 35 days during spring thaw until navigation opens and about 26 days in the fall from the end of navigation until freeze-up. A ferry is used during the navigation season and an ice bridge between freeze-up and spring thaw.

D.8.4.4 The highway network also includes a winter toll road, operated under lease by a private company, which follows the Mackenzie valley between Fort Simpson and Inuvik. It is generally used for part of its length, for approximately three months a year, but it has been open for the entire distance. Although incomplete, another winter road is operated intermittently south of Fort Simpson up the Liard River and Fort Nelson River valleys to Fort Nelson, British Columbia (INA/MPS, 1973, V.3). Other winter trails or tote roads link a number of settlements in the study area.

D.8.4.5 Except for petroleum products, highway transport is an increasingly important mode for supplying areas served by air, water and highway. It is difficult to obtain accurate data on the total tonnage transported because of the fragmented nature of the trucking industry. However, it is estimated that in 1970, 33,500 tons of cargo were moved by truck to Hay River and 35,000 tons to Yellowknife. Operating costs in the North run about double those in the South, mainly because of the gravel and winter roads which depreciate the value of a truck at a much faster rate than paved highways (Travacon, 1972, V.1).

D.8.4.6 When the Mackenzie Highway extension to Inuvik and Tuktoyaktuk is completed, it is expected to lure some traffic from the Mackenzie River and from the Mackenzie air routes. As truck transport is sufficiently flexible to respond quickly to demand for an increased number of vehicles and because it can be used year round with only minor interruptions, an extension to the all-weather Mackenzie Highway would provide significant savings in transportation costs.

D.8.5 *Air*

D.8.5.1 The vastness and remoteness of the study area combined with its very low population density make it difficult to provide good air transportation services. But these same factors make the people of the Canadian North more dependent on air transportation than perhaps anywhere else in the world. The present air services include scheduled and chartered service and the use of corporate aircraft. The cost per ton-mile varies with the type of aircraft, the base of operation, the type of service, and the volume of cargo (Tables XIV, XVI, XVIII and XIX, Appendix D).

D.8.5.2 Scheduled air services parallel the Mackenzie River and serve virtually all river communities with varying frequency. All of the communities within the study area except Jean Marie River, Nahanni Butte and Fort Providence have some type of scheduled air service (1973 Air Schedules). Pacific Western Airlines (PWA) is by far the largest carrier operating in the NWT and has the most extensive route pattern and highest frequency of service (Krolewski, 1970). It is estimated that PWA carried the following number of passengers on their scheduled runs in 1972:

Edmonton to	Passengers
Hay River	7,224
Fort Simpson	1,033
Norman Wells	2,560
Inuvik	9,824

NWT, Department of Economic Development, 1973

D.8.5.3 The cost of cargo and passenger transport on scheduled air carriers is only about half the charter rates. But passenger and freight rates on scheduled and charter carriers north of 60° run between 20 and 50 per cent above rates in southern Canada. The main reasons for the unusually high air transport costs in the North are: (i) the lack of backhaul cargo which results in rates almost double those in the South; (ii) the sparseness of population over a vast area and the relatively large fluctuations brought about by seasonal activities, holidays, etc. which result in low traffic density; (iii) irregularity of air schedules which results in wasted aircraft time and some duplication of service; and (iv) high operation, maintenance and labour costs. Northern scheduled air service has been basically a short haul operation with only one per cent of scheduled flights in 1970 exceeding 800 miles; 40 per cent of the flights were from 201-800 miles and 59 per cent were under 200 miles (Krolewski, 1970).

D.8.5.4 In addition to scheduled air services, an important role is played by the charter air carriers which generally serve the more remote areas away from the river and existing highways. In 1970 all of the 11 major charter air carriers operating in the Mackenzie valley-arctic coastal region but two, Carter Aviation and Buffalo Airways, were heavily involved in transport operations related to oil and gas exploration. Both of these carriers operated light aircraft and served the territorial and federal governments, tourist lodges and construction companies. Since the major upsurge in oil and gas exploration activity, the existing relatively old aircraft are quickly being replaced by more modern and efficient equipment (Travacon, 1972).

D.8.5.5 The third significant component of the Mackenzie air transport system involves the use of corporate aircraft. It is estimated that more than 800 tons of freight were moved from Edmonton to the Mackenzie delta by corporate aircraft in 1970 (Travacon, 1972, V.1)

D.8.6 *Future Developments*

D.8.6.1 Future developments in transportation in the North will depend largely on the level of activities of the oil and gas industry. While construction of a pipeline or pipelines down the Mackenzie valley would have a considerable effect on transportation, this is not likely to be a consideration before 1975. Nevertheless, oil industry traffic is increasing; in 1972, it was estimated at 145,000 tons, while community resupply amounted to 255,000 tons. As a percentage of total traffic, the oil industry's share has risen steadily from 8 per cent in 1965 to 17 per cent in 1968 and again to 36 per cent in 1972.

D.8.6.2 The expansion of the water transportation system is already underway and further expansion is expected as the demand to move bulk cargo and heavy equipment increases. There are no specific plans to extend the railway although improvements to existing terminal facilities would appear likely. The upgrading of airport facilities in some communities is being planned to accommodate larger aircraft and an upgrading of air navigation aids throughout the Mackenzie District is anticipated.

D.9 Communication

D.9.1. In the Mackenzie valley-Great Slave Lake area, commercial telecommunications (that is telephone and teletype) are provided by Canadian National Telecommunications (CNT). In addition, several radio networks provide emergency message services for local residents. The Canadian Ministry of Transport operates a radio and teletype network which carries air and marine traffic and meteorological data; the Northwest Lands and Forest Service, Indian and Northern Affairs operates a radio network in the Mackenzie District; and the government of the Northwest Territories has a system for the purposes of administration and game protection. The RCMP also operates radio facilities.

D.9.2 CNT service is provided via a land line and a micro-wave relay system between Hay River and Inuvik with connections to most intermediate points along the Mackenzie River and service extensions to Fort McPherson, Tuktoyaktuk, Aklavik and Reindeer Depot. The land line is still in use north of Norman Wells, and for connections to communities south of that point.

D.9.3 A direct link to southern Canada is provided by a high quality micro-wave relay system operated by CNT/Alberta Government Telephones between Hay River and Edmonton, Alberta. Other links to the South include a tropospheric scatter system operated by CNT/Saskatchewan Telecommunications between Uranium City, Saskatchewan and Fort Smith, Northwest Territories with messages routed via Hay River.

D.9.4 The Canadian communication satellite Anik was launched in 1972, and gradually came into operation in 1973. Anik is now providing a thin-line telecommunication system and television reception system for the eastern Arctic. In the western Arctic, Anik is used only for television reception at present, although it has potential to provide a wide range of communication services.

Appendix D

Chart I Major Historical Developments, Study Area

	Trading Posts	Missions	School	RCMP	Medical Facility	Native Group	Band Council Org	Present Govt Status[1]	Impact[2]
Lower Mackenzie									
Inuvik	1956	1956-Ang RC 1961-Pent 1964-LDS	1956-Govt	1959	1957-61 NS 1961-NHW Hosp	Mixed	—	T	H
Fort McPherson	1840	1860-Ang RC	1948-Miss 1950-Govt	1903-07 1909-21 1949	1945-NS	Kutchin or Loucheux	X	S	H
Arctic Red River	1870's	1859-Ang	1951-Govt	1926-69	N/A	Kutchin or Loucheux	X	Unorg S	H
Tuktoyaktuk	1934	1937-Ang RC 1957-Pent	1947-Miss 1950-Govt	1951	1956-NS	Eskimo	—	Ha	H
Aklavik	1912	1919-Ang 1926-RC 1950's-Pent	1922-Miss 1959-Govt	1922	1925-61 RC Hosp 1961-NS	Loucheux	X	Ha	M
Central Mackenzie									
Norman Wells	1937	N/A	1957-Govt	1944-47 1972	1942-OPC	Slave	—	S	H
Fort Norman	1810	N/A	1860-68-Miss 1950-Govt	1916-17 1921	1939-Ang. Hosp 1959-NS	Slave	X	S	M
Fort Good Hope	1805	1859-RC	1950-Govt	1924	1947-NS	Hare	X	S	M
Fort Franklin	1825	1958-RC	N/A	—	N/A	Hare & Dogrib	X	Ha	L
Upper Mackenzie									
Fort Simpson	1804	1858-Ang 1894-RC	1888-Ang 1917-RC 1949-Govt	1912	1916-73 RC Hosp. 1973-NHW Hosp	Slave	X	V	H
Wrigley	1877	1896-RC	1958-Govt	1930-33	1971-NS	Slave	X	S	H
Enterprise	N/A	N/A	—	—	—	—	—	Unorg S	H
Hay River	1868	1869-RC 1893-Ang	1920-Ang 1949-Govt	1925-33* 1947	1925-64 Ang Hosp 1964-NHW Hosp	Slave	X	T	H
Trout Lake	1923	N/A	1973-Govt	—	—	Slave	X	Unorg S	M
Fort Providence	1789	1861-RC	1867-RC 1959-Govt	1924	1963-NS	Slave	X	S	L
Fort Liard	Pre 1807	N/A	1955-Govt	1929-33 1944	1968-NS	Nahanni Slave	X	Unorg S	L
Nahanni Butte	1969	N/A	1961-Govt	—	—	Slave	X	Unorg S	L
Jean Marie River	1965	N/A	1953-Govt	—	—	Slave	X	Unorg S	L

List of Abbreviations:

Ang — Anglican
RC — Roman Catholic
Pent — Pentecostal
LDS — Latter Day Saints
Govt — Government
Miss — Mission
X — indicates Band Council representation
N/A — data not available
NS — Nursing Station
Hosp — Hospital
OPC — Out-patient clinic run by Imperial Oil until 1972, now by NHW

NHW — National Health & Welfare (assumed responsibility for operation of existing hospital)

[1] Present Government Status
T — Town S — Settlement V — Village Ha — Hamlet
Unorg S — Unorganized Settlement

[2] Impact level as defined in Gemini North, 1973, pp. 90-92
H — High M — Medium L — Low

*Hay River hospital operated intermittently over the period.

Source of Data: Forth et al., 1974, Figure 3, p. 30

Appendix D — *(continued)*

Table I Actual and Projected Population by Ethnic Group, Study Area and Northwest Territories, 1971-81

	1971			1976			1981		
Region	Native	Other[2]	All Groups	Native	Other[2]	All Groups	Native	Other[2]	All Groups
Lower Mackenzie	2,455	2,275	4,730	2,868	2,994	5,862	3,137	3,703	6,840
Central Mackenzie	880	400	1,280	984	517	1,501	1,083	650	1,733
Upper Mackenzie	1,940	2,545	4,485	2,169	3,349	5,518	2,387	4,141	6,528
Old Crow (Yukon)	160	15	175	194	28	222	191	19	210
Total Study Area	*5,435*	*5,235*	*10,670*	*6,215*	*6,888*	*13,103*	*6,798*	*8,513*	*15,311*
Rest of NWT	13,145	10,990	24,135	15,639	14,467	30,106	17,086	17,891	34,977
Total NWT [1]	*18,420*	*16,210*	*34,630*	*21,660*	*21,327*	*42,987*	*23,693*	*26,385*	*50,078*

[1] Total NWT does not include Old Crow [2] Including Métis
Source of Data: Lu and Mathurin, 1973

Table II Actual and Projected Population by Ethnic Group and Community, Study Area, 1971-81

	1971				1976				1981			
Community	Indian	Eskimo	Other*	*All Groups*	Indian	Eskimo	Other*	*All Groups*	Indian	Eskimo	Other*	*All Groups*
Inuvik	280	480	1,885	*2,645*	313	582	2,481	*3,376*	345	633	3,068	*4,046*
Fort McPherson	555	10	130	*695*	620	12	171	*803*	683	13	212	*908*
Arctic Red River	90	—	20	*110*	101	—	26	*127*	111	—	32	*143*
Aklavik	190	295	190	*675*	212	358	250	*820*	234	389	309	*932*
Tuktoyaktuk	30	525	50	*605*	33	637	66	*736*	36	693	82	*811*
Lower Mackenzie Total	*1,145*	*1,310*	*2,275*	*4,730*	*1,279*	*1,589*	*2,994*	*5,862*	*1,409*	*1,718*	*3,703*	*6,840*
Norman Wells	50	5	245	*300*	56	6	322	*384*	61	7	398	*466*
Fort Norman	185	—	65	*250*	207	—	86	*293*	228	—	106	*334*
Fort Good Hope	280	—	45	*325*	313	—	59	*372*	344	—	73	*417*
Fort Franklin	300	—	40	*340*	335	—	53	*388*	369	—	65	*434*
Colville Lake	60	—	5	*65*	67	—	7	*74*	74	—	9	*83*
Central Mackenzie Total	*875*	*5*	*400*	*1,280*	*978*	*6*	*527*	*1,511*	*1,076*	*7*	*651*	*1,734*
Fort Simpson	410	5	330	*745*	458	6	434	*898*	504	7	537	*1,048*
Fort Liard	205	—	10	*215*	229	—	13	*242*	252	—	16	*268*
Fort Providence	480	—	115	*595*	536	—	151	*687*	590	—	187	*777*
Wrigley	130	—	25	*155*	146	—	33	*179*	160	—	41	*201*
Jean Marie River — Nahanni Butte	110	—	—	*110*	123	—	—	*123*	135	—	—	*135*
Trout Lake — Kakisa Lake	25	—	190	*215*	28	—	250	*278*	31	—	309	*340*
Hay River — Enterprise	565	10	1,875	*2,450*	631	12	2,468	*3,111*	695	13	3,051	*3,759*
Upper Mackenzie Total	*1,925*	*15*	*2,545*	*4,485*	*2,151*	*18*	*3,349*	*5,518*	*2,367*	*20*	*4,141*	*6,528*
Old Crow	160	—	15	*175*	194	0	18	*212*	191	—	18	*209*
Total Study Area	*4,105*	*1,330*	*5,235*	*10,670*	*4,602*	*1,613*	*6,888*	*13,103*	*5,043*	*1,755*	*8,513*	*15,311*

*Including Métis
Source of Data: Lu and Mathurin, 1973

Appendix D — *(continued)*

Table III Vital Statistics by Ethnic Group, Mackenzie Area and Inuvik Zone, 1967-71

Year and Ethnic Group	Livebirths		Infant Deaths		Total Deaths		Natural Increase	
	No.	*Rate*[1]	No.	*Rate*[1]	No.	*Rate*[1]	No.	*Rate*[1]
1967								
Indian	244	*42.3*	11	*45.1*	40	*6.9*	204	*35.4*
Eskimo	161	*42.9*	8	*49.7*	25	*6.7*	136	*36.2*
Other[2]	308	*25.5*	10	*32.5*	50	*4.1*	258	*21.3*
1968								
Indian	255	*42.7*	14	*54.9*	46	*7.7*	209	*35.0*
Eskimo	182	*46.8*	16	*87.9*	44	*11.3*	138	*35.4*
Other[2]	405	*32.5*	12	*29.6*	37	*3.0*	368	*29.5*
1969								
Indian	248	*40.1*	6	*24.2*	40	*6.5*	208	*33.6*
Eskimo	189	*46.7*	18	*95.2*	38	*9.4*	151	*37.3*
Other[2]	356	*27.9*	8	*22.5*	58	*4.5*	298	*23.3*
1970								
Indian	264	*41.2*	14	*53.0*	45	*7.0*	219	*34.2*
Eskimo	178	*42.8*	25	*140.4*	57	*13.7*	121	*29.1*
Other[2]	407	*31.0*	10	*24.6*	63	*4.8*	344	*26.2*
1971								
Indian	239	*34.1*	14	*58.6*	46	*6.6*	193	*27.5*
Eskimo	164	*36.6*	16	*97.6*	43	*9.6*	121	*27.0*
Other[2]	458	*33.5*	3	*6.6*	62	*4.5*	396	*29.0*

[1] Rate per thousand [2] Including Métis
Source of Data: Canada, National Health and Welfare

Table IV Actual and Projected Elementary and Secondary School Enrolment by Ethnic Group, Study Area, 1961-76

	Indian	Eskimo	Other[1]	All Groups
1961	646	448	774	*1,868*
1966	678	662	1,203	*2,503*
1971	860	697	1,887	*3,444*
1976	N/A	N/A	N/A	*5,721*

[1] Including Métis; N/A — Not available
Source of Data: NWT, 1973

Appendix D — *(continued)*

Table V Estimated and Projected Population and Labour Force by Sex and Ethnic Group, Study Area, 1971-81

	Indian			Eskimo			Other*			All Groups		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1971												
Total Population	2,065	2,040	4,105	660	670	1,330	2,850	2,385	5,235	5,575	5,095	10,670
Ratio of Potential Labour Force to Total Population	*48.9*	*50.5*	*49.7*	*50.0*	*46.3*	*48.1*	*59.3*	*61.6*	*60.4*	*54.4*	*55.1*	*54.7*
Estimated Potential Labour Force (15-64 years of age)	1,010	1,030	2,040	330	310	640	1,690	1,470	3,160	3,035	2,805	5,840
Ratio of Active Labour Force to Total Potential Labour Force	*73.0*	*17.0*	*44.7*	*73.0*	*17.0*	*45.9*	*88.0*	*41.0*	*66.1*	*81.2*	*29.6*	*56.4*
Estimated Active Labour Force (15-64 years of age)	737	175	912	241	53	294	*1,487*	*603*	*2,090*	*2,465*	*831*	*3,296*
1976												
Total Population	2,269	2,333	4,602	810	803	1,613	3,715	3,173	6,888	6,794	6.309	13,103
Ratio of Potential Labour Force to Total Population	*50.8*	*50.6*	*50.7*	*49.2*	*46.5*	*47.9*	*60.1*	*61.0*	*60.5*	*55.7*	*55.4*	*55.5*
Estimated Potential Labour Force (15-64 years of age)	1,152	1,182	2,334	398	374	772	2,234	1,936	4,170	3,784	3,492	7,276
Ratio of Active Labour Force to Total Potential Labour Force	*73.0*	*17.0*	*44.6*	*73.0*	*17.0*	*43.4*	*88.0*	*41.0*	*66.2*	*81.9*	*30.3*	*57.1*
Estimated Active Labour Force (15-64 years of age)	841	201	1,042	291	64	355	1,966	794	2,760	3,098	1,059	4,157
1981												
Total Population	2,486	2,557	5,043	880	875	1,755	4,591	3,922	8,513	7,957	7,354	15,311
Ratio of Potential Labour Force to Total Population	*50.8*	*50.6*	*50.7*	*49.2*	*46.5*	*47.9*	*60.1*	*61.0*	*60.6*	*56.0*	*55.7*	*55.9*
Estimated Potential Labour Force (15-64 years of age)	1,261	1,295	2,556	433	407	840	2,761	2,394	5,155	4,455	4,096	8,551
Ratio of Active Labour Force to Total Potential Labour Force	*73.0*	*17.0*	*44.6*	*73.0*	*17.0*	*45.5*	*88.0*	*41.0*	*66.2*	*82.3*	*31.0*	*57.7*
Estimated Active Labour Force (15-64 years of age)	920	220	1,140	316	69	385	2,430	982	3,412	3,666	1,271	4,937

*Including Métis
Source of Data: Lu and Mathurin, 1973; Manders, 1973, Table 4

Appendix D — *(continued)*

Table VI Percentage Distribution of Labour Force by Specified Age and Ethnic Groups, Study Area, 1969-70

The Study Area[1]	14-24 Years			25-39 Years			14-39 Years			40 Years and Over		
	M	F	Total	M	F	Total	M	F	Total	M	F	Total
	%	%	%	%	%	%	%	%	%	%	%	%
Native	27.0	47.5	30.5	39.9	26.8	37.6	*66.9*	*74.3*	*68.1*	33.1	25.7	31.9
Other[2]	21.4	28.3	23.5	46.8	38.3	44.2	*68.2*	*66.6*	*67.7*	31.8	33.4	32.3
All Groups	24.7	36.1	27.4	42.7	33.6	40.6	*67.4*	*69.7*	*68.0*	32.6	30.3	32.0

[1] Ethnic origin taken as percentage of total number in each group by sex, i.e., native males 14 - 24 as per cent of total native males in labour force
[2] Including Métis. There was only a small sample for 'other' group
Source of Data: Derived from INA/MPS, 1974, V. 6, Table 21, p. 1-43

Table VII Gross Value of Non-renewable and Renewable Sectors of Regional Economy, Mackenzie District, 1941-71

	1941	1951	1961	1971
	$	$	$	$
Minerals[1]	3,812,635[a]	7,881,239[a]	17,397,676	898,132,000[b]
Gold	2,865,054	7,819,975	14,449,028	10,814,000
Silver	5,864	60,728	73,419	2,669,000
Copper	3,301	536	270,440	158,000
Nickel	—	—	2,604,789	N/A
Lead	—	—	—	22,514,000
Zinc	—	—	—	61,950,000
Pitchblende	925,196	N/A	N/A	N/A
Cadmium	—	—	—	27,000
Tungsten	13,220	N/A	N/A	N/A
Crude Oil	—	400,000	730,000	1,276,000
Gas	—	8,000	17,000	113,000
Total Non-Renewable Sector	*3,812,635*	*8,289,239*	*18,144,676*	*99.521,000*
Commercial Fishing[2]	—	—	674,800	916,500[c]
Domestic Fishing[3]	—	—	193,078[d]	—
Fur Production[4]	—	1,201,114[ce]	773,050[ce]	897,952[ce]
Forest[5]	—	—	235,429[c]	341,440[c]
Total Renewable Sector	—	*1,201,114*	*1,875,357*	*2,155,892*
Total Gross Value Renewable and Non-Renewable Sectors	3,812,635	9,490,353	20,020,033	101,676,892

[a] Based on after-smelted values of minerals outside of the District
[b] Preliminary figures
[c] Figures obtained by averaging values for two consecutive calendar years
[d] Value taken at 20¢/pound based on Bissett, 1967
[e] Annual figures for fur production are available for the NWT and also for the Mackenzie District for the periods July 1950 - June 1951 and July 1951 - June 1952. The proportion of fur production of the Mackenzie District to the NWT was 68.6 per cent during July 1950 - June 1951 and 69.3 per cent during July 1951 - June 1952. Hence the ratio 70 per cent was applied to estimate the fur production for the Mackenzie District for succeeding years (Kuo, 1973)

N/A — Not available

Source of Data: [1] *General Review of the Mineral Industries*, Statistics Canada, Catalogue 26-201; and North of 60°, Canada INA [2] Environment Canada, Fisheries and Marine Service [3] Bissett, 1967 [4] *Fur Production*, Statistics Canada, Catalogue 23-207 [5] INA, Water, Forest and Land Division

Table VIII Sources of Income by Ethnic Group, Study Area, 1969-70

Source of Income	Native		Other[2]	
	$	%[1]	$	%[1]
Wages/salaries	2,445,504	*67*	5,580,922	*92*
Self-employment	19,878	*1*	350,423	*6*
Hunting/trapping[3]	314,095	*9*	—	—
	2,779,477	*77*	*5,931,345*	*98*
Transfer payments	422,681	*11*	111,709	*2*
Social assistance[4]	212,538	*6*	—	—
Other welfare[4]	206,856	*6*	—	—
	842,075	*23*	*111,709*	*2*
Total Income	*3,621,552*	*100*	*6,043,054*	*100*

[1] Each income source presented as a percentage of the total income for each ethnic group, that is, native wages as a percentage of native income, etc.
[2] Including Métis, based on only a sample coverage of 41 per cent of total other population (included for comparison only)
[3] NWT Fur Traders' Record Books, July 1, 1969 — June 30, 1970. Income breakdown by ethnic group not possible
[4] Department of Social Development, NWT Government, Yellowknife, for October 1, 1969 — September 30, 1970; breakdown by ethnic group not possible, only negligible amounts would be ascribed to 'others'
Source of Data: INA/MPS, 1974, V. 6, Table 10, p. 1-22

Table IX Wages, Salaries and Own Account, Northwest Territories, 1969-70

		Percent of Total[4]
Non-renewable sector by industry:		
Mining	$12,256,000	
Petroleum	776,418	
Total	$13,032,418	18
Renewable sector by industry:		
Fishing[1]	$ 932,072	
Hunting and Trapping[1]	1,068,708	
Lumbering	111,867	
Total	$ 2,112,647	3
Transportation by employer:		
Crown Corporation (NTCL)	$ 2,901,000	
Federal Dept. of Transport	2,734,554	
Private Sector	4,254,600	
Total	$ 9,890,154	13
Communication by employer:		
Crown Corporation (CNT, CBC)	1,024,100	
Private Sector	9,613,800	
Total	$10,637,900	14
Government activities and services:		
Federal Government	$14,698,036	
Territorial Government	10,554,300	
Municipalities	508,502	
School Boards	523,881	
Military Pay and Allowances	5,000,000	
Total	$31,284,719	42
Private service sector:		
Transportation	*$ 4,254,600*	
Communication	*9,613,800*	
Utilities	483,200	
Trade	3,214,200	
Community, Personal and Business Services	3,480,500	
Total	*$ 7,177,900*[2] *($21,046,300*[3]*)*	10

[1] The figures are in fact sales values. These figures are used to represent the labour income due to difficulty in deducting the costs of the production of traditional activities
[2] Excluding Private Transportation and Communication
[3] Including Private Transportation and Communication
[4] Calculated as percentage of column 1
Source of Data: Derived from Palmer, 1973

Appendix D — *(continued)*

Table X Gross Expenditure by Government on Transfer Payments and Social Assistance, Northwest Territories, 1965-71

	1965-66	1966-67	1969-70	1970-71
	$	$	$	$
Blind Persons Allowance	43,080*	37,425*	26,850	26,100
Disabled Persons Allowance	25,835*	14,949*	29,427	30,752
Youth Allowance	34,176	39,340	51,672	60,540
Family Allowance	897,627	941,310	1,122,937	1,127,670
Old Age Security	405,690	462,979	708,447	792,989
Total Transfer Payments[1]	*1,406,408*	*1,496,003*	*1,939,333*	*2,038,051*
Social Assistance[2]	N/A	N/A	1,114,594	1,566,944
Total Gross Expenditure	*1,406,408*	*1,496,003*	*3,053,927*	*3,604,995*

*Estimated on the assumption that federal government contributed ¾ and the territorial government ¼

N/A — Not available

Source of Data: [1] *Health and Welfare Service in Canada, 1971*, National Health and Welfare, Ottawa; *Canada Year Book* [2] Northwest Territories Annual Report *People and Growth*

Table XI Distribution of Income by Category, Source and Ethnic Group, Study Area, 1969-70

Income Source	$1 – $999 Native	$1 – $999 Other*	$1,000 – $3,999 Native	$1,000 – $3,999 Other*	$4,000 – $9,999 Native	$4,000 – $9,999 Other*	$10,000 and Over Native	$10,000 and Over Other*	Income Not Specified Native	Income Not Specified Other*
	%	%	%	%	%	%	%	%	%	%
Wages and Salaries	29	8	38	16	21	43	1	22	11	11
Hunting/trapping	67	25	8	—	2	17	—	—	23	58
Self-employment	64	5	11	3	—	27	—	26	26	40
Earned Income	*33*	*8*	*35*	*15*	*19*	*42*	*1*	*22*	*12*	*13*
Unearned Income	73	91	27	8	—	—	—	—	—	—
Total Income	*34*	*13*	*44*	*16*	*15*	*41*	*1*	*22*	*7*	*8*

*Including Métis

Source of Data: INA/MPS, 1974, V. 6, Table 14, p. 1-30

Table XII Transport Services Available to Communities, Study Area, 1972

Community	All-weather Road	Winter Road	Rail	Water	Scheduled Air Service
Aklavik				X	X
Arctic Red River				X	X
Fort Franklin		X		X	
Fort Good Hope		X		X	X
Fort Liard		X		X	X
Fort McPherson				X	X
Fort Norman		X		X	X
Fort Providence	X				
Fort Simpson	X	X		X	X
Hay River	X		X	X	X
Inuvik				X	X
Jean Marie River					
Nahanni Butte				X	
Norman Wells		X		X	X
Tuktoyaktuk				X	X
Wrigley		X		X	X

Source of Data: Travacon, 1972, V. 1, Table 10, p. 79; and assorted published information — e.g. NTCL, Air Schedules, etc.

Table XIII Distance by Modes of Transportation to Communities, Study Area

	Distance from Hay River Barge	Highway	Air
Aklavik	1,025	—	—
Arctic Red River	925	—	710
Fort Franklin	617	—	—
Fort Good Hope	711	—	530
Fort Liard	—	—	—
Fort McPherson	980	—	—
Fort Norman	540	—	400
Fort Providence	—	111	—
Fort Simpson	238	297	197
Inuvik	1,042	—	750
Jean Marie River	—	—	—
Nahanni Butte	—	—	—
Norman Wells	591	—	450
Tuktoyaktuk	1,122	—	775
Wrigley	375	—	290

Source of Data: Compiled by INA, Northern Program Planning Division, 1973, from available maps

Table XIV Transportation Mode by Commodity for Selected Communities[1], Study Area, 1970

Commodities[2]	Points Served by Air, Water, Highway: Air	Water	High-way	Points Served by Air and Water Only: Air	Water
	%	%	%	%	%
Perishable foods	3.10	0.16	96.74	54.78	45.22
Other foods	0.35	0.17	99.48	3.76	96.24
Beer, ale, stout	0.03	0.0	99.97	0.63	99.37
Wine, spirits	4.20	0.0	95.80	37.50	62.50
Apparel	7.93	0.0	92.07	42.60	57.40
Furniture	1.34	0.34	98.32	8.98	91.02
Building products	0.22	0.35	99.43	0.66	99.34
Machines < 250 lbs.	13.96	0.0	86.04	6.89	93.11
Machines > 250 lbs.	1.93	0.93	97.14	3.73	96.27
Oil and gas exploration supplies	0.94	0.0	99.06	1.22	98.78
Miscellaneous manufactures	5.01	0.68	94.31	20.55	78.45
Vehicles and parts	2.69	3.94	93.37	3.40	96.60
Bulk fuel	0.0	85.30	14.70	0.0	100.0
Other petroleum	0.0	91.08	8.92	0.0	100.0
Chemical products	0.28	0.16	99.56	6.08	93.92

[1] Data are for study area communities included in the Travacon sample
[2] Information compiled from summary of way-bill sample in Travacon
Source of Data: Travacon, 1972, V. 1, Table 18

Table XV Length of Average Shipping Periods on Mackenzie Water Routes, Study Area

Communities	Period	Number of Days
Aklavik	June 15 — October 1	107
Arctic Red River	June 15 — October 1	107
Fort Franklin	June 7 — October 5	120
Fort Good Hope	June 7 — October 5	120
Fort McPherson	June 15 — October 1	107
Fort Norman	June 7 — October 5	120
Fort Providence	June 7 — October 5	120
Fort Simpson	June 7 — October 5	120
Hay River	June 5 — October 20	137
Inuvik	June 15 — October 1	107
Norman Wells	June 7 — October 5	120
Tuktoyaktuk	July 1 — October 1	92
Wrigley	June 7 — October 5	120

Source of Data: Travacon, 1972, V. 2, Appendix 9

Table XVI Transportation Charges by Commodity (per ton-mile), Study Area, 1970

Commodities	Water	Highway	Air
	¢	¢	¢
Perishable foods	6.65	9.42	51.87
Other foods	4.75	8.59	63.66
Beer, ale, stout	3.97	6.47	60.86
Wine, spirits	3.83	7.73	72.75
Apparel	5.67	15.76	59.97
Furniture	7.58	10.77	58.14
Building products	5.02	9.06	63.06
Machines < 250 lbs.	6.49	10.40	84.87
Machines > 250 lbs.	6.28	8.49	56.75
Oil and gas exploration supplies	6.03	12.14	58.57
Miscellaneous manufactures	4.29	12.16	62.18
Vehicles and parts	6.41	8.72	61.37
Bulk fuel	3.40	10.00	53.91
Other petroleum	3.57	9.09	92.30
Chemical products	4.08	5.40	60.51

Source of Data: Travacon, 1972, V. 1, Tables 15, 16 and 17, pp. 99-101

Table XVII Total NTCL Barge Tonnage[1], 1951-72

Year	Total Tonnage	Fluctuation for Five Year Periods
		%
1951	53,359	
1952	69,828	
1953	79,270	
1954	90,264	
1955	122,713	
1956	187,240	+130
1957	188,642	
1958	192,066	
1959	174,058	
1960	142,632	
1961	128,234	− 26
1962	113,598	
1963	119,300	
1964	127,903	
1965	191,500	
1966	171,065	+ 69
1967	166,214	
1968	206,970	
1969	256,354	
1970	280,736	
1971	283,321	+ 67
1972	398,650	

[1] Since NTCL is the largest carrier on the Mackenzie River system these data, while not showing actual figures, reflect the general trends in barge tonnage.
Source of Data: Travacon, 1972, V. 1, p. 7

Table XVIII Scheduled and Charter Air Services, Mackenzie Valley and Arctic Coast, 1970

Types of Service

Class 1 — Regular Scheduled Route Services
Air carriers who offer public transportation of persons, mails and/or goods by aircraft, serving designated points in accordance with a service schedule and at a toll per unit. In this class of service high operating standards are required. Basically, the service is provided to metropolitan areas and to larger population centres.

Class 2 — Regular Specific Points Service
Air carriers who offer public transportation of persons, mails and/or goods by aircraft serving designated points on a route pattern and with some degree of regularity, at a toll per unit. In many instances class 2 carriers enjoy protection against charter operators, who are not permitted to fly between points named in the license of the class 2 carrier.

Class 3 — Irregular Specific Point Services
Air carriers who offer public transportation of persons, mails and/or goods by aircraft, from a designated base, serving a defined area or a specific point or points, at a toll per unit. This service is provided to many northern communities, arranged in a semblance of a route pattern. It is not protected from competition by charter services.

Class 4 — Charter Air Carriers
Air carriers who offer public transportation of persons and/or goods by aircraft from a designated base, at a toll per mile or per hour for the charter of an entire aircraft, or at such other tolls as may be permitted by the Air Transport Committee.

Type and Name of Carrier	Scheduled Air Services (Mackenzie Valley and Arctic Coast)	
	Base	Stops
Class 1		
— Pacific Western Airlines	Edmonton	Hay River, Yellowknife, Fort Smith, Fort Simpson, Norman Wells, Inuvik
Class 2		
— Pacific Western Airlines	Edmonton	Fort Smith, Wrigley, Yellowknife
	Edmonton	Yellowknife
— Northward Airlines Ltd.	Tuktoyaktuk	Inuvik
	Aklavik	Fort McPherson, Arctic Red River
	Inuvik	Arctic Red River, Fort Good Hope, Norman Wells, Fort Norman, Fort Franklin
Class 3		
— Ptarmigan Airways	Yellowknife	Snowdrift, Fort Reliance
— Arctic Air Ltd.	Fort Nelson	Fort Liard, Fort Simpson
— Reindeer Air Service Ltd.	Yellowknife	Fort Franklin, Fort Norman, Fort Good Hope, Inuvik, Colville Landing
— Northward Airlines Ltd.	Yellowknife	Coppermine, Cambridge Bay, Gjoa Haven, Spence Bay, Pelly Bay
	Yellowknife	Cambridge Bay
	Coppermine	Holman Island, Johnson Point, Sachs Harbour, Tuktoyaktuk, Inuvik
— Northwest Territorial Airways Ltd.	Yellowknife	Port Radium, Hope Landing, Coppermine, Cambridge Bay
— Pacific Western Airlines	Cambridge Bay	Resolute
	Yellowknife	Hope Landing, Coppermine, Cambridge Bay

Table XVIII Scheduled and Charter Air Services, Mackenzie Valley and Arctic Coast, 1970 *(concluded)*

Class 4

Charter Aircraft Carriers (Mackenzie Valley and Arctic Coast)

1. Pacific Western Airlines Ltd.
2. Northwest Territorial Airways
3. Northward Aviation Ltd.
4. Aero Arctic Ltd.
5. Gateway Aviation
6. Latham Island Airways
7. Koenel's Air Service Ltd.
8. Ptarmigan Airways Ltd.
9. Sioux Airways Ltd.
10. Narrow's Airways
11. Wardair Canada Ltd.
12. Carter Air Services Ltd.
13. Mackenzie Air Ltd.
14. Nahanni Air Services Ltd.
15. Air Providence
16. Arctic Air Ltd.
17. Buffalo Airways Ltd.
18. Klondike Helicopters
19. Copper & Sons Aviation Services Ltd.
20. Reindeer Aviation
21. Aklavik Flying Service Ltd.
22. International Jet Air Ltd.
23. Trans-North Turbo Air (1971) Ltd.

Source of Data: Canadian Transportation Committee, Air Transport Committee, Directory of Canadian Commercial Air Services, 1971

Table XIX Type of Air Service Available in Selected Communities, Study Area, 1970

	Population 1971[3]	Type of Runway[2]	Air Service and Aircraft Type
		(feet)	
Aklavik	677	2,000	Class 2 (Otter)
Arctic Red River	108	W & I[1]	Class 2 (Twin Otter)
Fort Franklin	339	3,000	Class 2 (Twin Otter)
Fort Good Hope	327	3,600	Class 2 (Twin Otter)
Fort Liard	263	3,600	Class 3 (Beaver)
Fort McPherson	679	W & I[1]	Class 2 (Twin Otter)
Fort Norman	248	4,400	Class 2 (Twin Otter)
Fort Providence	587	5,100	Charter
Fort Simpson	747	6,000	Class 1 (Boeing 737)
Hay River	2,406	6,000H[1]	Class 1 (Boeing 737)
Inuvik	2,669	6,000H[1]	Class 1 (Boeing 737)
Norman Wells	301	6,000H[1]	Class 1 (Boeing 737)
Tuktoyaktuk	596	3,500	Class 3 (F-27)
Wrigley	152	4,200	Class 1 (Convair 640)

[1] Abbreviations are as follows: W = water I = ice H = paved
Source of Data:
[2] Courtney, J., *Northern Air Transport Study*, System Analysis Research Branch, CTC, 1971
[3] Statistics Canada, Census of Canada, 1971

E

The Resource Use Setting of the Study Area

E.1 Introduction

E.1.1 Renewable resource use in the study area includes the traditional activities of hunting, trapping and fishing along with forestry, recreation and tourism, water use and limited small scale agriculture. Uses of non-renewable resources embrace petroleum exploration and development, quarrying of granular materials, mining and mineral exploration. Transportation and communication, urban land use, conservation and controlled land uses are also included.

E.1.2 Although exploration is proceeding in the petroleum and mineral sectors, little development activity has taken place in the study area as yet. And use of the renewable resource sector generally does not approach the area's productive capacity. The intensity of use of renewable resources in trapping, hunting and fishing varies throughout the study area. A particular resource may be overharvested in one locality and underharvested or unused in another. The locations of permanent settlements are largely responsible for this uneven pattern.

E.2 Traditional Resource Uses

E.2.1 Most Northerners in the study area have some knowledge of, or experience in hunting and trapping and both activities are important to the local economy. (Locations of hunting and trapping areas in the Mackenzie valley are shown in Fig. E-1.) Fur is the main export of communities in the study area; and hunting and fishing are vital sources of food for the resident population (paragraph D.5.2.3; INA/MPS, 1973, V.5).

E.2.2 Although a variety of fur bearing animals are trapped, the five most harvested species are muskrat, beaver, marten, mink and lynx (Fig. E-2). Muskrat is the most important species in the lower Mackenzie region and in the Old Crow area; while beaver and marten are the most common in the central and upper Mackenzie regions (Tables I and II, Appendix E).

E.2.3 As in the past, there is activity on the traplines in early and midwinter, but the most intensive trapping occurs in late winter and early spring. There is little overlapping of trapping areas from settlement to settlement except for a few minor locations in the Mackenzie delta. The Old Crow trappers have little competition from other settlements except far to the east in the valleys of the Eagle and Bell Rivers (INA/MPS, 1973, V.5). Trappers from other settlements generally confine themselves to adjacent river valleys and lowlands (Fig. E-1).

E.2.4 Pelts are primarily sold for cash income, used as trim on clothing or used for handicrafts. Some species of harvested fur bearers are also used for human consumption and for dogfood. The estimated imputed value of the meat of fur bearers in 1969-70 was $135,200 in the Mackenzie valley and $400 in Old Crow (INA/MPS, 1973, V.5).

E.2.5 As indicated in paragraph D.7.4.1, participation in trapping in the study area is declining. Few hunter/trappers are now engaged in resource harvesting on a full-time basis. The extent of this general decline is indicated by the estimated total number of pelts harvested in the study area. (For more detailed information on the fur harvests in 1965-66 and 1971-72 see Tables I and II, Appendix E.)

Total Fur Harvest (to the nearest 100 pelts)

	Mackenzie Valley Communities	Old Crow
1962-63	203,200	15,500
1965-66	104,400	8,057
1971-72	95,700	9,500

Naysmith, 1971; NWT Game Division, 1973

E.2.6 Although participation is declining, trapping remains an important source of income for native people in the study area (paragraphs D.7.2.3 and D.7.2.4; Table III, Appendix E). However, the value of the local fur trade (that is, monies paid to the trappers by local traders) has fluctuated widely in the study area from year to year (Table IV, Appendix E).

E.2.7 Moose, caribou and black bear are the major game food species in the Mackenzie valley. Caribou is the most important food species in the central and lower Mackenzie regions and in the Old Crow area. Moose is the predominant game food species in the upper Mackenzie followed by caribou and black bear. Although consumption records are not kept, hares are an important food source in the central and upper Mackenzie; and birds are likewise important, particularly in the lower Mackenzie region. (INA/MPS, 1973, V.5)

E.2.8 Native people in the study area hunt moose most frequently along the banks of the Mackenzie and its tributaries and on the larger islands in the Mackenzie River. About 90 per cent of moose hunting in the Mackenzie valley takes place in the area from Jean Marie River north to Fort McPherson (NWT Game Division, 1973). Hunters in the central and upper Mackenzie regions hunt woodland caribou in the valley, and more recently barren-ground caribou have been hunted in the area

Information Canada

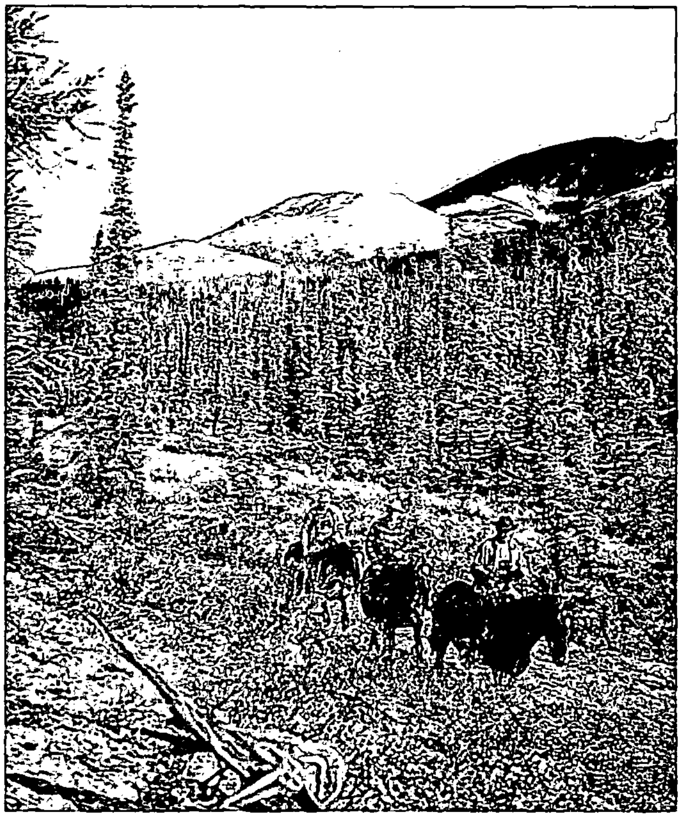
Fig. E-2 Eskimo trapper with arctic fox.

between Great Bear and Great Slave Lakes. The Porcupine caribou herd is the main source of food for hunters in Old Crow and in the delta, particularly those from Fort McPherson and Aklavik.

E.2.9 The native people hunt caribou individually and on a community basis primarily for food but also for cash income through the sale of meat. In addition, in recent years outfitting or recreational hunting with a guide for big game has become an important activity in the study area (Fig. E-3; NWT Game Division, 1973).

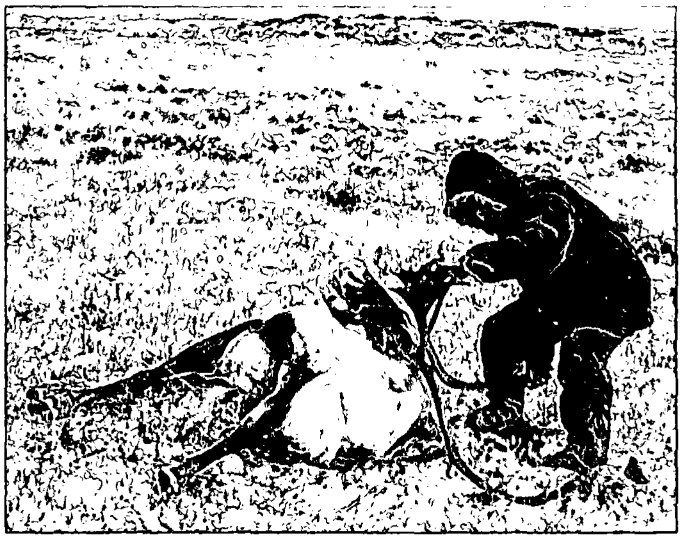
E.2.10 Only a small quantity of meat is bartered or sold by individual hunter/trappers in the study area since game is harvested primarily to meet their own needs. Organized caribou hunts supplement individual efforts, and the meat from these hunts that is surplus to the participants' needs may be sold in the communities (INA/MPS, 1973, V.5).

E.2.11 In addition to utilizing big game for food, Natives still use the hides of moose, caribou, grizzly bear, black bear and polar bear to some extent for clothing materials and other domestic needs as well as for sale and for use in handicrafts. Wolf and wolverine, the most sought after furs for trimming parkas, have recently been in short supply and, therefore, are even more valuable than usual.



Information Services, NWT

Fig. E-3(a) Recreational hunting in the Mackenzie Mountains.



Information Canada

Fig. E-3(b) Hunter and caribou.

E.2.12 Participation in hunting has not declined as much as trapping. Hunting is generally more attractive than trapping because large amounts of fresh meat can be harvested, particularly if caribou migrations are intercepted. Other attractions include the excitement of the chase and the recreational aspects of the hunt (Fig. E-3). Also hunting does not require routine work like patrolling traplines in adverse weather conditions (INA/MPS, 1973, V.5).

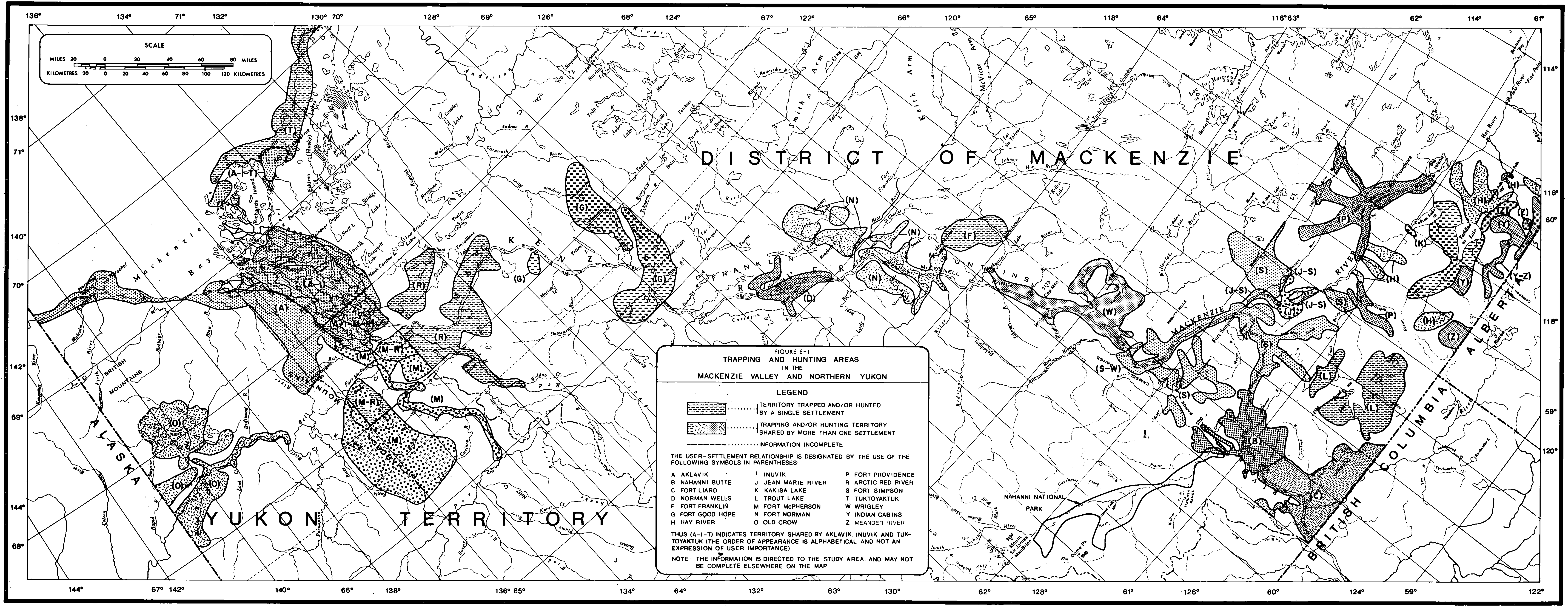


FIGURE E-1
TRAPPING AND HUNTING AREAS IN THE MACKENZIE VALLEY AND NORTHERN YUKON
LEGEND
TERRITORY TRAPPED AND/OR HUNTED BY A SINGLE SETTLEMENT
TRAPPING AND/OR HUNTING TERRITORY SHARED BY MORE THAN ONE SETTLEMENT
INFORMATION INCOMPLETE
THE USER-SETTLEMENT RELATIONSHIP IS DESIGNATED BY THE USE OF THE FOLLOWING SYMBOLS IN PARENTHESES:
A AKLAVIK
B NAHANNI BUTTE
C FORT LIARD
D NORMAN WELLS
F FORT FRANKLIN
G FORT GOOD HOPE
H HAY RIVER
I INUVIK
J JEAN MARIE RIVER
K KAKISA LAKE
L TROUT LAKE
M FORT McPHERSON
N FORT NORMAN
O OLD CROW
P FORT PROVIDENCE
R ARCTIC RED RIVER
S FORT SIMPSON
T TUKTOYAKTUK
W WRIGLEY
Y INDIAN CABINS
Z MEANDER RIVER
THUS (A-I-T) INDICATES TERRITORY SHARED BY AKLAVIK, INUVIK AND TUKTOYAKTUK (THE ORDER OF APPEARANCE IS ALPHABETICAL AND NOT AN EXPRESSION OF USER IMPORTANCE)
NOTE: THE INFORMATION IS DIRECTED TO THE STUDY AREA, AND MAY NOT BE COMPLETE ELSEWHERE ON THE MAP
SCALE
MILES 20 0 20 40 60 80 MILES
KILOMETRES 20 0 20 40 60 80 100 120 KILOMETRES
DISTRICT OF MACKENZIE
YUKON TERRITORY
ALASKA
BRITISH COLUMBIA
ALBERTA
NAHANNI NATIONAL PARK

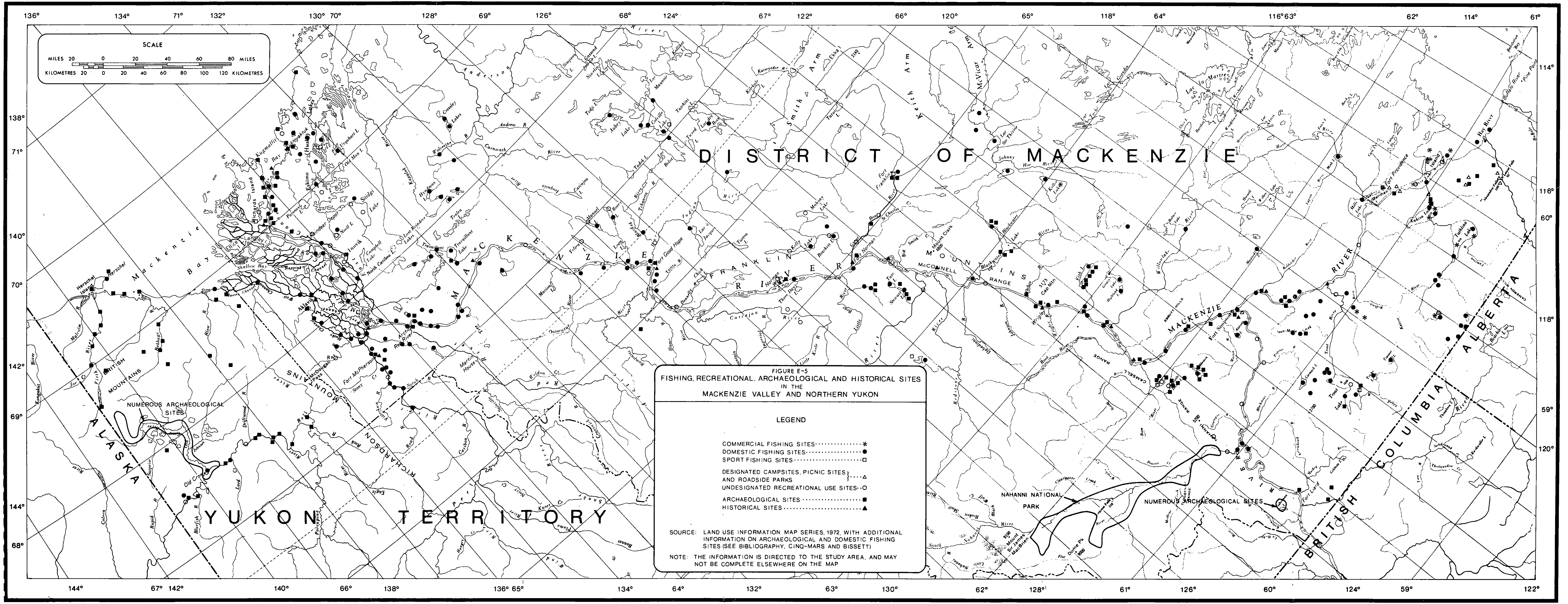


FIGURE E-5
FISHING, RECREATIONAL, ARCHAEOLOGICAL AND HISTORICAL SITES IN THE MACKENZIE VALLEY AND NORTHERN YUKON

LEGEND

- COMMERCIAL FISHING SITES ✻
- DOMESTIC FISHING SITES ●
- SPORT FISHING SITES □
- DESIGNATED CAMPSITES, PICNIC SITES AND ROADSIDE PARKS △
- UNDESIGNATED RECREATIONAL USE SITES ○
- ARCHAEOLOGICAL SITES ■
- HISTORICAL SITES ▲

SOURCE: LAND USE INFORMATION MAP SERIES, 1972, WITH ADDITIONAL INFORMATION ON ARCHAEOLOGICAL AND DOMESTIC FISHING SITES (SEE BIBLIOGRAPHY, CINQ-MARS AND BISSETT)

NOTE: THE INFORMATION IS DIRECTED TO THE STUDY AREA, AND MAY NOT BE COMPLETE ELSEWHERE ON THE MAP

E.2.13 Annual fluctuations in caribou kill figures mainly reflect variations in herd movements rather than variations in participation. Thus large kills occur if the herds are readily accessible, and low kill figures generally indicate the absence of caribou close to the settlements.

E.2.14 Residents of communities in the study area harvested approximately 800 caribou on *organized hunts* in 1971-72. A total of about 2,000 animals were taken in organized hunts in the entire Northwest Territories. (For more information on organized hunts in 1971-72 see Table V, Appendix E.)

	Organized Hunts		
	Number of Hunts	Caribou Kill	Total Value
	#	#	$
Aklavik	1	160	9,600
Fort McPherson	1	300	17,160
Fort Franklin	1	330	19,800
Total	*3*	*790*	*46,560*

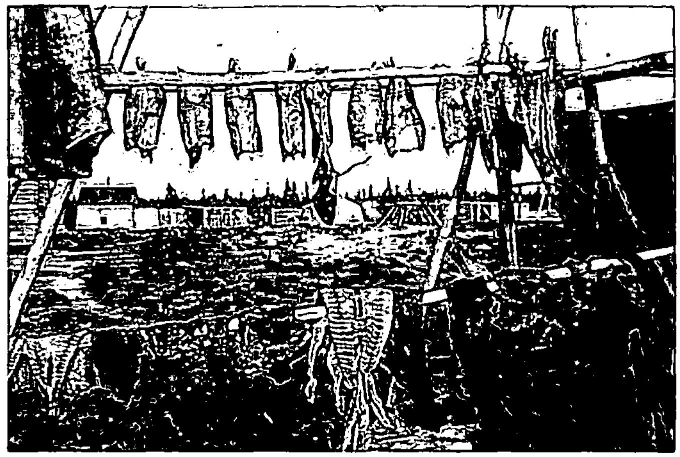
NWT Game Division, 1973

E.2.15 Throughout the study area domestic fishing, chiefly in the form of gill netting, is a major source of protein during the summer when trapping has ceased and hunting is difficult (Fig. E-4). Autumn and winter fishing are also important food sources for hunter/trappers and their dogs (INA/MPS, 1973, V.5). (Locations of domestic fishing sites are shown in Fig. E-5.) Domestic fishing sites are usually located at the mouths of rivers and streams or in eddies where debris and currents will not destroy the nets.

E.2.16 The most important species harvested in the study area are whitefish, inconnu, northern pike, pickerel, grayling and lake trout. The estimated domestic fish harvest for 1972 was as follows:

	Main Species	Number of Pounds
Lower Mackenzie[1]	Arctic char, whitefish, inconnu, herring, northern pike, suckers	561,000
Central Mackenzie[1]	Whitefish, herring, inconnu, lake trout, grayling, northern pike, suckers	129,000
Upper Mackenzie[1]	Whitefish, northern pike, suckers	134,900
Old Crow[2]	Salmon, burbot, suckers, grayling, northern pike, whitefish	30,200*

*For 1973
[1] INA/MPS, 1973, V. 5, Appendix 46
[2] Stager, 1974



Information Canada

Fig. E-4(a) Indian fishing camp.

Information Office, INA

Fig. E-4(b) Eskimo stone fishing weir.

E.2.17 At present there are nine recreational fishing lodges in the Mackenzie valley (de Belle et al., 1972). Those within the study area are located on Trout Lake and Cli Lake (Fig. E-5).

E.2.18 There is commercial fishing on seven lakes in the Mackenzie valley (de Belle et al., 1972). Production at these fisheries in 1972 was as follows:

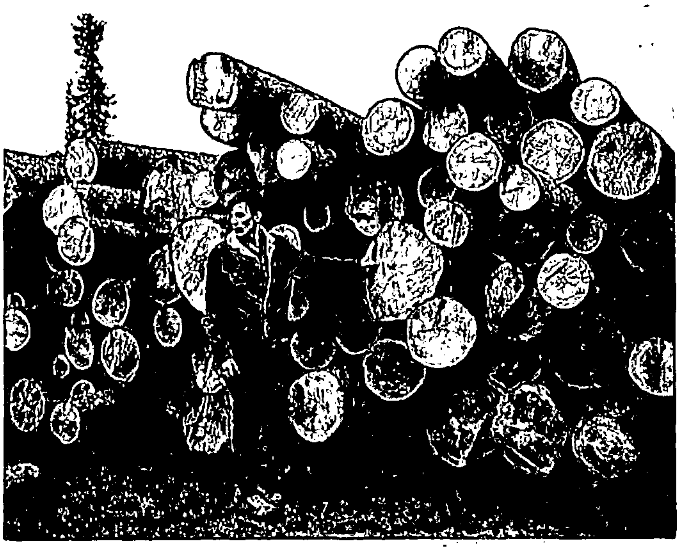
	Quota	Production	Value
	pounds	*pounds*	*$*
Kakisa Lake	41,000	47,600	*13,600*
Tathlina Lake	68,000	49,000	*20,170*
Dogface Lake	5,000	2,300	*600*
Great Slave Lake	1,930,000 (winter)	900,000	*180,000*
	3,055,000 (summer)	2,475,000	*495,000*
Reade Lake	3,000	re-opens March 1, 1975	
MacEwan Lake	7,000	re-opens Jan. 1, 1975	
Keller Lake	300,000	re-opens March 1, 1976	

NWT Game Division, 1973

E.2.19 Although increased recreational fishing is feasible on the lakes and rivers in the study area, fish resources must be closely managed to avoid conflict between recreational needs and those of the native people.

E.3 Forestry

E.3.1 Forests in the Mackenzie valley are dominated by black spruce, white spruce, balsam poplar, white birch, jack pine and aspen. Forest cover in the study area and adjacent river valleys is extensive, but merchantable timber stands are restricted to the Liard watershed north of 60° and to some areas of the Mackenzie valley (Fig. E-6). The approximately 4,150 square miles of relatively good timber stands in these two areas could yield approximately 5.4 billion cubic feet of rough lumber products. Although lack of accurate regeneration data precludes estimating the sustained annual yield, it is estimated on a conservative basis that these areas could fill the local needs of the western Mackenzie region for the foreseeable future, and in addition meet the anticipated requirements of the proposed pipeline (Forest Management Institute, 1974).



Information Office, INA

Fig. E-6 Log deck, Arctic Red River, NWT.

E.3.2 At present, activity in the study area is limited to relatively small logging and sawmill operations which serve local demand for fuel wood, round timber and lumber. There are two commercial sawmills, one at Jean Marie River and the other at Fort Simpson (Fig. E-7). Operating domestic sawmills are located at Wrigley, Fort Good Hope, Norman Wells and Fort McPherson. Another one, at Arctic Red River, has been closed for the past few years. A logging operation located in the lower Mackenzie region, provides logs for pilings used in the delta.

E.3.3 These local sawmills supply half of the rough forestry products required for housing, piling, boardwalks, mine timbers and telephone poles. More refined lumber products such as plywood and furniture are imported from southern Canada (Acres, 1973).

Wood Utilization in Mackenzie District

	Sawlogs	Round Timber	Fuel Wood	Total Estimated Volume of Primary Forest Products[1]
	(f.b.m.)	(linear feet)	(cords)	(cubic feet)
1965-66	2,522,947	214,000	8,950	*1,308,000*
1966-67	3,328,000	606,000	8,339	*1,496,000*
1967-68	3,626,000	211,000	7,595	*1,413,000*
1968-69	2,736,000	64,000	1,038	*648,000*
1969-70	5,090,000	296,000	1,189	*1,178,000*
1970-71	3,873,000	429,000	1,147	*958,000*
1971-72	1,405,000	820,000	2,696	*674,000*
1972-73	2,814,000	1,375,000	3,810	*1,161,650*

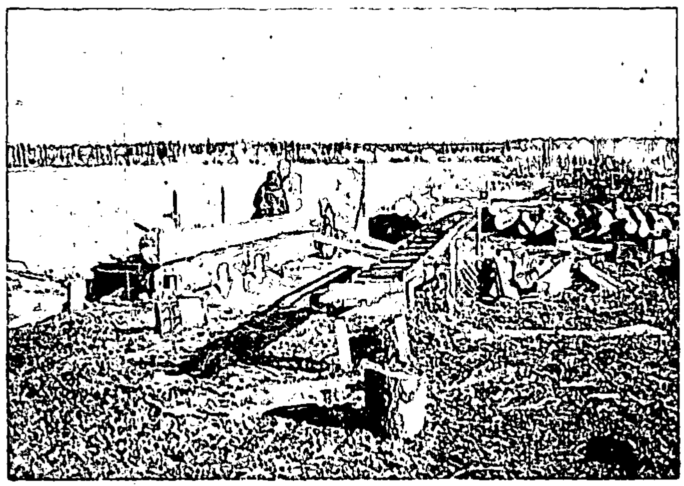
[1] Based on the following conversion factors: sawlogs — 5 f.b.m. = 1 cubic foot; round timber — 5 linear feet = 1 cubic foot; fuel wood — 1 cord = 85 cubic feet.
Canada, INA, Forest Management Section, 1973

E.3.4 In 1971-72 the value of forest production in the Mackenzie District was estimated at $260,000. Stumpage fees paid in recent years have ranged from a low of $3,173 in 1964-65 to a high of $8,103 in 1966-67 (INA/MPS, 1973, V.3).

E.4 Recreation and Tourism

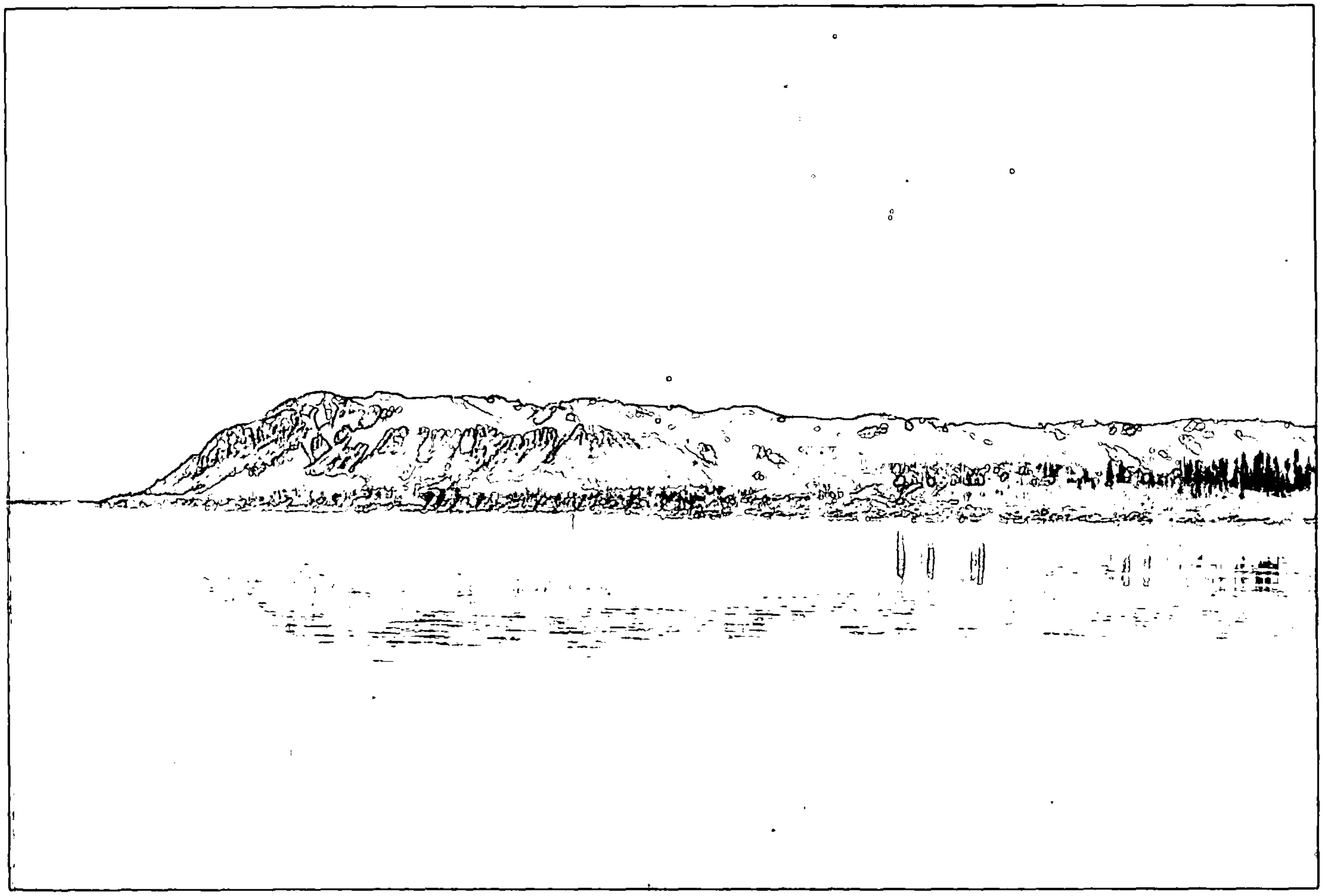
E.4.1 Use of recreational resources in the study area is not heavy at the present time (Fig. E-5). Approximately 1,000 tourists visited the Northwest Territories in 1960 and over 20,000 were expected in 1973. And it is estimated that about 100,000 tourists will visit the NWT annually by 1983; 40,000 of these tourists are expected to travel by the Mackenzie Highway (Acres, 1973).

E.4.2 There are 13 government operated campgrounds, roadside parks, and picnic sites in the Mackenzie valley. (For the locations of these recreational areas see Fig. E-5.) A commercial cruise vessel has operated along the Mackenzie River between Hay River and Tuktoyaktuk since the summer of 1971, stopping at many of the communities along the river.



Information Office, INA

Fig. E-7 Sawmill, Jean Marie River, NWT.



D.K. MacKay

Fig. E-8(a) Bear Rock, near Fort Norman, NWT.

E.4.3 There are also local recreational uses of lakes or rivers close to the settlements. For example, use is made of Fish and Kelly Lakes east of Norman Wells; Fossil Lake and Hare Indian River near Fort Good Hope; and Dolomite and Yaya Lakes and Boot Creek near Inuvik. Activities include camping, boating, fishing, hiking and, in the winter, cross-country skiing and snowmobiling. The Mackenzie, Porcupine, Rat and Peel Rivers are recognized as historic canoe routes and their use is increasing annually (de Belle et al., 1972). Bear Rock and the Ramparts are examples of scenic attractions in the area (Fig. E-8).

E.4.4 Archaeological and historical sites have been found throughout the Mackenzie valley and in the Old Crow area (Fig. E-5), but at present the tourist potential of this resource has not been developed. The NWT is assessing the potential effects on recreational tourism of improved accessibility to the Mackenzie valley.

E.5 Water Resource Uses

E.5.1 The use of water resources for transportation and recreation are discussed in sections D.8.2 and E.4 respectively. This section describes the use of water for household supply, sewage disposal and hydro electric power.

E.5.2 Most of the communities in the study area draw their water from either a river or a nearby lake, but a few have wells. However, the amount of water actually used by these communities has not been assessed. (For a summary of community water supply, and sewage and garbage disposal facilities see Table VI, Appendix E.)

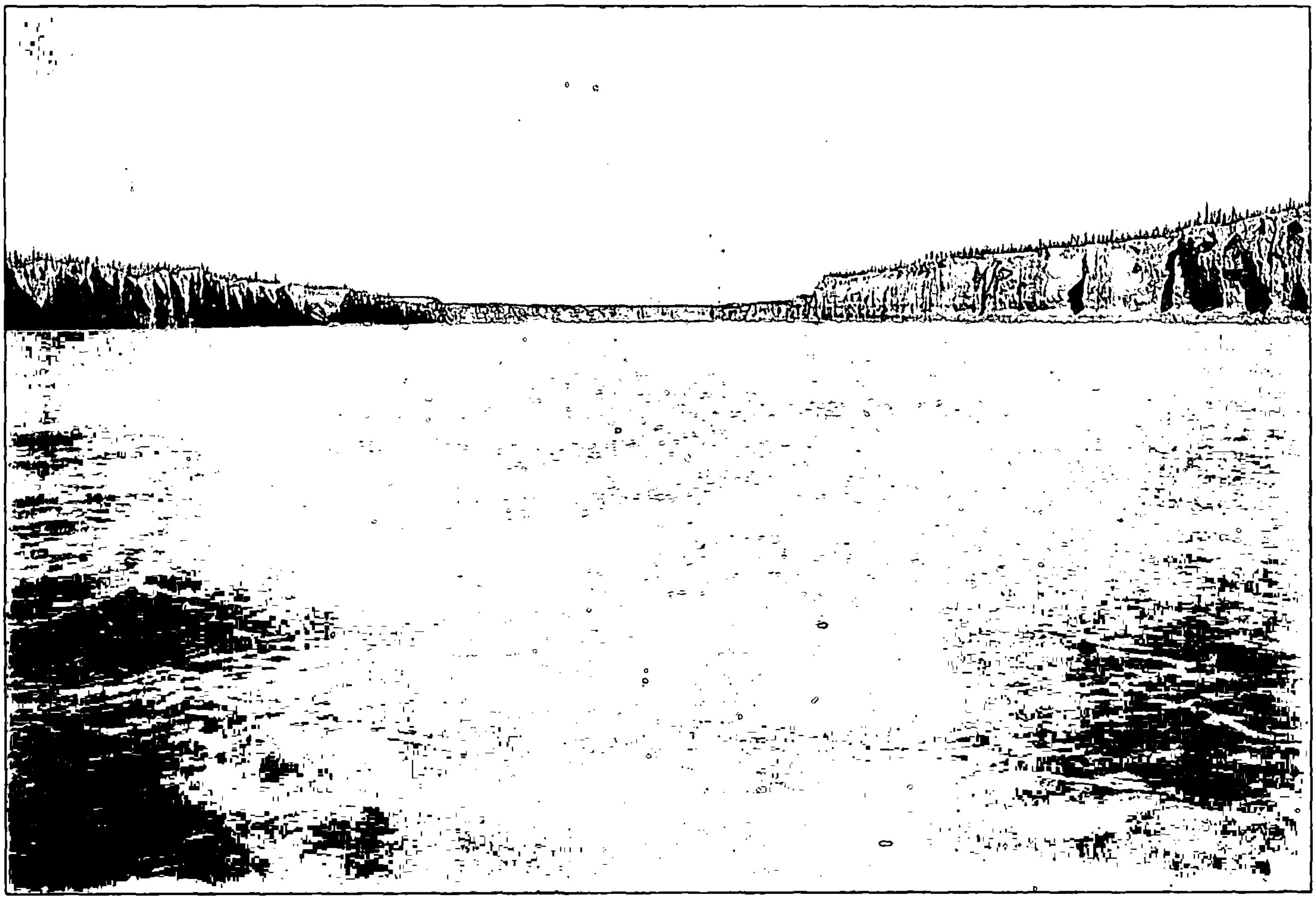
E.5.3 Treatment of water for domestic uses ranges from plant treatment to no treatment at all; and distribution varies from individual pickup to piped water systems or utilidors. Sewage disposal ranges from use of sewage bags deposited in dumps or in lagoons to piped sewage systems.

E.5.4 There are no hydro electric power developments in the study area, but projects are under consideration for Lady Evelyn Falls on the Kakisa River and for Great Bear River (Fig. E-9).

E.6 Agriculture

E.6.1 Department of Agriculture surveys have delineated approximately 2.75 million acres of arable land in the upper Mackenzie watershed, south of 62° north (Canada, Department of Agriculture, 1972). The 1966 Census located ten farms in the Northwest Territories averaging about 59 acres, which produced a combined total of $21,150 in cash crops in 1966 (INA/MPS, 1973, V.3).

E.6.2 Inherent limitations such as the number of frost free days, low precipitation, paucity of good soil, limited local demand for agricultural products, projected cost of production and lack of local interest led researchers to conclude in the 1960's that



D.K. MacKay

Fig. E-8(b) The Ramparts on the Mackenzie River

commercial agriculture was not a viable proposition throughout the study area (Nowosad and Leahey, 1960; Villiers, 1967; Higgins, 1969). Nevertheless, the relative success of mission gardens at such locations as Fort Good Hope, Fort Simpson and Nahanni Butte, and the Department of Agriculture's success with certain crops at Fort Simpson is well known (Higgins, 1969). While spiralling food costs will not necessarily improve the viability of a commercial operation, the local people in the upper Mackenzie region could probably reduce their living costs by growing some of their own garden produce.

E.7 Mineral Exploration and Development and Quarrying

E.7.1 Precious metals such as gold and silver prompted the original exploration of the North, but base metals have come into prominence in recent years. Although there are six producing mines in the Mackenzie valley and vicinity, none are located in the study area (Acres, 1973).

E.7.2 Since 1969 there has been increased interest in lead and zinc deposits in the area from Wrigley southward to the South Nahanni River, but no commercial ore bodies have been delineated as yet. In 1971 the area north of Inuvik was explored for bentonite; and reconnaissance work has been carried out for base metal sulphides in the northern part of the study area between the delta and the Alaska border (INA/MPS, 1973, V.3).

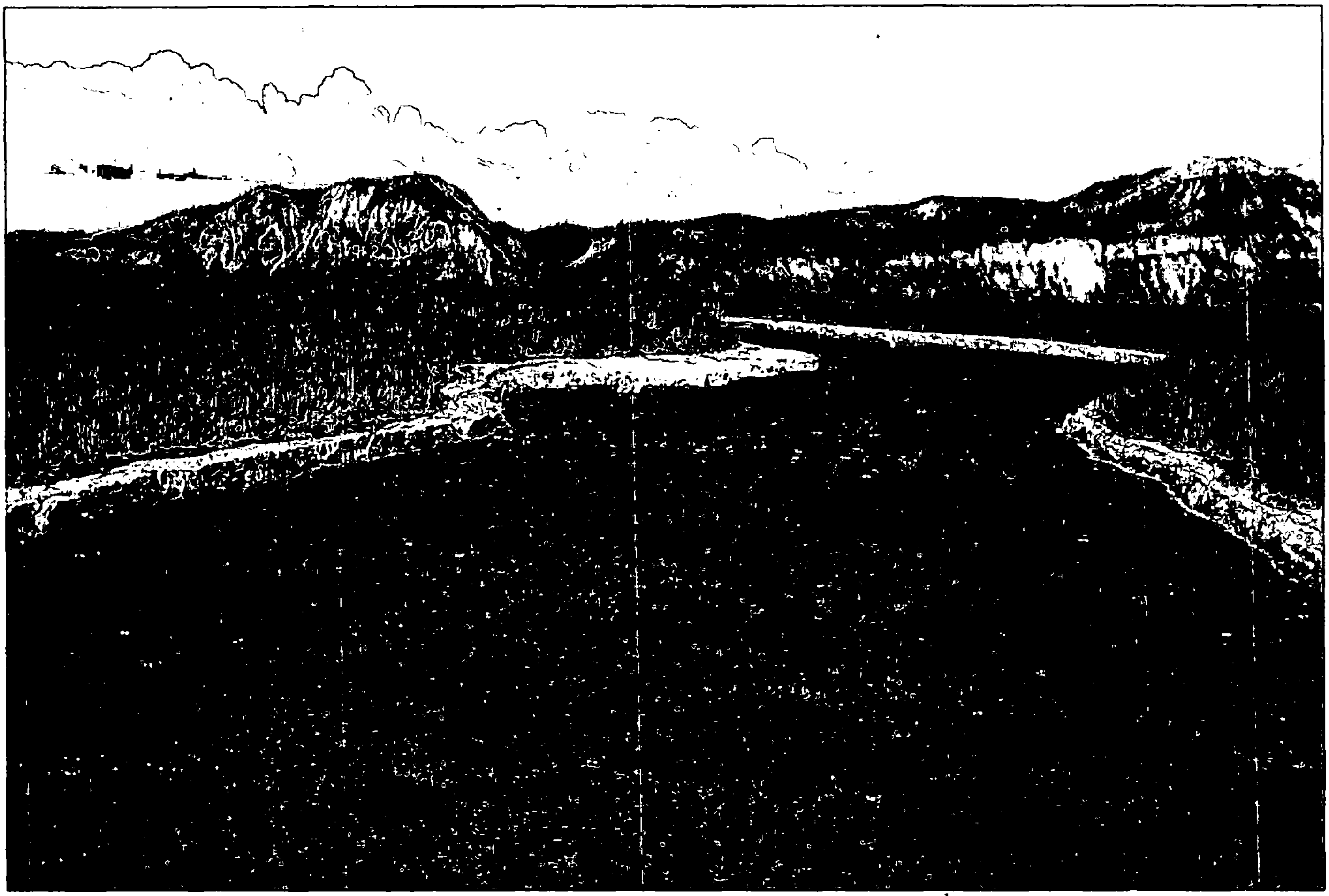
E.7.3 Oil production is presently restricted to a limited area surrounding the Norman Wells refinery, which is currently producing close to its capacity of 3,000 barrels per day (Fig. E-10). Its products meet the needs of local markets and a proportion of the needs of communities farther north, although an increasing amount of diesel oil and gasoline is supplied from refineries in Edmonton. Only a limited amount of natural gas for home heating has been produced at Norman Wells (Acres, 1973).

Production and Value of Oil and Natural Gas in NWT

	Natural Gas		Crude Oil	
	Production	Value	Production	Value
	(mcf)	$	(bbl)	$
1961	41,678	*17,326*	516,979	*730,160*
1970	81,939	*34,578*	846,003	*1,142,104*
1971	270,000	*113,000*	945,000	*1,276,000*

Statistics Canada 26-201 and 26-202

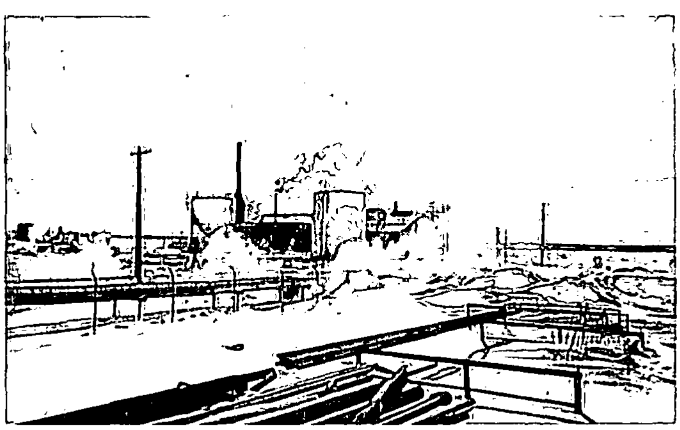
E.7.4 Prospects for future gas and oil production in the Northwest Territories are extremely encouraging. The Mackenzie delta-Beaufort Sea area and the sedimentary basin of the Mackenzie valley are two of three main sites of petroleum exploration (Fig. E-11). A number of companies are exploring in the Mackenzie delta; and major reserves of natural gas and some oil have been discovered there. In addition, major natural gas discoveries have been made in the Arctic Islands.



E.B. Peterson

Fig. E-9 Rapids on Great Bear River, NWT.

E.7.5 Land uses associated with petroleum exploration and development in the study area include seismic work, well drilling, camp sites (Fig. E-11) and winter access roads. Exploration sites are scattered throughout the study area, with the major concentration being in the Mackenzie delta. Development use is limited at present to Norman Wells with its refinery and storage tanks (Fig. E-10).



Information Office, INA

Fig. E-10 Imperial Oil refinery, Norman Wells, NWT.

E.7.6 Granular resources include all unconsolidated material and bedrock suitable for the construction of roads, airstrips and building pads. Pads of granular materials have been used to preserve the thermal regime by preventing the thawing of ground ice below buildings, roads and other structures.

E.7.7 Construction of the Mackenzie and Dempster Highways has greatly increased the use of granular resources (Fig. E-12). Borrow pits and rock quarries have also been developed to meet the needs of all-weather highway construction as far north as Fort Simpson and between Fort McPherson and Inuvik. Thus, the demand for granular resources has increased in recent years largely because of oil and gas exploration, and highway construction.

E.7.8 Good quality granular materials are in limited supply in the upper and central Mackenzie regions in the vicinity of Fort Simpson, Fort Norman and Norman Wells; considerable quantities are available in the Wrigley and Fort Good Hope areas. In the lower Mackenzie region, Inuvik and Tuktoyaktuk have adequate materials for settlement use if the resources are properly managed; Arctic Red River and Fort McPherson have adequate supplies as a result of pits developed for the Dempster Highway. (Details on the availability of granular materials are found in reports prepared for Indian and Northern Affairs by Ripley et al. *a*; Ripley et al. *b*; Pemcan, 1973; EBA, 1974.)

Information Office, INA

Fig. E-11(a) Seismic drill with ice bit, Mackenzie delta.

B.E. Darling

Fig. E-11(b) Drilling rig, Mackenzie delta.

E.8 Transportation and Communication

E.8.1 Transportation and communication services are discussed in sections D.8 and D.9. They are discussed here solely in relation to land use (Fig. E-13).

Mackenzie Highway Committee, INA

Fig. E-12 Construction activity on Dempster Highway

E.8.2 Only a small amount of shoreline area is devoted to wharves and other water related transportation facilities. With the exception of Hay River, Fort Simpson and Inuvik, most settlements have limited off-loading areas. However, increased river traffic from a large scale development project would result in a greater requirement for shore facilities at various locations (Fig. E-14).

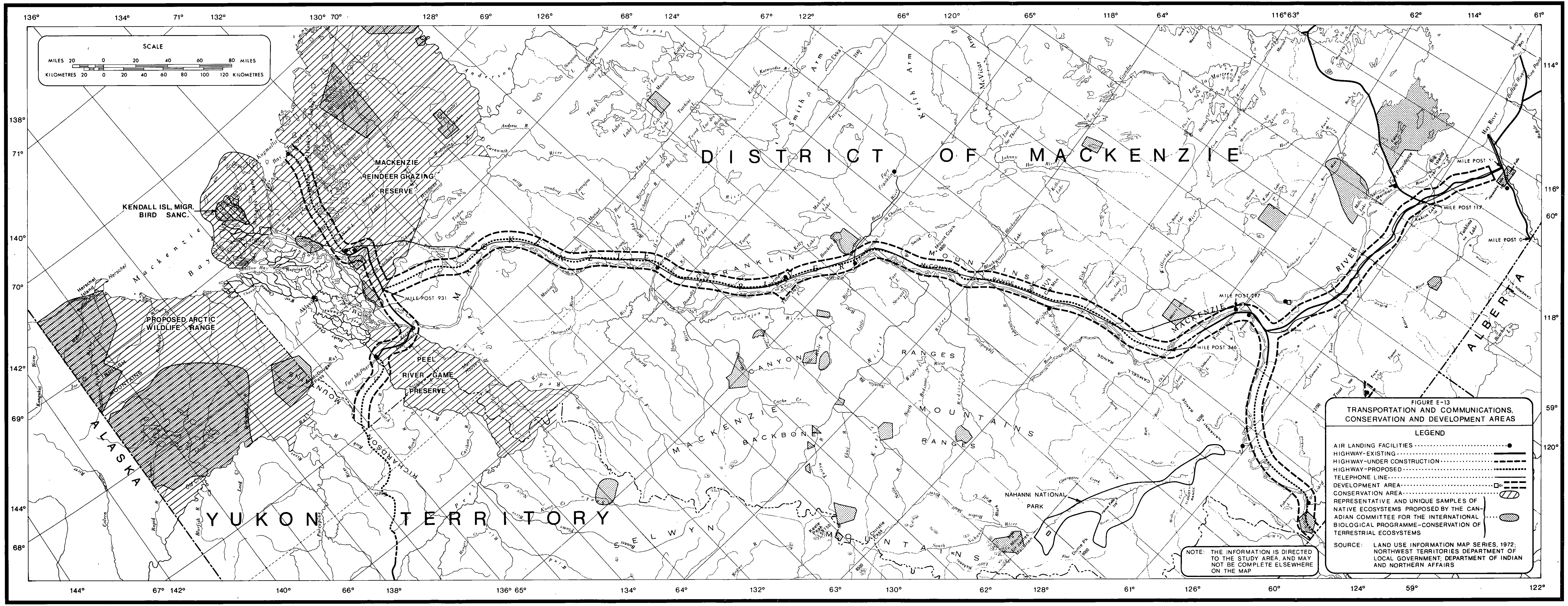
E.8.3 The use of land by the present and planned highway network is in itself insignificant; however, as noted in paragraph E.7.7, the use of relatively scarce granular materials is significant. Moreover, a highway network can facilitate other land and resource uses. Similarly the land used for communication land lines and facilities in the communities is insignificant.

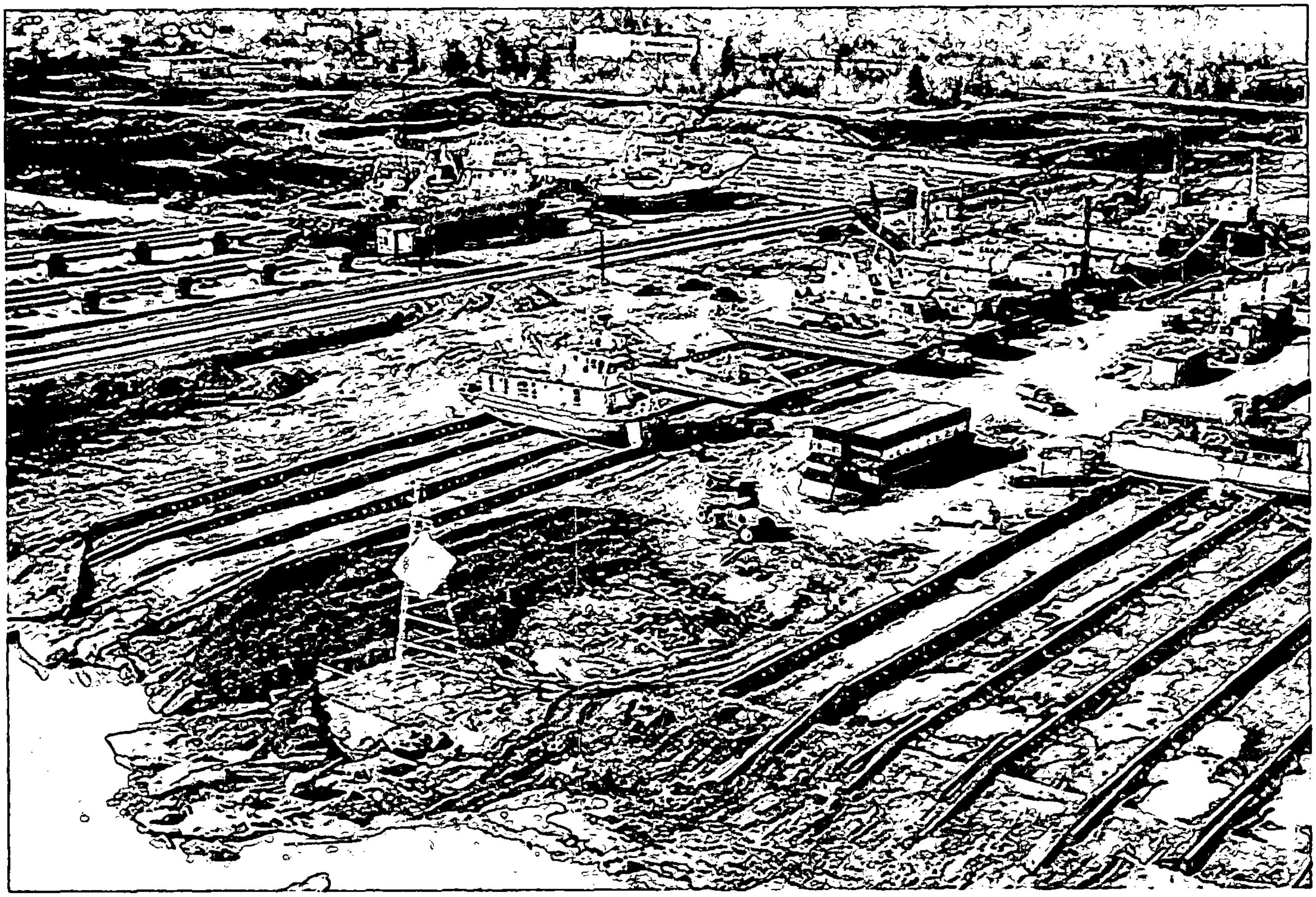
E.8.4 Extension of the Mackenzie Highway from Fort Simpson along the Mackenzie valley to Inuvik and Tuktoyaktuk began in 1972. The Dempster Highway between Dawson City, Yukon and Arctic Red River, NWT, will link the Yukon road system with Inuvik and with other Mackenzie valley communities located on the Mackenzie Highway. These roads will provide increased access to a variety of renewable and non-renewable resources in the study area.

E.8.5 Since the early 1920's aircraft have been used extensively in a wide range of functions in the study area. (For a more detailed discussion see section D.8.5.) In the study area, Inuvik and Norman Wells have hard surfaced airfields in excess of 6,000 feet and Fort Simpson has a 6,000 foot earth strip. The other communities serviced by air have either earth or gravel strips or facilities only for water and winter landings. Communication and meteorological facilities for air and marine traffic make very limited use of land in the study area.

E.9 Urban Land Uses

E.9.1 The use of land by the settlements in the study area is also very limited. The populations in these communities in 1971 ranged from about 47 in Jean Marie River to 2,645 in Inuvik (Table VII, Appendix E). Inuvik covers an area of approximately 540 acres, while Jean Marie River is only about 35 acres. Approximately 2,223 acres in the study area are 'built up' at present (Table VII, Appendix E). Most of the communities in the study area could be expanded physically to cope with increased populations and expanded economic activities (INA/MPS, 1973, V.5).


SCALE
MILES 20 0 20 40 60 80 MILES
KILOMETRES 20 0 20 40 60 80 100 120 KILOMETRES
DISTRICT OF MACKENZIE
YUKON TERRITORY
ALASKA
ALBERTA
MACKENZIE REINDEER GRAZING RESERVE
KENDALL ISL. MIGR. BIRD SANC.
PROPOSED ARCTIC WILDLIFE RANGE
PEEL RIVER GAME PRESERVE
NAHANNI NATIONAL PARK
FRANKLIN MOUNTAINS
MACKENZIE MOUNTAINS
MACKENZIE RIVER
RICHARDSON MOUNTAINS
BRITISH MOUNTAINS
SELWYN MOUNTAINS
CANYON RANGES
BACKBONE RANGES
CAMSELL RANGE
MILE POST 931
MILE POST 297
MILE POST 346
MILE POST 117
MILE POST 1
MILE POST 0
Mackenzie Bay
Herschel Island
Fort McPherson
Fort Good Hope
Fort Franklin
Providence
Hay River
FIGURE E-13
TRANSPORTATION AND COMMUNICATIONS, CONSERVATION AND DEVELOPMENT AREAS
LEGEND
AIR LANDING FACILITIES
HIGHWAY-EXISTING
HIGHWAY-UNDER CONSTRUCTION
HIGHWAY-PROPOSED
TELEPHONE LINE
DEVELOPMENT AREA
CONSERVATION AREA
REPRESENTATIVE AND UNIQUE SAMPLES OF NATIVE ECOSYSTEMS PROPOSED BY THE CANADIAN COMMITTEE FOR THE INTERNATIONAL BIOLOGICAL PROGRAMME-CONSERVATION OF TERRESTRIAL ECOSYSTEMS
SOURCE: LAND USE INFORMATION MAP SERIES, 1972; NORTHWEST TERRITORIES DEPARTMENT OF LOCAL GOVERNMENT; DEPARTMENT OF INDIAN AND NORTHERN AFFAIRS
NOTE: THE INFORMATION IS DIRECTED TO THE STUDY AREA, AND MAY NOT BE COMPLETE ELSEWHERE ON THE MAP



NTCL

Fig. E-14(a) NTCL wharf and dry-dock, Hay River, NWT.

E.10 Controlled Land Uses and Conservation

E.10.1 Crown lands in the Northwest Territories and the Yukon Territory "... are under the control, management and administration of the Minister..." of Indian and Northern Affairs (Section 3(1), Territorial Lands Act). "Where he deems it necessary for the protection of the ecological balance or physical characteristics of any area in the Yukon Territory or the Northwest Territories, the Governor in Council may ...set apart and appropriate any territorial lands in that area as a land management zone" (Section 3A, Territorial Lands Act, as amended June 26, 1970). In such land management zones, the Governor in Council may make regulations respecting the protection, control and use of the land and the issue of permits for the use of the surface of the land including the terms and conditions of such permits (Section 3B, Territorial Lands Act, as amended June 26, 1970).

E.10.2 In order to ensure orderly development in the area immediately surrounding the communities, lands have been transferred from federal to territorial control and administration. In the study area this transfer has taken place for Hay River, Fort Providence, Fort Simpson, Norman Wells, Aklavik and Inuvik. The other transfers are scheduled to be completed by 1975.

E.10.3 In January 1973 the Mackenzie Development Area was established by Commissioner's Order No. 2-73, which also established the Mackenzie Development Area Regulations. This 'development area' covers a strip of land extending four miles on either side of the Mackenzie Highway from the vicinity of Enterprise northward to the Yukon border on the Dempster Highway and to Tuktoyaktuk. This development area also includes proposed pipeline routes along much of its length.

E.10.4 Two existing wildlife reserves, the Peel River Game Preserve and the Mackenzie Reindeer Grazing Reserve, are located partially within the study area. A third, the Arctic International Wildlife Range, has been proposed. This wildlife reserve would include the Yukon north of the Porcupine River and the existing Arctic National Wildlife Range in adjacent northeastern Alaska. There are also several migratory bird sanctuaries in the outer Mackenzie delta.

E.10.5 In 1965 a subcommittee of the Canadian Committee for the International Biological Programme was formed. This subcommittee was designed to organize a nationwide program for the conservation of terrestrial ecosystems under a program sponsored by the National Research Council of Canada. The Canadian subcommittee was intended to encourage the setting aside of representative and unique examples of natural ecosystems in the form of ecological reserves in order to facilitate conservation and scientific investigation. A number of reserves have been proposed within the study area but none have been officially designated as yet.

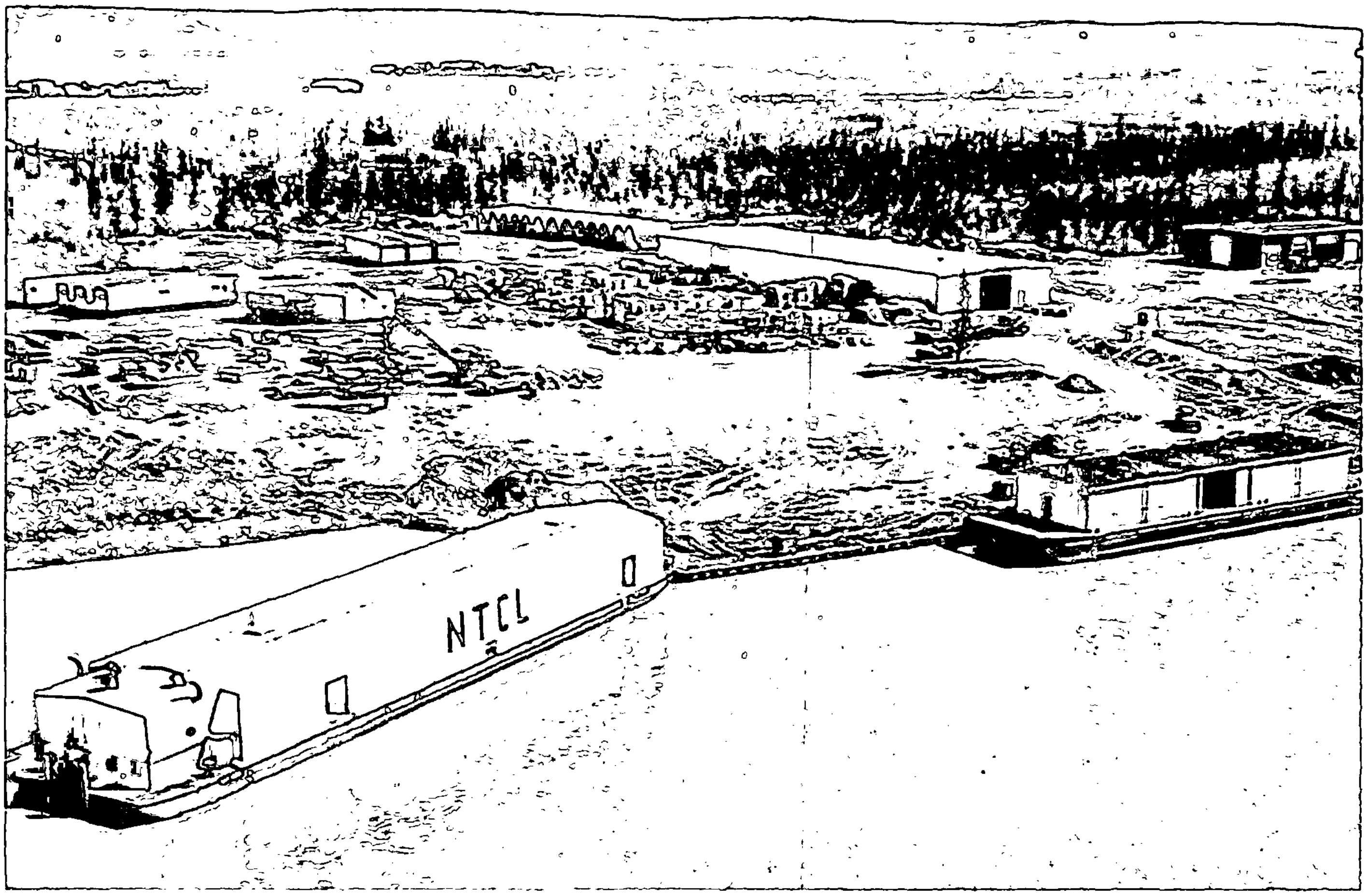


Fig. E-14(b) NTCL dock, Inuvik, NWT.

E.10.6 There are no national parks within the study area; however, Nahanni National Park abuts the area on the west and interest has been expressed by Government and naturalists in dedicating other areas to national parks. Interest has also been expressed in establishing a Pingo National Park on the Tuktoyaktuk peninsula, and some rivers in the study area have potential as 'wild river' national parks.

Appendix E

Table I Total Fur Harvest for Selected Communities, Study Area, 1965-66

	Fort Providence	Fort Simpson*	Norman Wells**	Fort Good Hope	Fort McPherson	Arctic Red River	Aklavik	Inuvik	Tuktoy-aktuk	Old Crow	Study Area
Marten	65	1,238	1,490	1,550	67	79	53	533	386	142	*5,603*
Muskrat	2,808	1,476	1,948	1,339	24,881	966	21,090	29,259	14	7,860	*91,641*
Lynx	16	258	17	47	72	33	209	232	6	15	*905*
Mink	51	234	168	244	101	10	178	315	28	10	*1,339*
Beaver	232	1,653	654	829	259	60	257	652	1	12	*4,609*
White Fox	—	—	—	2	—	—	—	75	260	—	*337*
Seal	—	—	—	—	—	—	—	—	—	—	—
Red Fox	—	7	10	14	3	1	20	33	52	3	*143*
Cross Fox	—	5	10	2	3	3	10	26	30	—	*89*
Wolf	2	15	3	—	—	—	—	—	1	—	*21*
Polar Bear	—	—	—	—	—	—	—	—	25	—	*25*
Squirrel	1,744	3,021	70	160	80	11	6	8	—	4	*5,104*
Bear	10	23	16	2	3	3	—	1	—	—	*58*
Silver Fox	—	—	1	1	—	—	3	1	6	—	*12*
Weasel	189	754	200	211	170	59	212	459	277	10	*2,541*
Otter	—	1	11	3	1	—	—	—	—	—	*16*
Other	—	5	2	—	—	—	—	1	6	1	*15*
Total harvest by community	*5,117*	*8,690*	*4,600*	*4,404*	*25,640*	*1,225*	*22,038*	*31,595*	*1,092*	*8,057*	*112,458*

*Includes Wrigley
**Includes Fort Norman
Source of data: NWT Fur Export Tax Returns, 1965-66; Naysmith, 1971

Table II Total Fur Harvest for Selected Communities, Study Area, 1971-72

	Fort Providence	Fort Simpson*	Norman Wells**	Fort Good Hope	Fort McPherson	Arctic Red River	Aklavik	Inuvik	Tuktoy-aktuk	Old Crow	Study Area
Marten	105	1,364	1,070	1,435	754	61	198	841	602	76	*6,506*
Muskrat	284	514	150	1,515	23,021	84	24,145	24,472	2,123	9,303	*85,611*
Lynx	568	1,355	24	37	81	45	209	536	—	24	*2,879*
Mink	62	134	109	82	277	5	594	910	6	23	*2,202*
Beaver	219	1,184	49	632	122	6	1	67	—	12	*2,292*
White Fox	105	—	13	6	1	1	56	491	2,067	—	*2,740*
Seal	—	—	—	—	—	—	—	268	53	—	*321*
Red Fox	9	12	12	14	17	7	35	146	33	1	*286*
Cross Fox	1	—	8	17	—	1	43	117	29	8	*224*
Wolf	3	26	1	11	3	1	—	13	6	4	*68*
Polar Bear	—	—	—	—	—	—	—	1	12	—	*13*
Squirrel	1,126	602	28	115	48	3	—	4	—	—	*1,926*
Bear	18	5	1	9	1	—	1	6	1	—	*42*
Silver Fox	3	—	—	1	1	—	—	12	4	—	*21*
Weasel	66	121	60	37	16	—	35	39	—	16	*390*
Otter	1	2	4	2	—	—	—	1	—	3	*13*
Other	3	10	2	2	1	—	—	9	3	4	*34*
Total harvest by community	*2,573*	*5,329*	*1,531*	*3,915*	*24,343*	*214*	*25,317*	*27,933*	*4,939*	*9,474*	*105,568*

*Includes Wrigley
**Includes Fort Norman
Source of data: NWT Fur Export Tax Returns, 1971-72 and Yukon Game Branch, 1973

Appendix E — *(continued)*

Table III Value of Fur Production for Five Major Species, Northwest Territories and Mackenzie Valley, 1968-69 to 1971-72

	Northwest Territories			*Mackenzie Valley*		
	Average Pelt Value	Number of Pelts	A Value	Number of Pelts	B Value	B of A
	$		$		$	%
1968-69						
Muskrat	1.05	272,875	286,519	181,125	190,181	*66*
Beaver	13.69	9,680	132,519	5,495	75,227	*57*
Marten	9.15	11,703	107,082	7,693	70,391	*66*
Lynx	28.10	3,345	93,995	1,664	46,758	*50*
Mink	17.66	6,059	107,002	1,879	33,183	*31*
			727,117		*415,740*	*57*
1969-70						
Muskrat	.98	114,108	111,826	84,793	83,097	*74*
Beaver	12.92	8,157	105,388	4,848	62,636	*59*
Marten	10.27	11,803	121,217	8,517	87,470	*72*
Lynx	22.50	4,893	110,093	3,033	68,243	*62*
Mink	14.99	9,429	141,341	3,788	56,782	*40*
			589,865		*358,228*	*61*
1970-71						
Muskrat	1.29	86,824	112,003	68,197	87,974	*79*
Beaver	10.60	7,192	76,235	3,055	32,383	*43*
Marten	9.85	8,799	86,670	6,543	64,449	*74*
Lynx	16.95	5,258	89,123	3,270	55,427	*62*
Mink	11.34	4,021	45,598	1,964	22,272	*49*
			409,629		*262,505*	*64*
1971-72						
Muskrat	1.68	97,722	164,173	76,603	128,693	*78*
Beaver	15.88	6,335	100,600	2,630	41,764	*42*
Marten	10.40	8,867	92,217	6,110	63,544	*69*
Lynx	26.80	5,492	147,186	3,637	97,472	*66*
Mink	16.24	4,260	69,182	2,257	36,654	*53*
			573,358		*368,127*	*64*

Source of data: Compiled from NWT Fur Traders' Record Books and Fur Export Tax Returns

Table IV Value of Total Fur Harvest for Selected Communities, Study Area, 1962-70

	1962	1963	1964	1965	1966	1967	1968	1969	1970
	$	$	$	$	$	$	$	$	$
Aklavik	60,359	71,752	56,904	42,815	66,725	41,281	49,959	99,707	65,856
Arctic Red River	4,566	7,652	14,190	2,836	4,218	2,580	2,561	8,879	1,409
Fort Good Hope*	38,978	43,362	53,308	29,310	32,755	34,441	19,635	19,077	14,155
Fort McPherson	34,545	52,237	45,913	33,022	48,196	26,995	43,682	72,603	20,174
Fort Norman**	9,309	16,043	24,533	11,287	9,772	12,764	13,819	11,070	10,862
Fort Providence	16,482	12,754	10,446	8,041	6,073	6,070	9,342	16,082	19,332
Fort Simpson***	19,924	32,895	42,270	33,125	37,569	30,302	29,888	28,489	27,041
Inuvik	74,356	111,062	109,879	74,430	74,336	74,726	60,800	127,003	86,373
Tuktoyaktuk	10,064	27,826	30,537	13,792	13,764	8,613	2,948	8,002	9,463
Wrigley	11,779	15,195	16,703	6,215	4,604	3,106	8,368	11,700	8,648
Total	*280,362*	*390,778*	*404,683*	*254,873*	*298,012*	*240,878*	*241,002*	*402,612*	*263,313*

*Includes Colville Lake returns
**Includes Norman Wells returns
***Includes Jean Marie River returns
Source of data: Compiled from NWT Fur Traders' Record Books

Appendix E — *(concluded)*

Table V Organized Hunts in Selected Communities, Study Area, 1971-72

	Amount of Assistance	Type of Assistance	Number of Hunts	Caribou Taken	Weight	Assistance Cost/lb.	Total Value
	$			(estimated)	(pounds)	¢	$
Aklavik	586	aerial spotting	1	160	16,000	3.7	9,600
Fort Franklin	3,512	spotting, supplies and transportation	1	330	33,000	10.6	19,800
Fort Good Hope	361	N/A	1	N/A	N/A	N/A	N/A
Fort McPherson	286	aerial spotting	1	300	30,000	1.0	17,160
Fort Simpson	322	transportation	1	6 moose 1 caribou	2,100	15.3	1,250
Hay River	888	gasoline	1	150	15,000	5.9	9,000

N/A — Not available

Source of data: NWT Game Division, 1973

Table VI Community Water Supply, Sewage and Garbage Disposal Facilities, Study Area, 1972

	Water			Sewage		Garbage	
	Source	Treatment	Delivery	Collection	Disposal	Collection	Disposal
Aklavik	lake-S river-W	Chl, Plt	Tr, Ps	Tr	D	Tr	D, Df
Arctic Red River	lake-S river-W	Chl	Tw	Tr	D, Df	Tr	D, Df
Fort Good Hope	lake-S ice-W river	Chl	I, Tr, U	Tr, U	D	Tr	D
Fort McPherson	lake	Chl, Plt	Wp, Tr, U	I, Tr, U	D	Tr	D
Fort Norman	river	Chl	Tr	Tr	D	Tr	Df
Fort Providence	river	Chl	Tr	P, Tr	Df	Tr	Df, B
Fort Simpson	river	Chl, Plt	Bp	Bp	D	Tr	D
Inuvik	river	Chl, Plt	Tr, U	Tr, U	D	Tr	D
Jean Marie River	well river	—	I	P, I	D, Sep	I	D
Norman Wells	river	Chl, Plt	I, Tr, U	P, Tr, U	D	Tr	Df
Trout Lake	lake	—	I	—	—	I	D
Tuktoyaktuk	lake-S ocean-W	Chl	Tr	Tr	D, Df	Tr	D
Wrigley	river-W	Chl	W-S, Tr, Tw	P, Tw	Sep	Tw	D, B

S — summer
W — winter

Chl — chlorination
Plt — plant

I — Individual
Wp — Waterpoints
Tr — Trucked
Tw — Tractor/Wagon
Ps — Piped-summer
U — Utilidor
Bp — Buried Pipe

P — Privies
Sep — Septic

D — open dump
Df — dump & fill
L — lagoon
B — burning

Source of data: Derived from Gemini North, 1973

Table VII Population and Estimated Size of Selected Communities, Study Area, 1971

Communities	Population[1]	Approximate Acreages*[2]	Communities	Population[1]	Approximate Acreages*[2]
Aklavik	675	92**	Jean Marie River	47	35
Arctic Red River	110	75	Norman Wells	300	325
Fort Good Hope	325	147	Trout Lake	48	30**
Fort McPherson	695	72	Tuktoyaktuk	605	80
Fort Norman	350	188	Wrigley	155	49
Fort Simpson	745	590	Old Crow	175	24**
Inuvik	2,645	540			

*Acreages include surveyed townsite lands regardless of present development and some developed lands that are not surveyed. Airstrips and airports are not included except for the small strip at the northern edge of Inuvik

**Estimated from air photographs

Source of data:
[1] Table I, Appendix D
[2] INA, Technical Services Branch, *Site Plans*

F

Implications of Proposed Northern Pipelines

F.1 Introduction

F.1.1 Pipeline construction in southern Canada normally involves a trench and bury method. This technique has little effect on terrain, is not a barrier to movement of animals, does not generally create soil stabilization problems, and normally does not create a lasting, unsightly disturbance because revegetation is rapid. Pipeline construction and operation in southern Canada has also been acceptable from a socio-economic point of view and has not created severe resource use conflicts. The central question then is: Why should there be concern over proposed *northern pipelines*?

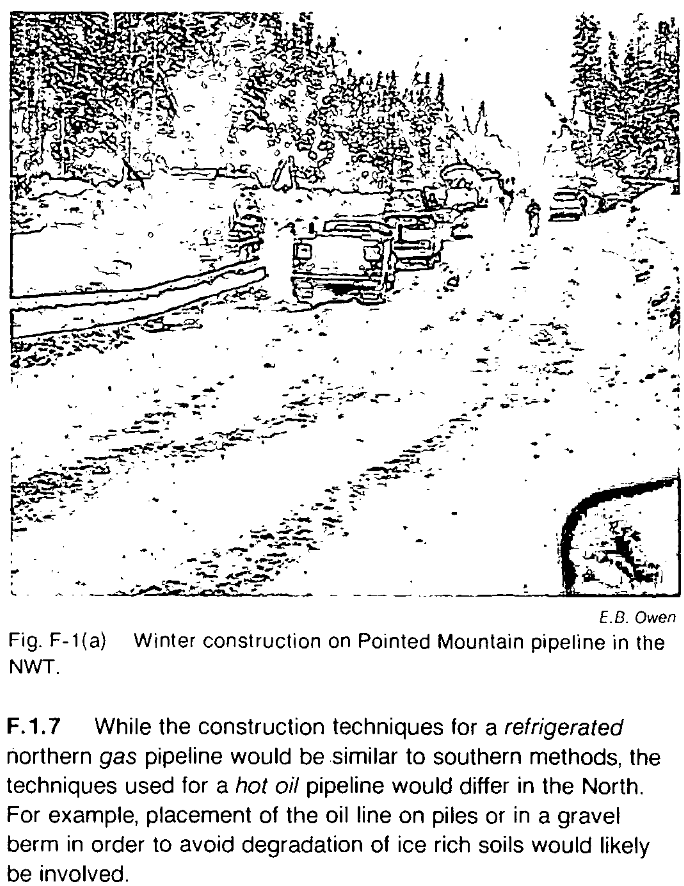
F.1.2 This chapter focusses on those conditions in the Mackenzie valley and northern Yukon that appear to be sufficiently different from those in southern Canada to require special care or modifications in project design if proposed northern pipelines were approved.

F.1.3 Since this report is not an assessment of a specific application, a detailed description of proposed pipeline facilities is not included. The expected side effects of either an oil or gas pipeline are considered, and any that would apply to only one type of pipeline is specified. The two kinds of pipelines would be similar in terms of the overall size of the project, the kinds of construction equipment used, and the proposed general routing.

F.1.4 The following features of the proposed Mackenzie valley *gas* pipeline provide a generalized description of proposed northern pipelines (Canadian Arctic Gas Study Limited, 1973). The pipeline would total about 1,150 miles in length through the northern Yukon and along the Mackenzie valley. There would be a compressor station about every 50 miles – with three in the northern Yukon and about 18 in the Northwest Territories from Richards Island to the Alberta-Northwest Territories border. Once the full capacity of about four billion cubic feet per day was reached, the capacity of the pipeline could be increased by looping, that is by placing a parallel pipeline along the same right of way.

F.1.5 Refrigeration is a unique feature of the proposed gas pipeline. In the area of perennially frozen ground, the gas would be refrigerated to below -4°C (25°F) at each compressor station in order to reduce the risk of melting the permafrost.

F.1.6 Equipment similar to that used in the recent construction of 48 inch pipelines in Alberta and Saskatchewan would be utilized. 'Off the shelf' equipment was also used to construct the Pointed Mountain pipeline, built during the winter of 1972, and at the Canadian Arctic Gas test site near Norman Wells (Fig. F-1). Standard equipment would probably require such modifications as higher clearance, greater weight distribution through use of wide tracks, and heavier frames. Equipment would include tractors, scrapers, graders, ditchers, back hoes, pipe benders, welding rigs and coating equipment. Although some of the construction equipment might be self-propelled from railhead or barge landing sites, some would need to be transported. Some of this auxiliary transport would probably require load capabilities in excess of 60 tons; and with the exception of water transport, all equipment would have to be capable of operating at extremely low temperatures (Bell, 1973).



E.B. Owen

Fig. F-1(a) Winter construction on Pointed Mountain pipeline in the NWT.

F.1.7 While the construction techniques for a *refrigerated* northern *gas* pipeline would be similar to southern methods, the techniques used for a *hot oil* pipeline would differ in the North. For example, placement of the oil line on piles or in a gravel berm in order to avoid degradation of ice rich soils would likely be involved.

F.1.8 Features of northern oil or gas pipeline construction which would differ from techniques used in the South would include: (i) greater concentration of activity during the winter when the frozen soils could support heavy machinery; (ii) use of packed snow or ice roads to minimize surface damage in areas underlain by ground ice; (iii) greater concentration of personnel

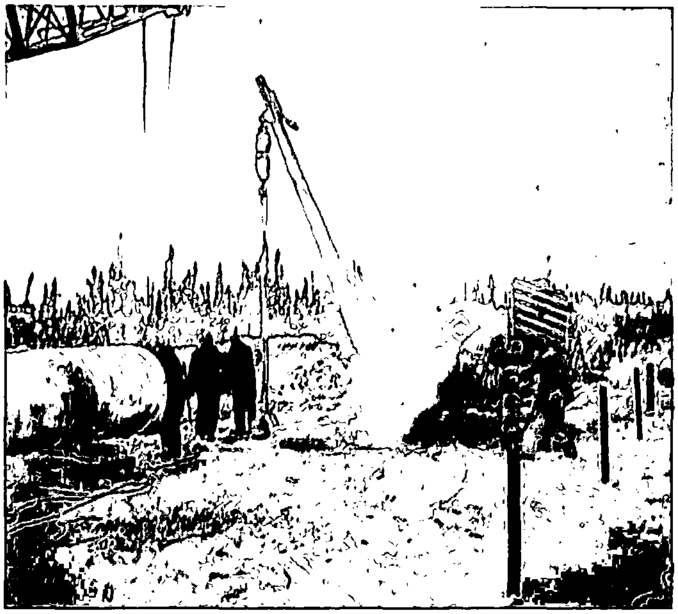


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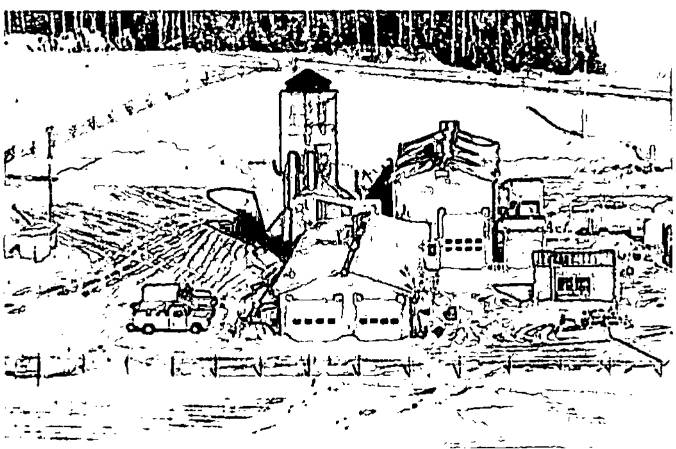
Fig. F-1(b) Winter construction at CAGSL test site near Norman Wells, NWT.

into large construction camps; (iv) greater reliance on aircraft for servicing compressor or pumping stations and less reliance on access by permanent roads (Fig. F-2); (v) storage and handling of exceptionally heavy pipe (at an average thickness of about 0.72 inches, 48 inch diameter pipe would weigh about 365 pounds per foot of length; 60 foot lengths of pipe would weigh about 11 tons each (Bell, 1973)); and (vi) a particularly high volume of traffic on the right of way by a wide variety of vehicles, during the short winter work period.



TransCanada PipeLines Ltd.
Fig. F-2 Compressor station near Nipigon, Ontario.

F.2 Environmental and Resource Use Implications

F.2.1 *The General Approach*

F.2.1.1 This section is not a catalogue of all the side effects that might accompany route selection, construction, operation and abandonment of proposed gas and oil pipelines in the Mackenzie valley and the northern Yukon. First, the most important anticipated side effects are identified. Secondly, interrelationships between these various side effects are discussed. Within each of these two sections, side effects are presented separately for: (i) consideration during pipeline route selection; (ii) the expected methods of construction; and (iii) operational features of proposed northern pipelines. There are no examples of abandonment of a big inch pipeline in Canada, therefore it is assumed its effects would be similar to those of pipeline construction.

F.2.1.2 In sections F.2.2 through F.2.4 which deal with the main expected side effects of proposed pipelines, information is grouped according to the following five major concerns: (i) maintenance of stable engineering structures; (ii) prevention of erosion; (iii) maintenance of water and air quality; (iv) protection of renewable resources; and (v) protection of aesthetic values. These concerns are not identified by specific subheadings, but information pertaining to them is presented in the order discussed above in the three sections that deal with route selection, construction and operation.

F.2.1.3 In sections F.2.5 through F.2.7 which deal with interrelationships between predicted side effects, information is again grouped, where appropriate, according to these five general environmental concerns. In a sense, these sections also deal with a sixth broader concern – that is, the avoidance of major resource use conflicts.

F.2.1.4 A simple and brief narrative approach is used in sections F.2.2 through F.2.8, as outlined in paragraphs F.2.1.1 through F.2.1.3. Finally, the most important predicted side effects are summarized in Fig. F-5 in terms of whether they are: (i) short or long term; (ii) avoidable or unavoidable; and (iii) localized in occurrence or applicable throughout most of the study area. The reader is referred to this figure in section F.2.8, for a summary of the environmental and resource use implications of proposed northern pipelines.

F.2.2 *Major Environmental Implications – Pipeline Route Selection*

F.2.2.1 Plains, which are composed of former glacial lake bottom sediments, are a major concern in route selection. These areas are generally unsuitable locations for pipelines since they frequently exhibit unstable slopes, gully formation, and thermal erosion. Where these plains could not be avoided, very careful route section would be required, especially at stream crossings (Lavkulich, 1973). The burial method of construction in these lake bottom deposits would appear particularly unsuitable for *oil* pipelines, but might be suitable for *gas* pipelines. Locations of these deposits are identified in other reports published under the Environmental-Social Program (Hughes et al., 1973; Rutter et al., 1973).

F.2.2.2 Aside from bedrock, gravel and sand ridges are the most stable surface materials but construction activities might lead to problems where these deposits overlie soils with high ice content. As illustrated by the gravel pit at Inuvik, removal of gravel cover from underlying ice rich sediments might result in rapid collapse (Hughes et al., 1973). Other details of surficial geology particularly important for route selection are provided in paragraphs C.4.3.2 through C.4.3.6.

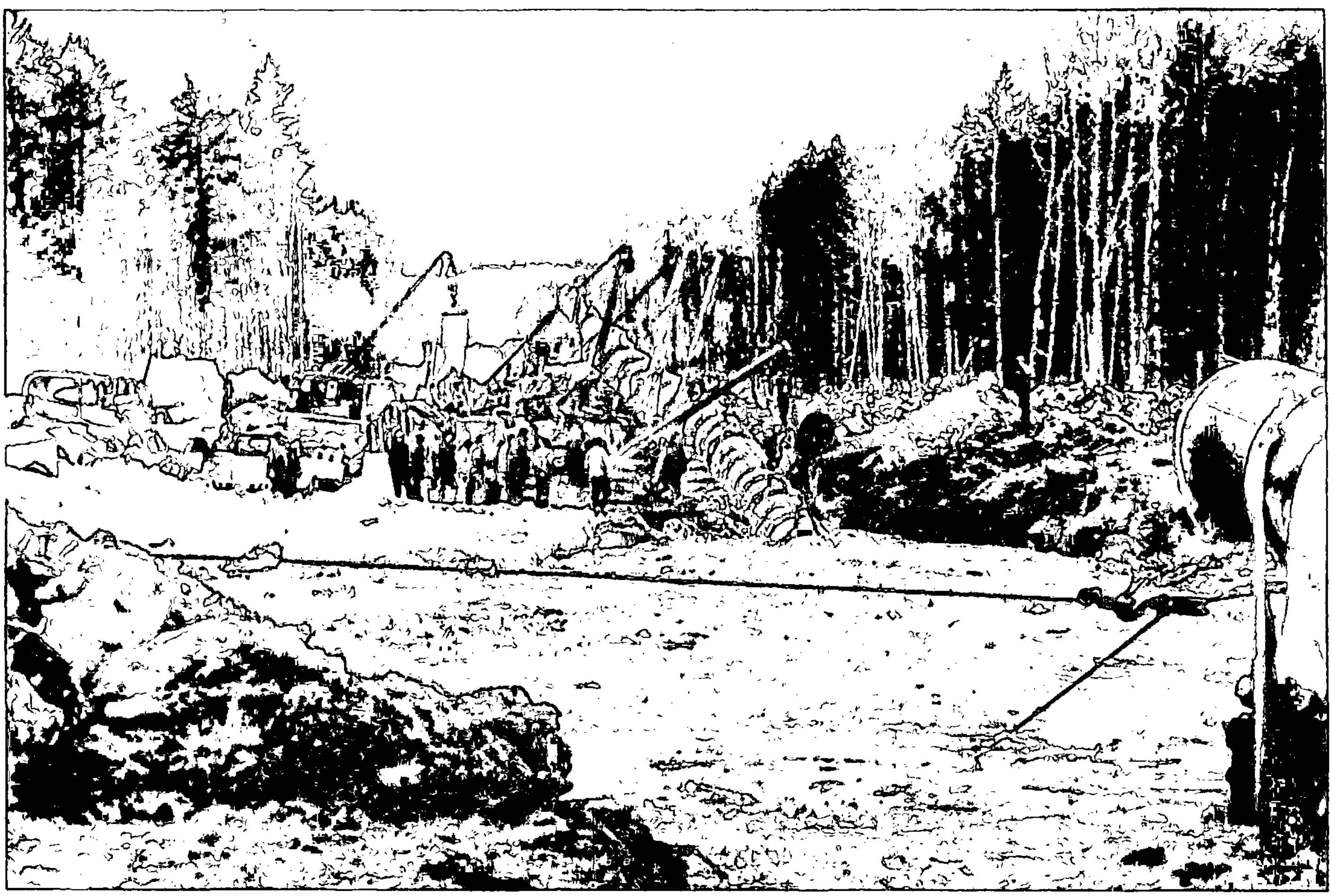
F.2.2.3 Since the most significant extreme events expected in the study area are associated with rivers and streams, maintenance of stable man made structures is of particular concern at proposed river crossing sites (Fig. F-3). There are major uncertainties in predicting interactions between water, ice and man made structures. For example, ice jams occur regularly at some sites but may occur infrequently or rarely at others. Such events as slumping of banks, landslides, or normal gradual processes of erosion and sedimentation may change a river channel creating new jam sites. Therefore, a particular part of a river may be adding river bed deposits one year and be subject to erosion another year (MacKay, 1973). These factors are very important in planning the location of facilities near river banks or in designing facilities to be buried in river beds. They are a concern at all river crossing sites, but might be most serious at the proposed Mackenzie River crossing near Fort Simpson. The most favorable crossing site in the vicinity of Fort Simpson is located above the Liard River junction where the risk associated with breakup and jamming of ice, and erosion of the river bed by ice would be significantly reduced. In contrast, a pipeline crossing between Fort Simpson and Camsell Bend, downstream of the Liard River junction, might be subject to severe ice jamming, excessive erosion (scour) of the river bed, and massive slumping of banks (MacKay, 1973). Further details on these river crossing hazards are provided in paragraphs C.5.7 through C.5.11.

F.2.2.4 Summer storms with intense rainfall are another example of extreme natural events that might cause flood and erosion hazards for proposed pipeline crossings. For example, an intense storm in July 1970 indicated that storm runoff from mountain streams entering the Mackenzie River from the west can cause greater changes to river channels than spring breakup (MacKay, 1973).

F.2.2.5 Special problems would be encountered in burying a pipeline below any braided stream (Fig. C-20). This would apply to most of the west side tributaries of the Mackenzie because these streams have wide areas that are flooded each year, shifting channels, unstable banks, and stream bed deposits that are easily moved during periods of high water levels (MacKay, 1973; Rutter et al., 1973). Comparisons of east side and west side tributaries of the Mackenzie River are provided in paragraphs C.5.14 and C.5.15.

F.2.2.6 The three common types of slope failure within the study area are described in paragraph C.4.3.7. Selection of pipeline routes that would avoid locations subject to slope failure is the simplest way to prevent this problem. Some kinds of slope failures are typically found adjacent to streams. When assessing bank stability at proposed river crossing sites, it must be remembered that slope failures might continue to move thousands of feet inland over a period of years (Code, 1973).

F.2.2.7 There is a highly erodable area on the Yukon north coast. In recent years sediment from this coastal erosion and from rivers has been deposited in spits along the mainland, and



C. Schlyter

Fig. F-3(a) Pulling pipe across small water course, northern Ontario.

C. Schlyter

Fig. F-3(b) Supporting pipe during water crossing operation, northern Ontario. Note 'river weights' are used.

in Phillips and Shoalwater Bays. The dynamics of this coastal area would have to be considered carefully during route selection and construction of any shore installations (McDonald and Lewis, 1973).

F.2.2.8 The major consideration during route and site selection for maintaining air quality within the study area is that poor choice of siting of exhaust producing facilities might lead to the undesirable accumulation of air pollutants or the development of ice fog during periods of cold weather. The circumstances under which these adverse conditions might develop are described in paragraph C.2.2.2. The best safeguard is to avoid close grouping of exhaust producing facilities, airports and heavily used automobile routes.

F.2.2.9 The major concern for maintaining water quality within the study area is the possibility of oil spills, especially in relation to the Mackenzie delta. An important safeguard in the case of an *oil* pipeline would be to select a route that avoided the Mackenzie delta and particularly hazardous river crossings.

F.2.2.10 Because of hydrologic factors (paragraphs C.5.14 and C.5.15) and the special problems of braided rivers (paragraph F.2.2.5), west side tributaries of the Mackenzie River would be very difficult to cross safely with either pipelines or roads. Therefore, pipelines would likely be built on the east side of the Mackenzie. But since clear streams would experience more intensive biological changes from increased siltation than would naturally silty streams, east side tributaries would be more susceptible to biological changes resulting from construction activities than would west side tributaries (Hatfield et al., 1972; Brunskill et al., 1973). The following areas are probably the most biologically sensitive to increased siltation: (i) all streams flowing into the Porcupine River drainage and all streams of the Yukon north slope; (ii) all clear rivers in the Mackenzie River drainage, especially along its east side; and (iii) clear lakes in the Mackenzie delta area (Brunskill et al., 1973). These natural variations in biological sensitivity to silt would have to be considered in route selection. However, it would also be important to assess the most biologically suitable stream crossing sites in terms of bank stability and engineering properties. An example of such engineering and environmental interrelationships is presented in paragraph F.2.5.3.

F.2.2.11 Careful route selection would be the first and most important step in reducing or avoiding adverse effects on wildlife. If some sensitive wildlife areas could not be avoided, close liaison between design engineers and biologists would help reduce disturbance from pipeline construction (Watson et al., 1973). The unpredictability of caribou migrations is the main wildlife problem related to route selection. Year to year variations in routes and timing of spring and fall migrations would make it difficult to predict when and where the barren-ground caribou would cross proposed pipeline routes (Environment Protection Board, 1973*d*; Watson et al., 1973).

F.2.2.12 As indicated in paragraph B.1.3, it was not an objective of the Environmental-Social Committee to select a specific pipeline route. However, several reports prepared for the Committee contain general recommendations regarding areas to be avoided and areas that would provide more suitable route alternatives (Brunskill et al., 1973; Bryan, 1973; Hughes et al., 1973; Lavkulich, 1973; MacKay, 1973; Rutter et al., 1973; Stein et al., 1973). And various reports contain more specific information on the hazards involved in proposed pipeline routes along the Mackenzie valley and northern Yukon (Code, 1973; Crampton, 1973; Heginbottom, 1973; Hughes et al., 1973; Kurfurst, 1973; Lavkulich, 1973; Rutter et al., 1973; Rampton, 1974; Zoltai and Pettapiece, 1974).

F.2.3 ***Major Environmental Implications – Pipeline Construction***

F.2.3.1 The discussions of surficial geology, hydrology, soils and vegetation in sections C.4 through C.7, indicate that the following aspects of the construction phase would have significant environmental side effects: (i) trenching and cutting into materials with high ice content; (ii) ditching and excavation for borrow pits; and (iii) unintentional damming of surface water flow (Crampton, 1973; Heginbottom, 1973; Hughes et al., 1973; Kurfurst, 1973; Lavkulich, 1973; Rutter et al., 1973; Strang, 1973; Zoltai and Pettapiece, 1974). These problems would be avoided most readily by detailed sampling of ground ice distribution along specific proposed routes. Maps of surficial materials, prepared under the Environmental-Social Program, would permit mile by mile assessment of suitability for proposed transportation and pipeline routes, but would not eliminate the need for detailed preconstruction sampling (Hughes et al., 1973).

F.2.3.2 The *ice content* of perennially frozen soil determines how disturbances affect the terrain. Sloping soils with high ice content tend to move when they thaw and mud flows commonly occur. Melting ice lenses in the soil which lead to mud flows can, in turn, add silt to spawning beds or other freshwater biological systems. Unfortunately, the amount of ground ice and its specific location cannot always be predicted by surface observations (paragraph F.2.3.1). Locating and delineating the extent of ground ice is difficult and some ice formations would remain undetected until exposed by trenching machines during pipeline construction, when remedial action might be difficult (Environment Protection Board, 1973*a*). Although ice wedges are always present where the surface polygonal pattern is evident, the reverse cannot be assumed; absence of this feature does not ensure the absence of ice wedges beneath the surface (Environment Protection Board, 1973*a*).

F.2.3.3 As discussed in sections C.4 through C.7, soils with high ice content close to the surface are the most likely to create problems of instability for man made structures. Exposure of these icy soils to melting conditions results in hazardous terrain, especially where slopes exceed five per cent. Other areas where engineering problems might occur during pipeline construction include: (i) areas of fine grained sediments subject to frost heaving, collapse and slumping; (ii) thick organic deposits with high moisture content; (iii) areas with a high rate of surface runoff; (iv) river crossings where river banks and river bed characteristics might cause problems; and (v) moraines which, unlike till plains, commonly contain large, irregularly distributed masses of ground ice (Hughes et al., 1973; Rutter et al., 1973).

F.2.3.4 The terrain in the study area is variable, especially in the *Discontinuous Permafrost Zone* where the ground may change from frozen to unfrozen and back to frozen all within a few feet. Construction methods in such areas could not be as flexible as the terrain would demand; it would therefore be appropriate to build for the worst possible conditions in any given section (Zoltai and Pettapiece, 1974).

F.2.3.5 If a pipeline, refrigerated to below 0°C (32°F), passed through an area of unfrozen peatland (as described in paragraph C.7.13), the material near the pipeline would likely freeze. Moisture would move into this frozen zone just as it moves into naturally occurring peat mounds. If this were to happen: (i) natural drainage through the peatland could be dammed causing surface ponding and (ii) the cold pipeline, with a mantle of frozen peat whose volume was greatly increased by attracted water, would be forced upward by ice accumulation, just as naturally occurring peat mounds rise through subsurface accumulations of frozen water. Such forces would place an undetermined degree of stress upon the pipeline at the boundary between frozen and unfrozen material (Zoltai and Pettapiece, 1974).

F.2.3.6 As peat is 1.5 to 2.0 metres (5.0 to 6.5 feet) thick in much of the study area, the bottoms of pipeline ditches could be in ice rich material below the peat; and there would be a high potential for subsidence in the case of a hot oil pipeline. Major channeling of surface drainage along any subsided line and potential erosion, where the pipeline would leave the peat surfaces to descend slopes to streams, would be other major environmental concerns (Hughes et al., 1973). In these areas subsidence would be less likely with a refrigerated gas pipeline, depending on the time lag between installation of the pipe and the startup of refrigeration. Erosion would be a particular concern during the time that the proposed gas pipeline would be buried but not yet refrigerated (Hughes et al., 1973).

F.2.3.7 Ditches would be backfilled progressively during winter pipeline construction, so that no open ditches would exist at spring runoff. However, as demonstrated by winter highway construction, frozen surficial materials cannot be easily compacted. If excess fill were placed over the backfilled ditch, this ridge could impound surface runoff along the upslope side of the ditch, creating an erosion hazard for the buried pipeline. Under permafrost conditions, the normal practice of ditching to divert surface water from erodable parts of the line would probably cause erosion problems comparable to those which the ditching was intended to prevent. Travel restrictions for tracked equipment on the thawed surface and saturated thawing backfill material would limit remedial measures. Therefore, particularly during the spring following the first winter of construction, prevention of erosion along the pipeline would be a major problem in all terrain units in the study area except gravel deposits and bedrock (Rutter et al., 1973).

F.2.3.8 Other types of terrain that would likely cause erosion problems during pipeline construction include: (i) slopes marked by parallel drainage and vegetation patterns such as those shown in Fig. C-21 (Crampton, 1973; Hughes et al., 1973); (ii) fine textured alluvial fans; and (iii) areas of fine textured lake bottom sediments with surface drainage (Hughes et al., 1973).

F.2.3.9 Maintaining water quality during the construction phase would be of more concern than air quality. The most likely causes of disturbance by proposed pipelines in lakes, streams and rivers would be: (i) siltation; (ii) loss of gravel spawning beds; (iii) loss of fish rearing habitats; (iv) blockage of fish migration routes; and (v) possible contamination by oil spills or the release of chemicals (Brunskill et al., 1973; Bryan, 1973; Stein et al., 1973).

F.2.3.10 As outlined in paragraph C.9.2.6, critical areas for the fish resource would be sections of rivers that remain unfrozen throughout the winter (Bryan, 1973). Groundwater flow is particularly important because it enables sections of some streams to maintain conditions suitable for overwintering of fish. Therefore, any disruption of it as a result of construction activities could be of major importance to fish resources.

F.2.3.11 As pointed out in paragraph F.2.2.11, most expected wildlife implications could be avoided by appropriate route selection; timing of construction activities would also be very important. A separate report of the Environmental-Social Program discusses the expected effects of proposed pipeline construction on wildlife (Watson et al., 1973), and these implications are summarized in Fig. F-4. In this figure estimates of 'duration' and 'magnitude' are based on an assessment of what might happen under the *worst* conditions. Actually, most construction would have a variety of effects, some of which could be beneficial under certain circumstances. Examples of these are provided in section F.2.6 where interrelationships of predicted side effects are discussed. The anticipated wildlife implications presented in Fig. F-4 assume construction of a *gas* pipeline. Most would also apply to an *oil* pipeline, but the implications of oil spills would be of additional concern.

Figure F-4 Potential Effects on Wildlife of Proposed Mackenzie Valley Gas Pipeline Construction Activities

Construction Activity	Potential Effect	Species Affected	Magnitude	Duration
Habitat Destruction or Loss				
Pipeline right of way	Destruction of habitat	Sheep	Severe	Short
		Moose	Light	Short
Buried refrigerated gas lines	Changes in aquatic thermal regime	Beaver	Variable	—
		Muskrat	Variable	—
		Waterfowl	Moderate	Long
Camp locations	Loss of habitat	Moose	Light	Long
		Raptors	Severe	Short
Borrow pit construction	Loss of habitat	Bear	Light	Long
		Fox	Light	Long
		Sheep	Light	Long
Removal of sand and gravel along water bodies and streams	Removal of riparian vegetation	Beaver	Variable	—
		Muskrat	Variable	—
		Waterfowl	Severe	Long
		Moose	Severe	Long
	Sedimentation	Muskrat	Light	Short
Removal of coastal sand bars	Loss of habitat	Waterfowl	Severe	Long
Stream crossings	Changes in sediment loads and introduction of erosion of stream banks;	Beaver	Moderate	Long
		Muskrat	Moderate	Long
		Waterfowl	Moderate	Moderate
	Drainage of adjacent ponds	Muskrat	Severe	Long
		Waterfowl	Severe	Long
Berms and road grades	Obstruction and/or redirection of normal surface and sub-surface water flows;	Beaver	Variable	—
		Muskrat	Variable	—
		Waterfowl	Moderate	Long
	Changes in sediment loads	Beaver	Variable	—
		Muskrat	Variable	—
		Waterfowl	Severe	Long
Ditching	Changes in normal surface and subsurface water flow	Beaver	Variable	—
		Muskrat	Variable	—
		Waterfowl	Severe	Long
Increased fires	Loss of habitat	Beaver	Moderate	Moderate
		Waterfowl	Moderate	Short
		Caribou	Severe	Long
		Moose	Severe	Short
Use of all-terrain vehicles	Terrain damage	Caribou	Light	Long
Disruption of Normal Behaviour Patterns				
Berms and road grades	Creation of travel lanes that change normal direction of movement; possible erosional damage to berm from trampling; Creation of snowdrifts that obstruct movement	Caribou	Moderate	Long
		Moose	Light	Long

Figure F-4 Potential Effects on Wildlife of Proposed Mackenzie Valley Gas Pipeline Construction Activities *(concluded)*

Construction Activity	Potential Effect	Species Affected	Magnitude	Duration
Borrow pit construction	Activity, blasting noise	Bear	Light	Short
		Sheep	Moderate	Moderate
		Waterfowl	Moderate	Short
		Caribou	Moderate	Short
		Moose	Light	Short
		Raptors	Severe	Moderate
Ditching	Open ditch during construction	Caribou	Severe	Short
		Moose	Light	Short
Reclamation procedures	Attract animals to areas where they are more vulnerable and away from traditional habitat	Moose	Light	Long
Operation of engine driven equipment	Noise	Beaver	Light	Short
		Muskrat	Light	Short
		Sheep	Severe	Short
		Waterfowl	Severe	Short
		Caribou	Moderate	Short
		Raptors	Severe	Short
Garbage and sewage disposal	Attraction of animals	Bear	Severe	Moderate
		Fox	Moderate	Short
Increased Human Activity				
Aircraft support	Aerial harassment	Bear	Moderate	Short
		Sheep	Severe	Moderate
		Waterfowl	Severe	Short
		Caribou	Severe	Moderate
		Moose	Moderate	Short
Use of all-terrain vehicles	Harassment	Bear	Moderate	Short
		Fox	Light	Short
		Sheep	Severe	Moderate
		Waterfowl	Moderate	Short
		Caribou	Severe	Short
		Moose	Light	Short
Construction camp activity	Disturbance due to human presence	Sheep	Moderate	Short
		Caribou	Light	Short
		Moose	Light	Short
		Raptors	Severe	Long
Roads, trails, air strips	Increased hunting and trapping (variable with all species depending on the regulatory control of harvest)	Beaver	Variable	—
		Muskrat	Variable	—
		Bear	Severe	Long
		Fox	Moderate	Moderate
		Sheep	Severe	Moderate
		Waterfowl	Light	Short
		Caribou	Moderate	Moderate
		Moose	Moderate	Moderate
		Raptors	Severe	Long
Introduction of pollutants, fuels, oils, toxic chemicals	Direct and indirect poisoning	Beaver	Moderate	Short
		Muskrat	Severe	Short
		Waterfowl	Severe	Short
		Raptors	Severe	Long

Watson et al., 1973, Table 1, Appendix II

F.2.3.12 Several recent studies have stressed that aircraft can create significant disturbance for wildlife (Environment Protection Board, 1973*b*; Watson et al., 1973). The increasing presence of aircraft would have to be controlled as carefully as the movement and use of any other type of machinery brought into the North. Although altitude restrictions would eliminate most directly harmful effects on wildlife, the possibility of long term effects can not be discounted. For example, studies indicate that female caribou, which normally will not leave their calves except under extreme harassment, may abandon them if disturbed by aircraft immediately after birth (before they are dry or have had time to nurse). Late winter, when the caribou's strength is lowest, and midsummer, the time of maximum stress from insects and heat, are also critical times for disturbance (Environment Protection Board, 1973*b*).

F.2.3.13 The use of insecticides could have special implications for wildlife if construction was not restricted to the winter. Accumulation of insecticide residues in their food chains would threaten the breeding success of peregrine falcons; the bald eagle could also be seriously affected.

F.2.3.14 In summary, construction of any proposed northern pipeline would have some unavoidable environmental implications. Some of these would also be unpredictable because engineering design is commonly developed as a pipeline is built and as different conditions are encountered. A main source of localized environmental implications could result from the common practice of altering the design to meet unexpected conditions. The development of untried techniques to fit localized problems might have side effects that could not be anticipated from any advance studies or from existing pipelines in other climatic regions.

F.2.4 *Major Environmental Implications – Pipeline Operation*

F.2.4.1 The implications of thaw depressions, which are discussed in paragraphs C.4.3.4, C.5.18 and C.6.4, are great because the pipe might not withstand the forces exerted by depressions occurring near the installed pipeline (Environmental Protection Board, 1973*a*). For example, tests related to the proposed Alaska oil pipeline indicated that a 100 foot span of pipe wrinkled when there was one foot of differential settlement, but the span ruptured only when there was at least eight feet of differential settlement (Pietsch et al., 1973).

F.2.4.2 The expansion of man's activities in the North has increased the incidence of fire. Therefore, fires would probably occur more frequently during pipeline operation than at present. Paragraph C.7.18 describes the chain of events by which fires might lead to subsidence, development of wet depressions, gullying or landslides. Under these circumstances the effects of fires on the terrain could be especially significant when attempting to maintain the stability of man made structures.

F.2.4.3 Problems relating to erosion would probably be less intense during the operation phase of a northern pipeline than during construction. Revegetation and stabilization of the buried trench would gradually reduce the contribution of a pipeline to sedimentation. Natural erosive forces, however, could continue to threaten pipeline facilities either through the processes mentioned in paragraph F.2.4.2 above, or through erosion at river crossing sites. For example, ice jams are critically important to man made facilities located at river crossings because ice gouging and greatly increased water flows when ice jams break up, have the potential for river bed erosion (paragraph C.5.10).

F.2.4.4 The long term effects of oil spills on land are not yet documented for the Mackenzie valley (Hutchinson and Hellebust, 1973). In the short term, oil spilled on soils near the Mackenzie delta apparently had a stimulating effect on activity of soil micro-organisms (Parkinson, 1973). The decomposition of crude oil in northern soils could perhaps be accelerated by applying specific bacteria and urea-phosphate fertilizers to the soil. In addition, questions regarding areas that have been burned over remain unanswered. Use of burning to clean up oil spills might destroy the micro-organisms capable of utilizing oil in the process, then ways of re-establishing these organisms would have to be investigated (Cook and Westlake, 1973). The major problems associated with winter oil spills in the North might be avoided if contingency plans were to take advantage of the fact that snow is an effective oil absorbent. Any winter oil spills would create an oil-snow-ice mixture that, with proper disposal equipment, could be contained, moved and disposed of before there was widespread oil contamination during spring melting (Mackay et al., 1974).

F.2.4.5 It was suggested in paragraph F.2.2.8 that the best time for avoiding areas that might be susceptible to air pollution and ice fog was during route selection. In addition to causing abnormal sound effects, poor visibility and bending of radar beams, inversion conditions (described in paragraph C.2.2.2) also trap emissions such as vehicle exhaust causing localized air pollution problems (Burns, 1973). For example, the formation of ice fog due to burning of fuels would be unavoidable in weather colder than -40°C (-40°F). A typical incinerator operating at this temperature for two hours could create an ice fog cloud 500 metres (1,600 feet) in diameter. Little or no ice fog would be expected to form at temperatures warmer than -30°C (-22°F) (Csanady and Wigley, 1973).

F.2.4.6 The main implications of pipeline operation for such wildlife species as moose, Dall sheep, arctic fox and certain waterfowl, would result from the use of pipeline related roads and airstrips, combined with the increased use of all-terrain vehicles and aircraft. This would lead to increased hunting pressure, particularly on moose. The summary of expected effects on wildlife as a result of proposed pipeline construction shown in Fig. F-4, would also apply during the operations phase.

F.2.4.7 The slow growth rates of arctic aquatic systems, described in paragraph C.9.1.6, introduce a vulnerability to man's activities. If a lake full of arctic char or lake trout is 'fished out' in a season or two, it would take many years for the population to return to its former level (Dunbar, 1973). This is indicative of the major, long term expected implications of northern pipelines on renewable freshwater resources.

F.2.5 *Interrelationships of Predicted Side Effects During Pipeline Route Selection*

F.2.5.1 Most of the major side effects outlined in section F.2.2 are based on the viewpoint of one particular scientific discipline. In addition to the interpretations and conclusions of specialists, assessment of a pipeline application would require an understanding of the interrelationships of various predicted side effects. Biological and engineering considerations often provide interpretations that would need to be balanced one against the other during decision making. This section provides examples of environmental concerns that would have to be considered from the vantage point of several different disciplines. Many additional examples would become evident if the detailed reports identified in Appendix II were used in assessing a pipeline application.

F.2.5.2 It is suggested in paragraphs F.2.2.1, F.2.2.2, F.2.2.12 and F.2.3.3 that some construction problems could be avoided or minimized if certain areas of difficult terrain were bypassed in the process of pipeline route selection. However, another objective is to keep the route alignment reasonably straight, since this is one way of reducing overall surface disturbance. Because of the irregular distribution of various terrain units in the study area, it would not be possible to select a route that would always stay on the most suitable terrain. Therefore, a balance would have to be struck between maintaining a reasonably straight alignment and avoiding the most difficult kinds of terrain (Hughes et al., 1973).

F.2.5.3 Paragraph F.2.2.10 presents one example where engineering and terrain criteria would lead to the conclusion that tributaries on the east side of the Mackenzie River would provide better crossing sites than west side tributaries, while an opposite conclusion could be advanced on the basis of biological criteria. Another example centres around the question of whether it would be better to cross a tributary near its mouth or farther upstream. Sufficient quantities of sediment could kill fish immediately downstream from the source of added sediment; and newly settled sediment could kill both fish eggs and food organisms eaten by fish (Bryan, 1973). If the amount of suspended sediments was increased, headwaters of streams with their normally clear water and clean rocky beds, would suffer a greater reduction in quantity of the fish food organisms than would lower sections. Lower sections, even when clear, are areas of sediment deposition, and the species living there are already adapted to certain levels of disturbance. As a result, increased suspended sediment in the lower sections of a river would have a less pronounced effect than in the upper sections (Brunskill et al., 1973). However, the biological desirability of pipeline crossings in the lower reaches of Mackenzie River tributaries would have to be balanced against the relatively higher potential for erosion where these tributaries are incised into ice rich sediments of former glacial lakes (Hughes et al., 1973).

F.2.5.4 Continuing with this example, there are other relationships that would have to be considered. Outlets of Mackenzie River tributaries are biologically important. First, large numbers of migratory waterfowl use these tributaries following spring breakup because these junctions provide open waters early and are likely to have a richer food supply than the main river (Watson et al., 1973). Secondly, river mouths are very important feeding and rearing areas for fish (Stein et al., 1973). For these reasons, plus the terrain considerations outlined above, the consensus might be not to cross near the mouths of Mackenzie River tributaries. Conversely, the aquatic biology viewpoint is that stream crossings should be close enough to the mouths of tributaries to ensure that drifting organisms from the headwaters could recolonize any disturbed areas (Brunskill et al., 1973). There would obviously be no 'correct' answer that would apply to all streams. In general the most suitable solution might be to place the crossing site far enough upstream to permit containment of any oil spill and to recognize the terrain, wildlife and fishery considerations mentioned above, but far enough below the headwaters to ensure recolonization by drifting organisms after any stream bed disturbance at the crossing site.

F.2.5.5 Another example of interrelationships between expected side effects can also be drawn from fisheries and terrain viewpoints. Examination of the two northern Yukon pipeline route alternatives strictly from a fisheries' point of view, indicates that more fish spawning and rearing areas would be affected by a pipeline in the Porcupine drainage than in the Beaufort Sea drainage. In part, this is because most char and grayling spawning and wintering areas lie upstream of the prospective pipeline route in the Beaufort drainage. In contrast, spawning and wintering habitats of many species lie downstream of the proposed Porcupine route (Bryan, 1973). However, the following terrain features would have to be considered in evaluating the environmental concerns related to the alternative northern Yukon routes. The Porcupine route would follow a broad interstream divide from the west bank of the Peel River to the crest of the Richardson Mountains, and from the Driftwood River to the Alaska border. Selection of a route along broad interstream divides would minimize potential erosion and siltation. There would be few major stream crossings in the Porcupine drainage alternative and only the Bell River would present major erosion hazards. Subject to confirmation by geotechnical studies, burial of oil or gas pipelines appears possible in substantial parts of this route alternative. In contrast, the proposed routing in the Beaufort drainage would lie across the entire length of the drainage pattern and there would be numerous stream crossings. Many of the streams have braided channels that would present problems due to scour at stream crossings. Terrain conditions along the Beaufort drainage are such that burial of a warm pipeline would not be recommended except at certain localized intervals (Rampton, 1974). In summary, assuming the worst case, *possible* damage to the fish resource might be greater in the Porcupine drainage than in the Beaufort Sea drainage, but the *probable* damage could be the reverse.

F.2.5.6 The examples of interrelationships outlined above are quite apart from the concerns of the people who either live near various route alternatives or traditionally utilize particular river mouths as domestic fishing areas. These aspects of resource use in relation to expected environmental side effects are discussed in socio-economic sections of this chapter.

F.2.5.7 There is little agricultural potential in the Mackenzie valley and northern Yukon in comparison to southern Canada. None of the areas that might have local agricultural potential would be crossed by currently proposed pipeline routes.

F.2.5.8 Several ecological reserves have been proposed within the study area under the sponsorship of the International Biological Programme and currently proposed pipeline routes would pass close to some of them. (Locations of the proposed reserves are shown in Fig. E-13.) However, these reserves could be located and zoned so that facilities such as proposed pipelines could pass through some portion, allowing them to serve as outdoor laboratories for long term assessment of environmental and resource use implications of man made facilities.

F.2.6 *Interrelationships of Predicted Side Effects During Pipeline Construction*

F.2.6.1 The Mackenzie delta is an excellent example of complex interrelationships (Fig. C-11). This delta must be considered a special case because of its distinctive geological, hydrological and biological features and because of the existing concern in relation to oil spills. The main source of difficulties for any pipeline crossing the delta would be the active nature of its environment. Channel and lake bank erosion, river bed erosion in channels, ice jams and flooding are all normal events in the delta and they would all pose special problems in relation to pipeline construction. The interaction of these events with existing permafrost conditions could further complicate the situation. Pipeline construction would probably lead to increased use of delta channels by boats, and to construction of landing facilities for these boats, and of aircraft landing sites on the delta's surface. The channel banks and the high, occasionally flooded portions of the delta's surface are the most likely areas to be affected by such construction. Pollutants of all kinds would have to be carefully controlled because no part of the delta is far from a channel or lake and all parts of its surface are subject to flooding.

F.2.6.2 *Alluvial fans* are characterized by major shifts of drainage from one channel to another during flood periods. Concentration of drainage into a single channel would increase the force of a stream producing channel erosion. If multiple channel crossings were to be avoided when passing over alluvial fans, the crossing would have to be located at the head of the fan above any fork in the stream. However, the advantages of such a crossing would have to be balanced against the fact that channel scouring would be at a maximum (Hughes et al., 1973).

F.2.6.3 One factor complicating the prediction of side effects of pipeline construction is the degree to which new disturbances would interact with existing ones. For example, movement of pipe and other construction materials from barge landing sites to points along the proposed right of way could create a demand to use existing winter roads or seismic lines. This could result in considerable surface disturbance because of the repeated use of old roads or seismic lines that are in the process of stabilizing. This is particularly true where soils are wet and the recolonizing vegetation is composed of species that would not tolerate disturbance. In these cases, a second round of disturbance would cause severe damage to the terrain (Strang, 1973). As another example, proposed pipeline construction would place further demands on gravel and sand deposits in the North, in addition to those for the construction of roads and other facilities. Particularly in the Tuktoyaktuk-Mackenzie delta-Yukon north coast region, deposits of sand and gravel, actively forming in shoreline areas, would be in demand for construction materials. In coastal areas, cutting into a spit could set up an instability that would destroy it, and natural gravel replacement by longshore currents would be insufficient to repair certain spits and beaches (McDonald and Lewis, 1973).

F.2.6.4 From a biological point of view, the lakes and streams that drain small watersheds would probably experience greater changes in the aquatic organisms as a result of a given amount of unusual siltation (produced by a disturbance such as pipeline construction) than would larger watersheds. The changes resulting from disturbance on a small watershed would have a greater chance of being biologically irreversible than on a large watershed; and similar disturbances on large watersheds would likely be of short duration (Brunskill et al., 1973). Superimposed on this relationship are the findings of the terrain studies, carried out under the Environmental-Social Program, which indicate that landscape units differ greatly in potential erosion and silt production (Crampton, 1973; Hughes et al., 1973; Rutter et al., 1973; Zoltai and Pettapiece, 1974). Therefore, when comparing one watershed to another, any predictions of side effects related to stream erosion or siltation that are normally considered area dependent, would also have to consider the natural variations in surficial materials.

F.2.6.5 In addition to the risks of oil spills discussed in paragraph F.2.4.4, each proposed pipeline construction camp of 500-700 men would produce between two and three tons of solid wastes per day and 40-50 gallons of liquid wastes per person per day. Construction camps of this size would be located every 60 to 100 miles along the proposed route (Grainge et al., 1973). Problems related to waste disposal could be avoided by carefully designed facilities provided there is recognition of the large amount of wastes that would be produced. The waste disposal question is another example of the interrelationship between a technical problem and other aspects of resource use and management in the North. For example, studies carried out under the Environmental-Social Program indicate that much of the wastes produced in pipeline construction camps could be disposed of in ways that are environmentally beneficial, that is either as an insulating cover to reduce melting of ground ice or as a nutrient source for vegetation. Each specific case would require its own waste management plan, but the broad objective would be to encourage utilization of waste materials in the North. Recommendations for achieving this objective are provided in other reports of the Environmental-Social Program (Grainge et al., 1973; Hartland-Rowe, 1973).

F.2.6.6 It was pointed out in paragraph F.2.3.11 that construction activities could either be detrimental to wildlife or beneficial to it. (The detrimental side effects are summarized in Fig. F-4.) Predicted beneficial side effects might include: (i) creation of water bodies by obstruction of drainage or by excavation of borrow pits, which could provide satisfactory waterfowl and muskrat habitat if properly managed; (ii) under certain circumstances, sedimentation which is known to enhance lakes and estuaries, could create deltas that would be used extensively as waterfowl and muskrat habitat; and (iii) forest fires which are beneficial to moose over the long term and which, in fact, may be the major reason for their widespread occurrence in the North.

F.2.6.7 The important relationship between groundwater discharge, open water areas in winter, and overwintering areas for fish, outlined in paragraphs C.9.2.6 and F.2.3.10, illustrates how disruption of one factor such as groundwater could lead to an entirely unexpected chain of events. Subtle *secondary* and *tertiary* environmental side effects might arise some distance from the *primary disturbance* and after a considerable period of time has elapsed.

F.2.6.8 Any attempt to reduce adverse side effects by concentrating construction activities into a specific time period or season would have to weigh recommendations from all specialized investigations. Past experiences of northern exploration and construction crews, plus the terrain studies discussed in this report, emphasize the value of a winter concentration of activities that would otherwise cause surface damage. Similarly, other studies under the Environmental-Social Program have shown that disruption of behavioral patterns of most wildlife species would be lessened if construction were limited to the period from November 15 to April 15 (Watson et al., 1973). The periods, May 15 to June 30 and September 15 to November 15, are when the fish resources in the Mackenzie valley are considered biologically sensitive to disturbances that would accompany proposed pipeline construction. For instance, spawning and migration of major fish species occur during these periods. In summary, a winter construction period seems best from all viewpoints. However, *winter* disturbances might also be significant in special situations. There is evidence of considerable biological activity during the winter by algae under the ice and by bottom dwelling organisms in delta lakes and channels. Aquatic organisms in delta channels can tolerate large amounts of silt during the flood stage, but the effects of siltation in their environment during the winter are not known. Therefore, winter disturbances to delta water areas would have to be minimized in the interests of protecting aquatic organisms, some of which provide food for fish, (Brunskill et al., 1973).

F.2.6.9 If one objective during proposed pipeline construction was to keep the levels of suspended sedimentation below biological tolerance limits during the most critical time periods (paragraph C.9.1.3), then the problem would have to be examined from both biological and geological points of view. The most critical time, from a biological point of view, would be during low flow conditions from July through September (Brunskill et al., 1973). Thus the crossing of streams when flow is low and the biologically harmful effects of additional suspended sediment is at a maximum is to be avoided. From a geological point of view, however, it would be preferable to cross streams during low flow conditions because channels could then be returned to a nearly natural state without interferring with major flow events. In addition, the *area* influenced by the increased sediment load would be minimized in the autumn because the capacity of the low flow to move sediment would be reduced (McDonald and Lewis, 1973).

F.2.7 *Interrelationships of Predicted Side Effects During Pipeline Operation*

F.2.7.1 The possibility of oil spills in the vicinity of the Mackenzie delta provides the best example of complex interrelationships involving interpretations from different disciplines. Quite apart from the delta itself, the effects of any oil spill would be extended into the adjoining areas of the Beaufort Sea by the enormous flow of the Mackenzie River. This does not mean that oil spilled on the delta would be flushed away quickly. If oil entered the delta at any time of year, some of it would probably be trapped there for an indefinite period of time (Lewis, C.P., 1973, personal communication). Flow into the delta lakes occurs during spring flooding and may also occur at any time throughout the summer. Oil carried into these lakes, would not escape entirely during periods of outflow. Also, large proportions of the delta may be inundated during spring flooding and any oil contained in these floodwaters would be spread over a large area. The flow in delta channels in winter can be altered greatly by the formation and development of ice cover (Anderson and Mackay, 1973); therefore it would be difficult to forecast the path pollutants might take if they were mixed with the water.

F.2.7.2 Concern over oil spills in the Mackenzie delta arises, in part, from the feeling that if both an oil and gas pipeline were constructed in the Mackenzie valley and northern Yukon, they would be located fairly close to each other since detailed information would already be available on the route of the 'first' pipeline. If this were to happen, it would be important to consider the relationship of currently proposed routes to the Mackenzie delta. For example, the currently proposed gas pipeline route crosses the Peel River downstream of Fort McPherson, not far from the delta; parallel routing of any future oil pipeline could be questioned because of the possibility of oil spills so close to the delta.

F.2.7.3 The long term operation of a northern pipeline would add to the permanent population of settlements serving as maintenance centres. There would be increasing pressure on the land surrounding these settlements which would serve as waste disposal sites. As an example, measurements of the effects of sewage released into unfrozen fens at Hay River indicated that sewage from one man for one year exerted a measurable adverse effect on about 40 square metres (430 square feet) of this wetland. It was also indicated that such unfrozen wetlands could serve as efficient secondary and tertiary sewage treatment sites. However, after four years of using the Hay River testing area, it is not known whether this wetland is in stable equilibrium and can continue to serve as a filter for sewage at the same rate as during the first four years of its use (Hartland-Rowe, 1973). There are arguments against waste disposal as a sustainable 'use' of streams and lakes in the Arctic, particularly because of the relatively slower rate of biological breakdown of waste materials and the associated risks to human health (Greenwood and Murphy, 1972).

F.2.7.4 Any pipeline construction camps and any longer term operations facilities requiring a substantial year round water supply might face problems in some areas because many small streams have very low discharge in late summer, fall and winter (Brunskill et al., 1973). These problems could be avoided if the facilities were located near large rivers. In many parts of the study area, the best supply of good quality year round groundwater is found in alluvial deposits paralleling the large rivers. In the long term these alluvial deposits would have to be developed as water supply areas; and industrial activities would have to be designed to avoid conflicting with these potentially important groundwater sources.

F.2.7.5 The presence of one or more major pipelines would alter existing land use patterns in the Mackenzie valley and the northern Yukon. The main categories of expected alterations include: (i) production of resources such as timber or minerals would become economical due to expanded transportation facilities or readily available energy sources; (ii) increased resident and transient populations would create greater pressures on recreational lands, and wildlife and fish populations; (iii) increased demand for land to meet residential, business and administrative needs would exist in certain communities (section F.3.9); and (iv) increased land and resource use requirements involving airfields, roads, water supply, garbage and sewage disposal, and gravel would occur. Although they are not inevitable, some resource use conflicts would probably result.

F.2.7.6 The setting of land use priorities and zoning would be a major objective. In particular, it might be necessary to allocate such resources as gravel, and to weigh the value of a gravel plain as a site for an airstrip, or as a source of material for various construction purposes. As an example, the airport and village at Wrigley occupy a large part of a gravel area in a region of scarce gravel; Inuvik is also partially built on gravel and nearby supplies are almost exhausted (Hughes, O.L., 1973, personal communication).

F.2.7.7 These land use planning considerations could be augmented by the following sources of information compiled under the Environmental-Social Program: (i) maps of surficial materials including information on vegetation, soils and drainage (Hughes et al., 1973); (ii) maps of terrain sensitivity (Kurfurst, 1973); (iii) maps of surface susceptibility to disturbance (Crampton, 1973; Zoltai and Pettapiece, 1974); (iv) maps of wildlife habitat and caribou migration routes (Watson et al., 1973); (v) maps of current vegetation (Forest Management Institute, 1974); and (vi) maps of current land use (de Belle et al., 1972).

F.2.7.8 Because the forest resources in the Mackenzie valley and northern Yukon are limited compared to southern Canada (paragraph E.3.1), any increased demand for wood products as a result of pipeline development would be of relatively great importance on a local scale. For example, in communities such as Fort Simpson, Wrigley, Arctic Red River and Fort McPherson, local timber resources might come under pressure from competing demands (Forest Management Institute, 1974).

F.2.7.9 Fire suppression priorities are not uniform throughout the study area. For example, in remote areas where protection of life and property are not required, a general aim is to limit fire damage to a level believed to have existed for thousands of years. In contrast, a much higher fire suppression priority is applied to areas around settlements (INA, 1973). Pipeline operation might lead to localized concentrations of human activity around maintenance centres and compressor or pumping stations. As a result, new areas might warrant a fire suppression priority comparable to that now provided for areas around settlements. In addition to the fire related terrain stability questions discussed in paragraphs C.7.18 and F.2.4.2, fire has important but imperfectly understood effects on wildlife habitat. For example, fire can improve moose habitat by increasing the abundance of shrubs; conversely, it can reduce the amount of caribou forage by eliminating lichen woodland (Watson et al., 1973; Forest Management Institute, 1974).

F.2.7.10 Operation of a pipeline would result in several other direct requirements for land. In addition to the actual pipeline right of way, which might be 120 feet wide for roughly the entire length of the Mackenzie valley and across the northern Yukon, land would be required for various permanent installations to operate the pipeline. These would include: (i) compressor station sites, occupying four or five acres (there would be about 21 compressor station sites in the Mackenzie valley and northern Yukon; an oil pipeline would require a similar number of sites for pumping stations); (ii) land for the gathering systems of smaller diameter pipelines; (iii) sites for such related facilities as airstrips, access roads, and storage areas; and (iv) land in or adjacent to communities for residential and commercial development, and for port and dock facilities. The demand for waterfront development is expected to be particularly important in such communities as Hay River and Inuvik (Figs. F-13 and F-15). The expected increase in recreational land use would also create a demand for waterfront space for such commercial developments as fishing camps, parks, campground sites, or motels.

F.2.7.11 Proposed northern pipelines could also have interrelationships with possible hydro electric developments. The power required to service pipelines could probably be produced from potential hydro electric developments on rivers such as the Great Bear (Fig. E-8) and the Kakisa. The development of these sites could affect fish and wildlife populations and could result in loss of land due to flooding. On the other hand, development could provide relatively low cost power for local consumption.

F.2.7.12 The expansion of the Mackenzie River water transportation system that would be needed to service the proposed pipeline and all the related facilities, would create demands for additional channel dredging and shoreline and harbor site improvements.

F.2.7.13 One of the most difficult things to predict is the *cumulative* effect of the various side effects that are generally viewed in isolation. No matter how much care might be taken during pipeline construction and operation, the overall environmental and resource use effects would be determined largely by the *total* development of roads, borrow pits, feeder lines, and drill sites. There has therefore been much discussion of a 'corridor' through the Mackenzie valley. There is no clearly defined 'best' width for a corridor to contain these various facilities. However, it is generally agreed that a narrow corridor, only several hundred feet in width, would be best for maintaining relatively undisturbed conditions over the greatest possible area. Conversely, in some cases a narrow corridor could force the various facilities too close to each other. For example, a road could disrupt natural drainage patterns and create new ponds which, in turn, could trigger melting of ground ice. This melting could lead to subsidence around a nearby pipeline or related facilities. Similarly, roads greatly increase the presence of man and the accompanying risk of man made fires. Therefore, it would be preferable if various man made facilities were *not* forced into a narrow corridor in terrain that tends to be unstable after fire has destroyed the vegetation cover. Difficulties could also arise if all facilities were located in a specific corridor, since the preferred route for pipelines might, for example, be unacceptable for a highway with its more restrictive grade limitations. As a final example, a specific river crossing might be acceptable for a highway or a gas pipeline but not for an oil pipeline, with the greater environmental threat in the event of a pipeline rupture. These illustrate the kinds of relationships to be considered before making a firm decision in favor of either a narrow or a wide corridor in a given area. In summary, the *assessment* of proposed pipelines *must not view pipelines in isolation*; they must be considered in the context of nearby facilities that either exist or are being proposed.

F.2.8 *Summary of Environmental and Resource Use Implications*

F.2.8.1 The main environmental and resource use implications reported from studies carried out under the Environmental-Social Program are summarized in sections F.2.2 through F.2.4. These main points, plus others that raise important technical issues,

Figure F-5 Summary of Predicted Environmental and Resource Use Side Effects on Wildlife of Proposed Pipelines, Mackenzie Valley and Northern Yukon

Expected Side Effect	Duration		Control		Distribution		Paragraph Reference in Chapter F
	Short	Long	Avoidable	Unavoidable	Local	General	
1. Creation of unstable slopes		X	X		X		F.2.2.1; F.2.3.2; F.2.3.3; F.2.3.8
2. Channeling of drainage, gullying		X	X		X		F.2.2.1; F.2.3.6; F.2.3.7
3. Thermal erosion, subsidence		X	X		X		F.2.2.1; F.2.2.2; F.2.3.2; F.2.3.6; F.2.4.1; F.2.6.3
4. Ponding of surface water		X	X		X		F.2.3.1; F.2.3.5; F.2.7.13
5. Siltation of streams	X			X		X	F.2.2.10; F.2.3.9; F.2.5.3; F.2.5.4; F.2.6.4
6. Oil spills		X	X		X		F.2.2.9; F.2.3.9; F.2.4.4; F.2.7.1; F.2.7.2; F.2.7.13
7. Addition of solid and liquid wastes, chemical contamination		X	X		X		F.2.3.9; F.2.3.13; F.2.6.1; F.2.6.5; F.2.7.3
8. Addition of air pollutants	X		X		X		F.2.2.8; F.2.4.5
9. Ice fog formation	X			X	X		F.2.2.8; F.2.4.5
10. Loss of fish habitat, reduced water quality	X		X		X		F.2.2.10; F.2.3.9; F.2.3.10; F.2.5.3; F.2.5.4; F.2.5.5; F.2.6.4; F.2.6.7
11. Blocking of fish migrations	X		X		X		F.2.3.9; F.2.6.9
12. Loss of wildlife habitat		X		X	X		F.2.2.7; F.2.2.11; F.2.3.11; F.2.3.12
13. Disruption of wildlife behavior patterns	X		X		X		F.2.2.11; F.2.3.11; F.2.3.12; F.2.6.8
14. Harassment of wildlife	X		X		X		F.2.2.11; F.2.3.11; F.2.3.12
15. Increased hunting and fishing pressure		X		X		X	F.2.2.11; F.2.3.11; F.2.3.12; F.2.4.6; F.2.4.7
16. Increased incidence of fire		X		X		X	F.2.4.2; F.2.7.9
17. Increased demand on water supplies	X			X	X		F.2.7.4
18. Use of land for pipeline facilities and its withdrawal from other resource uses		X		X	X		F.2.6.3; F.2.7.5; F.2.7.8; F.2.7.10; F.2.7.11
19. Increased demand for support activities that have environmental side effects		X		X	X		F.2.7.10; F.2.7.12; F.2.7.13

have been re-examined in sections F.2.5 through F.2.7. They reflect the diverse findings or viewpoints to be considered during any assessment of the environmental and resource use implications of proposed northern pipelines. This section further condenses the main points into a summary table (Fig. F-5), which also contains estimates of duration, avoidability and distribution of the predicted side effects.

F.2.8.2 The ratings of *short* versus *long term, avoidable* versus *unavoidable*, and *local* versus *general* are mainly a synthesis of opinions contained in a number of the more detailed reports. The summary of predicted environmental and resource use side effects in Fig. F-5 provides paragraph references to discussions of the main wildlife concerns. Those wishing more detailed information on these areas are referred to other published reports of the Environmental-Social Program listed in Appendix II.

F.2.8.3 The following arbitrary definitions were applied in Fig. F-5:

Short term – no longer than the period of proposed pipeline construction (three years or less);

Long term – extending beyond the period of proposed pipeline construction (more than three years);

Avoidable – predicted side effects avoidable by appropriate routing or construction methods and timing;

Unavoidable – predicted side effects inevitable if project proceeds;

Local – predicted side effects ranging from specifically localized (e.g. the Mackenzie delta) to regional (e.g. the northern Yukon or the Discontinuous Permafrost Zone);

General – predicted side effects applicable throughout the study area.

F.3 Local Social and Economic Implications

F.3.1 *Introduction*

F.3.1.1 When considering the implications of the proposed gas pipeline for the people in the study area, three facts bear repeating. First, the population is small and the communities, although scattered, are fairly close to the proposed pipeline routes. Second, the magnitude of the development and its buildup and decline would be dramatic; that is, the labour force employed at the height of construction would likely be four to five times the size of the present labour force in the area, and the main impact could occur within a five to six year period. Third, as a direct result of the first two points, the proposed development would produce significant socio-economic changes in communities within the study area which could have profound long term effects on all the people, and particularly the Natives.

F.3.1.2 This is not to say that socio-economic changes are a new phenomenon in the area or that the direction of the changes would be negative on balance. As elsewhere, the social system in the study area is dynamic. Unlike past situations, however, *all* socio-economic aspects would likely be affected, and the *rate* of change would probably increase. Therefore, the objectives of this section are: (i) to identify and assess the main socio-economic aspects that would be significantly affected by pipeline development; and (ii) to note those areas of community life where difficulties in adjusting to increased rates of change might occur.

F.3.1.3 The main effects of the proposed development on the people would be economic in nature — that is, it would mean changes in labour demand, incomes, training opportunities, etc. Marked changes in the institutional or organizational structure such as different arrangements for meeting education and health needs or discharging local government responsibilities are not anticipated, although they might be indirectly influenced by economic or social factors. The effects of the proposed development on native culture, life style and traditional pursuits would be very important; it is anticipated that native people would have to adjust to a considerable number of social and economic changes induced by the proposed development. The most likely areas of social adjustment are discussed in some detail as are those areas of native culture which would be influenced significantly. However, cultural influences are only discussed in general terms.

F.3.1.4 Related to the *extent* of change is the concern that the *rate* of change might provoke a state of shock, whereby some native people would be unable to cope with everyday situations. Since examples of 'cultural shock' occurring at a group level are exceedingly rare, a reasonable answer to this concern is that most people are very adaptable to change, if they understand and agree with the need for change and are involved in and benefit from it. It would be preferable if native groups favored the construction of a pipeline, and were fully involved in the employment and business opportunities stemming from the development. While they have recently expressed concerns regarding land claims (paragraph D.3.11), the sections that follow are based on the assumption that any differences would be resolved to the point where Natives would have a high rate of participation in the employment and income benefits resulting from the proposed pipeline.

F.3.2 *Pipeline Related Labour Demand*

F.3.2.1 Employment opportunities for territorial residents, the resultant increased incomes, and the anticipated rapid population growth are *directly* related to the demand for workers induced by the proposed pipeline development. In this section, the anticipated demand for workers *directly involved in pipeline development* and in possible *additional petroleum development* either within or adjacent to the study area are discussed.

F.3.2.2 Pipeline related labour demand would include *all activities* beginning with logistics buildup and construction preparations through to full capacity operation. As indicated in the table that follows, 65 per cent of the man years required between 1975 and 1983 would be related to mainline construction. Once this stage of development was completed the number of man years directly related to pipeline development would decline very rapidly, with only three per cent of the total man years required for work during the first years of the operation and maintenance phase.

Estimated Man Years of Pipeline Related Employment, 1975-83

Grouped Activities	Man Years	Per Cent of Total Man Years
	#	%
Mainline construction	17,164	65
Compressor station and facility construction	3,829	14
Operation of camps	2,827	11
Transportation and material handling	1,798	7
Operation and maintenance	770	3
Total	26,388	100

Manders, 1973

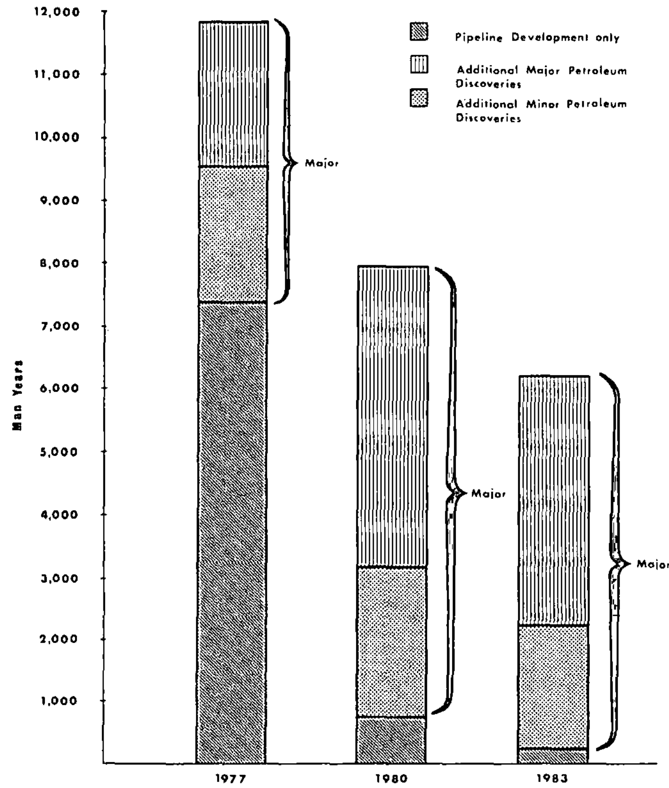
F.3.2.3 At this point an explanation concerning *man years of employment* on pipeline development work in the North is in order. In the following sections one man year is considered equivalent to 1,600 hours of employment in any occupation category during a single construction season (INA/MPS, 1973, V.1). It is recognized that this might be high for some activities and low for others, but it is considered a reasonable figure.

F.3.2.4 In addition, the term *profile year* merits explanation. It has been assumed that it would take nine years (1975-83) to move from logistics buildup to full capacity operation. Furthermore, the timing of the various phases has been arbitrarily designated as follows: 1975-76 — logistics buildup; the fall of 1976 to the summer of 1979 — the main construction phase with *1977* designated as the *profile year of mainline construction*; 1979-81 — construction of operation facilities would be completed, and *1980* is designated as the *buildup to capacity profile year;* and finally *1983* is designated as *capacity operation profile year*. The profile years would change if the development period were moved forward or backward, or if any phase were compressed or expanded.

F.3.2.5 The estimated man years of employment attributed to pipeline construction and operation activities, *plus* the additional employment that would be created by petroleum development activities, are only discussed for an average or typical year in each phase of development – that is for a *profile year* (Fig. F-6). Estimated pipeline related employment in a profile year consists of 20 main occupation groupings plus 16 of lesser importance which are classified as 'other occupations' (INA/MPS, 1974, V.6, pp. 2-22 to 2-24). Although it excludes a small number of highly skilled occupations, for all practical purposes this figure equals the total estimated demand. (For more details on the jobs created by pipeline and petroleum development see Table I, Appendix F.)

Figure F-6

Estimated Man Years of Employment, 1977, 1980, and 1983



SOURCE OF DATA:
Table I Appendix F

F.3.2.6 The figures in paragraph F.3.2.2 and in Fig. F-6 are the best estimates of labour demand available at the time of writing. Although these estimates are considered somewhat conservative, they are believed to be quite close to the proper proportions; those for employment related to transportation and handling of materials might be somewhat more conservative than for other activities.

F.3.2.7 Fig. F-6 illustrates the estimated average man years of employment required during the three phases of pipeline development. If the proposed development is examined in *isolation*, it is evident that the number of employment opportunities would decline very rapidly after the inital buildup. In 1977, the mainline construction profile year, there is expected to be a demand for 7,375 man years. This would probably decrease to about 746 man years in 1980, the buildup to capacity profile year; and to 222 in the capacity operations profile year, 1983 (Table IV, V and VI, Appendix F). If additional petroleum development occurred, and it is assumed that it would, this situation would be avoided or at least postponed.

F.3.2.8 In order to evaluate the effects of additional petroleum development on the demand for labour, two alternatives have been examined: (i) that *major reserves* of both oil and gas would be found in the Mackenzie delta by 1975 which would be "...sufficient to support both a large diameter gas pipe from the Delta to link with the Mackenzie Pipeline, and a large diameter oil pipe from the Delta to the South, to be built by 1980...": and (ii) that *minimum reserves* of oil and gas would be found by 1975 "...which would support similar but smaller pipes" (INA/MPS, 1973, V.1, p. 151).

F.3.2.9 Based on these assumptions, it is estimated that many man years of employment would be required for petroleum exploration and field development. If a *major discovery* were made, approximately 7,200 man years would be required in 1980, declining to about 6,000 in 1983. Assuming *minor discoveries*, about 2,400 man years would be required in 1980, with a decline to about 1,900 in 1983. These additonal requirements would compensate for much of the decline in pipeline related demand (Fig. F-6; Table I, Appendix F).

F.3.3 *Estimated Labour Supply Directly Related to Pipeline Development*

F.3.3.1 This discussion of labour supply in the northern territories is restricted to the segment of the labour force 15-64 years of age, either working or looking for work, and having training and/or work experience related to the demands of pipeline development. This is referred to as the *active labour force with pipeline related experience*. Those with petroleum development related skills have not been added on in order to avoid double counting since there would be considerable overlapping of skills. Section D.6.5 was concerned with the present and future size of the labour supply in the *study area*; the focus here is on the *two northern territories*.

F.3.3.2 It is estimated that the active labour force with pipeline related experience in the *two northern territories* would number: 10,484 in 1977; 12,029 in 1980; and 13,697 in 1983. Natives would account for approximately 27 per cent of the experienced labour force.

Estimated Active Experienced Labour Force

	Pipeline Construction Profile Year 1977	Buildup to Capacity Profile Year 1980	Capacity Operation Profile Year 1983
Native	2,977	3,363	3,762
Non-native	7,507	8,666	9,935
All Groups	*10,484*	*12,029*	*13,697*

Derived from Table II, Appendix F

F.3.3.3 However, it is likely that only a relatively small number of these northern men and women would actually be available for pipeline related employment. It is further assumed that Natives would become more receptive to wage employment and increasingly oriented towards it through exposure to the proposed pipeline and other large projects. Therefore, native participation in the later stages of pipeline development would likely be higher than during the construction phase. Based on these assumptions, the following estimates were made:

Estimated Available Experienced Labour Force

	Pipeline Construction Profile Year 1977	Buildup to Capacity Profile Year 1980	Capacity Operation Profile Year 1983
Native	675	877	962
Non-native	477	551	622
All Groups	*1,152*	*1,428*	*1,584*

Derived from Table III, Appendix F

F.3.3.4 If native participation in the labour force increased, the overall potential labour supply would be affected. In the forecast, jobs in the general labour categories would be filled to a considerable extent by territorial workers with *pipeline related skills*. If the labour pool for pipeline work were broadened to include *all unskilled northern workers* interested in employment, not just those with previous pipeline experience, the number of available workers, particularly Natives, would increase greatly. In addition, female participation rates during pipeline construction and operation have been based on estimates of current participation. Although it is generally expected that the rate of female participation would increase, it is difficult, if not impossible, to quantify the extent of the anticipated increase based on data presently available.

F.3.4 *Examination of Estimated Labour Supply and Demand*

F.3.4.1 Considering the proposed gas pipeline in *isolation*, the anticipated man year requirements for each of the three profile years, 1977, 1980 and 1983, were compared to the estimated available labour force in the northern territories. If there was little other employment activity in the North during pipeline construction, the entire estimated *labour force* would likely be available for pipeline related employment. If other major projects were going on simultaneously, the labour supply situation would be very complex.

F.3.4.2 During 1977, the construction profile year, pipeline related jobs would greatly exceed the available labour supply (Table II, Appendix F). It is estimated that there would be 675 native and 477 non-native workers available in the northern territories to fill 7,375 jobs (Table I, Appendix F). Available labour would exceed available jobs only in the categories of administrative trainee, carpenter's apprentice and 'other occupations'. The small number of surplus workers could be absorbed into other jobs easily because of the high demand for workers and the reasonably high level of occupational mobility of labour force participants. Thus a net regional labour shortage of about 6,270 workers is anticipated (Table IV, Appendix F); and the additional workers would have to be 'imported' from the South. If additional petroleum exploration and development activities were underway at the same time, there would be an even greater demand for workers and an even greater need to 'import' them from outside the territories. Assuming *major discoveries* were made, an additional 4,420 workers would be required; in the case of *minor discoveries*, 2,175 additional jobs would be available (Table I, Appendix F).

F.3.4.3 By 1980, the second profile year, there would be a substantial reduction in the number of jobs directly related to the proposed gas pipeline (Table V, Appendix F). It is estimated that there would be only 746 jobs, with 877 Natives and 551 Non-natives available to fill them. This surplus would be particularly evident in such categories as administrative trainee, driver, labourer, office assistant, principal operator and welder's helper (Table V, Appendix F). These people would *not* necessarily be unemployed, but it is unlikely that they would find employment on the proposed *gas pipeline*.

F.3.4.4 In contrast, if *major discoveries* were made, there would be approximately 7,200 *additional* jobs in petroleum exploration and development in 1980. The general skills category would account for roughly 4,376 jobs or 61 per cent of the demand. Assuming *minor discoveries*, there would be approximately 2,400 additional jobs of which 1,450 or 60 per cent would be in the general skills category (INA/MPS, 1973, V.1, Tables 31 and 33). As a result of these additional petroleum based activities, labour demand would continue to outstrip the available supply and additional workers would again have to be 'imported' from the South.

F.3.4.5 In 1983, the capacity operation profile year, there would be about 222 pipeline related jobs and the net surplus on the gas pipeline would be in excess of 1,400 workers. Only technicians would still be in substantial demand and would have to be brought in from the South unless sufficient Northerners had been trained to meet this requirement. Resident labour with virtually all other occupational skills would be redundant to the needs of the proposed gas pipeline unless looping of the line were required at that time (Table VI, Appendix F).

F.3.4.6 Once again, if simultaneous petroleum exploration and development occurred, the employment picture would be altered substantially. Assuming *major discoveries*, about 5,990 jobs would have to be filled in 1983, with 3,726 or 62 per cent in the general skills category. If *minor discoveries* were made, 1,945 jobs would be available, with 1,192 or 61 per cent for workers with general skills (INA/MPS, 1973, V.1, Tables 31 and 33). In either eventuality, there would be sufficient employment to absorb available northern workers.

F.3.4.7 Aside from potential long term employment in petroleum exploration and development and barring a marked upsurge in other industrial development activities, the main opportunities for full-time employment would probably exist at the two extremities of the Mackenzie valley. In the upper Mackenzie region further exploration for minerals, continued high transportation activity, gradual growth of the service sector, increased tourism, and possibly some new industrial activities such as forestry would likely keep employment at a relatively high level. In the lower Mackenzie, work on gathering systems, scrubbing plants and development of new gas fields would probably provide the main employment stimulus, buttressed by modest continuing growth in the service and government sectors in the larger centres.

F.3.4.8 The extent of a 'bump' in employment caused by high pipeline related demand followed by rapid decline would depend in no small way on the general level of activity in the immediate post-construction period. If roads and perhaps railroads were built, new towns developed, oil and gas fields brought into production, another pipeline project begun, or the initial gas pipeline looped, high levels of labour demand would persist and the regional labour force could be fully absorbed. However, if some major development did not take place and there was a general slackening off of major capital investment, the situation could be very difficult. Incomes and expectations concerning material living standards would have risen to unprecedented levels during pipeline construction and there could be considerable dissatisfaction if these were not continued.

F.3.4.9 In addition to the presence of other development activities, land issues could affect the native employment picture. If an early settlement similar to the one in Alaska were reached between Government and the native people, employment opportunities might be created within the native communities and a considerable portion of the available native labour force could be absorbed. This might also occur if proposals were adopted to provide alternate means of earning a living, such as encouragement of resource and service activities related to development, (INA, Special Staff Group, 1973, pp. 72-73). To this end, a study into entrepreneurial opportunities in the Northwest Territories is being carried out under the Environmental-Social Program beginning in 1974.

F.3.5 *Earnings from Pipeline Related Employment*

F.3.5.1 The effect of pipeline related employment on income has been estimated for each of the profile years – 1977, 1980 and 1983 (Table VII, Appendix F). The number of people employed in each occupation category during each profile year was derived from the employment estimates presented earlier; the data on wages were derived from adjustments to the INA/ MPS study (Manders, 1973).

F.3.5.2 The gross earnings of territorial residents during 1977, the construction profile year, are estimated at about $5.3 million. Residents of the study area would receive about $2.2 million (42 per cent) of the total. Native people, both in the study area and in the rest of the northern territories, would receive about 75 per cent of total direct wage income from pipeline activities (Table VII, Appendix F).

F.3.5.3 By 1980, the buildup to capacity profile year, the annual earnings of northern residents from the proposed pipeline would have declined greatly, from about $5.3 million in 1977 to about $3 million. It is assumed that residents of the study area would have priority placement in jobs; therefore 70 per cent of the earnings would go to study area residents and only 30 per cent to residents of the rest of the northern territories. Similar to 1977, 76 per cent of the total earnings of Northerners would go to the native population in 1980 (Table VII, Appendix F).

F.3.5.4 In 1983, the capacity operation profile year, earnings from the proposed pipeline accruing to northern residents would have declined further – to about $0.95 million. Eighty-three per cent of this would go to residents of the study area, with $0.6 million going to the Natives; native residents of the rest of the northern territories would only receive about seven per cent of the total (Table VII, Appendix F).

F.3.6 *Effects of Proposed Pipeline Development on Traditional Pursuits*

F.3.6.1 Factors related to Natives' participation in hunting, trapping and fishing include: the extent of dependence on these activities for income; the effects of increased income from wage employment on those presently engaged in these pursuits – and on present recruitment rates; and whether participation in traditional pursuits, such as trapping for cash income, would be similar to participation in hunting for recreational and cultural reasons (section D.5.2). In addition, this section discusses the probable effects of pipeline income on the Natives' value system, particularly as it influences the achievement of status, and whether defining values increasingly in economic terms would lead to a more structured class system.

F.3.6.2 It is estimated that income in cash and kind to communities from hunting and trapping varies, but continues to account for 20 per cent of the Natives' total annual income on a regional basis (section D.7.2). Considering the declining number of *full-time* trappers and the low recruitment rate, the proportion of total income from this source is expected to continue to decrease, particularly if wage employment opportunities were to increase.

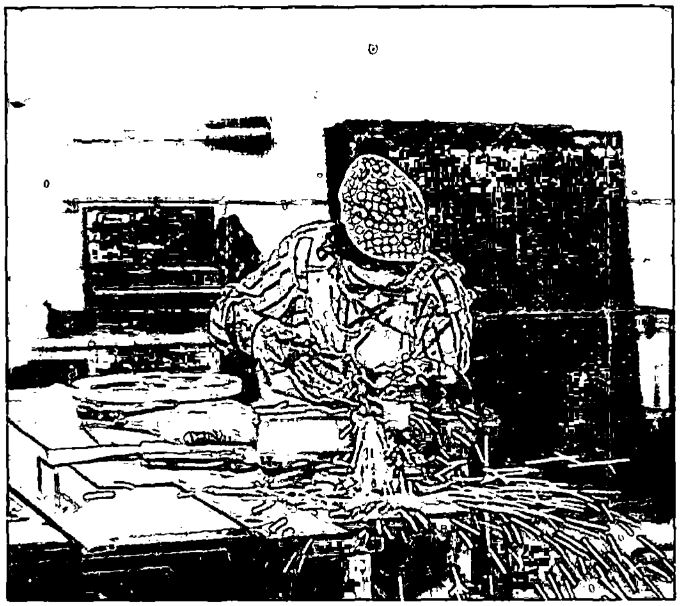
F.3.6.3 The outlook for *part-time* trapping by Natives is less certain. The value of some fur species has more than tripled recently; and if some income from wage employment were used to buy better equipment which would permit harvesting more isolated trapping areas (paragraph E.1.2), this type of trapping could continue at present levels. In addition, there would likely be a high demand for furs and fur trimmed handicrafts produced by local residents during the construction phase, which would stimulate the trapping industry for a while at least.

F.3.6.4 Although increased wage employment is expected to result in a continued decline in trapping, hunting and fishing for domestic use would probably continue at a high level. The challenge of the hunt, the psychological need to get out on the land and the recreational aspects are likely to stimulate high participation. Moreover, native people tend to prefer local game and fish to imported meat and recent price increases seem to ensure the continued importance of game and fish for food.

F.3.6.5 Regarding the probable effects of pipeline employment on the Natives' value system, it is likely that many men who formerly gained prestige through their proficiency in hunting and trapping would have to turn to wage employment to maintain their status as did the Eskimos during construction of the DEW Line (paragraph D.5.2.8). Although prestige is still accorded to those who are knowledgeable of and proficient in the traditional pursuits, especially in the more isolated communities of the central Mackenzie, high status would probably become more closely related to level of income as opportunities for wage employment increased.

F.3.6.6 For women, the change from being a full participant in trapping, hunting and fishing with a well-defined role, to being an urban housewife in an unfamiliar modern home where a direct relationship between care of the home and contributing to the well-being of the family is not readily apparent, could be a very unsettling and unrewarding experience (Stevenson, 1968). Indeed in this sense, native women would face a more serious role-definition problem than would men in the transition from a subsistence economy to a wage economy.

F.3.6.7 Moreover, for both men and women, increasing involvement in wage employment and the resultant scaling of income according to occupation levels could give rise to a more pronounced economic class system in essentially native communities. It is likely that the number of native small businessmen would increase and that they would become quite



T. Nodwell

Fig. F-7(a) On the job training at Alberta Gas Trunk Line service centre, Calgary, Alberta.

T. Nodwell

Fig. F-7(b) On the job training at Alberta Gas Trunk Line compressor station, Rocky Mountain House, Alberta.

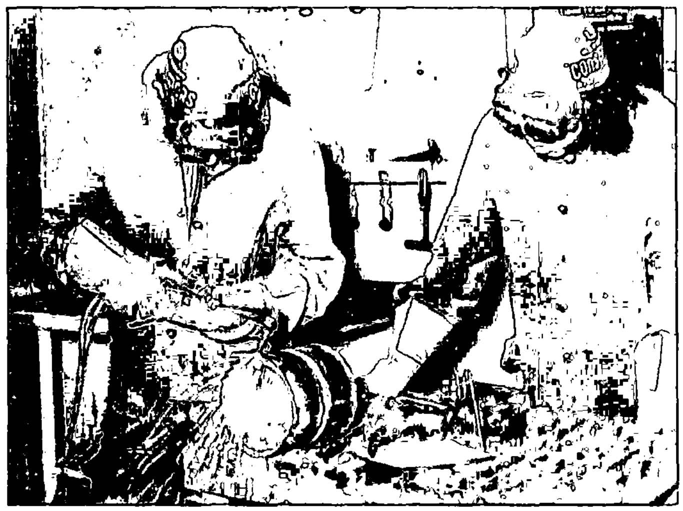
affluent. The more educated, better trained Natives, primarily the younger people, could fill technical and administrative positions and form a middle class; and the majority, lacking specific skills or training, could fill the labouring positions and form the lower economic and social group.

F.3.7 *Effects of Job Training on Labour Supply*

F.3.7.1 The 1972 Pipeline Guidelines state that the successful applicant would have to train and employ northern residents, particularly native people, for work on pipeline construction and operation (Appendix III). However, some petroleum companies operating in the North began increasing the number of their northern employees and instituted on the job training programs prior to announcement of these guidelines. For example, in 1971 one company selected about 16 candidates, mainly Natives, from the Northwest Territories and the Yukon, to participate in on the job training at operating facilities in Alberta (INA/MPS, 1974, V.6, pp. 3-28 and 3-29; Figs. F-7 and F-8). In the following year, the number of trainees was increased to 25.

F.3.7.2 After six months of paid training, those who were willing and suitable became full-time employees. They chose the trade they preferred and continued in a combined training and employment situation. In the spring of 1974, 11 of the original 16 candidates were still employed and as drop-outs occurred, the company recruited northern replacements. Although the program is somewhat limited in scope because it relies on training positions in the South, it appears to have been successful (Alberta Gas Trunk Line, 1974, personal communication).

F.3.7.3 Also, in the summer of 1973 one consortium established a task force to plan and coordinate an overall training and employment program intended to meet the requirements of the 1972 Pipeline Guidelines. At the time of writing, the program appears similar in content to standard trades training or apprenticeship programs except that the basic background subjects such as mathematics, science and language, are broken into small units and are taught in relation to practical application.



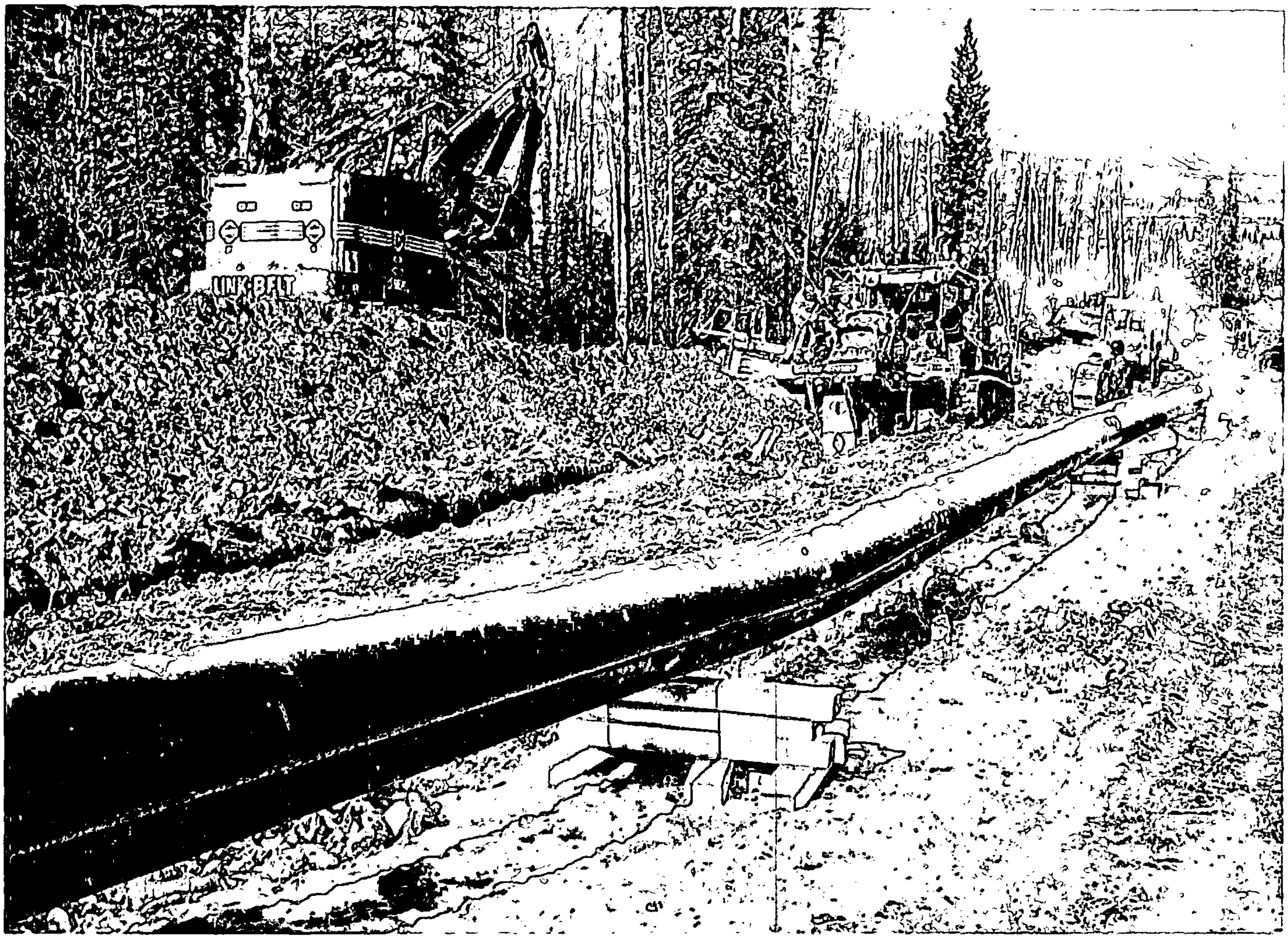
Intoramtion Services, NWT

Fig. F-8 Training welders at Adult Vocational Training Centre, Fort Smith, NWT.

The program appears to differ in method, however, in that more use is being made of on the job training.

F.3.7.4 By late October 1973, three classes had been screened and had entered the orientation phase. The Northwest Territories and the Department of Manpower were involved in the screening procedure and in the initial training. Each class consisted of approximately 12 men, mainly of native origin. Northerners entering the first three courses had a minimum academic level of grade nine.

F.3.7.5 The Northwest Territories recognizes the need for staff at the settlement level to: (i) inform residents of training and employment opportunities both on the proposed pipeline and on other projects; and (ii) facilitate workers and their families taking advantage of these opportunities. Some settlements either already have or are planning to establish a labour pool (Gemini North, 1972); and the Department of Manpower has an office in the larger comunities. However, a method of ensuring that



E.B. Owen

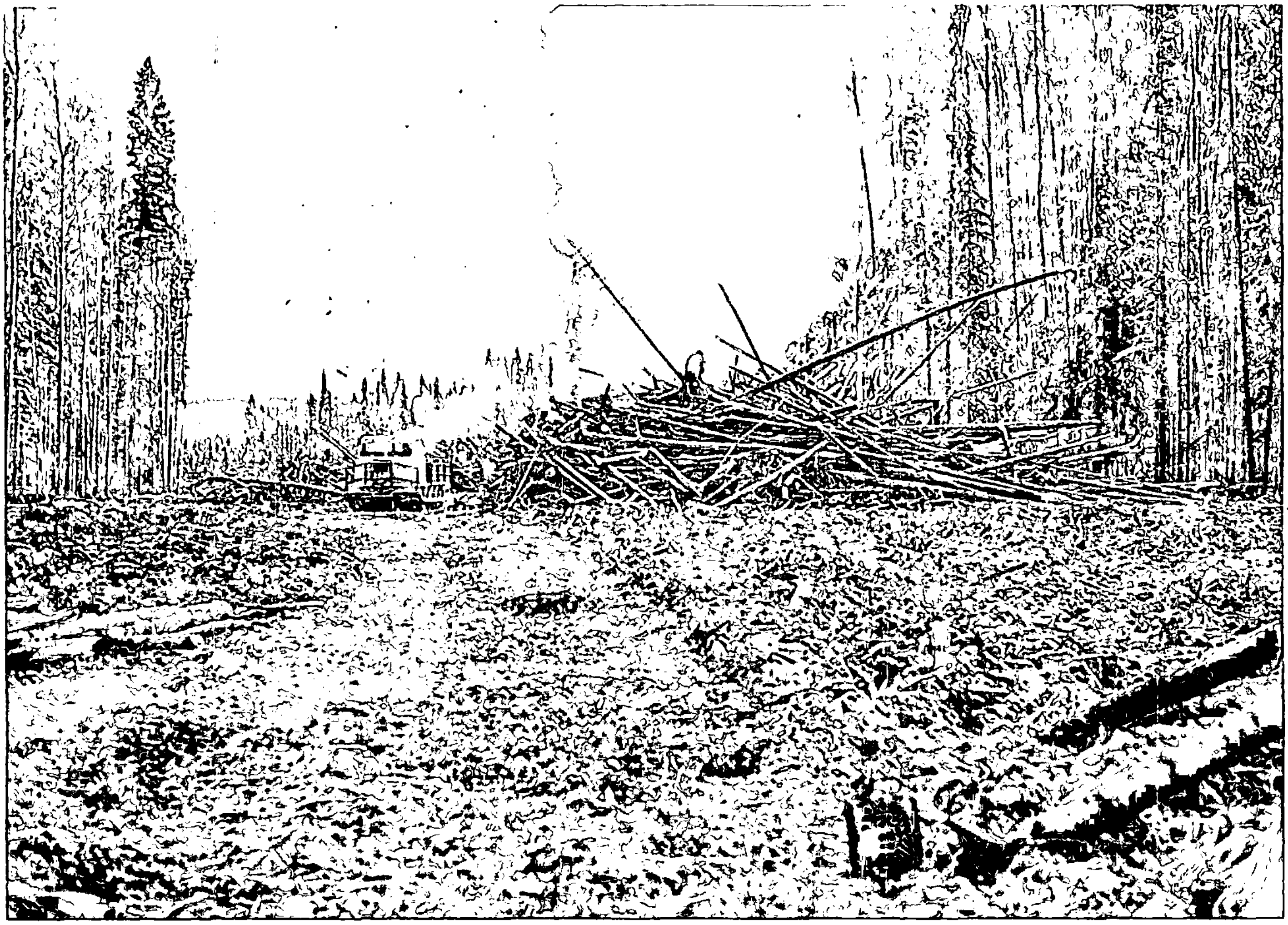
Fig. F-9 Construction work on the Pointed Mountain pipeline in the NWT.

residents of the small settlements are *regularly* informed of employment opportunities has not yet been determined.

F.3.7.6 Although preparatory training and counselling for pipeline related work are either underway or in the planning stages, the *ability* of resident northern adults and youths to fill the available training positions is equally important. At present the formal education requirement for many types of trades training is grade ten. However, in 1969-70 only four per cent of the study area's native population 14 years of age or over had completed *any* of grades 10-13 compared to 70 per cent of the non-native population (INA/MPS, 1974, V.6, pp. 1-16 and 1-17). Despite modest increases in retention of pupils from elementary to secondary school (paragraph D.6.3.3), the pool of native adults and youths with a minimum education of grade ten is not expected to increase greatly during the next few years. It is likely therefore that the consortium would be hard pressed to find enough suitable candidates for their training program if the entrance requirement of grades nine or ten were retained.

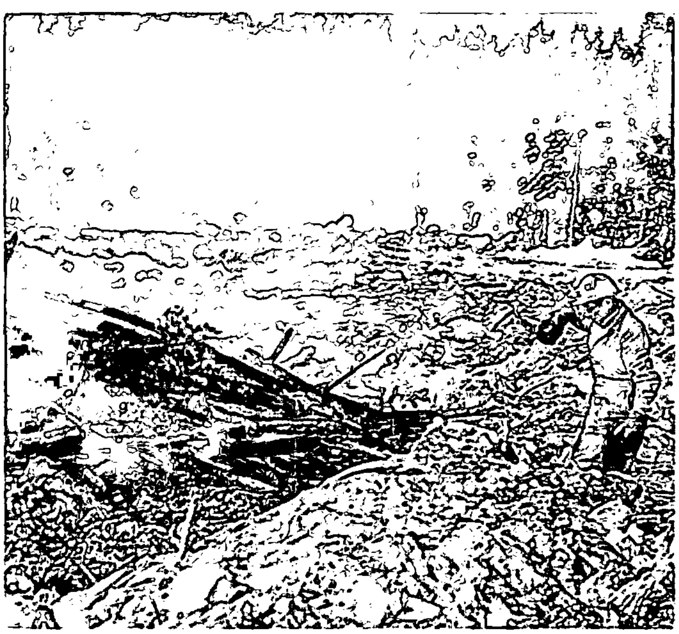
F.3.7.7 Other factors affecting the pool of available native trainees include: regional mobility of workers; trends in vocational training; and specific characteristics of the projected labour force. In a regional context, the various native groups in the Northwest Territories have not generally been mobile either in terms of changing their place of residence or of working away from their home settlements (INA/MPS, 1974, V.6, p. 1-19). In the past a few Natives employed by the Hudson's Bay Company, or a transportation company, have moved from one post to another. And, as noted in section D.5.6, there have been attempts to relocate Natives from isolated settlements to work in development activities such as the DEW Line, the Great Slave Lake Railway and various mining projects. But, in general, Natives have *not* been inclined to move in search of employment and previous attempts by Government and industry to relocate them have been largely unsuccessful.

F.3.7.8 Recent construction activities on the Pointed Mountain pipeline (Fig. F-9) and Hire North's clearing activities on the Mackenzie Highway (Fig. F-10) indicate that single native workers who are prepared to live in a camp, would adjust satisfactorily to moves of limited distances along the proposed pipeline route (Scott, 1973). Married workers living in camps would likely adjust well only if communication with their families was facilitated and provisions were made for regular visits. These workers would adapt to the demands of pipeline work more readily if their families moved from more remote settlements to those adjacent to the proposed route (for example, from Nahanni Butte to Fort Simpson), since regular visits could then be arranged more easily. The effects of pipeline employment on the family are less predictable since one must consider such factors as: the effects of housing shortages, changes in schools, separation from friends and relatives, and the social environment of a boom town.



Information Office, INA

Fig. F-10(a) Clearing activities by Hire North on the Mackenzie Highway.



Information Office, INA

Fig. F-10(b) Clearing activities by Hire North on the Mackenzie Highway

F.3.7.9 As of March 1974, neither of the northern territories has taken a policy position either for or against planned relocation of northern residents to meet the projected employment demands of the proposed pipeline. However, there would likely be some spontaneous intra-regional movement of area residents, and there is little doubt that a substantial number of 'speculative transients' would converge on the more accessible growing centres along the proposed route prior to and during the construction phase. In a somewhat analogous situation, a stream of workers from the rest of the United States flocked to Alaska in the summer of 1973 in search of employment on the proposed Alaska pipeline and added to the area's unemployment and welfare problems (Edmonton Journal, 1973). To avoid problems arising from migration into communities, preventive measures such as provision of an adequate employment information system and service facilities in the form of a contingency program for transients, should receive active consideration by both territorial governments.

F.3.8 *Effects of Pipeline Development on Living Conditions in the Study Area*

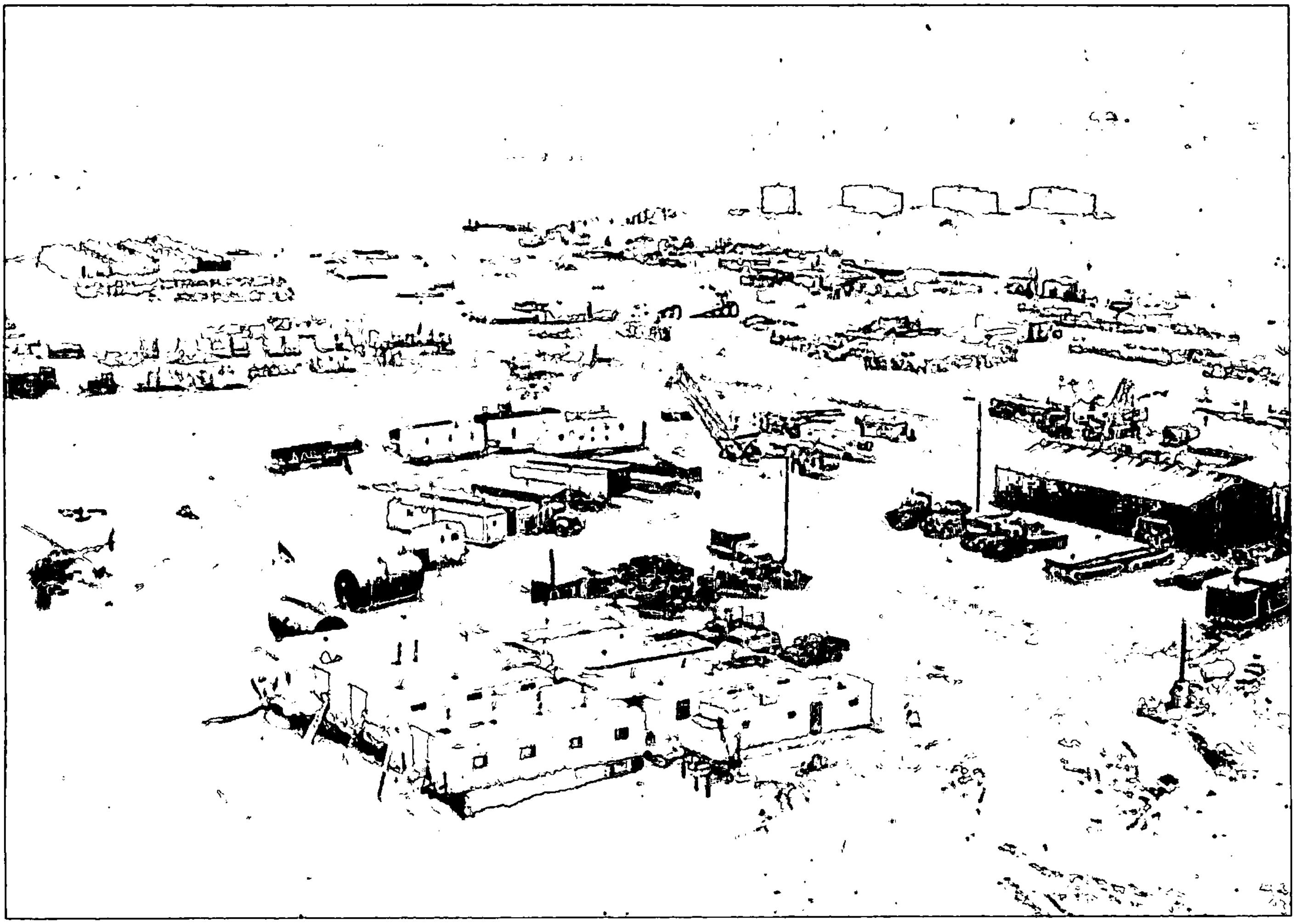
F.3.8.1 Only a few of the 18 communities within the study area are expected to be significantly affected by the proposed pipeline development. In addition to the main transportation and administrative centres of Hay River and Inuvik, only one centre in each of the upper, central and lower Mackenzie regions would likely experience major impact – these are referred to as *regional centres* (INA/MPS, 1973, V.1, p. 95). The effects on these centres during the construction and development phases would include: increased transportation activity; enlargement of the service sector; increased population; and possibly some 'spin-off' industrial activities. However, this section focusses on those aspects of labour force and population growth *directly* related to pipeline development, and particularly on the effects of the additional workers required to satisfy labour demand during the construction phase (section F.3.4).

F.3.8.2 The estimates of the number of additional workers living in communities and the resulting population increase assume that only a portion of the total workers would remain for a full year and that there might be different workers each year. In general, workers with families are expected to stay for a year or more; workers who are single or without their families are likely to remain for shorter periods of time. During the preconstruction phase, the majority of workers would be without families and would stay short periods of time – ranging from a few days to about nine months. During the mainline construction phase, about two-thirds of the pipeline related workers staying in communities would be without families; and one half of these would only stay for a short time, and be changing constantly. In the operation phase about one half of the pipeline related workers would be accompanied by families; and it is likely that all workers (both family and single status) would reside in communities for a year or more (Table VIII, Appendix F).

F.3.8.3 In 1975, the logistics buildup year, the small additional labour force would likely affect the regional centres *directly*, since such activities as transportation and material handling would be centred there (Fig. F-11). It is estimated that there would be an increase of about 113 workers – that is, nine with families and 104 single – which would result in an increase of about 135 persons in each regional centre (Table VII, Appendix F).

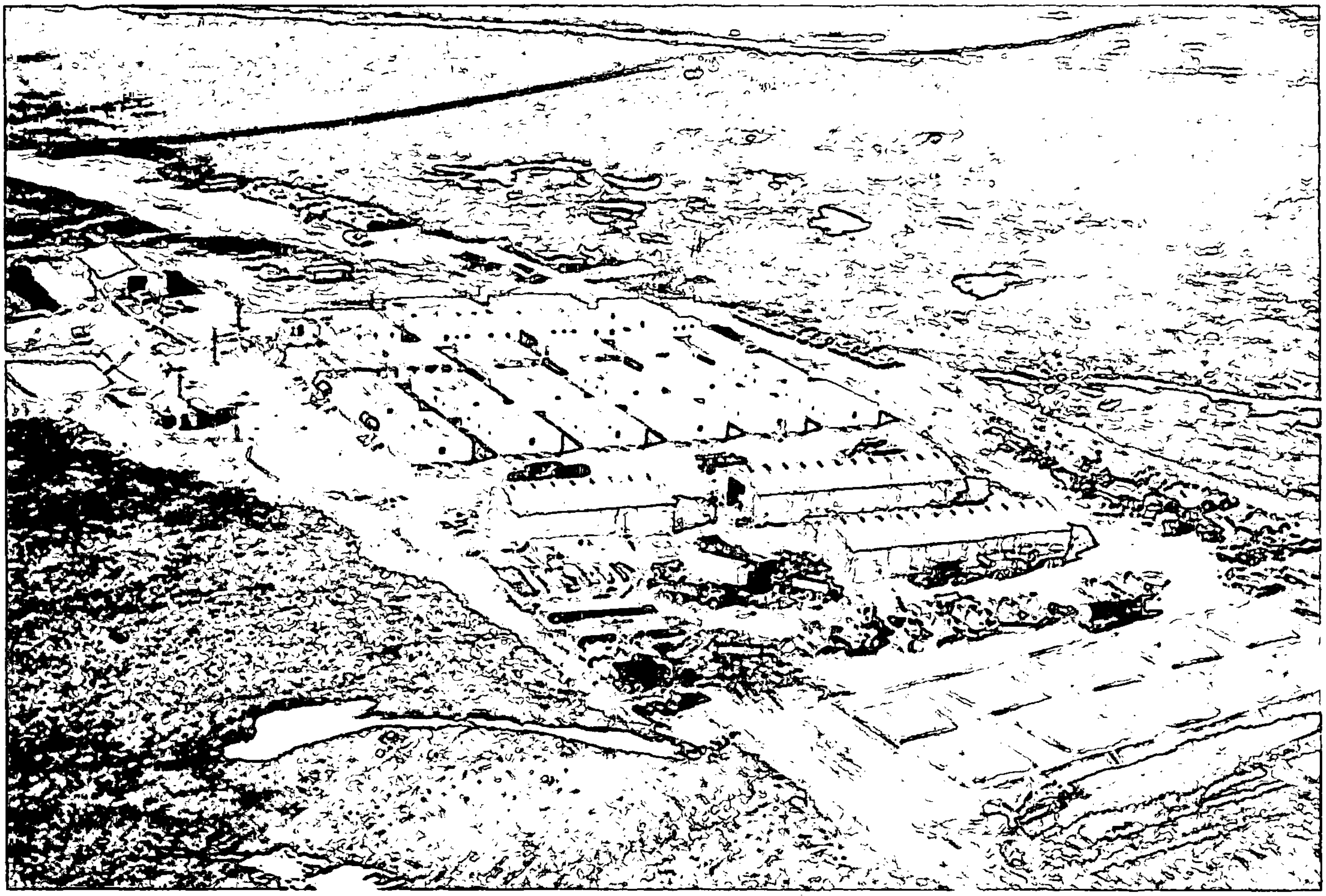
F.3.8.4 During the mainline construction period from 1977-79, the large additional labour force is expected to have only an *indirect* effect on the regional centres since the workers would live in self-contained camps located some distance from the communities (Fig. F-12). In 1979 there would be about 202 additional workers – that is, 65 with families and 137 single – for an increase of 430 persons in each of the three communities (Table VIII, Appendix F).

F.3.8.5 In the regional centres, the additional population *directly* related to pipeline development would be relatively small during the early years of capacity operation. There would probably be more pipeline workers early in the startup phase than in later operation years because of initial problems, continued testing, etc. In 1983 the capacity operation profile year,



Information Office, INA

Fig. F-11 Staging area, Tuktoyaktuk, NWT.



ATCO

Fig. F-12(a) Large self-contained camp, Alaska north slope.

there would be about 100 additional workers – that is, 50 with families and 50 single – for an estimated total of 275 extra people in each regional centre (Table VIII, Appendix F).

F.3.8.6 In addition to the expected pipeline related workers, increased personnel would also be required in the public sector. For example, there would be additional employment liaison staff, game management and land use personnel, teachers, nurses, social workers, RCMP officers and support workers. It is estimated that there would be about 40-45 additional government workers in each regional centre between 1977 and 1980. In the private sector, a further 30-45 positions might be created in each regional centre between 1976 and 1981. This would *not* necessarily require in-migration of additional population since local people, or the relatives of government staff or pipeline employees could fill these positions. Assuming possible multiple labour force memberships within families, the added population in each regional centre required to fill the new jobs in the public and private sectors could be in the order of 140-165 persons at the height of mainline construction (Table VIII, Appendix F).

F.3.8.7 If the three regional centres receive the main population impact as expected, the additions to the study area's population would range upwards from about 960 persons in 1975, the logistics buildup year, to as high as 1,990 in 1979 and then decline to about 1,085 in 1983, with the start of capacity operation (Table VIII, Appendix F). This estimate does *not* include additions to the population of Hay River or the further increase if a regional centre were to become a *divisional headquarters* for pipeline operation (INA/MPS, 1973, V.1). Moreover, no attempt has been made to quantify the possible impact of speculative transients, that is those from either within or outside the northern territories who would come to valley communities in search of work.

Information Services, NWT

Fig. F-12(b) Hire North highway construction camp in the NWT.

F.3.9 *Additional Accommodation Requirements in Regional Centres*

F.3.9.1 While development activities (such as stringing) that employ large numbers of workers would be mainly self-sufficient with respect to accommodation, some workers directly employed on the development and others indirectly related to the pipeline would require varying amounts of accommodations in the regional centres themselves. During the logistics buildup and early construction phases, the main demand in each regional centre would be for hostel or apartment units to quarter workers without families. The supply of these types of accommodations would have to be expanded when the peak construction phase was reached and would then decline during the buildup to capacity phase. As the composition of the labour force changes from most workers living in single quarters to more workers being accompanied by families, the demand for self-contained accommodations would increase from a minimal amount in the logistics buildup phase to about one third of all units (paragraphs F.3.8.3 through F.3.8.5). And while it is estimated that there would also be less demand for self-contained houses in 1983 (the capacity operation profile year) from pipeline related workers than during the height of construction, a housing surplus would probably not occur since other sectors of the local economy are expected to expand in these regional centres.

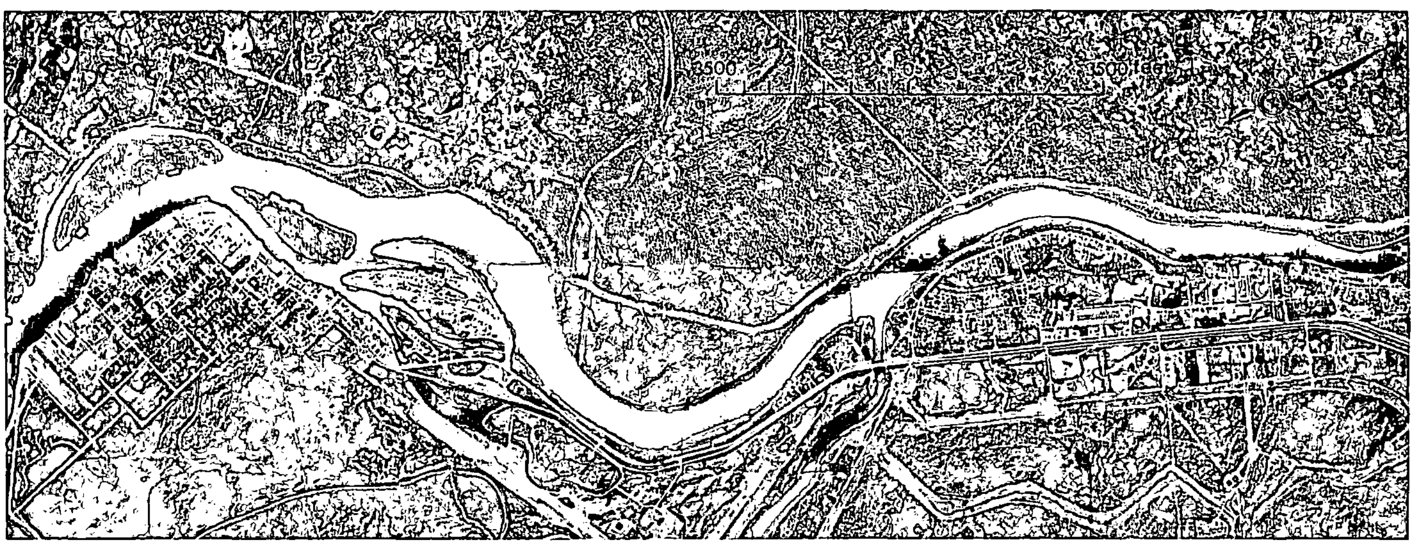
F.3.9.2 Using the categories in Table VIII, Appendix F as a guide to requirements — that is families, singles and temporary workers — the following estimates of accommodation by type were made for the three regional centres: (i) in 1975, the logistics buildup year, 120 homes for families and accommodation for 400 singles would be required; the majority of singles could be housed in hostels; (ii) by 1979 about 320 homes would be required for families and 530 units to accommodate singles; only a small proportion of singles would be housed in temporary hostels; and (iii) proceeding to 1983, about 190 homes for families and housing for 185 singles would be required to accommodate the population directly and indirectly related to the pipeline. However, as noted above, this would not likely result in surplus housing stock.

F.3.9.3 These estimates of additional accommodations only consider requirements in the three regional centres. In the transportation centre of Hay River, demand could equal 60 per cent of that for *all* three regional centres — that is, 160 homes for families and 225 units for singles (Fig. F-13). If a regional centre such as Norman Wells (Fig. F-14) or Inuvik (Fig. F-15) were selected as a divisional headquarters, further accommodations for about 70 workers would be required, that is perhaps 50 homes for families and 20 units for singles. Thus the additional accommodations required in the study area at the height of pipeline construction could amount to approximately 550 units for families and 775 units for singles.

F.3.9.4 These estimates make no allowance for the present housing situation in the study area or for the additional accommodations required to meet *normal* population growth during the pipeline construction period. A survey of available housing recently undertaken by the Northwest Territories Housing Commission indicates a *present* shortage of family and single units. Considering the present small housing stock, the existing shortages, and the anticipated demand from normal growth, plus that related to the pipeline, the following steps would have to be taken in the near future to avoid a real housing crisis during the pipeline construction period: immediate community planning; action to alleviate present housing shortages; and at least a start on the local services and facilities needed in the future.

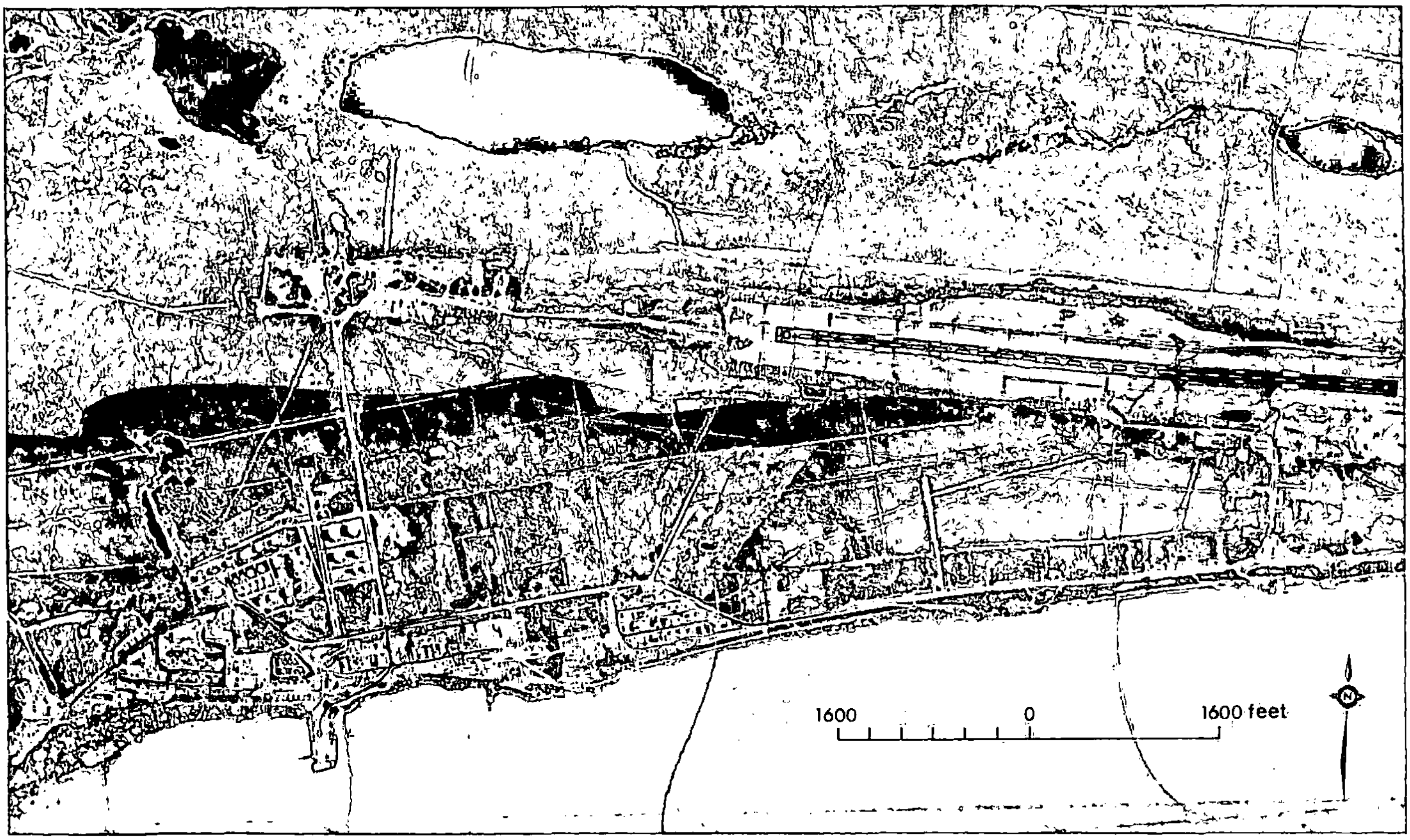
F.3.9.5 To date community planning in most study area communities has consisted of concept planning or devising solutions for existing problems. However, a study presently being carried out under the Environmental-Social Program, is assessing housing and community development needs in the study area. When the study is completed, reasonably accurate estimates of the costs of such facilities as roads, sewage, water and hydro electric power should be available.

F.3.9.6 In addition to accommodations and basic services, new office space, warehousing and other commercial building space would be required. It is estimated that 15,400 square feet of space for pipeline related business and 6,500 square feet for



Engineering and Architecture Branch, INA.

Fig. F-13 Aerial photograph of Hay River, NWT.



Engineering and Architecture Branch, INA

Fig. F-14 Aerial photograph of Norman Wells, NWT.

government would be needed in each regional centre. In addition, 12,700 square feet of warehousing and storage space would be required (INA/MPS, 1974, V.4). No estimate of private sector requirements is available. However, there is a clearly definable need for an additional 4,000-6,000 square feet of recreation space in each regional centre (Canada, DPW, 1973, personal communication).

F.3.10 ***Additional Community Service Requirements in Regional Centres***

F.3.10.1 *Public Services and Facilities*

F.3.10.1.1 Some additional public services would be required to meet the needs of the projected increased population in each regional centre. Most would be required for people living in these centres, but workers living in self-contained camps outside the communities would create additional demands on services such as health, welfare, education and law enforcement.

F.3.10.2 *Education Services and Facilities*

F.3.10.2.1 It is estimated that there would be at least 130 additional school age children in each regional centre. These children, plus those added by normal population growth, would have to be accommodated in the schools. As a case in point, Inuvik presently has 35 elementary school classrooms and 36 teachers, plus 27 secondary school classrooms and 20 teachers — for a total of 62 classrooms and 56 teachers (Gemini North, 1973, Table 23, p. 153). Enrolment of elementary and secondary school pupils in Inuvik between 1971 and 1979 is estimated as follows:

	1971	1975	1979
Estimated Number of Pupils	1,231	1,433	1,798

Based on Table VIII, Appendix F and Gemini North, 1973, Table 23, p. 153

F.3.10.2.2 Therefore, approximately 20 additional classrooms and 20 more teachers would be required in Inuvik (Table VIII, Appendix F; Gemini North, 1973, pp. 188-189).

F.3.10.2.3 Increased permanent population in the regional centres might also lead to demands to extend secondary school facilities through to grade 12. In addition, proposals to assist native northerners to participate in the proposed pipeline development would create an immediate requirement for additional vocational and trades training facilities.

F.3.10.3 *Health Services and Facilities*

F.3.10.3.1 It is anticipated that medical facilities would be provided in the construction camps to handle routine or emergency treatment. Even so, the large number of accidents that could be expected to occur on such a major project would strain existing local clinic or emergency facilities. (The more serious cases and those requiring further treatment would either be hospitalized in the nearest regional centre or in centres with better medical facilities such as Yellowknife, or in the South.) Also, the additional population as well as the local residents in each regional centre would require medical facilities. It has been estimated therefore that each regional centre might require a temporary 24 bed hospital staffed by 2 doctors, 5 nurses and nurses' aides, and 5 maintenance workers (INA/MPS, 1973, V.1, p. 99).

Engineering and Architecture Branch, INA

Fig. F-15 Aerial photograph of Inuvik, NWT.

F.3.10.3.2 However, actual requirements might be somewhat lower since many northern communities appear to have facilities and staff capable of serving a much larger population (Northern Health Service, 1973, personal communication). For example, Fort Simpson with a 12 bed hospital, a clinic, one full-time doctor and one part-time dentist, could probably serve a population of over 2,000 if one additional doctor, one or two nurses and a full-time dentist were present. Norman Wells, with a 13 bed nursing station, a clinic, one doctor and two nurses, can presently handle industrial accidents, and could probably service the increased population if one doctor, and two or three nurses or nurses' aides were added to the staff. There might also be requirements for a child care clinic and for out-patient facilities. These additional facilities would likely be sufficient to meet expected demand even if Norman Wells were to become a permanent divisional headquarters.

F.3.10.4 *Other Public Services*

F.3.10.4.1 It is of great importance that the requirement for employment and family counselling noted in the 1972 Pipeline Guidelines (Appendix III) be recognized as an integral part of any training and employment program. To this end, the NWT is considering providing family counselling and social adjustment training programs. In addition, more social workers would be needed to deal with such problems as dislocation, resettlement, increased child neglect and disruption of family life resulting from conditions of rapid change. Resident social workers would probably be needed in all the large communities, with additional workers in each regional centre. Moreover, courtroom and detention facilities would likely be required in each regional centre (Gemini North, 1973, pp. 192-196).

F.3.11 *Effects on the Private Sector of Pipeline Related Demand for Materials*

F.3.11.1 Large amounts of additional materials would be required during pipeline construction including fuel, equipment and parts, pipe and other construction materials, and provisions. Since most of these supplies could not be obtained locally (sections E.3, E.6 and E.7), they would be shipped in from the South. The total volume of supplies and materials that would be required during the construction period is estimated at well over 1.7 million tons. The pipe which would be primarily shipped directly to the construction sites during the first year, would account for about 67 per cent of this freight. The remaining 0.6 million tons would likely be shipped to the regional centres for transshipment to the construction sites. Fuel would account for about 0.35 million tons of this freight; and provisions, supplies, parts, etc., the remainder (INA/MPS, 1973, V.1).

F.3.11.2 Bulk commodities such as fuel would be transported to the regional centres by barge and truck. In addition, during the peak years some supplies and parts would probably arrive at each centre by air. Transshipment of supplies and personnel from each regional centre to the construction sites would probably be handled by trucks and buses. These services would likely decrease or be phased out after 1979.

F.3.11.3 At present there are about 18 contracting companies in the study area that might receive subcontracts for work during the construction phase and for other construction and maintenance work. In addition, the volume of construction work not directly related to the pipeline is likely to increase. This would include housing, schools, hospitals, office buildings, municipal water and sewage disposal facilities, roads, airports and related facilities. Contractors would find it difficult to meet the normal building demands plus those related to the pipeline (section F.3.9).

F.3.11.4 Due to problems such as financing and delivery time in obtaining heavy equipment used to prepare the right of way or in transporting materials, local contractors and transport companies would be in a difficult position. The uncertainty of a date for starting construction, coupled with the large investment required, make the situation highly speculative, and therefore beyond the means of many small operators. In addition, prices are continuing to escalate. Much of the equipment required would be in short supply and would be considerably more expensive by the time a decision is reached on the proposed development.

F.3.11.5 Some background information is provided on transportation and communication in sections D.8 and D.9. Labour demand stemming from increased transportation and communication activities is discussed in sections F.3.2 and F.3.8, and the discussion of the effects on living conditions in regional centres takes into account population increases resulting from these sectors. Similarly, this section discusses some effects of pipeline related demand for materials on the private sector. As such, these and earlier observations indicate the manner in which changes in transportation and services would affect local, social and economic conditions. However, this report does not purport to assess the likely effects of the proposed pipeline development upon the transportation and communication network of the study area.

F.3.12 *Additional Territorial or Federal Government Personnel Related to Proposed Pipeline Development*

F.3.12.1 As discussed in section F.3.8, the total number of government employees in the regional centres is expected to increase from about 448 in 1974 to 680 in 1980. Annual salaries and allowances are estimated at roughly $7.1 million in 1974 and would rise steadily to about $10.4 million in 1980 (Gemini North, 1973).

F.3.12.2 Federal government personnel located in the regional centres are expected to increase by about 70 administrative and professional and 60 support staff due to pipeline construction. Costs of salaries and fringe benefits for these 130 community based staff have been estimated at $1.3 million annually (based on 1970 pay scales). Other costs related to the increased government personnel would include the provision of: residential accommodations; additional office space; and municipal, educational, medical and other services (INA/MPS, 1973, V.1).

F.3.13 *Construction Costs for Additional Factilities Related to Proposed Pipeline Development*

F.3.13.1 The proposed pipeline development would place heavy pressure on the construction industry and would create great demand for building materials and supplies (sections F.3.9 and F.3.10). Each regional centre would require a number of additional facilities ranging from housing to airports, telecommunications and other public facilities.

F.3.13.2 Based on 1973 price estimates, the anticipated building costs in each regional centre at the height of mainline construction, would be as follows:

Estimated Building Costs

	Million
	$
Single family accommodations	3.6
Multiple accommodations	2.8
Dormitories or hotels (equipped)	1.2
Office buildings (government and others)	1.1
Warehousing and storage	0.5
Recreation buildings	0.2
Total cost for each regional centre	*9.4*

These estimates do not include costs of serviced land, sewage, water, etc.
Canada, DPW, 1973, personal communication

F.3.13.3 The additional space required for *education facilities* might be provided by adding extra classrooms to existing schools or by building new ones. Based on 1973 estimated costs, additional capital construction costs would range from $2.3 million in Inuvik for a 20 room school to $0.7 million in Fort Simpson for eight additional classrooms (INA, Architectural Branch, 1973, personal communication).

F.3.13.4 The additional *hospital facilities* in each regional centre might be provided by establishing a small permanent nursing station in conjunction with an existing hospital or an expandable nursing station in conjunction with existing facilities. An expandable facility would cost an estimated $0.35 million (Northern Health Service, 1973, personal communication).

F.3.13.5 Finally, there is a need for additional *serviced land*, and an upgranding of *municipal services* in each regional centre to meet the demands of projected population growth. As noted in paragraph F.3.9.5, the development plan studies for selected communities in the study area are not complete. However, preliminary reports concerning two communities that might become regional centres indicate estimated additional costs of $3.5 million and $11.9 million respectively (NWT Government, 1974, personal communication).

F.3.14 *Increased Income Associated with Proposed Pipeline Development*

F.3.14.1 The total *increased income* of workers in the two northern territories from direct pipeline employment during the period 1975-95 is estimated at $23 million; and at $5.7 million from employment directly related to the pipeline in the public and private sectors. Thus the total increased income from direct and indirect pipeline employment is estimated at $28.7 million.

Estimated Incremental Income (1970 values)

	Pipeline Construction Period 1975-79	Buildup to Capacity Period 1980-83	Capacity Operation Period 1984-95	Total
	Million $	Million $	Million $	Million $
Direct pipeline employment	15.3	5.2	2.5	23.0
Public sector	1.7	0.4	0.5	2.6
Private sector	2.1	0.5	0.5	3.1
Combined Increase	*19.1*	*6.1*	*3.5*	*28.7*

INA/MPS, 1973, V. 1, Tables 25 and 26, pp. 115 and 116

F.3.14.2 In addition, residents of the northern territories would receive training and related allowances while preparing for pipeline employment. It has been estimated that these would be as follows:

Estimated Training and Related Allowances (1970 values)

	Pipeline Construction Period 1975-79	Buildup to Capacity Period 1980-83	Capacity Operation Period 1984-95	Total
	Million $	Million $	Million $	Million $
Salaries and Allowances	2.9	0.6	0.1	3.6

INA/MPS, 1973, V. 1, Table 29, p. 137

F.3.15 *Revenues from Short Term Workers and Visitors Associated with Proposed Pipeline Development*

F.3.15.1 The net revenue to the NWT from short term pipeline construction workers is estimated at about $10 per round trip away from the construction sites; revenues from officials and other visitors would likely be about $20 per trip; and revenues from 'imported' workers and their families would amount to about 10 per cent of their gross income. Thus revenues from short term 'imported' labour and visitors would be about $1.1 million from 1975-95; and about $8.4 million over the same time period from imported workers and their families living in the study area. Total revenues from short term workers and visitors between 1975 and 1995 would amount to approximately $9.5 million (INA/MPS, 1973, V.1, pp. 133-134 and Table 28, p. 135).

F.3.16 *Territorial Taxes on Land for Pipeline Right of Way, the Pipeline Itself, and Ancillary Installations*

F.16.1 Both the Northwest Territories and the Yukon would realize revenues from property taxes on the pipeline itself, and on ancillary installations. The land required for the right of way would amount to approximately 20,500 acres, with 17,000 acres in the NWT and 3,500 acres in the Yukon (INA/MPS, 1973, V.1, p. 138). Land tenure would likely be for the length of the amortization period in the first instance with provision for renewal as might be required; and annual 'rental' rates would likely be subject to change from time to time. The revenues accruing to the two northern territories from a direct tax on the *pipeline*, based on existing rates in the territories and applied to its whole length, and *pipeline related facilities* from 1978-99 are estimated as follows:

Estimated Annual Taxes on the Pipeline and Related Facilities

	NWT	YUKON
	Million $	Million $
1978-83	4.6	1.0
1984-89	3.3	0.7
1990-95	2.5	0.5
1996-99	1.8	0.4
Total Revenue	*12.2*	*2.6*

Manders, 1973, Table 16, p. 41

F.3.16.2 In addition, licences and fees for stumpage and quarrying of gravel are estimated at about $3.1 million in the NWT from 1975-79 (INA/MPS, 1973, V.1, Table 29, p. 137).

F.3.17 *Territorial Taxes on Pipeline Company Buildings*

F.3.17.1 The pipeline company would probably require about $20.6 million worth of dwellings, office space, warehouses and other structures to directly service the needs of pipeline construction and operation in the northern territories. Initial assessment values of buildings in the NWT might be approximately $7.2 million. The estimated tax revenues in the NWT from 1976-99 are as follows:

Estimated Annual Property Taxes on Pipeline Buildings

	NWT
	Million $
1976-81	0.4
1982-87	0.3
1988-93	0.3
1994-99	0.2
Total Revenue	*1.2*

Manders, 1973, Table 17, p. 43

F.3.17.2 The 1972 Pipeline Guidelines state that the two territorial governments would receive prior consideration when any surplus pipeline facilities were disposed of (Appendix III). A precise value cannot be placed on any future surplus facilities, since the final value would depend on such factors as the extent to which they would have depreciated, and how far they would have to be moved. In addition, if a major looping program were to follow construction of the gas pipeline, there might be no surplus facilities. Nevertheless, it has been estimated that salvage and residual values of *facilities on the right of way* would amount to $1.5 million from 1980-95; and $1.2 million for *facilities in the communities* over the same period (INA/MPS, 1973, V.1, Table 29, p. 137).

F.3.18 *Territorial Taxes on Fuel and Alcoholic Beverages Associated with Proposed Pipeline Development*

F.3.18.1 It is estimated that the construction of the Yukon-Northwest Territories portion of the proposed pipeline would require about 74.6 million gallons of fuel, consisting of diesel and heating fuels, and aviation and automobile gasoline (Canadian Arctic Gas Study Limited, 1973). Fuel would probably be consumed proportionately per mile of pipeline construction, with roughly 85 per cent being used in the NWT and 15 per cent in the Yukon.

F.3.18.2 Based on current territorial fuel tax rates and assuming that all fuel would be taxed at full rates, estimated tax revenues would be as follows:

Estimated Annual Taxes on Fuel for Proposed Pipeline Construction

	NWT		YUKON	
	Gallons	Revenue	Gallons	Revenue
	Million	Million $	Million	Million $
Diesel	50.2	7.03	8.9	1.25
Aviation Fuel	2.6	0.01	0.5	0.01
Gasoline	5.3	0.74	0.9	0.13
Heating Fuel	5.3	0.16	0.9	0.13
Total	*63.4*	*7.94*	*11.2*	*1.52*

Based on Manders, 1973, p. 45; Canadian Arctic Gas Study Ltd., 1973

F.3.18.3 Taxes on the additional sales of alcoholic beverages resulting from pipeline related activity might be another source of increased revenue for the territorial governments. These have been estimated as follows:

Estimated Taxes on Alcoholic Beverages from Proposed Pipeline Development in NWT

	Pipeline Construction Period 1975-79	Buildup to Capacity Period 1980-83	Capacity Operation Period 1984-95	Total
	Million $	Million $	Million $	Million $
Estimated taxes	2.4	0.3	0.3	3.0

INA/MPS, 1973, V. 1, Table 29, p. 137

F.3.19 *Social Adjustment of Native People*

F.3.19.1 As noted in section F.3.1, this chapter is based on the assumption that the native people in the study area would generally be in agreement with the proposed pipeline development and would participate in the project. The task now is to identify and assess some critical aspects of the social adjustment process. Although this could be undertaken at the individual, family, or community levels, the focus here is confined to the family and community levels.

F.3.19.2 Two aspects requiring consideration are information and counselling services, since both play a central role in the paragraphs that follow. The need to provide objective information about proposed pipeline and highway development to the people in the study area was recognized early, and the Environmental-Social Program has funded an Information and Education Program since 1972. Some progress has been made, but recent statements by native spokesmen and NWT officials indicate that much remains to be done (Arctic Petroleum Operators Association Seminar, 1973; Forth et al., 1974). Since the main offices of the consortium are located in Toronto and Calgary, and the federal departments with substantial involvement in planning and dispensing information are in Ottawa, the desirability of having a central coordinating information service located in the study area cannot be overstressed.

F.3.19.3 The need for a comprehensive counselling service to assist workers in adapting to the demands of wage employment: and families in adjusting to the social and economic change have already been discussed (paragraph F.3.7.5). The value for such services was amply demonstrated during construction of the DEW Line and the Great Slave Lake Railway; and methods of providing these services for native people have been examined by such organizations as the Alberta and Saskatchewan Newstart Corporations. It is therefore important that counselling services; staffed by native people, to the extent that it is practical, be in place at the commencement of the proposed pipeline development.

F.3.19.4 The concerns of the government in the Northwest Territories and of social scientists who have studied native family life, particularly in a town setting, were considered in identifying those aspects of family life that would be vulnerable to increased social and economic change (Honigmann and Honigmann, 1970; Forth et al., 1974). Concerns for the native family in a social setting analogous to Inuvik or Fort Simpson include: the control and direction of children and youths; marital discord arising from increased stress and changing roles; effective use of money; misuse of alcohol; and care of the elderly and infirm.

F.3.19.5 As noted in paragraph D.5.6.7, native children have a greater degree of self-determination than non-native children. Native children are relatively free of overt parental direction after the age of three or four. They assume responsibility for such decisions as whether or not to attend school; and rely on and are influenced by their age group to a greater extent than non-native children. In earlier times these age groups served the special function of inculcating hunting and trapping skills and traditional roles. But in modern towns, where petty crime, misuse of alcohol and drugs, and sexual promiscuity are increasing, native young people are presented with a variety of less desirable models to emulate than formerly. Native parents frequently seek assistance from teachers, nurses and priests for controlling their teenagers, but professional counsellors are not available. Moreover, provisions of staff and community facilities for the early supervision of children might be more successful than supplying highly trained professional counsellors. The NWT considers it would need more social workers indigenous to the community, and such facilities as nursery schools and day care centres to counteract the anticipated increases in child-centred problems such as child neglect and juvenile delinquency (Forth et al., 1974).

F.3.19.6 Discord between native men and women might take many forms. The pressures of wage employment for men, and the lack of meaninful roles and loneliness for their wives, might lead to increased drinking. This could eventually lead to loss of job, wife beating, and child neglect (Stevenson, 1968). Also young native women who are often better educated than native males, sometimes prefer to associate with non-native men, and this might cause resentment among the native men (Lubart, 1970). Furthermore, it has been observed in the northern portions of the provinces that native females often adapt to wage employment more readily than native males; this might well occur in the study area. Therefore, discord between the sexes would likely increase during pipeline development; within the marital situation because of external stresses such as demanding work routines, and in general because of some native women's desire to improve their situation. These psychological stresses are often turned inward towards oneself (as in depression) or outwards towards others (as in wife beating while intoxicated), in both cases requiring professional help.

F.3.19.7 The high demand for labour could attract many people who would not ordinarily participate in the labour force, including students, older people and married women. If these people filled local jobs vacated by the more mobile members of the labour force, labour market pressures might be eased somewhat. Increased labour demand might also result in native young people leaving public or vocational schools to take pipeline related employment. After working for relatively high wages they might find it difficult to return and complete their education or training. In the long run this would hinder development of a native labour force prepared to enter a wide range of occupations.

F.3.19.8 Many NWT government departments are concerned with how native people would handle increased incomes resulting from pipeline related work (Forth et al., 1974); and a researcher has recently indicated that increased income, regardless of source, would lead to increased alcohol consumption by native people (Gemini North, 1973). Therefore, the NWT Department of Education is planning to offer home and money management courses to native people in the study area. While the education aspect of money management is important, other measures are needed such as a consumer protection ordinance and a range of positive and attractive alternative ways for using money. For example, investment opportunities such as credit unions, banks and home ownership are needed, as well as ensuring the availability of various durable consumer goods.

F.3.19.9 Many native people, government officials and researchers agree that the proposed pipeline development would increase the alcohol problem in the study area; and it is considered the most pressing social problem at present. Much has been written on the misuse of alcohol in the North; the extent and seriousness of this problem requires no further elaboration. Moreover, much is known about all phases of the problem from causation to methods of treatment and rehabilitation. Thus the problem can be defined and successfully controlled and treated within limits, if there is determination on the part of Government and industry to act and if appropriate resources are allocated. A recent study on alcoholism in the North includes recommendations to the federal government for a comprehensive program of alcohol education and treatment (Wacko, 1973). Another study concerned with the general effects of development in the Northwest Territories also recommends a specific program to control alcohol problems in the Mackenzie valley (Forth et al., 1974).

F.3.19.10 The final problem to be examined at the family level is that of the elderly and infirm. In the essentially native settlements, parents and grandparents often live in one dwelling or aged parents live near their sons or daughters. This pattern would be broken during the construction phase if families were to relocate to settlements close to the construction activity leaving their elderly and infirm kin behind without supervision or care. Every effort would have to be made in these cases, in terms of housing, special allowances, etc., to facilitate keeping the members of the extended family together. In addition, prior to commencement of the proposed development activity, the NWT Department of Social Development would have to develop contingency plans in each study area settlement for the care and supervision of the elderly and infirm who might be left behind.

F.3.19.11 Community conditions likely to affect the adjustment of native people in the growing centres during the proposed pipeline development can be broken into two categories. One includes conditions resulting from physical growth and change that would apply to any community; the other includes the ethnic irritations that are likely to become actual issues during pipeline development. Both categories would have implications for assessment of any application.

F.3.19.12 Conditions arising from physical growth which would be potentially disruptive of community relations include: lack of community planning; shortages of serviced land, basic utilities, and accommodations; lag in public programs to meet the needs of a growing population and inadequacies in delivering these services; lack of access for northern entrepreneurs to expanding business opportunities; and failure of the communities to benefit from cheaper energy. As indicated in paragraphs F.3.4.9 and F.3.9.5, the NWT is undertaking studies of entrepreneurial opportunities, and housing and community planning. Housing shortages resulting in overcrowding have well known effects on personal health and social adjustment, as well as on community relations. Early impressions from the housing and community planning studies, indicate there is pressure now on housing in the larger centres of the study area (NWT, Dept. of Local Government, 1974, personal communication). With pipeline development, the pressure would grow and the cost of providing required accommodation, serviced land and related facilities would be very high.

F.3.19.13 The studies concerning entrepreneurial opportunities are progressing (NWT, Dept. of Local Government, 1974, personal communication). The search for viable enterprises will be difficult, since the North presents many obstacles to local industries including: a fairly unskilled labour force; a paucity of investment capital; a small local market; and high transportation costs. Pipeline development would probably create various opportunities in the construction, transportation, and service industries; however, many of these related industries would likely close down as the boom declined. It is important therefore to seek out industries with a long life potential, and those that would process or manufacture products required in the area.

F.3.19.14 As noted previously, the anticipated population growth associated with proposed pipeline construction would require additional education and welfare services and facilities in many communities in the study area. In addition, the methods of delivering some of these services would require upgrading or innovation. Education services in the study area are reasonably adequate and although additions to staff and facilities would require some lead time and funds, they would probably not be a great problem. Welfare services, on the other hand, would require the strengthening of such components as child care, child protection, family counselling and correctional and alcohol treatment services.

F.3.19.15 Health services pose a different challenge. The extent of the anticipated demand for increased health services related to pipeline and highway development is not clear. Therefore, a study on the subject was begun in 1974 under the auspices of the government of the Northwest Territories. Considering past difficulties in attracting medical specialists and dentists to larger centres in the northern territories, it is anticipated that special measures would be required in the study area.

F.3.19.16 Recently the NWT began a recreation program involving staff assistance in leadership and the provision of such facilities as community centres and portable swimming pools for summer use. Despite these efforts, the available recreational facilities in most communities are very limited and the 'bar' is often the only public place for socializing. The situation would worsen with the pressure of additional pipeline workers unless definite steps were taken to upgrade existing recreational facilities.

F.3.19.17 Concerns that local businessmen would have little opportunity to share in the increased economic activity, and that communities would not benefit from cheaper energy are very real at the local level. Because of the complexity and scale of the proposed pipeline development, special efforts by the large contractors would be required to ensure that northern businessmen and contractors participate to the maximum of their capabilities. Such efforts, if they were made, would do much to correct Northerners' concerns about lack of opportunities to benefit from resource industries developed by southern companies. It would also help counteract the usual complaint that outsiders receive preferential treatment and that local residents are bystanders when a business boom occurs. In a similar manner, bringing natural gas or electricity developed from it to communities adjacent to the proposed route would do much to promote the feeling that the pipeline development was worthwhile.

F.3.19.18 The pipeline development could avoid being an irritant to native residents by paying attention to such things as: land use planning with due consideration for traditional activities and usage; opportunities for high paying jobs for Natives; equal quality housing for Natives; and ensuring residents' retention of control over local matters. Community and industrial development planning in and around native settlements would have to consider present uses of land and water, for example not planning a pipeline crossing where the Natives usually fish. Although most native people have yet to select land in accordance with Treaties 8 and 11, some bands, such as the one at Hay River, have requested that the Minister of Indian and Northern Affairs reserve certain lands for their use. Other bands might follow suit, but in any event both Government and industry would have to consider traditional land uses before deciding on the pipeline route alignment.

F.3.19.19 Despite the training and employment program instituted by one company in 1971 to prepare Natives and other northern residents for pipeline development, it might appear that native people were employed only as labourers. This could occur because there was little local response to the training program, or because workers who left a community were employed elsewhere. In order to alleviate this problem, native workers who had completed a training program and were qualified for jobs in the higher occupation levels could be employed in or near their home communities to serve as 'role models' for other native people and to demonstrate that Natives could compete for better jobs.

F.3.19.20 Allocation of housing is another important issue. The past disparity between native housing and that provided for government and industry employees has been a source of poor ethnic relations (Parsons, 1970). The anticipated population increase in growing centres would require a substantial amount of new housing; and the majority would probably be built by Government and industry. The needs of native and non-native people for better or additional housing would have to receive equal consideration in allocating these new units.

F.3.19.21 The final issue at the community level with an important bearing on ethnic relations and the adjustment of native people is community control and participation in the decision making process on local matters. Officials in the NWT Department of Local Government and natives people in local communities have expressed their concern; and appear to be searching for restrictive measures to prevent outsiders from taking over control of settlements, particularly the native communities (Forth et al., 1974). Instead of restrictive measures, it would be preferable for Government and industry, together with settlement organizations, to seek positive measures to ensure local control over community matters. In addition, Government and industry would have to be prepared to establish a method for obtaining local input into pipeline development decisions that would have an important influence on local matters.

Appendix F

Table I Estimated Man Years of Employment, 1977, 1980 and 1983

	Pipeline Construction Profile Year 1977	Buildup to Capacity Profile Year 1980	Capacity Operation Profile Year 1983
Pipeline Development[1]	7,375	746	222
Additional *Minor Petroleum Discoveries*[2]	2,175	2,400	1,945
Additional *Major Petroleum Discoveries*	4,420	7,200	5,990

Source of data:
[1] Manders, 1973
[2] INA/MPS, 1973, V. 1, Tables 31 and 33

Table II Estimated Active[1] Labour Force with Pipeline Related Skills or Experience by Ethnic Group, Northern Territories, 1977, 1980 and 1983

Active Skilled Labour Force (15-64 years of age)	Pipeline Construction Profile Year 1977		Buildup to Capacity Profile Year 1980		Capacity Operation Profile Year 1983	
	#	%	#	%	#	%
Natives						
The Study Area	627	6	661	6	684	5
Rest of the Northern Territories	2,350	22	2,702	22	3,078	22
Total	2,977	28	3,363	28	3,762	27
Non-natives						
The Study Area	1,023	10	1,152	10	1,254	9
Rest of the Northern Territories	6,484	62	7,514	62	8,681	63
Total	7,507	72	8,666	72	9,935	72
Total Active Skilled Labour Force	10,484	100	12,029	100	13,697	100

[1] Men and women who are either employed or looking for work
Source of data: Based on Manders, 1973; Table V, Appendix F

Appendix F — *(continued)*

Table III Estimated Available Labour Force with Pipeline Related Skills or Experience by Ethnic Group, Northern Territories, 1977, 1980 and 1983

Available Skilled Labour Force	Pipeline Construction Profile Year 1977		Buildup to Capacity Profile Year 1980		Capacity Operation Profile Year 1983	
	#	%	#	%	#	%
Natives						
The Study Area	298	*26*	347	*24*	360	*23*
Rest of the Northern Territories	377	*33*	530	*37*	602	*38*
Total	*675*	*59*	*877*	*61*	*962*	*61*
Non-natives						
The Study Area	153	*13*	175	*13*	188	*12*
Rest of the Northern Territories	324	*28*	376	*26*	434	*27*
Total	*477*	*41*	*551*	*39*	*622*	*39*
Total Available Skilled Labour Force	1,152	*100*	1,428	*100*	1,584	*100*

Source of data: Based on Manders, 1973; Table V, Appendix F

Table IV Estimated Available Labour Supply by Selected Major Occupation Categories and Ethnic Group, Northern Territories, 1977

Occupation Categories[1]	Available Jobs	NATIVE Study Area	NATIVE Rest of Northern Territ.	NATIVE Total	NATIVE Surplus Labour[2]	NATIVE Surplus Jobs[2]	NON-NATIVE Study Area	NON-NATIVE Rest of Northern Territ.	NON-NATIVE Total	NON-NATIVE Surplus Labour[3]	NON-NATIVE Surplus Jobs[3]
Administrative trainee	*81*	15	18	33	—	*48*	19	50	69	21	—
Carpenter	*131*	2	5	7	—	*124*	4	9	13	—	*111*
Carpenter's apprentice	*53*	21	25	46	—	*7*	3	6	9	2	—
Cook's helper	*243*	6	8	14	—	*229*	4	8	12	—	*217*
Driver (truck and bus)	*795*	13	20	33	—	*762*	8	16	24	—	*738*
Electrician's apprentice	*53*	1	2	3	—	*50*	3	10	13	—	*37*
Engineer (professional)	*36*	1	1	2	—	*34*	1	3	4	—	*30*
Foreman	*204*	3	5	8	—	*196*	8	10	18	—	*178*
Labourer (general)	*1,883*	164	211	375	—	*1,508*	13	24	37	—	*1,471*
Mechanic	*151*	2	3	5	—	*146*	11	19	30	—	*116*
Mechanic's helper	*167*	3	2	5	—	*162*	4	5	9	—	*153*
Millwright	*143*	1	2	3	—	*140*	1	8	9	—	*131*
Oiler	*166*	1	3	4	—	*162*	1	1	2	—	*160*
Office assistant	*71*	6	5	11	—	*60*	25	60	85	25	—
Plumber's apprentice	*53*	1	2	3	—	*50*	1	1	2	—	*48*
Principal operator	*1,037*	23	30	53	—	*984*	8	19	27	—	*957*
Surveyor's assistant	*70*	1	1	2	—	*68*	7	10	17	—	*51*
Technician	*83*	1	1	2	—	*81*	1	1	2	—	*79*
Welder	*711*	1	1	2	—	*709*	2	3	5	—	*704*
Welder's helper	*775*	13	15	28	—	*747*	1	3	4	—	*743*
Other occupations	*469*	19	17	36	—	*433*	28	58	86	—	*347*
Total	*7,375*	*298*	*377*	*675*	—	*6,700*	*153*	*324*	*477*	*48*	*6,271*

[1] Includes only those occupations which could be filled by residents of the Northern Territories
[2] This figure was derived by subtracting the *total* number of *Natives* from the number of *available* jobs
[3] This figure was derived by subtracting the *total* number of *Non-natives* from the number of *surplus* jobs

Source of data: Based on Manders, 1973, Table 3

Appendix F — *(continued)*

Table V Estimated Available Labour Supply by Selected Major Occupation Categories and Ethnic Group, Northern Territories, 1980

Occupation Categories[1]	Available Jobs	NATIVE Study Area	NATIVE Rest of Northern Territ.	NATIVE Total	NATIVE Surplus Labour[2]	NATIVE Surplus Jobs[2]	NON-NATIVE Study Area	NON-NATIVE Rest of Northern Territ.	NON-NATIVE Total	NON-NATIVE Surplus Labour[3]	NON-NATIVE Surplus Jobs[3]
Administrative trainee	*6*	19	25	44	38	—	21	57	78	116	—
Carpenter	*43*	2	6	8	—	*35*	4	10	14	—	*21*
Carpenter's apprentice	*33*	25	37	62	29	—	4	6	10	39	—
Cook's helper	*20*	8	16	24	4	—	4	12	16	20	—
Driver (truck and bus)	*7*	15	26	41	34	—	9	18	27	61	—
Electrician's apprentice	*33*	1	3	4	—	*29*	4	11	15	—	*14*
Engineer (professional)	*11*	1	1	2	—	*9*	1	4	5	—	*4*
Foreman	*19*	3	7	10	—	*9*	8	12	20	11	—
Labourer (general)	*192*	189	295	484	292	—	14	27	41	333	—
Mechanic	*8*	2	5	7	—	*1*	13	23	36	35	—
Mechanic's helper	—	3	4	7	7	—	4	5	9	16	—
Millwright	*88*	1	3	4	—	*84*	2	9	11	—	*73*
Oiler	—	1	1	2	2	—	1	1	2	4	—
Office assistant	*15*	7	9	16	1	—	30	70	100	101	—
Plumber's apprentice	*32*	1	2	3	—	*29*	1	1	2	—	*27*
Principal operator	*52*	27	44	71	19	—	10	23	33	52	—
Surveyor's assistant	—	1	1	2	2	—	8	11	19	21	—
Technician	*50*	1	1	2	—	*48*	1	1	2	—	*46*
Welder	*7*	1	1	2	—	*5*	3	4	7	2	—
Welder's helper	—	15	21	36	36	—	1	4	5	41	—
Other occupations	*130*	24	22	46	—	*84*	32	67	99	15	—
Total	*746*	*347*	*530*	*877*	*464*	*333*	*175*	*376*	*551*	*367*	*185*

[1] Includes only those occupations which could be filled by residents of the Northern Territories
[2] This figure was derived by subtracting the *total* number of *Natives* from the number of *available* jobs
[3] This figure was derived by subtracting the *total* number of *Non-natives* from the number of *surplus* jobs
Source of data: Based on Manders, 1973, Table 3

Table VI Estimated Available Labour Supply by Selected Major Occupation Categories and Ethnic Group, Northern Territories, 1983

Occupation Categories[1]	Available Jobs	NATIVE Study Area	NATIVE Rest of Northern Territ.	NATIVE Total	NATIVE Surplus Labour[2]	NATIVE Surplus Jobs[2]	NON-NATIVE Study Area	NON-NATIVE Rest of Northern Territ.	NON-NATIVE Total	NON-NATIVE Surplus Labour[3]	NON-NATIVE Surplus Jobs[3]
Administrative trainee	—	19	28	47	47	—	23	56	79	126	—
Carpenter	*8*	3	7	10	2	—	4	12	16	18	—
Carpenter's apprentice	—	26	42	68	68	—	4	7	11	79	—
Cook's helper	—	8	8	16	16	—	5	10	15	31	—
Driver (truck and bus)	*8*	15	33	48	40	—	9	22	31	71	—
Electrician's apprentice	—	1	3	4	4	—	4	15	19	23	—
Engineer (professional)	*10*	1	1	2	—	*8*	1	4	5	—	*3*
Foreman	*10*	3	9	12	2	—	9	13	22	24	—
Labourer (general)	*28*	195	339	534	506	—	16	32	48	554	—
Mechanic	*15*	3	6	9	—	*6*	13	26	39	33	—
Mechanic's helper	—	3	5	8	8	—	5	6	11	19	—
Millwright	—	2	3	5	5	—	2	10	12	17	—
Oiler	—	1	1	2	2	—	1	2	3	5	—
Office assistant	*19*	7	11	18	—	*1*	33	82	115	114	—
Plumber's apprentice	—	2	2	4	4	—	1	2	3	7	—
Principal operator	*16*	28	50	78	62	—	10	26	36	98	—
Surveyor's assistant	—	1	2	3	3	—	8	15	23	26	—
Technician	*54*	1	1	2	—	*52*	1	2	3	—	*49*
Welder	*12*	1	2	3	—	*9*	3	4	7	—	*2*
Welder's helper	—	15	24	39	39	—	1	5	6	45	—
Other occupations	*42*	25	25	50	8	—	35	83	118	126	—
Total	*222*	*360*	*602*	*962*	*816*	*76*	*188*	*434*	*622*	*1,460*	*54*

[1] Includes only those occupations which could be filled by residents of the Northern Territories
[2] This figure was derived by subtracting the *total* number of *Natives* from the number of *available* jobs
[3] This figure was derived by subtracting the *total* number of *Non-natives* from the number of *surplus* jobs
Source of data: Based on Manders, 1973, Table 3

Table VII Estimated Gross Wages and Salaries from Pipeline Related Employment, Northern Territories, 1977, 1980 and 1983

Gross Wages and Salaries	Pipeline Construction Profile Year 1977 Study Area	1977 Rest of Northern Territ.	1977 Total	Buildup to Capacity Profile Year 1980 Study Area	1980 Rest of Northern Territ.	1980 Total	Capacity Operation Profile Year 1983 Study Area	1983 Rest of Northern Territ.	1983 Total
	$	$	$	$	$	$	$	$	$
Native	1,774,828	2,264,344	4,039,172	1,766,591	506,358	2,272,949	581,115	68,164	*649,279*
Non-native	445,974	869,645	1,315,619	337,865	387,580	725,445	209,730	91,864	*301,594*
All Groups	*2,220,802*	*3,133,989*	*5,354,791*	*2,104,456*	*893,938*	*2,998,394*	*790,845*	*160,028*	*950,873*

Source of data: Based on Manders, 1973

Appendix F — *(concluded)*

Table VIII Estimated Added Population in Each Regional Centre, Study Area, 1975-83

Type of Activity		1975	1976	1977	1978	1979	1980	1981	1982	1983
Pipeline Development	— Families	9	47	60	60	65	43	43	43	50
	Single	17	68	80	80	69	27	27	27	50
	Temporary	87	33	59	59	68	5	5	5	—
Public Sector	— Families	22	22	22	22	22	20	18	16	11
	Single	21	21	21	21	21	18	16	14	10
	Temporary	—	—	—	—	—	—	—	—	—
Private Sector	— Families	10	15	20	20	20	20	15	10	5
	Single	10	15	20	25	25	20	15	10	5
	Temporary	—	—	—	—	—	—	—	—	—
Total	— *Families*	*41*	*84*	*102*	*102*	*107*	*83*	*76*	*69*	*66*
	Single	*48*	*104*	*121*	*126*	*115*	*65*	*58*	*51*	*65*
	Temporary	*87*	*33*	*59*	*59*	*68*	*5*	*5*	*5*	—
Total Number of Dependents		*143*	*294*	*357*	*357*	*374*	*290*	*266*	*242*	*231*
Total Added Population		*319*	*515*	*639*	*644*	*664*	*443*	*405*	*367*	*362*

For Section F.3.8, to calculate added population contributed by any type of activity, use 3.5 dependents per family

Source of data: Derived from INA/MPS, 1973, V. 1, Table 21

G

Conclusions and Recommendations

G.1 General Conclusions and Recommendations

G.1.1 Assessment of a specific pipeline application for the Mackenzie valley and northern Yukon should not consider the proposed pipeline in isolation. Instead, an application should be assessed in relation to the cumulative effects of all planned development activities within the study area (paragraph F.2.7.13). In addition, if such a project proceeds, a primary objective should be to ensure that any negative effects on the environment and northern society are avoided or minimized, and the benefits maximized.

G.1.2 If there is a decision to proceed with the construction of proposed northern pipelines, it would be important to carry out measurements of the environmental side effects. This *monitoring* process would serve to: (i) obtain an early warning of emerging problems so that preventive or corrective action could be taken; (ii) ensure that specified terms and conditions were being followed; (iii) allow a distinction between changes brought about by natural causes and those resulting from the project itself; and (iv) obtain a better scientific understanding of cause and effect relationships. It is beyond the scope of this report to recommend which factors should be monitored by industry, which by Government, and which by both Government and industry. However, monitoring of at least three subject areas would be desirable: (i) the integrity of the pipeline system (monitoring for pressure and temperature changes or leaks as well as for external factors that might be a threat to the pipeline); (ii) the physical environment (monitoring soil stability, movement and temperature, groundwater levels, surface water flow, and air and water quality); and (iii) the biological environment (monitoring plant and animal populations, distribution, and habitat productivity).

G.1.3 *Early planning should be undertaken to set up a system for monitoring the socio-economic effects of the pipeline on the people and communities of the Mackenzie valley*. The monitoring process would serve to: (i) ensure that the conditions and agreements attached to the application were being followed; (ii) document the extent of benefits or costs attributable to the various phases of the pipeline development; (iii) help distinguish between factors directly and indirectly influenced by the development over the short and intermediate term, so that remedial action could be taken when undesirable trends were identified; and (iv) identify those factors significant to social and economic change for forming a basis to understand the effects of other developments of a similar nature in the northern territories. Studies conducted under the Environmental-Social Program have identified some key variables that should be considered in this monitoring process (Fig. B-2).

G.2 Environmental and Resource Use Conclusions and Recommendations

G.2.1 *Conclusions and Recommendations – Proposed Pipeline Route Selection*

G.2.1.1 Proposed pipeline routes between the Northwest Territories-Alberta and the Alaska-Yukon borders cross little mountainous terrain except for the alternative across the Richardson Mountains west of Fort McPherson. The proposed development is therefore relatively free of hazards associated with construction on very steep mountain slopes (paragraphs F.2.2.1 and F.2.2.2). During construction, however, hazards associated with steep river banks and valley walls would be encountered.

G.2.1.2 Natural river icings (surface accumulations of ice that build up during the winter and usually last throughout the summer) are not expected to cause engineering problems (paragraphs C.5.12 and C.5.13). However, icings induced by a chilled gas pipeline could result in heaving and in serious disruption of surface drainage. These, in turn, could lead to ponding and acceleration of both thermokarst development and stream erosion (paragraphs F.2.3.5 and F.2.3.6).

G.2.1.3 Glaciated uplands and local windblown sand deposits generally provide the best route alternatives and sources of construction materials (paragraphs F.2.2.1, F.2.3.3, F.2.3.8). Silt and clay soils are usually the least satisfactory because they have higher contents of excess ice and are more susceptible to surface disturbances, particularly on slopes.

G.2.1.4 Earthquake risk is greatest in the area surrounding and south of Fort McPherson, NWT (section C.4.1). However, even in this relatively restricted area, the risk is lower than that calculated for the area of southern Alaska which the Alaska oil pipeline will cross (Stevens and Milne, 1973).

G.2.1.5 *With respect to fish resources, the Mackenzie delta, Big Fish, Rat and Trout Rivers and Jean Marie Creek, are either very sensitive to disturbance or important for domestic use. If pipeline activities are proposed for these river systems, restrictions on construction techniques and scheduling would be required in order to adequately protect this resource* (Stein et al., 1973).

G.2.1.6 Dall sheep, peregrine falcons and bald eagles are very sensitive to disturbances from man's activities (sections C.8.3.4 and C.8.3.12), and they are the wildlife species that would likely be most affected by proposed northern pipeline development.

Careful route selection and siting of associated facilities would be essential to protect these species (paragraphs F.2.2.11 and F.2.3.13).

G.2.1.7 *Because of its broad environmental sensitivity, particularly with regard to fish and wildlife, the Mackenzie delta should be studied and monitored intensively if proposed pipelines are to be located there* (MacKay, 1973).

G.2.2 *Conclusions and Recommendations – Proposed Pipeline Construction*

G.2.2.1 Conventional techniques for constructing earthworks to control accelerated erosion are unsatisfactory in ice rich permafrost terrain. The frozen condition of northern soils imparts a stability to them, and preservation of this frozen state is important for maintaining terrain stability. An insulating organic layer over the mineral soil is of the utmost importance for preserving the permafrost. *It is therefore desirable to avoid compacting, rutting or removing soil in ice rich permafrost areas during pipeline construction activities.*

G.2.2.2 Responses of ice rich permafrost terrain to surface disturbances vary with the season: the frozen state in winter is the least vulnerable; the thawing state in spring is the most vulnerable; and the relatively dry state in summer and fall is of intermediate vulnerability (Strang, 1973). In the case of a buried pipeline cutting across drainage courses on moderately steep slopes, the major concern is springtime erosion of poorly compacted material from winter construction. The advantages of the higher compaction possible in summer and fall construction should be weighed against the disadvantages of increased vegetation disturbance during the growing season. *It is recommended that project design and construction plans take particular account of seasonal differences in terrain stability.*

G.2.2.3 Continued use of a winter road for two or more years, using snow packed methods of construction, may retard recovery of vegetation for an indefinite period (Kerfoot, 1972; Lambert, 1972). *It is recommended that use of snow packed roads be limited to just one winter to ensure rapid recovery of vegetation.*

G.2.2.4 If man made structures hinder natural drainage, ponding may result and any icy materials below the surface may melt, resulting in subsidence. *Structures that would disrupt natural drainage and cause ponding should therefore be avoided in areas underlain by ice rich permafrost* (paragraphs F.2.3.1 and F.2.3.5).

G.2.2.5 *Construction of roads or pads in ice rich permafrost should follow the end dumping method.* (This involves dumping the construction material on the *undisturbed* terrain to build up a working surface, thereby ensuring the protection of the natural insulating layer beneath the finished construction.) *In addition, the insulating cover on the remainder of the working area should be restored if it is damaged or destroyed during construction* (Strang, 1973; Zoltai and Pettapiece, 1974).

G.2.2.6 Many gravel river beds are important breeding areas for fish. In addition, the size and arrangement of stones on the river bed are adjusted to the flow conditions and protect the river bed from erosion. *It is therefore recommended that disturbance of gravel river beds be minimized. If the natural surface is disturbed, it should be replaced to the natural level with stones of the same size; this can be most readily accomplished when stream flow is low* (McDonald and Lewis, 1973). *As a general precaution, sharp river bends should be avoided as pipeline crossing points* (Code, 1973).

G.2.2.7 Except for sand and gravel, unconsolidated sediments in the Tuktoyaktuk peninsula-Mackenzie delta-Yukon Coastal Plain region usually contain large volumes of excess ice. If this ice is permitted to melt appreciable subsidence will result, with accompanying loss of soil strength (Rampton, 1974). *Any proposal to bury a warm pipeline in perennially frozen ice rich soils should be accompanied by strategies for preserving their naturally frozen state.*

G.2.2.8 Many coastal beaches and spits are archaeologically and biologically important. *It is therefore recommended that before removal of material from such areas is allowed studies be carried out to determine whether such removal is acceptable, and if so, under what terms and conditions* (paragraph F.2.6.3). *In addition, the spectacular granite remnants that occur on the unglaciated hills in the western part of the Old Crow Range should also receive specific protection against possible quarrying for rock fill* (Hughes et al., 1973).

G.2.2.9 *Man induced siltation should be kept to a minimum in the course of constructing pipeline crossings through relatively clear rivers* (paragraphs F.2.2.11 and F.2.3.9). *Because springs provide open water areas in winter and enable the recolonization of fish food organisms in streams and rivers after spring floods, it is recommended that construction activities avoid disrupting the discharge of groundwater in the vicinity of these springs* (paragraph F.2.3.10).

G.2.2.10 *To lessen the disruption of behavioral patterns of most wildlife species, construction activities should be restricted to the period from November 15 to April 15 in areas where such wildlife species are particularly sensitive.* This would avoid most major migration, nesting or reproductive periods, and would coincide with the inactive period for grizzly bears and black bears (paragraph F.2.6.8).

G.2.2.11 *It is recommended that the pipeline avoid the more important and sensitive moose and sheep habitats, thereby lessening the possibility of their loss during construction activities, and that terrain damaged by construction activities be revegetated in the first growing season thereafter.* In addition, camps, compressor stations, air strips, and supply and maintenance roads should be located away from the critical wildlife areas shown on maps prepared under the Environmental-Social Program (paragraphs F.2.2.11 and F.2.3.12). Increased human activity, involving a wide variety of vehicles, might have to be strictly controlled in some sensitive areas.

G.2.2.12 *Recommended safeguards to prevent undue disturbance to barren-ground caribou during pipeline construction are: (i) to halt construction along the probable migration routes prior to spring migrations; and (ii) if it is necessary to have construction camps or open trenches in the path of spring migrations, to create visual and physical barriers, such as flagging or snow fencing.* More specific recommendations for caribou protection are contained in another published report (Watson et al., 1973). Recommended practices include dates for closing of trenches, minimum flight altitudes to reduce harassment from aircraft, control of firearms and all-terrain vehicles, and avoiding disturbance, particularly when caribou are crowded together in large dense herds.

G.2.2.13 Except for the Richardson Mountains, pipeline routes proposed at present are well away from the mountains and thus avoid most Dall sheep range. Low flying aircraft and helicopters are particularly disturbing to these animals. *Aircraft should be kept as far away as possible from Dall sheep range at all times, but particularly during the winter when their feeding areas are restricted and in spring at lambing time* (Watson et al., 1973).

G.2.2.14 Harassment of arctic fox by aircraft, heavy equipment, or explosives might result in females abandoning their young. *Known denning sites should be avoided from mid May to early September in order to reduce fox harassment* (Watson et al., 1973).

G.2.2.15 The large migration of waterfowl along the Mackenzie River spans all of May and part of June. *Disturbance by man or aircraft of breeding swans and geese are most likely to occur from May 20 to July 1 and it is recommended that disturbance be avoided during this period* (Watson et al., 1973).

G.2.2.16 To date research has not revealed any effective chemical repellent for bears. *For this reason, the best defence is to maintain camp cleanliness including appropriate storage or disposal of materials that attract bears. Another recommended precaution is to avoid man-bear contacts in the vicinity of known denning sites from early April to mid June* (Watson et al., 1973).

G.2.3 *Conclusions and Recommendations – Proposed Pipeline Operation*

G.2.3.1 The increased activity associated with operating one or more pipelines in the Mackenzie valley and northern Yukon would result in a greater risk of fire. *Fire suppression planning should consider: (i) changes in priority zones necessitated by proposed pipeline development; and (ii) the environmental side effects that could result from a given fire suppression plan in the vicinity of gas or oil pipelines* (paragraph F.2.7.7).

G.2.3.2 *Explicit contingency plans for dealing with oil spills should accompany any proposal for an oil pipeline. These should include plans for containment and removal of the oil, and for rehabilitation of the damaged areas.*

G.2.3.3 Near settlements and airports, facilities such as power plants or incinerators which produce exhaust should be located in such a way that exhaust fumes do not concentrate to produce ice fog during cold, calm weather. *Aircraft landing strips should be located away from combustion sources and automobile traffic near airports should be minimized in very cold weather* (paragraphs F.2.2.8 and F.2.4.5).

G.2.3.4 Increased hunting and fishing pressures resulting from improved access provided by pipeline related roads and airstrips, together with an expected increase in use of all-terrain vehicles and aircraft, could be one of the greatest influences on the harvesting and management of fish and wildlife species. The control of illegal hunting could be a major administrative task.

G.3 Local Social and Economic Conclusions and Recommendations

G.3.1 Most archaeological and historical sites found near the proposed pipeline routes are of such a nature as to be easily destroyed by pipeline construction activities. Such extensive archaeological deposits as Engigstoiak, Klo-kut, Old Chief, Rat Indian Creek, Kittigazuit and Kopuk would require total protection from construction activities mainly because of their size, their nature and their cultural importance (Cinq-Mars, 1974). *More detailed examination of the proposed routes might reveal similarly important sites that should be avoided. In addition, qualified archaeological staff should be assigned to the various pipeline construction spreads and related activities, so that contingency measures for special salvage procedures could be implemented quickly for sites of lesser importance.*

G.3.2 The population of the study area is small and young, with a high rate of natural increase in comparison to that of Canada as a whole. Present estimates of the study area's population indicate that there are approximately equal numbers of Natives and Non-natives. If the proposed pipeline development were to proceed, there would likely be a relatively large increase in the area's population due to the labour demands created by the pipeline and the native population's continued high rate of natural increase. However, the main increments to the total population would result from the migration of workers from outside the region (paragraph D.6.1.3).

G.3.3 In terms of gross numbers, there is expected to be minimal movement between settlements during the proposed development. Nevertheless, there would be some intra-regional migration during the construction phase, plus a considerable influx of people from outside the region. The pull of workers into strategically located centres would likely expand the service facilities in these centres, providing secondary employment. This centralizing effect, where larger centres tend to grow and smaller ones decline, would continue well into the post-construction period (paragraph F.3.8.7).

G.3.4 The relocation of native families from their home settlements to industrial employment sites some distance away has had limited success in the past (paragraphs D.5.6.4 through D.5.6.6), and the success of future mobility programs is by no means assured. *Some spontaneous relocation of native families from their home settlements to labour demand centres adjacent to the proposed pipeline route should, however, be anticipated. A contingency mobility program should therefore be established to provide a comprehensive range of services to assist native families who wish to move.*

G.3.5 Recent construction activities in the general region, such as the Pointed Mountain pipeline and Hire North's clearing activities on the Mackenzie Highway suggest that single native men in particular adjust satisfactorily to construction work and camp life away from their home settlements (paragraph F.3.7.8). *Where native men have an interest in pipeline work, appropriate preparatory training, and a willingness to live in a camp setting, they should be encouraged to take the training and employment opportunities made available by the proposed pipeline development.*

G.3.6 Over the past few years, reasonably well educated single native women have been moving from small settlements in the study area to compete successfully for work in the service sector of the growing centres in the valley (Forth et al., 1974). *Native women should receive training and employment opportunities arising from the proposed pipeline development on an equal basis with native men.*

G.3.7 The main short term benefits of the proposed development for Natives would be the increased employment and income opportunities. During the logistics buildup and main construction years all Natives who desire it, from the study area at least, should have ample opportunities for employment on the pipeline development (Fig. F-6). The increased incomes of Northerners from pipeline related employment and training allowances over the nine year period is forecast to be in the order of $32.3 million (paragraphs F.3.14.1 and F.3.14.2).

G.3.8 The peak demand for pipeline workers would be attained in the third or fourth year of development and decline thereafter. The operation phase would require a relatively small number of fairly highly skilled workers; and a large proportion of those formerly employed on the pipeline would have to turn to other industrial sectors to obtain work (paragraphs F.3.2.7 and F.3.4.5). *Government and industry should plan alternate industrial employment projects in order to avoid a surplus of northern workers, particularly Natives, during the early operation years of the pipeline development.*

G.3.9 The premature influx of southern Canadians to various transportation centres along the proposed pipeline route in speculative search for employment would worsen the local unemployment and welfare situation and increase the rates of social problems and crime (paragraph F.3.7.9). *An active publicity campaign should be undertaken well in advance of commencement of construction to discourage the influx of speculative transients to communities in the study area. In addition, as a precautionary measure, a program should be prepared to deal effectively with such problems as accommodation, job placement, and return transportation so that the transients would not be a burden on the local communities.*

G.3.10 Pipeline construction and operation would result in more extensive involvement of native people in a modern economic system, and in more intensive social contact with Non-natives. Further economic integration and adoption of southern Canadian values and customs could result in heightened psychological pressures on individuals and families and an increase in social problems (paragraphs F.3.6.5 through F.3.6.7).

G.3.11 The *economic importance* of hunting, trapping and fishing to native people is expected to continue to decline due to the attractions of petroleum and pipeline related employment. Trapping which has been mainly a seasonal part-time source of cash income in recent times, would likely be the most affected of the traditional pursuits (paragraphs F.3.6.2 and F.3.6.3). Moreover, there is little likelihood of growth in employment in other renewable resource sectors in the near future comparable to that projected in relation to petroleum and minerals. *In its policy objectives for the North, Government has recognized the goal of "...equality of opportunity for northern residents by methods which are compatible with their own preferences and aspirations"* (paragraph A.5.16), *and should proceed accordingly with programs to provide meaningful alternate employment opportunities for Natives who are unable or unwilling to accept industrial type jobs.*

G.3.12 *The involvement of Natives in hunting and fishing for food and other purposes is expected to remain fairly constant* (paragraph F.3.6.4). Natives normally prefer traditional sources of protein, and the rising price of imported meats might make local game and fish even more attractive. Their need to get out on the land for psychological and recreational reasons is equally important. Interest in, and use of these resources, would likely increase if the proposed pipeline development provided a higher level of income so that Natives could afford better equipment and therefore be able to make more effective use of these resources.

G.3.13 Training related to pipeline employment, and the work experience itself, would improve both the level of skill of the labour force and the labour force participation rate, particularly of the native people, in the area affected (section F.3.7). However, stability of labour demand and variety of occupational opportunities are also required to maintain initial gains, and to ensure that the quality of the study area's labour force would continue to improve.

G.3.14 Training and employment associated with the proposed pipeline would tend to 'cream off' the more competent residents from native settlements to the growing centres. Participants would improve their skills, income, and general living standards, and become a valuable asset to the receiving communities. The donor communities, on the other hand, would lose the more aggressive, better educated members of their work force and possibly their future leaders (Usher, 1972). *It is recommended that all forms of education and training for Natives in the region be expanded and enriched, and that preparation for pipeline related work and employment in non-pipeline jobs receive equal attention. Fundamental to the training thrust is the principle that all occupational training must lead to a clearly identified job upon completion whether it pertains to pipelines or to other sectors.*

G.3.15 From past experience, the performance of native workers on the job is expected to be satisfactory (Stevenson, 1968). However, foreman/native worker relations and the relationships between Natives and Non-natives on the job should be improved (paragraph D.5.7.6). *First line supervisors should receive special training concerning communication with and handling of native workers, and a cadre of native foremen should be trained for the pipeline development. Moreover, non-native pipeline workers should receive short courses on how to get along with native workers.*

G.3.16 Serviced land, housing, and commercial space are in short supply throughout the valley at present; and given a relatively large increase in population due to the proposed development, the present minor shortages could become serious (section F.3.9). The local communities have neither the resources to plan and develop the required infrastructure; nor should they have to accept the responsibility, since the proposed development is largely beyond their control. *Immediate planning should be undertaken to ensure that there would be sufficient serviced land, basic utilities and services, and an adequate* *supply of housing to meet the demands that would be imposed by the various phases of the proposed pipeline construction and operation* (paragraph F.3.19.12).

G.3.17 In addition, population increases in selected centres would strain present community services in the fields of health, education, welfare, policing and recreation (section F.3.10.4). However, after a relatively limited period of shortages, most community services would probable adjust satisfactorily and provide an improved level of service. Where shortages of medical specialists or dentists presently exist or services such as alcoholism prevention and treatment are absent, these situations would likely persist. *Agencies responsible for providing these services to communities in the study area should actively plan for the increases in staffing and facilities indicated by projected demand related to the proposed development pipeline. And extraordinary measures should be pursued to staff those specialist positions where shortages are expected to occur.*

G.3.18 If the proposed pipeline were to proceed, the communities along its route should benefit from modernized local facilities such as sewage and water, and from improved public services including health, education and welfare in the medium term.

G.3.19 The misuse of alcohol is a visible and grave situation in the North, and is a factor underlying many of the social problems and delinquencies that now occur (paragraph F.3.19.9). It is expected that increased local incomes due to the proposed pipeline would tend to aggravate present alcohol abuse. *It is recommended therefore that both territorial governments develop comprehensive alcohol education and treatment programs. Moreover, if the NWT institutes such a program it would be advisable to begin it on a pilot project basis in the Mackenzie valley.*

G.3.20 Efforts have been made to inform people in the study area about the proposed pipeline; however, there is a continuing need to inform the residents about the pipeline and its anticipated effects (Arctic Petroleum Operators Association Seminar, October 1973). *Programs to provide information on matters relating to the proposed pipeline development that are important to local people should be continued, coordinated and intensified.*

G.3.21 Because the environmental and social terms and conditions for the proposed pipeline would likely be very detailed, constant interplay would be required between industry and government agencies in the field to make on the spot decisions. Local government organizations now feel they are not sufficiently involved in decisions concerning local matters, especially regarding recent development activities (Forth et al., 1974). The presence of many senior officials from Government and industry in area communities during the construction phase, and the number and complexity of decisions having some local implications, could result in these communities' feeling that many decisions disregard local input. *It is therefore recommended that prior to the commencement of construction, appropriate means be instituted whereby area communities would have the opportunity to be regularly informed about pipeline plans and procedures having local importance. In addition, each community should clearly understand the degree to which they could participate in, and have some control over, matters relating to pipeline development.*

G.3.22 It is unlikely that private construction and transportation undertakings by Northerners would expand rapidly enough to have the range of expertise required to assume more than a minor share of the increased business created by the proposed pipeline development. Northern businesses in the service sector are likely to be an exception; they might expand to accommodate a substantial proportion of the increase during the construction phase, but they would have to retract once the construction phase was over. *The appropriate government agencies in concert with the interested pipeline consortium should immediately identify new business opportunities related to the proposed pipeline development, and should assist Northerners with feasibility studies and with establishing viable enterprises.*

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* In process of preparation June 1974; titles subject to change.

**Out of print June 1974.

Addresses of Report Publishers

Canada Map Office, Energy, Mines and Resources, 615 Booth Street, Ottawa, K1A 0E9

Information Canada, 171 Slater Street, Ottawa, K1A 0S9 (NOTE: publications are also available from Information Canada outlets in major centres across Canada.)

National Research Council of Canada, Montreal Road, Ottawa, K1A 0S3.

Public Information, Indian and Northern Affairs, 400 Laurier Avenue, Ottawa, K1A 0H4.

Geological Survey of Canada, Energy, Mines and Resources, 601 Booth Street, Ottawa, K1A 0E8. (NOTE: information regarding open file maps related to reports can be obtained from the above address.)

Appendix III

1. Guidelines for Northern Pipelines, 1970

Department of Energy, Mines & Resources
Department of Indian Affairs and Northern Development

For Immediate Release

OTTAWA (August 13, 1970) – Canadian government guidelines for construction and operation of northern oil and gas pipelines were announced jointly today by the Honourable J.J. Greene, Minister of Energy, Mines and Resources, and the Honourable Jean Chrétien, Minister of Indian Affairs and Northern Development.

Knowledge of northern Canada's petroleum potential has been quickly expanding and major companies in the industry have publicly expressed interest in constructing pipelines. Some already have plans and research underway.

It is vital to Canadian economic growth and the protection of our northern environment that the Government of Canada's policies relating to this major economic development be made known now to the public and the industry, the Ministers said. Government leadership in policy and direction of this potential major economic contribution will be maintained and, if required, new guidelines will be issued, they added.

The guidelines relate to pipelines tapping oil and gas resources north of the 60th degree of latitude in the Yukon Territory and the Northwest Territories and from Alaska. They establish requirements ranging from environmental protection, pollution control and Canadian ownership and participation to training and employment of residents of the north. Initially, only one trunk line each for oil and gas will be permitted in the north within a "corridor" to be established at a future date.

Mr. Greene and Mr. Chrétien met in Ottawa today with the National Advisory Committee on Petroleum to discuss these requirements with its members and bring the guidelines to the attention of the oil and gas industry as a whole.

The new guidelines for northern pipelines are as follows:

1. The Ministers of Energy, Mines and Resources, and Indian Affairs and Northern Development will function as a point of contact between Government and industry, acting as a Steering Committee from which industry and prospective applicants will receive guidance and direction to those federal departments and agencies concerned with the particular aspects of northern pipelines.

2. Initially, only one trunk oil pipeline and one trunk gas pipeline will be permitted to be constructed in the north within a "corridor" to be located and reserved following consultation with industry and other interested groups.

3. Each of these lines will provide either "common" carrier service at published tariffs or a "contract" carrier service at a negotiated price for all oil and gas which may be tendered thereto.

4. Pipelines in the north, like pipelines elsewhere which are within the jurisdiction of the Parliament of Canada, will be regulated in accordance with the National Energy Board Act, amended as may be appropriate.

5. Means by which Canadians will have a substantial opportunity for participating in the financing, engineering, construction, ownership and management of northern pipelines will form an important element in Canadian government consideration of proposals for such pipelines.

6. The National Energy Board will ensure that any applicant for a Certificate of Public Convenience and Necessity must document the research conducted and submit a comprehensive report assessing the expected effects of the project upon the environment. Any certificate issued will be strictly conditioned in respect of preservation of the ecology and environment, prevention of pollution, prevention of thermal and other erosion, freedom of navigation, and the protection of the rights of northern residents, according to standards issued by the Governor General in Council on the advice of the Department of Indian Affairs and Northern Development.

7. Any applicant must undertake to provide specific programs leading to employment of residents of the north both during the construction phase and for the operation of the pipeline. For this purpose, the pipeline company will provide for the necessary training of local residents in coordination with various government programs, including on-the-job training projects. The provision of adequate housing and counselling services will also be a requirement.

The Federal Government will maintain a continuing review of proposals for the construction of northern pipelines and has underway a general review of foreign ownership and control. Further guidelines may be issued as a result of such reviews and would apply to all applications for such pipelines.

2. Expanded Guidelines for Northern Pipelines, 1972

as tabled in the House of Commons June 28, 1972 by the Honourable Jean Chrétien

Foreword

The Government is today making known its current views on expanded guidelines for the construction and operation of oil and gas pipelines in the Yukon Territory and the Northwest Territories. The proposed guidelines deal with the corridor concept, the environment, and social implications, and are a further elaboration of those announced in August 1970 by the Minister of Energy, Mines and Resources and the Minister of Indian Affairs and Northern Development.

The Government's purpose in expressing these latest views is to give further guidance to industries engaged in research and planning in connection with northern pipelines and to afford the opportunity to northern residents, and all others concerned to make observations on the guidelines proposed.

In particular, the Government is ready to sit down with the representatives of the native peoples involved, invite their views on the guidelines proposed, and reflect these views wherever possible.

It is the Government's intention, after making any such modifications, to bring these expanded guidelines into force on or about December 31, 1972.

Preamble

Initial Canadian government guidelines for construction and operation of northern pipelines, were announced by the Ministers of the Departments of Energy, Mines and Resources and Indian Affairs and Northern Development in August 1970. At that time, it was stated that further guidelines might be issued. As a result of further studies, research and investigations that have been carried out since 1970, it appears timely to issue expanded guidelines as quickly as possible. Proposed new guidelines on the corridor concept, the environment, and social implications (items 2, 6 and 7 of the August 1970 guidelines) are set out hereunder. These guidelines are Government's current views on what should be included in the northern pipeline guidelines. The Government's purpose in expressing these latest views is to give further guidance to those engaged in research and planning in connection with northern pipelines and to afford the opportunity to northern residents and all others directly concerned to make observations on the proposed guidelines. In particular, the Government is ready to sit down with representatives of the native peoples involved, invite their views on the guidelines proposed, and reflect these views wherever possible. It is the Government's intention, after taking into consideration any observations that may be made, to bring these expanded guidelines into force on or about December 31, 1972. It should be emphasized that the guidelines may be further revised after that date should further pertinent and significant information become available.

Items 2, 6 and 7 of the August 1970 guidelines read as follows:

"2. Initially, only one trunk oil pipeline and one trunk gas pipeline will be permitted to be constructed in the North within a "corridor" to be located and reserved following consultation with industry and other interested groups.

"6. The National Energy Board will ensure that any applicant for a Certificate of Public Convenience and Necessity must document the research conducted and submit a comprehensive report assessing the expected effects of the project upon the environment. Any Certificate issued will be strictly conditioned in respect of preservation of the ecology and environment, prevention of pollution, prevention of thermal and other erosion, freedom of navigation and the protection of the rights of northern residents, according to standards issued by the Governor General in Council on the advice of the Department of Indian Affairs and Northern Development.

"7. Any applicant must undertake to provide specific programs leading to the employment of residents of the North both during the construction phase and for the operation of the pipeline. For this purpose, the pipeline company will provide for the necessary training of local residents in coordination with various government programs, including on-the-job training projects. The provision of adequate housing and counselling services will also be a requirement."

General

Public comments on the guidelines that follow are invited. Specific comments and suggestions are invited from both the general public and industry with respect to the concept and design of a transportation corridor that might include in the long run not only trunk pipelines, but also a highway, a railroad, electric power transmission lines, telecommunication facilities, etc. Comments and suggestions should be addressed to:

Director
Environmental-Social Program,
Northern Pipelines,
400 Burnside Building,
151 Slater Street,
Ottawa, Ontario.
K1P 5H3.

These guidelines refer only to trunk pipeline systems over land and associated bodies of fresh water on the mainland north of 60° and do not apply to pipelines that may be proposed for the Arctic Islands and intervening marine areas.

These guidelines apply to all aspects of oil or gas pipeline pre-construction, construction, operation and abandonment, including not only the actual right-of-way, but also all associated and ancillary facilities such as roads, docks and landing areas, storage areas, airstrips, pumping or compressor stations and communication and maintenance structures.

The term "Applicant" refers to the pipeline applicant, its agents, contractors and subcontrators.

The term "Native People" refers to Indian, Eskimo and Métis people in the Yukon Territory and the Northwest Territories.

In order to translate the intent of these guidelines into action, where this is appropriate, the Applicant will be required to enter into agreements containing covenants that detail specific undertakings. Two general undertakings in each agreement or contract will be: that the Applicant shall be required to post a performance bond respecting the execution of the contractual undertakings, and the security deposit for the bond will be in the form of (a) a promissory note guaranteed by a chartered bank, payable to the Receiver General, or (b) a certified cheque drawn on a chartered bank payable to the Receiver General, or (c) bearer bonds issued or guaranteed by the Government of Canada, or (d) a combination of the securities mentioned in (a), (b) and (c); and that the Applicant shall cooperate with the monitoring service set up by the government to ensure contract compliance, and the cost of the monitoring service will be a charge to the operation.

These guidelines are not to be construed as substitutes for the requirements of applicable acts, ordinances or regulations.

Pipelines "Corridor" Guidelines

Introduction

The 1970 Guidelines made provision for the establishment of a "corridor" to enclose trunk oil and gas pipelines. The following comments and proposals relate to the application and implementation of this corridor concept.

Purpose and Use of "Corridor" Concept

Control of pipeline routes is required to minimize environmental and social disturbance, to ensure maximum benefits to northern residents and communities, and to channel resource development in accordance with governmental priorities. In approaching the concept of a pipeline "corridor", the Government of Canada recognizes the need for flexibility in the choice of pipeline routing in consideration of resource and market locations, economics, engineering and construction requirements, and the severity and sensitivity of Arctic terrain conditions.

The concept of "one trunk oil pipeline and one trunk gas pipeline" within a "corridor" was enunciated with the intention of confining environmental and social disturbance resulting from trunk pipelines to a narrow zone, thus limiting insofar as possible the geographic area involved in these disturbances and leaving as much as possible of our northern lands in an undisturbed state. On the other hand, it is recognized that restriction of both oil and gas pipeline construction activities to a *narrow* "corridor" would lead to increased intensity of land use and the possibility of unacceptable environmental and social disruption. The routing of oil and gas pipelines close to other transportation-communication systems (and the probability of subsequent development of such systems adjacent to pipelines) may add to problems of maintaining the environment. Even minor disturbances arising from adjacent developmental activities may reinforce one another to produce cumulative ecological disruptions. Moreover, local shortages of gravel or other granular materials may result from close spacing of construction projects. In addition, the differing terrain requirements of oil and gas pipelines may prevent adjacent routings under some circumstances. Thus, caution will be required in defining specific routes or "corridor" boundaries.

"Corridor" for Trunk Pipelines in Yukon Territory and Mackenzie Valley Region

Information is presented here concerning the general routing of pipeline "corridors" and applications for pipeline permits across the northern portion of the Yukon Territory and through the Mackenzie Valley region of the Northwest Territories, to carry oil and gas to southern markets from sources in this part of Canada and/or from the Alaska north slope. The present comments apply only to trunk pipelines in the area outlined above, and do not apply to pipelines or "corridors" that may be proposed for other parts of the Yukon Territory and the Northwest Territories.

1. The Government of Canada is prepared to receive and review applications* to construct one trunk oil pipeline and/or one trunk gas pipeline within the following broad "corridors" (*Applications are to be filed with the National Energy Board for a Certificate of Public Convenience and Necessity, and with the Department of Indian Affairs and Northern Development, under the Territorial Lands Act, for tenure of land comprising the pipeline right-of-way.):

i) Along the Mackenzie Valley region (in a broad sense) from the Arctic coast to the provincial boundary;

ii) Across the northern part of the Yukon Territory either adjacent to the Arctic coast or through the northern interior region from the boundary of Alaska to the general vicinity of Fort McPherson, and thus to join the Mackenzie "corridor".

2. To confine the environmental (and social) disturbance arising from pipelines and their construction to a limited area, trunk oil and gas pipelines within the corridors outlined in 1. above are to follow routes that are as close together as is consistent with the differing engineering constraints and environmental hazards of the two types of pipelines, but not so close together as to bring about undesirable environmental interaction between the two lines. The same principle is also to apply where the trunk pipeline route lies parallel and near to a present or proposed highway or other overland communication system.

3. In view of the influence of the *first* trunk pipeline in shaping the transportation corridor system and in moulding the environmental and social future of the region, any applicant to build a first trunk pipeline within any segment of the corridor system outlined in 1. above must provide with his application:

i) assessment of the suitability of the applicant's route for nearby routing of the other pipeline, in terms of the environmental-social and terrain-engineering consequences of the other pipeline and the combined effect of the two pipelines (fully engineered proposals concerning the other pipeline are not necessarily required);

ii) assessment of the environmental-social impact of both pipelines on nearby settlements or nearby existing or proposed transportation systems; and

iii) comparison of the applicant's proposed route with alternative pipeline routes, in terms of environmental and social factors as well as technical and cost considerations (fully engineered proposals concerning alternative routes are not necessarily required).

4. In relation to the pipeline corridors identified in 1. above, the Government will identify geographic areas of specific environmental and social concern or sensitivity, areas in which it will impose specific restrictions concerning route or pipeline activities, and possibly areas excluded from pipeline construction. These concerns and restrictions will pertain to fishing, hunting, and trapping areas, potential recreation areas, ecologically sensitive areas, hazardous terrain conditions, construction material sources, and other similar matters. Statements announcing the above will be released through the office of the Director, Environmental-Social Program, Northern Pipelines.

5. If and when an applicant has received governmental authorizations to construct and operate any trunk pipeline, it is contemplated that Land Management Zones under the Territorial Lands Act and/or Development Areas under the Area Development Ordinances would be established to encompass the pipeline route and the additional lands required for ancillary facilities such as roads, staging areas, gravel and borrow pits, construction camps, etc.

Environmental Guidelines

Introduction

Guideline No. 6 of August 1970 required that any applicant "must document the research conducted and submit a comprehensive report assessing the expected effects of the project upon the environment". The amplification of this guideline presented below registers some current environmental concerns of government and is intended to indicate to potential applicants some of the major topics that should be included in such an environmental assessment. These concerns are registered in general terms but applicants are to respond in some detail in their environmental assessment with specific engineering design data and proposals that take into consideration the conditions encountered along their particular route. In responding to these concerns, applicants also are to provide documented evidence that they possess not only the necessary knowledge, but also the capability to carry out the specific proposals. As indicated in the 1970 guidelines, applicants will have available, and may be required to submit, all background data upon which the environmental assessment is based. However, the focus should be on specific responses to the concerns outlined below. In connection with these environmental concerns, government may impose restrictions or exclusions on pipeline activities in specific geographic areas that are environmentally sensitive, as outlined in Section 4 of the Pipeline "Corridor" Guidelines.

Guidelines: Some Current Environmental Concerns of Government

Any applicant for a Certificate of Public Convenience and Necessity and for right-of-way and other related land requirements, must submit a comprehensive assessment, based upon documented research, of the expected effects of the project upon the environment. Any certificate issued will be strictly conditioned with respect to applicable statutes providing for the protection of the environment and the following environmental concerns of government:

1. that a pipeline be constructed*, operated and abandoned in keeping with good engineering practice to ensure its safety and integrity, in the interests of good environmental management and the reduction of environmental damage (*Where the words 'construction' or 'constructed' are used they are meant to include preconstruction activities of a pipeline project.);

2. that construction, operation and abandonment of a pipeline will be done so as to avoid or minimize adverse effects upon the surrounding terrain, including vegetation, and aesthetic damage to the landscape;

3. that rivers and other waterbodies will be approached and crossed, either overhead or underground, in a way that will minimize environmental disturbance to the waterbody itself, to its bed and banks, and to the adjacent land or vegetation during construction, operation, and abandonment of a pipeline;

4. that a pipeline will be constructed, operated and abandoned with a minimal disruption to river and lake regimes, water quality, and feeding, reproduction and migrating stages of fish and other aquatic organisms;

5. that a pipeline will be constructed, operated and abandoned with minimal interference to the lands and vegetation that serve as feeding, reproduction and migrating areas for mammals and wildfowl, and with maximum protection to rare or endangered species and their habitats;

6. that adequate provision be made for disposal of sewage, garbage and various gaseous, liquid and solid wastes and all toxic materials during construction, operation or abandonment phases of the project;

7. that adequate provision be made for preservation or salvage-excavation of archaeological and historical sites, and that minimal damage to such sites will result from pipeline activities;

8. that effective plans be developed to deal with oil leaks, oil spills, pipeline rupture, fire and other hazards to terrestrial, lake and marine habitats, that such plans be designed to minimize environmental disturbances caused by containment, clean-up or other operations and to bring about adequate restoration of the environment, that they be designed to deal with minor and major incidents, whether they are single-event or occur over a period of time and that they include contingency plans to cope with major hazards or critical situations;

9. that an effective plan be developed for implementation of specific environmental safeguards through an educational program for field personnel prior to and during construction and operation of the pipeline;

10. that an effective pipeline performance monitoring system of inspection and instrumentation be established to ensure operational performance in keeping with the above-stated environmental concerns.

Suggested Topics for Response to Environmental Concerns

Examples of the kinds of topics that could be included in an applicant's environmental assessment in response to these environmental concerns of government are presented below. The items are numbered to coincide with the arrangement of the ten environmental concerns in the foregoing section. The listing of topics is not complete and the material is not intended for use as a formal checklist.

It is suggested that *specific proposals* or *information* be presented regarding the following:

1. Safety and integrity of the pipeline (Items applicable to this concern are incorporated in concerns 2-10 immediately below.)

2. Terrain and vegetation

a) methods of handling potential problems in relation to earthquakes, landslides, avalanches, or terrain changes resulting from thawing of frozen ground;
b) methods of minimizing removal of vegetation and the organic mat in permafrost areas with high ice content;
c) methods of minimizing interference with the movement or quality of water on and in the ground with particular attention given to the expected boundary or limit of influence: where drainage disruptions are expected, the boundary of influence may be well beyond the actual area of construction;
d) methods of minimizing the loss of strength and volume of soil as a result of melting of ground ice, particularly if the ice occurs in segregated masses; if such melting cannot be entirely prevented then there should be indications of how consequent instability and differential thaw-settlement is to be minimized;
e) safeguards to be taken against potential dangers to a pipeline from differential vertical movement caused by uneven settlement from thawing of permafrost materials or from "growth" of permafrost; where soil collapse over ice masses and differential flotation and sinking over liquefied soil could deform or rupture pipe, proposed safeguards should be identified;
f) methods of maintaining slope stability in general;
g) methods of construction and location of permanent facilities in a way that will harmonize with their natural setting;
h) removal and/or appropriate disposal, of debris created by construction activities and plans for buffer strips of natural vegetation between public roads and pipeline facilities;
i) quantity and quality of aggregate or borrow materials required, details of the geographical distribution of the requirements and proposals as to sources of the required material, including proposed access routes from pit or quarry to point of use, and restoration of pits and quarries;
j) plans to carry out assisted revegetation or alternative methods of providing an insulating cover on which natural revegetation can occur;

3. River and lake crossings

a) for river or stream crossings to be installed beneath the watercourse, depth of maximum anticipated scour and depth of proposed placement of pipe, supported by bore-hole logs and other data indicating the scour depth;
b) design of approaches to river crossings so as to maintain stability of valley walls and river banks and to minimize changes that could lead to slope failures, gullying and related disturbances;
c) design of underground crossings of rivers and streams that could withstand the effects of runoff, bank erosion, meander cutoffs, lateral migration of stream channels, ice jams, and icings, the magnitudes of which should be calculated according to reasonably expected extremes for a particular stream crossing area;
d) design of approaches to and crossings of ponds or lakes, with particular reference to degradation or growth of ground ice, and shore or bank regression or collapse through thermokarst or other processes.

4. River and lake regimes

a) methods for construction of stream and river crossings in a way that will minimize interference with fish passage or degradation of aquatic habitats through erosion and sedimentation;
b) alternative fish passage structures in cases where the proposed project requires stream channel modifications that would obstruct migrating fish;
c) schedules of construction activities and evidence that the project contains the flexibility to allow pipeline, road, or other construction to cease for periods of time when important areas critical to fish, wildlife, or waterfowl are temporarily threatened;
d) methods of minimizing the addition of sediment and introduction of oils and greases into water bodies as a result of preconstruction or construction activities, particularly in respect to access roads and ice-bridges;
e) proposed location, volume, composition and disposal of pipeline test fluids;
f) plans to restore fish and wildlife habitats that are damaged by pipeline activities;
g) dates and proposed methods of construction within 300 feet of any water body frequented by fish.

5. Wildlife

a) methods of minimizing the restriction of movement of wild animals such as caribou;
b) methods of protection of wetland areas used as feeding, breeding, or staging areas by migratory waterfowl or as habitat for fur-bearers;
c) methods of minimizing harassment and other impact upon wildlife populations from greatly increased human intrusions and the operation of boats, ground vehicles, aircraft, and compressor or pumping stations;
d) safeguards proposed and alternatives that were considered for the habitats of rare or endangered species;
e) control of possession of firearms in construction camps and on construction operations.

6. Waste and toxic material

a) methods of waste disposal to avoid health hazard to humans and animals as well as aesthetic pollution; information should be provided on use of water from streams, springs or lakes for domestic, camp or construction purposes and on location of camps and sewage disposal systems relative to local drainage patterns;
b) how ice fog accumulation and air pollution will be minimized;
c) the nature, transportation and use of any pesticides, herbicides, pipe coating materials, anti-corrosion materials, flushing agents, or other toxic substances, proposed for the

project, and information on their expected persistence and mobility in surrounding ecological systems.

7. Archaeological sites

a) archaeological surveys to identify prehistoric sites prior to and during construction phases of a pipeline project;
b) procedures to promote recognition, reporting, and assessment of archaeological materials encountered in pipeline activities, including orientation of construction personnel;
c) arrangements for preservation or salvage-excavation of sites judged to be of archaeological significance.

8. Contingency plans

a) how the possible loss of oil or gas through pipeline leaks would be routinely detected and stopped quickly (the maximum potential undetected loss *from the pipeline* should be specified and evidence provided. This value is to be as low as is technologically feasible.);
b) how oil which has escaped into the terrestrial, lake or marine environment would be detected, how it would be disposed of and how the elements of the environment affected by the oil would be rehabilitated;
c) methods to prevent burning of vegetation and proposals for a general contingency plan for fire prevention and suppression on the right-of-way, on the immediately surrounding land, and on lands involved in ancillary activities during preconstruction, construction, operation, and abandonment phases of the project.

9. Environmental briefings

a) how the applicant intends to carry out environmental briefings to ensure that personnel are fully aware of all environmental restrictions for each construction section and each construction and operational phase of the project, and the reasons for such restrictions.

10. Monitoring

a) continuous surveillance and maintenance programs along the pipeline right-of-way;
b) plans to monitor the environmental side effects during and after construction, including downstream sampling of sediment and potentially toxic materials.

Social Guidelines

Introduction

Guideline No. 6 of August 1970 reads in part as follows: "Any certificate issued will be strictly conditioned in respect of ... the protection of the rights of northern residents, ...". Government recognizes the concerns of the Indian people of the Territories with regard to the construction and operation of northern pipelines. Government is prepared to discuss with the Indian people their land claims and Treaty rights whenever they express their willingness to meet on the matter, and any decisions made concerning northern pipelines will be without prejudice to Indian land claims and Treaty rights. Guideline No. 7 of August 1970 requires the applicant to undertake specific training programs, to employ residents of the North during the construction and operational phases of the pipeline, and to provide adequate housing and counselling service. The following social guidelines are an elaboration of those issued in 1970. They are consistent with Canada's policy on northern development. They give priority to a higher standard of living and equality of opportunity for northerners by means compatible with their own preferences and aspirations. In addition, they seek to minimize the adverse social and economic consequences associated with rapid large-scale development, where these adverse effects can be predicted with some degree of certainty.

Guidelines:

1. The Applicant must undertake specific programs leading to the employment, at all occupational levels, of residents of the territories – and in particular native people, during the construction and operation of the pipeline. Such programs or projects shall include but not be limited to: advance information on all jobs in a manner that ensures that the information reaches potential workers; skills required for various occupations and anticipated duration of employment; upgrading and skill training; other forms of integrated training that include on-the-job work experience; and counselling for those unfamiliar with industrial jobs or wage style living. All training, orientation and counselling courses will be planned and carried out in co-operation with the various agencies of government responsible for these matters. The pipeline companies shall have particular responsibility for on-the-job work experience.

2. Priority placement in jobs shall be accorded native people of the territories in keeping with the tenor of Article 5 of the International Labour Organization Convention 111, 1958, ratified by Canada, and the government's intent to increase employment opportunities for members of disadvantaged minority groups. During the consultation between government, unions and employers as outlined in the Convention, ways and means will be found to ensure access for these employees into the appropriate union locals and hiring halls where there is a requirement. In addition, in accordance with the principle of employment of local workers which is accepted by organized labour, the Applicant will employ labour from the locality where work is being executed to the extent it is available. The Applicant shall comply with the above Convention and employment principles, and cooperate with government's effort to operate an effective recruitment, placement and counselling service.

3. The collective agreements signed by the Applicant and organized labour shall not distinguish between residents of the territories and others respecting special benefits and allowances, including housing for operational staff, and the nature of these benefits shall be in no way inferior for employees from the territories. In addition, in situations where special measures are required to ensure the employment of native people as outlined in the International Labour Convention 111, the Applicant shall negotiate special agreements related to the employment of native people, in consultation with the native people and government. Related to the above matters but not restricted thereto is the requirement for the Applicant to set up special orientation and consultation machinery to familiarize its staff and employees with the culture and aspirations of native people and of territorial residents generally. Conversely, this orientation and consultation will acquaint employees from the territories with the pipeline industry and the work habits and life style of non-territorial employees. The orientation and consultation activity shall be planned and operated with the participation of native people, other northern residents, organized labour, the Applicant and the appropriate governmental agency that will coordinate and monitor the various functions performed.

4. Contracts and sub-contracts shall be so designed and publicized as to invite and encourage bids from native organizations, settlement councils and local contractors. In addition, the businesses and commercial organizations of the territories shall be invited and encouraged to supply goods and services required for the pipeline development and operation.

5. A substantial number of native people depend on trapping and hunting as a principal means of livelihood, and many derive a real satisfaction from being on the land and being master of a familiar environment. Therefore, the pipeline will be constructed, operated and abandoned with minimal interference to traditional trapping, hunting and fishing areas. In addition, where the pipeline construction is planned to be located in proximity to a settlement – particularly a native settlement or localized area subject to

intensive use, then the location of construction camps, associated activities and the detailed siting of the pipeline will be decided by government after consultation with the Applicant, and the settlement council, or local government body, or the native organization.

6. Where the construction, operation or abandonment of a pipeline results in loss or damage to the undertakings or property of territorial residents – and native people in particular – then the Applicant shall deal promptly and equitably with all reasonable claims.

7. In order to ensure that the social and economic benefits outweigh the costs, the Applicant shall make a conscious effort to contribute to the social and economic development of the territories. This objective shall have particular relevance regarding: locating permanent infrastructure and maintenance facilities so that their presence will be to the benefit of communities; preserving scarce resources such as aggregate and forest products required by communities – both present and future demands; assuring residents reasonable access to transportation and communication facilities associated with the pipeline system; making gas energy available to selected territorial communities at places and costs to be negotiated between the Applicant and the appropriate governmental agency; and the Applicant shall give prior consideration to the territorial governments – concerning the disposal of all surplus facilities, equipment, or infrastructure, at a place to be negotiated between the Applicant and the respective government.

8. The pipeline construction activity shall be self-sufficient with respect to certain services such as sewer and water, power, roads, fire prevention, recreation services and emergency health services unless there is a prior agreement to the contrary. With respect to other public services that by their nature must remain under public control such as police protection, base hospitals and like services, there will be early consultation with the appropriate level of government to ensure adequate preparation and continuing liaison during the construction and operation phases to ensure maximum coordination and cooperation.

Appendix IV

1. List of Plants Mentioned in Text

Common Name	*Scientific Name*
Trees	
balsam popular	*Populus balsamifera*
black spruce	*Picea mariana*
jack pine	*Pinus banksiana*
white birch	*Betula papyrifera*
white spruce	*Picea glauca*
trembling aspen	*Populus tremuloides*
Shrubs	
alder	*Alnus crispa*
cassiope	*Cassiope tetragona*
cranberry	*Oxycoccus microcarpus*
dwarf birch	*Betula nana*
Labrador tea	*Ledum groenlandicum*
lingonberry	*Vaccinium vitis-idaea*
mountain avens	*Dryas* sp.
red osier dogwood	*Cornus stolonifera*
willow	*Salix* sp.
Herbs	
moss campion	*Silene acaulis*
Graminoids	
cotton grass	*Eriophorum* sp.
horsetail	*Equisetum* sp.
sedge	*Carex* sp.
Mosses and Lichens	
feathermoss	*Hylocomium splendens*
lichen (reindeer moss)	*Cladina* sp.
sphagnum	*Sphagnum* sp.

2. List of Birds and Mammals Mentioned in Text

Common Name	*Scientific Name*
Birds	
Waterfowl	
greater scaup	*Aythya marila*
old squaw	*Clangula hyemalis*
pintail	*Anas acuta*
snow goose	*Chen caerulescens*
whistling swan	*Olor columbianus*
white-winged scoter	*Melanitta deglandi*
Raptors	
bald eagle	*Haliaeetus leucocephalus*
golden eagle	*Aquila chrysaetos*
osprey	*Pandion haliaetus*
gyrfalcon	*Falco rusticolus*
peregine falcon	*Falco peregrinus*
Mammals	
Lagomorphs	
snowshoe hare	*Lepus americanus*
arctic hare	*Lepus arcticus*
Rodents	
beaver	*Castor canadensis*
lemming - brown	*Lemmus sibiricus*
- varying	*Dicrostonyx torquatus*
muskrat	*Ondatra zibethica*
Carnivores	
arctic fox	*Alopex lagopus*
black bear	*Ursus americanus*
grizzly bear	*Ursus arctos*
mink	*Mustela vison*
otter	*Lotra canadensis*
polar bear	*Ursus maritimus*
wolf	*Canis lupus*
Ungulates	
caribou - reindeer	*Rangifer tarandus sibiricus*
- woodland	*Rangifer tarandus caribou*
- barren-ground	*Rangifer tarandus groenlandicus*
Dall sheep	*Ovis dalli*
moose	*Alces alces*

3. List of Fish Species Mentioned in Text

Common Name	*Scientific Name*
Salmon and Trout Family	
arctic char	*Salvelinus alpinus*
chinook salmon	*Oncorhynchus tshawytscha*
chum salmon	*Oncorhynchus keta*
dolly varden	*Salvelinus malma*
lake trout	*Salvelinus namaycush*
Grayling Family	
arctic grayling	*Thymallus arcticus*
Whitefish Family	
arctic cisco	*Coregonus autumnalis*
broad whitefish	*Coregonus nasus*
humpback whitefish	*Coregonus clupeaformis*
inconnu	*Stenodus leucichthys*
lake cisco	*Coregonus artedii*
least cisco	*Coregonus sardinella*
mountain whitefish	*Prosopium williamsoni*
round whitefish	*Prosopium cylindraceum*
Perch Family	
yellow walleye	*Stizostedion vitreum*
Pike Family	
northern pike	*Esox lucius*
Sucker Family	
longnose sucker	*Catostomus catostomus*
white sucker	*Catostomus commersoni*
Minnow Family	
emerald shiner	*Notropis atherinoides*
flathead chub	*Platygobio gracilis*
lake chub	*Couesius plumbeus*
redbelly dace	*Chrosomus eos*
spottail shiner	*Notropis hudsonius*
Trout-Perch Family	
trout perch	*Percopsis omiscomaycus*
Stickleback Family	
brook stickleback	*Culaea inconstans*
ninespine stickleback	*Pungitius pungitius*
Smelt Family	
boreal smelt	*Osmerus eperlanus*
pond smelt	*Hypomesus olidus*

Common Name	*Scientific Name*
Mooneye Family	
goldeye	*Hiodon alosoides*
Cod Family	
burbot	*Lota lota*
Sculpin Family	
slimy sculpin	*Cottus cognatus*
spoonhead sculpin	*Cottus ricei*
Lamprey Family	
arctic lamprey	*Lampetra japonica*