Granular Resource Requirements for Proposed Mackenzie Valley Pipelines:

Technical Papers and Workshop Proceedings

Sponsored by:
Northern Oil and Gas Action Program (NOGAP) Project A4:
Granular Resources Inventory and Management

NOGAP Project Manager:
R.J. Gowan
Department of Indian Affairs
and Northern Development (DIAND)

Prepared by:
R.J. Mahnic and T.J. Fujino
Stanley Associates Engineering Ltd.

June, 1993

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EXECUTIVE SUMMARY

A workshop to discuss the granular resource requirements for proposed Mackenzie Valley pipelines was held February 16 and 17, 1993 in Yellowknife, NWT. This workshop was convened to summarize previously completed borrow resource inventory studies, identify any new granular resource requirements or development constraints in the Mackenzie Valley and Delta regions, and identify any future research requirements or outstanding granular resource management issues. This information will be used in future planning for Mackenzie Valley hydrocarbon development.

The workshop was sponsored by the Northern Oil and Gas Action Program (NOGAP) Project A4: Granular Resources Inventory and Management and the Department of Indian Affairs and Northern Development (DIAND). The services of Stanley Associates Engineering Ltd. of Yellowknife and Edmonton were engaged by DIAND to help with pre-workshop preparations, the facilitation of the workshop agenda, and preparation of these workshop proceedings. The main elements of the workshop consisted of introductory statements by the project sponsor and facilitators; a series of invited technical presentations by industry, government, and consultant groups; a series of discussion panels involving industry, government and aboriginal group representatives; and a concluding plenary session.

The workshop brought together thirty representatives of oil and gas production and transportation companies, federal and territorial government departments, aboriginal groups, local contractors, and others with a specific interest in the granular resources of the Mackenzie Valley area. Special invitations to participate in the workshop were extended to the main aboriginal groups of the Mackenzie Valley and Delta regions: the Inuvialuit, the Gwich'in, and the Slavey's of the Sahtu and Deh Cho. Aboriginal representatives provided a review of their claims and granular resource management issues within their region.

It is widely recognized that large quantities of sand, gravel and other granular materials would be required for construction of major trunk pipelines and collectors, gas plants, compressor and pumping stations, staging areas and other onshore facilities associated with hydrocarbon development in the Mackenzie Valley and Delta regions. This massive demand for a limited, non-renewable resource could place added pressure on the supplies that will be required for community use and for other major public projects, such as the extension of the Mackenzie Highway.

Technical presentations at the workshop showed the considerable breadth and scope of granular resource research that NOGAP funds have supported. Regional granular resource deposit inventories have been completed for the South Slave Region, the Upper Mackenzie Valley, the Lower Mackenzie Valley and the Mackenzie Delta Region. Also significant are the studies of granular resources that might feasibly be recovered from the bed of the Mackenzie River. Current uses of granular in the Mackenzie Valley region include roadway and airstrip construction, various public works projects and the Norman Wells pipeline.

According to several industry sources at the workshop, the economic outlook is for sustained low oil and gas prices, and, therefore, the development of any major oil or gas production or pipeline facilities in the next 5-10 years is highly unlikely. It was also stated that the projections for granular resource requirements that were made during the 1970s and early 1980s are probably higher estimates than would be required for a future pipeline development. Improved construction techniques, improved quality of pipeline steel, the use of foam or other synthetic padding, and "lessons learned" from the Norman Wells pipeline experience in the mid-1980s, would all contribute to the likely need for less granular resources.

It was agreed that one of the main reasons for success achieved to date is the cooperation of industry, various federal and territorial government departments and the Inuvialuit Land Administration through their participation in program planning and reviews, sharing of available information, and joint-funding and management of projects. Considering the current economic climate, continued cooperation will be needed to complete future granular resources inventory work.

ACKNOWLEDGEMENTS

On behalf of Stanley Associates Engineering Ltd. (SAEL) we would like to express our appreciation to those who provided assistance, information and commentary to these *Granular Resource Technical Papers and Workshop Proceedings*. Special thanks are extended to Mr. Bob Gowan, DIAND project manager, for his informed guidance and support. Mr. Bob Mahnic of Communiplan Inc. (and a consulting associate of SAEL), served as the workshop facilitator and principal editor of these proceedings. Mr. Jack Fujino provided direction as the senior technical advisor and co-editor of these proceedings.

The invited technical presentations on Mackenzie Valley granular resources were both in-depth and informative. It was our pleasure to work with Ms. Alejandra Duk-Rodkin, Mr. Bob Gowan, Mr. Ross Goodwin, Mr. Nick Hernadi, Ms. Rita Olthof, Mr. Neil MacLeod, Mr. Bryan Peterson, Mr. Jim Nicholson, Mr. John Smith and Mr. Jim McDougall in this regard. The efforts of the discussion panel members to provide spontaneous and thought-provoking dialogue with a minimum of prepared material is greatly appreciated. Our sincere thanks to: Mr. Jim Herbert, Mr. Ollie Kaustinen, Mr. John Smith, Mr. Gary White, Mr. Steve Harbicht, Mr. Brian Ferguson, Mr. Tom Andrews, Mr. Charles Klengenberg, Ms. Sue Heron-Herbert and Mr. George Cleary.

The efforts of Mr. Bob Gowan, Mr. Lorne Matthews and Mr. Jim McDougall to share their computer expertise through a demonstration of their various granular resource inventory and energy project granular demand modelling programs is also appreciated.

Mr. Colin Anderson, SAEL's manager of NWT operations in Yellowknife, was instrumental in ensuring the smooth coordination of workshop arrangements and facility preparations. We also acknowledge the efforts of Ms. Liesbeth van Blarikom for the recording of the workshop presentations and Ms. Carol Bechdholt for her patience and accuracy in transcribing the audio-cassette material and preparation of these important proceedings. Our thanks also to Mr. Stephen Traynor of DIAND for his help in reviewing the draft workshop proceedings.

We also believe that much of the real success of any workshop hinges on the question period discussions and plenary group sessions. These sessions provided an open forum for all participants to engage in dialogue and discussion of important granular resource issues. Thanks to all participants.

While these proceedings could not have been produced without the assistance and contributions of the aforementioned, Stanley Associates accepts full responsibility for any errors or omissions.

T. Jack Fujino, P.Eng.
Vice-President,
Stanley Associates Engineering Ltd.

R.J. (Bob) Mahnic
President,
Communiplan Inc.

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SECTION 1.

INTRODUCTION

INTRODUCTION

NORTHERN OIL AND GAS ACTION PROGRAM

The Northern Oil and Gas Action Program (NOGAP) is a research and planning program intended to advance the state of federal and territorial government preparedness for major hydrocarbon development in Canada's northern territories. Government preparedness for major hydrocarbon development generally refers to acquiring the knowledge and analytical capability to make appropriate decisions concerning major northern development proposals. Preparedness requires the ability to evaluate environmental impacts and mitigate adverse ones; to develop guidelines and techniques to minimize hazards; to plan for additional public services and infrastructure; and, to implement means of enhancing northern opportunities and benefits from future hydrocarbon development.

NOGAP funds are used to accelerate work on current projects or to undertake new activities which existing budgets cannot accommodate. Projects are proposed by NOGAP participants to support their responsibilities in connection with northern hydrocarbon development. They are undertaken within the context of generic development scenarios which have been adopted for the program.

This workshop on borrow material requirements of proposed Mackenzie Valley pipelines is sponsored by DIAND as part of the NOGAP. DIAND engaged the consulting services of Stanley Associates Engineering Ltd. to provide workshop organizational, facilitation, and proceedings production services.

WORKSHOP TERMS OF REFERENCE

The workshop is intended to bring together representatives of oil and gas production and transportation companies, federal and territorial government departments, planning and regulatory agencies, aboriginal groups, communities, local contractors, and others with a specific interest in the granular resources of the Mackenzie Valley area in the NWT.

The major objectives are to present to these important stakeholder groups information on recent inventory work and potential pipeline-related borrow requirements; to determine the potential impact of these demands on public projects and other granular resource-related issues concerning the region, to discuss future inventory and management approaches and methods, and to develop recommendations that will assist resource managers in implementing them.

Large quantities of sand, gravel and other granular materials will be required for construction of major trunk pipelines and collectors, gas plants, compressor and pumping stations, staging areas and other onshore facilities associated with hydrocarbon development in the Mackenzie Delta-Beaufort Sea region and its transportation through the Mackenzie Valley. This massive demand for a resource that is already scarce will place added pressure on the supplies that will be required for community use and for other major public projects such as the possible extension of the Mackenzie Highway.

The potential effects of large scale granular resource extraction have been identified as one of the main issues to be addressed in regional planning. Some specific concerns relating to the future availability of granular resources include, but are not limited to: the adequacy of the existing inventories of supply and forecasts of demand for both community needs and major industrial and transportation developments; the need for conservation of existing materials; the reservation of adequate community supplies; the protection of the environment; and, the rehabilitation of depleted source areas.

WORKSHOP AGENDA AND PROCEEDINGS

The *Granular Resource Requirements for Proposed Mackenzie Valley Pipelines* workshop agenda is presented in Figure 1. The two-day workshop was attended by thirty representatives of oil and gas production and transportation companies, federal and territorial government departments, aboriginal groups and local contractors (Appendix A). The workshop consisted of both invited technical presentations and a series of more informal topical discussion panels. During the morning program of Day 1, eight technical presentations which outlined the "inventory" of granular resources along the Mackenzie Valley corridor were made. In the afternoon of Day 1, five technical presenters and three discussion panel members concentrated on the past, current and future "demand" for granular resources in the Mackenzie Valley corridor. During an optional evening program at the conclusion of the first day of the workshop, a northern pipeline construction video was shown and three northern granular resource-related computer programs were demonstrated.

Day 2 of the workshop concentrated on the constraints to future granular resource development in the Mackenzie Valley corridor. During the morning session, three discussion panel members presented their views concerning granular resource development and potential bio-physical, fisheries and heritage site impacts. This session was followed by a three-person discussion panel which reviewed the present status of aboriginal land claims in the western NWT and the impact of land claims on granular resource development. The Day 2 program concluded with a video presentation on granular resource management and a plenary work group session to identify any remaining research gaps or granular resource inventory or development issues.

The task of preparing these proceedings has been enhanced through the use of audio-tape recordings of all plenary, technical and discussion panel presentations. As well, invited technical speakers provided electronic media of their presentation material for re-formatting and inclusion in these proceedings.

Although we were most appreciative of their participation in the workshop, individual speakers commenting in the question periods have not been identified. As well, individuals are not named for their specific suggestions or recommendations made in the plenary sessions.

These *Granular Resource Technical Papers and Workshop Proceedings* have been organized in chronological order. The workshop opening remarks are noted in Section 2. The main body of the workshop consisted of formal, invited technical presentations and a series of more informal discussion panel presentations and plenary discussions. The submitted texts of the technical presentations and transcribed versions of the discussion panel presentations are reproduced in Sections 3 to 9. Section 10 of these proceedings contains the tabulated responses of the final plenary session. Section 11 of the proceedings consists of the concluding comments to the workshop.

It must be emphasized that some of the technical panel members were unable to provide a formal text of their presentation. This was also the case for all discussion panel presentations. As a result, the editors of these proceedings have had to rely upon the audio-tape versions of the presentations for transcription purposes. We apologize, in advance, for any misinterpretation or errors made in transcription. Cautionary notes have been attached to each of the presentations which were transcribed. If necessary, we would suggest the reader verify the accuracy of comments in the transcribed presentations with the respective presenter.

Figure 1. Granular Resources Workshop Agenda

Department of Indian Affairs and Northern Development (DIAND)

WORKSHOP ON BORROW MATERIAL REQUIREMENTS OF PROPOSED MACKENZIE VALLEY PIPELINES

February 16 - 17, 1993
The Explorer Hotel - Katimavik Room
Yellowknife, Northwest Territories

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DAY 1 – TUESDAY, FEBRUARY 16, 1993

7:15 - 7:45 a.m.	*Meeting with Technical Presenters*	
7:45 - 8:15	Workshop Registration	

Opening Plenary Session

8:15 - 8:25 a.m.	WELCOME AND OPENING REMARKS	Bob Gowan, DIAND
8:25 - 8:35	Workshop Objectives and Agenda Review	Colin Anderson, Stanley Engineering
8:35 - 8:45	Workshop Communications	Bob Mahnic, Communiplan/Stanley

Technical Panel "A" - Sources of Information on Borrow Resources

8:45 - 9:00 a.m.	Surficial Geology Mapping of the Mackenzie	Alejandra Duk-Rodkin, Geol. Survey of Canada
9:00 - 9:15	DIAND Northern Granular Resources Inventory	Bob Gowan, DIAND
9:15 - 9:30	Borrow Resources in Bibliographic Databases	Ross Goodwin, Arctic Institute
9:30 - 9:45	Question Period and Summary	Bob Mahnic, Communiplan/Stanley
9:45 - 10:00	*Coffee/Refreshment Break*	

Technical Panel "B" - Regional Borrow Deposits Inventories

10:00 - 10:20 a.m.	South Slave Region Inventory	Nick Hernadi, Thurber Engineering
10:20 - 10:40	Upper Mackenzie Corridor Inventory	Rita Olthof, EBA Engineering
10:40 - 11:00	Lower Mackenzie Corridor Inventory	Jim Oswell, HBT AGRA
11:00 - 11:20	Bed of Mackenzie River Inventory	Neil MacLeod, EBA Engineering
11:20 - 11:40	Mackenzie Delta Region Inventory	Jack Fujino, Stanley Engineering
11:40 - 12:00 p.m	Question Period and Summary	Bob Mahnic, Communiplan/Stanley
12:00 - 1:15	*Lunch Break*	

Technical Panel "C" - Typical Borrow Materials Usage

1:15 - 1:30 p.m.	Typical Transportation Requirements	Bryan Peterson, GNWT-Transport
1:30 - 1:45	Typical Community Requirements	Jim Nicholson, GNWT-Public Works
1:45 - 2:00	Norman Wells Pipeline Borrow Materials	John Smith, Interprovincial Pipe Line
2:00 - 2:15	Historical Borrow Demand Forecasts	Jack Fujino, Stanley Engineering
2:15 - 2:30	Question Period and Summary	Bob Mahnic, Communiplan/Stanley
2:30 - 2:45	*Coffee/Refreshment Break*	

Technical Panel "D" - Potential Industrial Demands

2:45 - 3:15 p.m.	Granular Resource Requirements for Potential Hydrocarbon Development	Jim McDougall, North of 60 Engineering
3:15 - 3:30	Question Period and Summary	Bob Mahnic, Communiplan/Stanley

. . . continued

Figure 1. Granular Resources Workshop Agenda (concluded)

Discussion Panel "A" - Industrial Borrow Demand Issues

3:30 - 3:45 p.m.	IPC Borrow Demand Issues	Jim Herbert, Inuvialuit Petroleum Corporation
3:45 - 4:00	Gas Pipeline Borrow Demand Issues	Ollie Kaustinen, Polar Gas
4:00 - 4:15	Oil Pipeline Borrow Demand Issues	John Smith, Interprovincial Pipe Line

Optional Evening Program

7:00 - 7:30 p.m.	"Norman Wells Pipeline Project" Video	
7:30 - 7:50	Mackenzie Valley Granular Resources: Computer Demonstration	Bob Gowan, DIAND
7:50 - 8:10	NORCOST Hydrocarbon Development: Computer Demonstration	Jim McDougall, North of 60 Engineering
8:10 - 8:30	Beaufort-Delta Pipeline Resources: Computer Demonstration	Lorne Matthews, GNWT-Energy and Mines

DAY 2 – WEDNESDAY, FEBRUARY 17, 1993

8:15 - 8:20 a.m.	Day 2 Agenda Review	Colin Anderson, Stanley Engineering

Discussion Panel "B" - Potential Constraints to Borrow Development

8:20 - 8:40 a.m.	Potential Environmental Impacts: Biophysical	Gary White, Science Institute of the NWT
8:40 - 9:10	Potential Environmental Impacts: Fisheries	Steve Harbicht and Brian Ferguson, DFO
9:10 - 9:30	Heritage and Archaeological Sites	Tom Andrews, Prince of Wales Heritage

Discussion Panel "C" - Land Claims and Borrow Supply: Aboriginal Perspective

9:30 - 10:00 a.m.	ILA and Borrow Resource Management	Charles Klingenberg, Inuvialuit Land Admin.
10:00 - 10:15	*Coffee/Refreshment*	
10:15 - 10:45	Gwich'in Land Claim and Borrow Resources	Sue Heron-Herbert, GNWT-Land Claims
10:45 - 11:15	Sahtu Land Claim and Borrow Resources	George Cleary, Sahtu Tribal Council

Plenary Work Group Session

11:15 - 11:30 a.m.	Overview of Plenary Work Group Format	Bob Mahnic, Communiplan/Stanley
11:30 - 12:30 p.m.	*Lunch Break*	
12:30 - 12:50	"Upon This Rock– Managing Our Granular Resources" Video	
12:50 - 2:30	Break-Out Work Group Session	Bob Mahnic, Communiplan/Stanley
2:30 - 2:45	*Coffee/Refreshment*	
2:45 - 3:15	Plenary Work Group Recommendations	Bob Mahnic, Communiplan/Stanley

Concluding Plenary Session

3:15 - 3:25 p.m.	Workshop Evaluations	
3:25 - 3:30	CLOSING REMARKS	Bob Gowan, DIAND

Stanley

SECTION 2.

WORKSHOP OPENING REMARKS

WORKSHOP OPENING REMARKS

WELCOME FROM WORKSHOP SPONSOR

(Presented by Bob Gowan, DIAND)

On behalf of DIAND, I'd like to welcome you to the Mackenzie Valley Pipelines Granular Resource Requirements Workshop. This workshop is part of Project A4 - Granular Resources Inventory and Management, sponsored by the Northern Oil and Gas Action Program (NOGAP). It is intended, therefore, that the results of the workshop will help DIAND, as the manager of the resource, prepare for future northern hydrocarbon development and the resulting demands for large quantities of granular materials. This requires a knowledge of the existing supplies and of future demands for both pipelines and other public and private projects, as well as consideration of other factors limiting the availability of supplies.

Since it was initially proposed about three years ago, there has been considerable interest in holding this granular resources workshop, from industry, native organizations and government. We acknowledge that the timing of the workshop may be less than ideal for the pipeline and energy industry and for some of the native organizations. Unfortunately, the timing has been controlled mainly by the availability of funding. At the same time, recent changes in the availability of granular resources as a result of land claims, increased environmental concerns and consideration of sustainable economic development initiatives are very significant. By holding the workshop in Yellowknife, we hoped to provide an opportunity for greater participation by those most affected.

WORKSHOP OBJECTIVES

(Presented by Colin Anderson, Stanley Associates Engineering)

I'd like to welcome each of you to Yellowknife. We're pleased that we have been able to gather representatives from the federal and territorial governments, Mackenzie Valley aboriginal groups, pipeline observers including IPL and Polar Gas, and contractors, consultants and scientists from Calgary, Edmonton and the north.

The workshop is intended to present information on the borrow material requirements in the Mackenzie Valley. One of the things that is very important is the potential effects of large scale granular resource extraction. It has been identified as one of the main issues to be addressed in the regional planning and also aboriginal land claim settlements in the Mackenzie Valley. Some specific concerns relating to the future availability of granular resources include but are not limited to: the adequacy of existing inventories of supply and forecast of demand for both community needs and major industrial and transportation developments; the need for conservation of existing materials; the reservation of adequate community supplies; the protection of the environment; and, the rehabilitation of depleted source areas.

The major objectives of this workshop are to present information on recent and historical inventory work and potential pipeline related borrow requirements; to determine the potential impact of new demands on public projects; to discuss future inventory and management approaches and methods; and to develop recommendations for resource management. We hope that everyone enjoys the workshop and finds it to be of value.

WORKSHOP COMMUNICATIONS

(Presented by Bob Mahnic, Communiplan/Stanley)

The technical presentations and other discussions we will hear over the next two days will provide each of you with an opportunity to communicate--as a technical presenter, as a panel discussant, and as a participant-observer. You will hear about the study and use of northern granular resources in respect of the past experiences and future plans of aboriginal organizations, government, pipeline operators, the oil and gas industry, contractors, and the consulting and scientific communities. It will be very interesting, over the next two days, to see where the commonalities of interest lie. I look forward to working with each of you to help uncover the shared experiences of the diverse groups represented here.

What is the main reason we are here? I think we are here for more reasons that to just attend a workshop. I think the main reason we are here is to communicate. The more involved that you are in the discussions, the question periods and the plenary sessions, the better this workshop is going to be, and that translates into better recommendations and future plans. As the workshop facilitator I am able to take things only so far. In fact, I should only be acting as a 'referee' to these proceedings. It will be the participation of each individual that will indicate whether or not we have had overall success at this workshop. Each of you is responsible for listening and for contributing ideas and suggestions.

I want to talk briefly about workshop communication and some effective communication techniques. These are all common sense concepts. We use them every day.

Why communicate? Well, while completing some of my "research" into the topic of communication, I have discovered some of the infamous Murphy's Laws of communication. Murphy the Pessimist has formulated a Law of Communication which states that *"the vacuum created by the failure to communicate will be quickly filled with rumour, misrepresentation, drivel and poison"*. It certainly does point out the need to communicate in a timely and effective manner. Being in the same room with people with similar interests and problems can be to your advantage. We are going to have to carefully break down and assess the results of past experiences which may have turned into problems because we did not communicate effectively.

What can we hope to accomplish in just two days? Well, perhaps we can share some important information with each other. Most of us are familiar with the axiom *"information is power"*. Murphy the Optimist believes that *"the ability to use information is power and information shared is power multiplied"*. I think if we keep this in mind throughout the workshop--that by sharing whatever relevant information we have--we can effectively help other groups as well. This again helps each of you in the long run. In the short run you may not see the immediate benefits of sharing your information, sharing your knowledge, your experience, and your expertise. I can assure you though, in the long run, significant benefits can be achieved. We will have to freely share our collective thoughts and experiences if we are to accomplish our goals for this important northern granular resources workshop.

Stanley

SECTION 3.

TECHNICAL PANEL "A"

SOURCES OF INFORMATION ON GRANULAR RESOURCES

SURFICIAL GEOLOGY MAPPING OF THE MACKENZIE TRANSPORTATION CORRIDOR

Alejandra Duk-Rodkin, Ph.D.

Research Scientist, Terrain Sciences Division
Geological Survey of Canada, Calgary, Alberta

ABSTRACT

The surficial geology mapping of the Mackenzie Valley Transportation Corridor was undertaken by the GSC in 1971-1973. Two A-Series maps cover the northern part of the Corridor, while the southern Corridor is covered by 11 maps. The maps include terrain evaluation for engineering purposes, sources of aggregate (sand and/or gravel), geomorphic processes, natural hazards (landslides), thickness of drift, and ground-ice content. The maps also include a comprehensive glacial history of the region that helps to determine problematic areas for engineering evaluation.

Most of the Quaternary sediments in the Mackenzie Valley are of glacial origin. During advance and retreat of the Laurentide ice sheet, glaciofluvial sand and gravel were deposited on the glaciated surfaces. Particularly important sources of aggregate are former deltas built into glacial lakes. Glaciofluvial complexes, kames and eskers are mostly related to long periods of ice sheet retreat. Glaciofluvial channels are also excellent sources of gravel and sand. Former glacial lake sediments and some morainic sediments have high ice content, and thus are unsuitable for any type of construction.

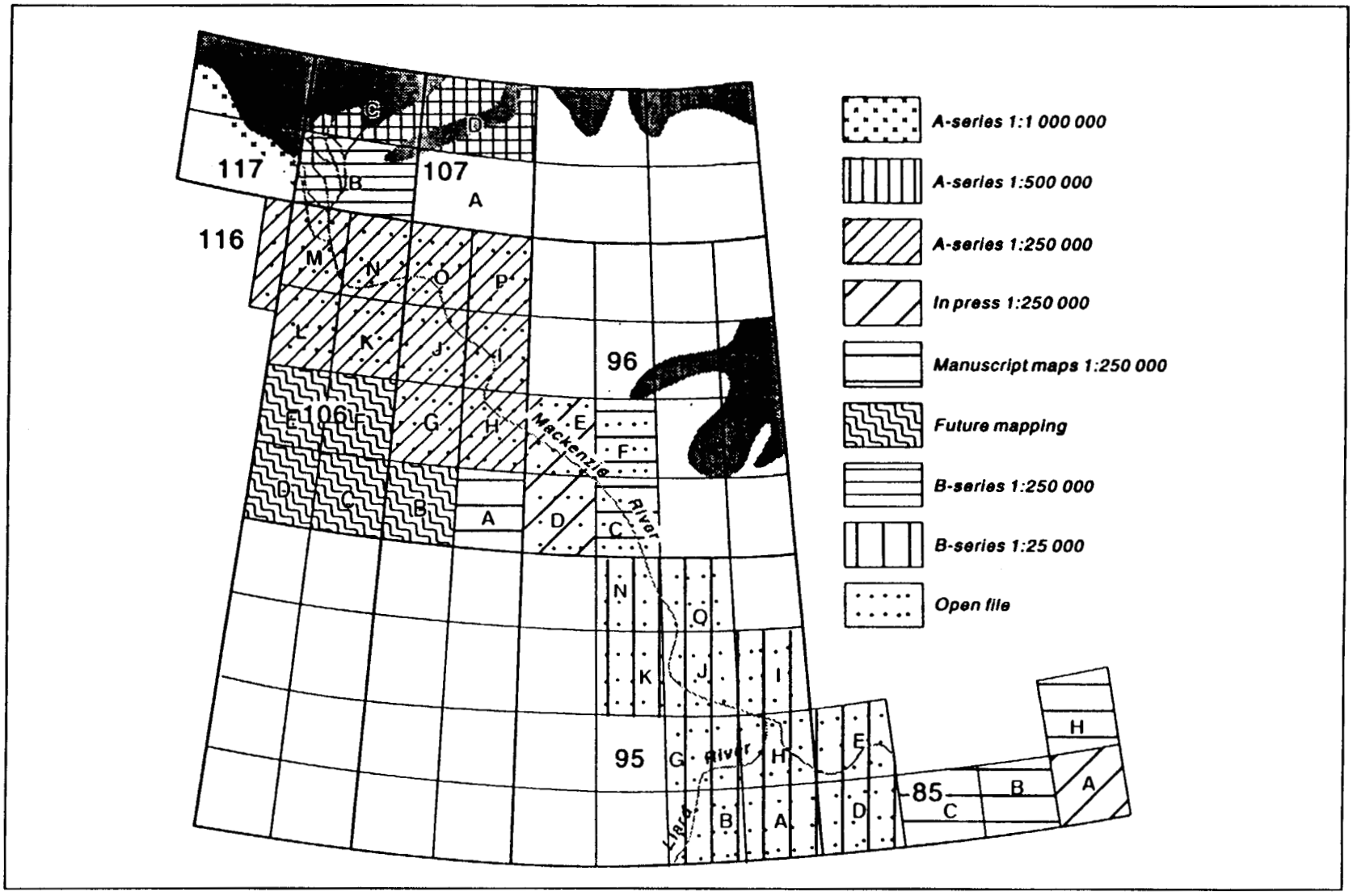
Introduction

Surficial geology studies in the Mackenzie Valley began in the late 1960s as part of "Operation Norman". The oil and gas pipeline proposal for the Mackenzie Valley initiated a series of studies within the Mackenzie Valley transportation corridor including studies of surficial geology. This mapping resulted in 35 Open File maps being completed in three years at 1:125,000 scale (Figure 1). The Mackenzie Valley Corridor was divided into three regions: northern (7 maps), central (16 maps) and southern (11 maps). Maps covering the three regions have been upgraded to A or B Series. Those of the northern region have been published as A-Series at 1:1,000,000 and 1:250,000 scales and B-Series at 1:250,000 scale and the southern region as B-Series at 1:125,000 scale. Mapping of the south part of the corridor has been expanded to the east to cover areas south of Great Slave Lake. These maps will be published as A-Series at 1:250,000 scale. Mapping of the central part of the corridor was begun by Duk-Rodkin in 1985. When the complete series of maps in the central region is finished it will total 19 maps published as A-Series at 1:250,000 scale.

The maps of the central part of the corridor were compiled from various sources of information including airphoto interpretation, field work, and seismic data (obtained from oil companies such as Amoco, Aquitane, Chevron, Dome, Imperial, Mobil, Shell, Sun, Western Decalta and others). Additional information on surficial geology and granular materials was obtained from Canadian Arctic Gas Pipeline, Foothills Pipe Lines, Dempster Lateral Gas Pipeline Project, Ripley, Klohn & Leonoff, EBA Engineering Consultants, Public Works Canada and others.

These maps contain information that have two main uses: 1) scientific, and 2) applied. Scientific information includes a comprehensive glacial history of the region. Glacial limits, erratics, meltwater channels, moraines, ridges, kames, and eskers are shown on the surficial geology maps and enable the user to understand past glacial movements. Applied information is of a geotechnical nature. Granular materials, quality of deposits for construction, geomorphic processes, natural hazards (slides), thickness of drift and ground ice content are some of the characteristics described in the extended legend on the back of the map sheets.

Figure 1. Surficial Geology Mapping: Mackenzie Corridor



Terrain Evaluation

Glaciofluvial channels and moraine belts associated with ice margins are often important sources of aggregate materials. Other sources include kames, glaciofluvial plains and terraces. Deltas deposited into glacial lakes are a source of sandy material rather than gravel, except where they were derived from mountainous terrain. Moraine plain areas were rarely associated with major ice margins, but may have scattered gravel deposits related to minor meltwater channels and/or eskers.

Following deglaciation, climatic conditions resulted in the formation of permafrost and associated active layer development. Processes resulting from active layer dynamics include retrogressive thaw flow slides that are particularly common in glaciolacustrine sediments. Up to 500 metres of down cutting by streams in the Canyon Ranges has caused major landslides, particularly in the foothill regions.

Relevant geotechnical information contained on the GSC surficial geology maps includes the location of granular deposits of glaciofluvial, morainic, lacustrine and alluvial origins.

1) Glaciofluvial deposits

Glaciofluvial plains and terraces are good construction sites where the material is gravel rather than sand. Glaciofluvial hummocks and eskers are a good source of gravel and some sand. Small unmapped deposits may also occur in association with minor meltwater channels.

2) Moraine deposits

Generally, moraine deposits provide good construction sites. When vegetation is removed there is potential for subsidence due to thawing of ground ice. The ice content can be up to 25%. Where the moraine cover is thin it can be removed and the underlying bedrock used for rip-rap. Areas of rolling moraines usually have a high ice content at depth and result in differential subsidence of up to 3 metres due to thawing of segregated ice masses. Most of the hummocky moraine units also have high gravel content (60-70%) and may be used as aggregate.

3) Lacustrine deposits

Forest fires or other disturbance of vegetation may cause active layer detachment slides followed by retrogressive thaw flaw slides. These occur commonly in glacial lake sediments. These deposits are also very susceptible to gullying and not recommended for any type of construction.

4) Alluvial deposits

Alluvial plains and terraces may be a source of aggregate where underlain by gravel rather than sand. Certain alluvial plains have thermokarst depressions and ice wedges due to high ice content (up to 50%). When the vegetative cover is removed the ice wedges melt, forming polygon-shaped depressions. Terraces are good construction sites. Alluvial deposits are also subject to periodic flooding; particularly alluvial fans which are generally unsuitable for any type of construction.

DIAND NORTHERN GRANULAR RESOURCES INVENTORY PROGRAM

Robert J. Gowan, P.Geol.

Geotechnical Advisor, Land Management Division
Department of Indian Affairs and Northern Development, Ottawa, Ontario

ABSTRACT

DIAND first attempted to establish a comprehensive inventory of Mackenzie Valley granular resources in the early 1970s. These efforts were in anticipation of an increase in demands due to hydrocarbon exploration activity in the Mackenzie Delta, completion of the Mackenzie Highway, and competing proposals for large diameter gas transmission facilities. Most of the initial work was completed by consulting firms contracted by DIAND. Supplemental to this were regional assessments based on surficial geology maps of the Mackenzie Corridor that were completed for DIAND by the GSC, and site specific investigations by government and industry.

With the expansion of hydrocarbon exploration into the Beaufort Sea in the 1980s and the growth of industrial support facilities in Tuktoyaktuk, a second period of granular resource inventory work was completed. This was largely concentrated in the Beaufort Sea-Mackenzie Delta-Tuk Peninsula area. Since 1984, significant funding has been available through NOGAP to assist in developing government preparedness for northern hydrocarbon development. More recently, the pressures on public supplies of granular resources have arisen from community land use concerns and from aboriginal land claims. Continued cooperation between key stakeholder groups is required to complete further granular resources inventory work.

The Department of Indian Affairs and Northern Development (DIAND) undertakes a northern granular resources inventory program in support of its responsibilities regarding management of granular resources in the Northwest Territories (NWT), the Yukon Territory and in the adjacent offshore areas. In recent years, the program has received limited "core" departmental funding and varying levels of support from special allocations as part of the Northern Oil and Gas Action Program (NOGAP) and the Inuvialuit Final Agreement Implementation Program. Over the past five years, considerable effort has been expended towards compiling existing information on northern granular resources into a series of computerized databases. These will provide improved accessibility to the extensive body of information that has been collected in numerous consultants reports. Once complete, this will be one of the most extensive computerized granular resource data collections in existence.

DIAND is responsible for the management of granular resources on most Crown lands in the NWT, the Yukon and in the adjacent offshore areas. Previously, this involved most of the known deposits in the Canadian North since Crown lands represented all but a few percent of the total area. This paper outlines DIAND's efforts to develop an inventory of the granular deposits in the Mackenzie Valley. It does not include, but does acknowledge, the significant body of information produced by various departments of the Government of the Northwest Territories (GNWT) and by other federal departments in support of their requirements as consumers of granular resources.

Background

The first attempts, commencing in the early 1970's, to establish a comprehensive inventory of Mackenzie Valley granular resources responded to an anticipated increase in demands due to hydrocarbon exploration activity in the Mackenzie Delta, plans for completion of the Mackenzie Highway and competing proposals for large diameter gas transmission facilities. Most of the initial work was completed in three stages by several consulting firms contracted by DIAND

(Pemcan Services, 1972; Ripley, Klohn and Leonoff, 1973; and, EBA Engineering and F.F. Slaney, 1974). Supplementing those reports were regional assessments of granular resource potential based on preliminary surficial geology maps of the Mackenzie Corridor that were completed for DIAND by the Geological Survey of Canada (Minning, *et al*, 1975; Lawrence, *et al*, 1975), and site specific field investigations, mostly by Public Works Canada and the petroleum industry. Bibliographic citations for all available granular studies will be included in the database and bibliography described in another paper in these proceedings (by Ross Goodwin).

Collectively, these studies formed a major part of the granular borrow materials extraction plans prepared by the pipeline proponents, and for much of the corridor, they have provided adequate information for all types of construction activities, continuing to the present. This work has been consolidated and summarized as part of regional studies that will be described in three following papers (by Rita Olthof, Jim Oswell, and Jack Fujino). In a few communities, growth has lead to depletion of the initially-identified deposits; but there has generally been little need for additional field work in much of the corridor.

With the expansion of hydrocarbon exploration into the Beaufort Sea in the early 1980s and the tremendous associated growth of industrial support facilities in Tuktoyaktuk, a second period of granular resource inventory work was needed. This was largely concentrated in the Beaufort Sea and in the Mackenzie Delta and Tuktoyaktuk Peninsula. These efforts have been intermittent and continue to the present.

More recently, the pressures on public supplies of granular resources have arisen primarily from community land use concerns and from land claims. Ownership of, and responsibility for management of granular resources has changed considerably in recent years as a result of land claims settlements. Granular resources are considered part of the surface title, and therefore are included with ownership of lands. As a result, a major proportion of the known granular deposits are now privately-owned, and generally more costly. This creates a greater demand for the remaining sources of supply on Crown lands, and an increased need for more effective management of the public resources. As a result, a significant effort is now needed in many areas to update and expand the existing information base before hydrocarbon development or other enhanced economic activity proceeds in the Mackenzie Vally region.

In support of this, DIAND's Land Management Division, Natural Resources and Environment Branch, has initiated a northern granular resources inventory program. The main objective of this program is to ensure that adequate scientific and technical information is available to support the department's responsibilities regarding management of northern granular resources.

Program Focus

DIAND's role in the preparation of a granular resource inventory is as a resource manager, not as a resource user. Therefore, it attempts to classify granular materials according to their natural condition (without processing) and their broadest range of potential uses, by all potential users. In contrast, a more specialized (e.g. highways) user-oriented inventory might classify materials according to their adherence to precise material specifications (e.g. surfacing material, or concrete aggregate). While the DIAND inventory gives highest priority to higher quality resources, it does not exclude lower quality materials since they also must be managed.

The main goal of the program is to develop a co-ordinated, systematic approach to granular resources inventory. Emphasis has been placed on avoiding duplication of effort and on utilization of existing information. The program also tries to make the inventory information more accessible to current and potential users.

Within the department, the responsibility for inventory activities is informally divided among headquarters, regional and district offices. *DIAND Headquarters* provides geotechnical support and research, and overall direction of the inventory program. Technical advice on granular resource issues is provided by headquarters personnel to various parts of the department, from senior managers, to regional land administrators, to resource management officers in the district offices. Granular resource inventory work related to major projects (e.g. pipelines) or transboundary issues would normally be undertaken by headquarters.

DIAND Regional offices have main responsibility for planning and administration. This would normally include initiation of regional granular resource

management plans and issuing quarry permits. Studies to identify, delineate or plan the development of specific public or community granular material sources are usually initiated by the regional offices.

DIAND District offices are responsible for operations. This includes inspection of proposed granular extraction sites and of existing pits and quarries and the monitoring of ongoing operations. They also represent the primary contact between DIAND and granular resource users.

It is important that all areas provide input to, and feedback on, the inventory activities of each of the others. For example, geotechnical interpretations may be required from headquarters, regional offices may identify new areas requiring more detailed inventory, and the districts may provide confirmation of predicted subsurface conditions based on site inspections.

Program Funding

Funding for most of the previous northern granular resource inventory work has involved special allocations. The original three-stage inventory work was completed with one-time funding allocated to the Mackenzie Highway Granular Working Group. Core funding for granular resources inventory and management in the past has been sporadic, variable and susceptible to postponement or cancellation. More recently, as local shortages of granular materials became apparent, funding for granular resources inventory work has been more plentiful and more certain.

Since 1984, significant funding for salaries and contracted studies has been made available through the Northern Oil and Gas Action Program (NOGAP), as Project A4 - Northern Granular Resources Inventory and Management. NOGAP was established to assist in developing government preparedness for future northern hydrocarbon development. The overall objectives of Project A4 are to provide information on the location, type, quantities and qualities of major borrow sources in the Mackenzie Valley and Beaufort Sea Regions, to support conservation and effective utilization strategies and policies, and to recommend appropriate management strategies and a more modern regulatory regime.

The NOGAP granular project initially focused on development of a preliminary inventory for the Beaufort Sea, but included several regional onshore studies, and evaluations of special materials that might be required for hydrocarbon development. The regional studies included field investigations on Richards Island (Subproject A4-07) and in the South Slave Region (Subproject A4-18; see also paper in these proceedings by Nick Hernadi), and a compilation of existing information for the Lower Mackenzie Corridor (Subproject A4-08; see also paper by Jim Oswell). Special studies of potential sources of concrete aggregates (Subproject A4-09) and of quarry rock (Subproject A4-12) for use in offshore hydrocarbon structures, and of the feasibility of dredging granular materials from the bed of the Mackenzie River (Subproject A4-10; see also paper by Neil MacLeod) were completed.

In 1990, Project A4 was revised to place greater emphasis on granular resource issues related to pipeline transportation of hydrocarbons in the Mackenzie Valley. These activities are the main focus of this paper and the workshop proceedings. The workshop is sponsored entirely by NOGAP, as Subproject A4-26A. NOGAP ends at the completion of the 1993-94 fiscal year.

The second major source of funding for granular resources inventory studies in the Mackenzie Delta area is a special allocation made as part of the Inuvialuit Final Agreement Implementation Program (IFAIP). IFAIP Task 7 - Sand and Gravel Inventories, received varying levels of funding for each of the first ten years of the program. The main objective of this task is to update and complete inventories of granular resources in the Inuvialuit Settlement Region. More specifically, the task attempts to transfer to the Inuvialuit Land Administration (ILA) existing data needed for granular resources management, to assist in determining and updating long-term demand forecasts, and to assist in establishing reserves for public use. Studies completed under Task 7 and covering parts of the Mackenzie Valley corridor include a series of reports on granular inventory and demand forecasts (Task 7.1) and development plans (Task 7.4) for Aklavik, Inuvik and Tuktoyaktuk, and geotechnical field investigations of new sources near each of these NWT communities (Tasks 7.2 and 7.5), and compilation of the existing information in computerized granular resource databases (Tasks 7.1 and 7.3).

The limited core funding available for granular resources management has generally been spent on an as-needed basis to address critical shortages in

communities throughout both territories. In 1991, a consistent level of core funding was established for granular inventory and management programs. This covers most salary and support costs, all travel costs, student assistants, and several small contracted studies each year. These studies generally relate to inter-regional granular issues (e.g. Dempster Highway), methods and tools for inventory and management (e.g. databases, training aids) and other geotechnical issues requested by DIAND Regional offices.

Beginning in 1993-94, limited "seed" funding will be available for granular resources research related to energy, through the Panel on Energy Research and Development (PERD). Two new PERD projects have been established. One PERD project will deal with environmental issues related to pipeline borrow development, and a second project is to support continued research on offshore granular resources development.

Granular Resources Databases

Over the past five years, considerable progress has been made towards compiling existing information on northern granular resources into a series of computerized databases. These will provide improved accessibility to the extensive body of information that has been collected in numerous consultants reports. They will also make it feasible to make this data available to existing and potential users, thereby making effective management an attainable goal. As a matter of policy, new information is now being collected in the standardized formats of the existing databases.

The northern granular resources inventory consists of four separate databases that are linked by two unique key fields. The databases include a **reports catalogue, a deposits database, a borehole database** and a **geographic database.** Each report or study in the report catalogue is identified by a unique **study number.** Each deposit or borrow source in the source database is identified by a unique **source number.** The remaining databases include both the study number and the source number. Each of the databases is described briefly in the following paragraphs.

The **Report Catalogue** contains a listing of all available reports containing granular resource data for the area under study; included are geotechnical, surficial geology, airphoto interpretation and geophysical reports. This information extends beyond a bibliographic database by including a preliminary evaluation of the extent and usefulness of the data in the reports. A summary of the main subject areas in the database and the number of data fields (in parentheses) in each area is shown in Figure 1.

The **Deposits Database** contains data for individual deposits (gravel/sand pits and/or deposits) that was obtained from the reports listed in the Report Catalogue. A comprehensive description of a Deposit and its materials is obtained if all fields are filled out. This database also summarizes the information contained in the Borehole Database. A summary of the main subject areas in the database and the number of data fields (in parentheses) in each area is shown in Figure 2.

The **Borehole Database** contains geotechnical borehole data from the reports listed in the Report Catalogue and for the individual sources listed in the Deposit Database. These include a description of the borehole, stratigraphic data and laboratory test results. A complete borehole log, and other graphical or tabular output can also be generated with the borehole database software. A summary of the main subject areas in the database and the number of data fields (in parentheses) in each area is shown in Figure 3.

The **Geographic Database** contains information needed to display the locations of the studies, sources or boreholes on a map using the *QUIKMap/inFOcus* desktop mapping system. It includes plotting instructions for symbols and labels, including size, colour, orientation and fill pattern.

The databases and their linkages are indicated in Figure 4, together with proposed additions to the granular inventory. Information on granular resource usage should be included in a separate database, that would be linked to the source database by source number. This would permit instantaneous determination of the remaining quantity of material in any source through a simple database report that would access both databases. Similarly, compilation of laboratory test data obtained during source development could be maintained in a material properties database that could be linked to both the source database and the borehole database to provide verification of the exploration data.

A brief summary of the current extent of granular resource databases in the Mackenzie Valley and the Inuvialuit Settlement Region is given in Table 1.

Figure 1. DIAND Granular Resources Database: REPORT CATALOGUE

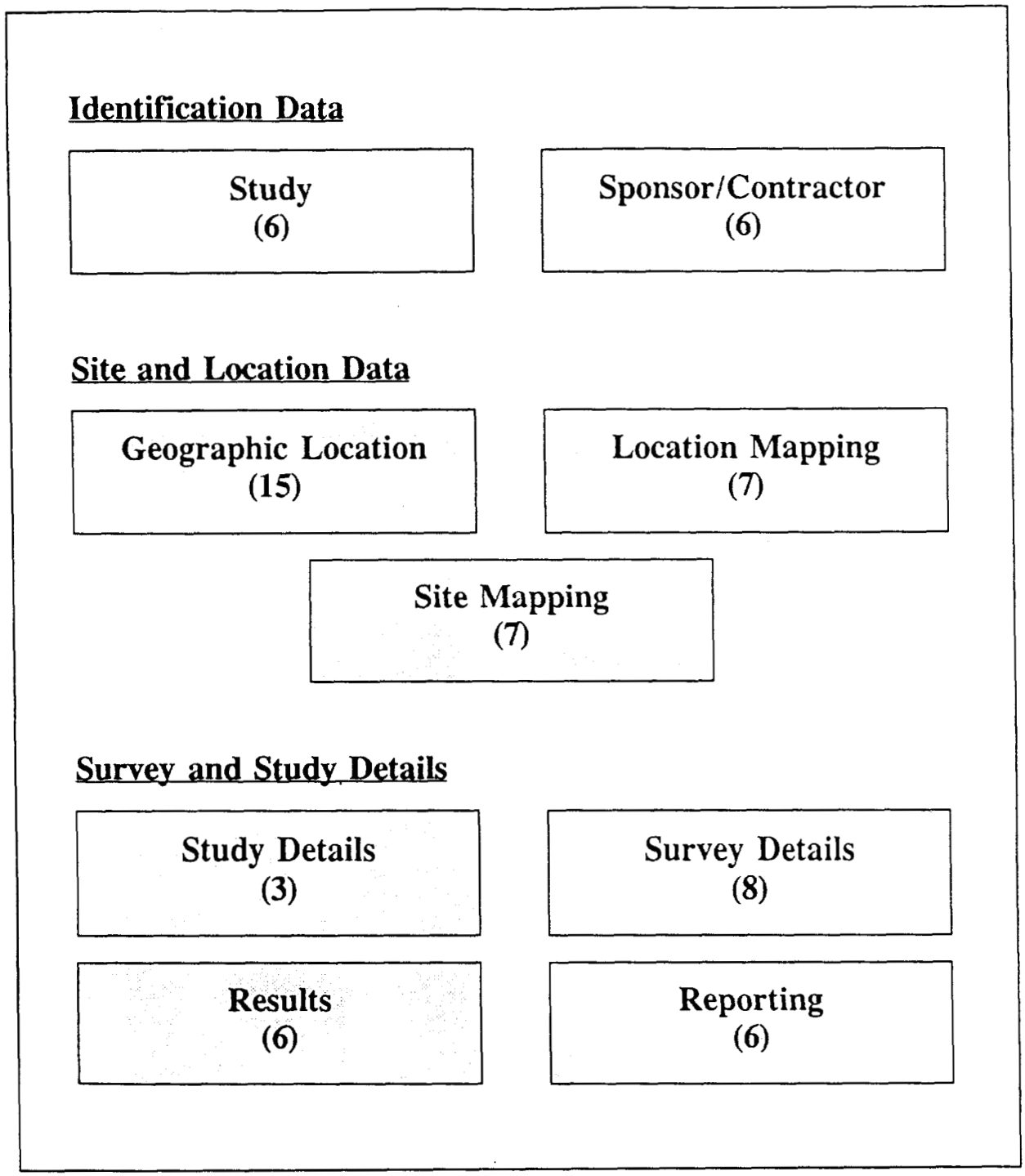


Figure 2. **DIAND Granular Resources Database: SOURCE CATALOGUE**

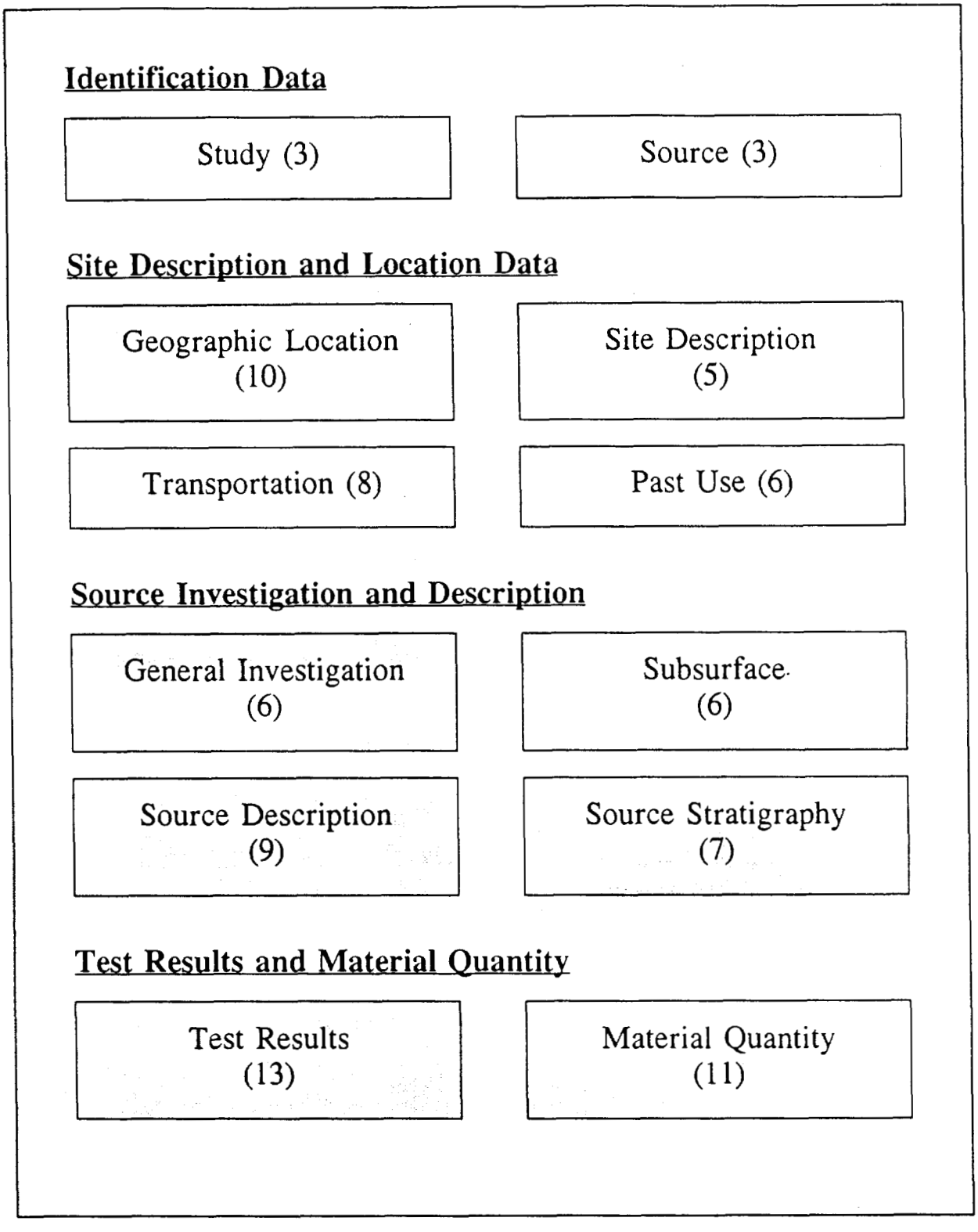


Figure 3. DIAND Granular Resources Database: BOREHOLE DATABASE

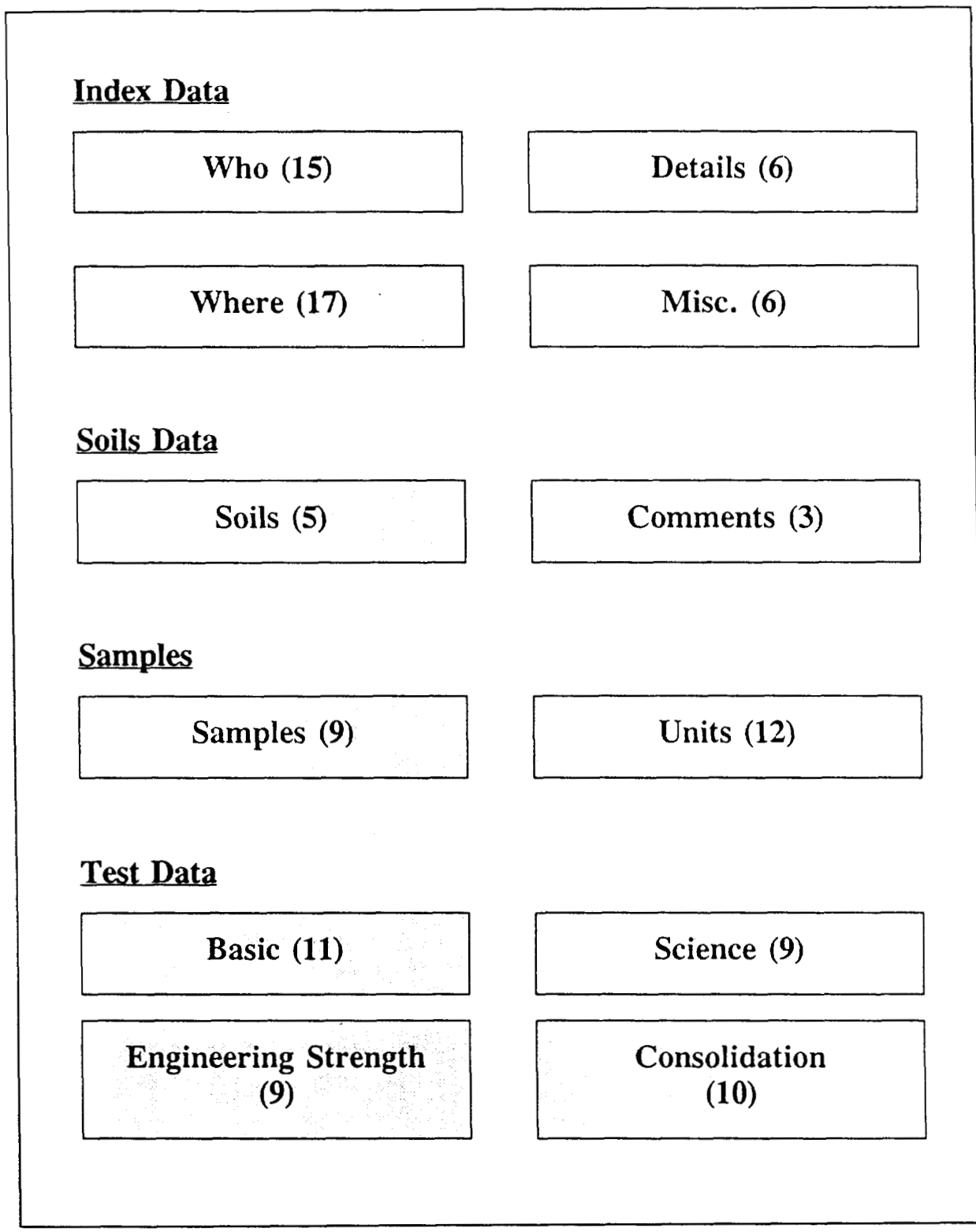


Figure 4. DIAND Granular Resources Database: GRANULAR DATABASES

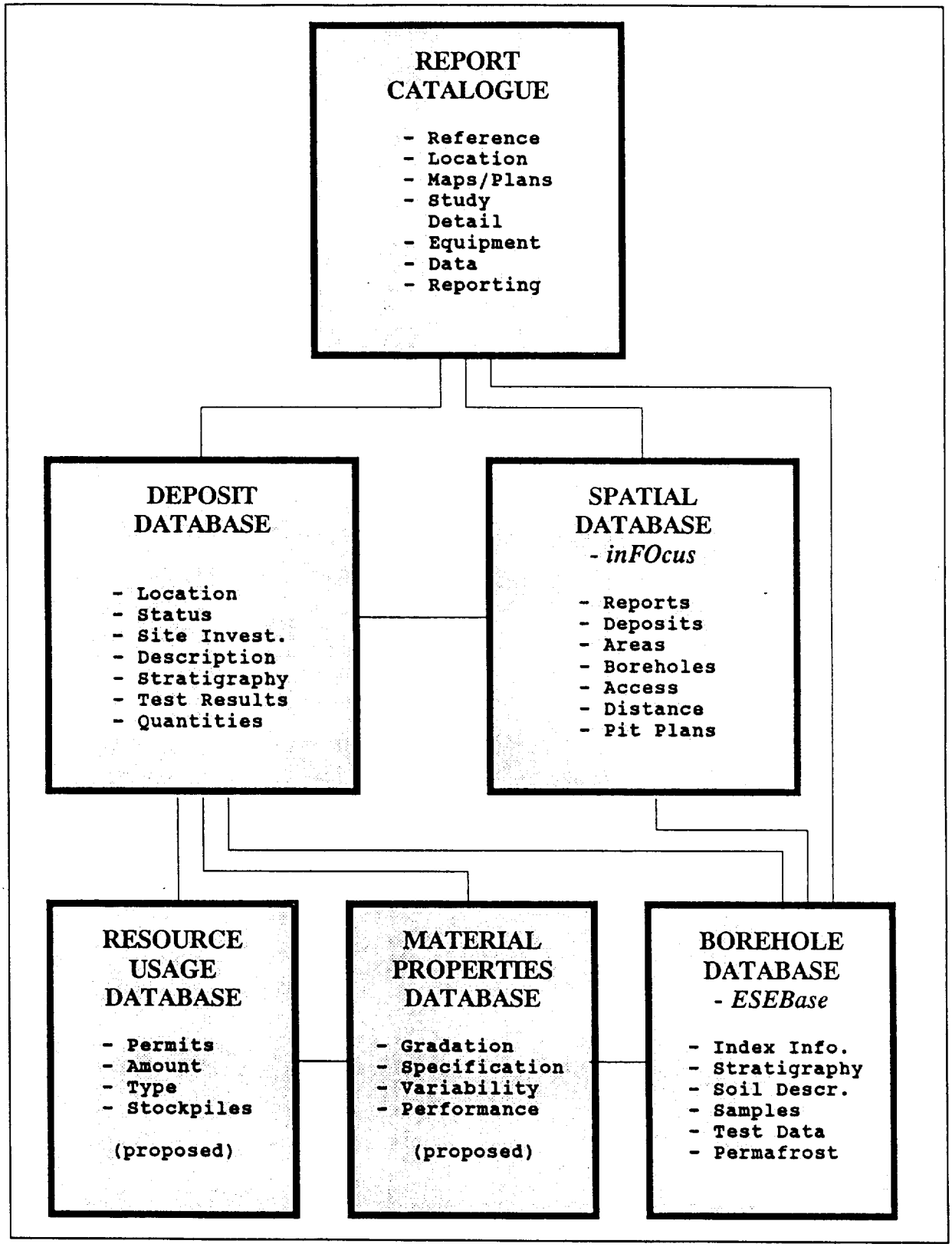


Table 1. NWT Granular Resource Databases

Region	Year Created	Contents	Records
Mackenzie Valley	1990	Borehole Database	12,695
	1992	Report Catalogue	130
	1992	Bibliography	188
North Mackenzie Valley	1992	Source Catalogue	558
South Mackenzie Valley	1992	Source Catalogue	762
Paulatuk	1991	Report Catalogue	7
	1991	Source Catalogue	4
	1991	Borehole Database	80
Inuvialuit Settlement Area	1987	Borehole Database	819
	1988	Source Catalogue	226
	1988	Report Catalogue	42
South Slave	1987	Source Catalogue	42

Ongoing studies are currently extending these databases and linking them with the geographic database. Once complete, a user-friendly interface will be developed to make this information accessible to users lacking database management experience.

It should be noted that the information compiled to date is often old data, and in most cases we have not identified the extent to which these sources have been utilized. To overcome this deficiency, it is planned to review each data record with local resource management officers and highway foreman, and update the source databases. Information held by the territorial government and other users would be a most welcome addition to the granular resource inventory.

Conclusions

Potential users of the northern granular resources inventory include government departments, native organizations, consultants and contractors. The interest expressed by several user groups has been encouraging and these efforts will continue for the next few years. Once complete, this will represent one of the most extensive computerized granular resource data collections in existence.

One of the main reasons for success achieved to-date is the co-operation of industry, various federal and territorial government departments and the Inuvialuit Land Administration through their participation in program planning and reviews, sharing of available information, and joint-funding and management of projects. Considering the current economic climate and the intense competition for limited claims implementation funds, continued co-operation will be needed to complete the needed granular resources inventory work.

BORROW RESOURCES IN BIBILIOGRAPHIC DATABASES

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ABSTRACT

This paper discusses the current granular resources coverage of the Arctic Science and Technology Information System (ASTIS), and describes a project to make this coverage comprehensive in order to produce a *Northern Granular Resources Bibliography* and database. The subject and scope of the proposed bibliography and database are described in detail, and feedback is encouraged from workshop attendees to ensure that the scope of the project meets the needs of potential users. Possible sources of additional citations are listed, and attendees are invited to add to this listing. The formats of the proposed bibliography and database are then described, and, once again, attendees are encouraged to provide feedback on whether these will meet the needs of the users. A draft copy of the *Northern Granular Resources Bibliography*, containing only citations that are already in the ASTIS database, will be distributed to workshop attendees for comment.

Introduction

The Arctic Science and Technology Information System (ASTIS) is a multidisciplinary arctic bibliographic and research project database (Figure 1). ASTIS abstracts and indexes recent literature about the Arctic, and provides descriptions of recent and ongoing arctic research projects. ASTIS is a program of the Arctic Institute of North America (AINA) of the University of Calgary.

The geographic emphasis of ASTIS is on the Canadian Arctic and Canadian arctic waters. ASTIS includes all subjects: the earth sciences, life sciences, engineering and technology, renewable and non-renewable resources, government, economic and social conditions, land use and native people. ASTIS gathers information from many sources, enters this information into an automated database, and then disseminates the contents of the database through a variety of publications and services. More information about ASTIS's information sources and products is contained in the ASTIS brochure.

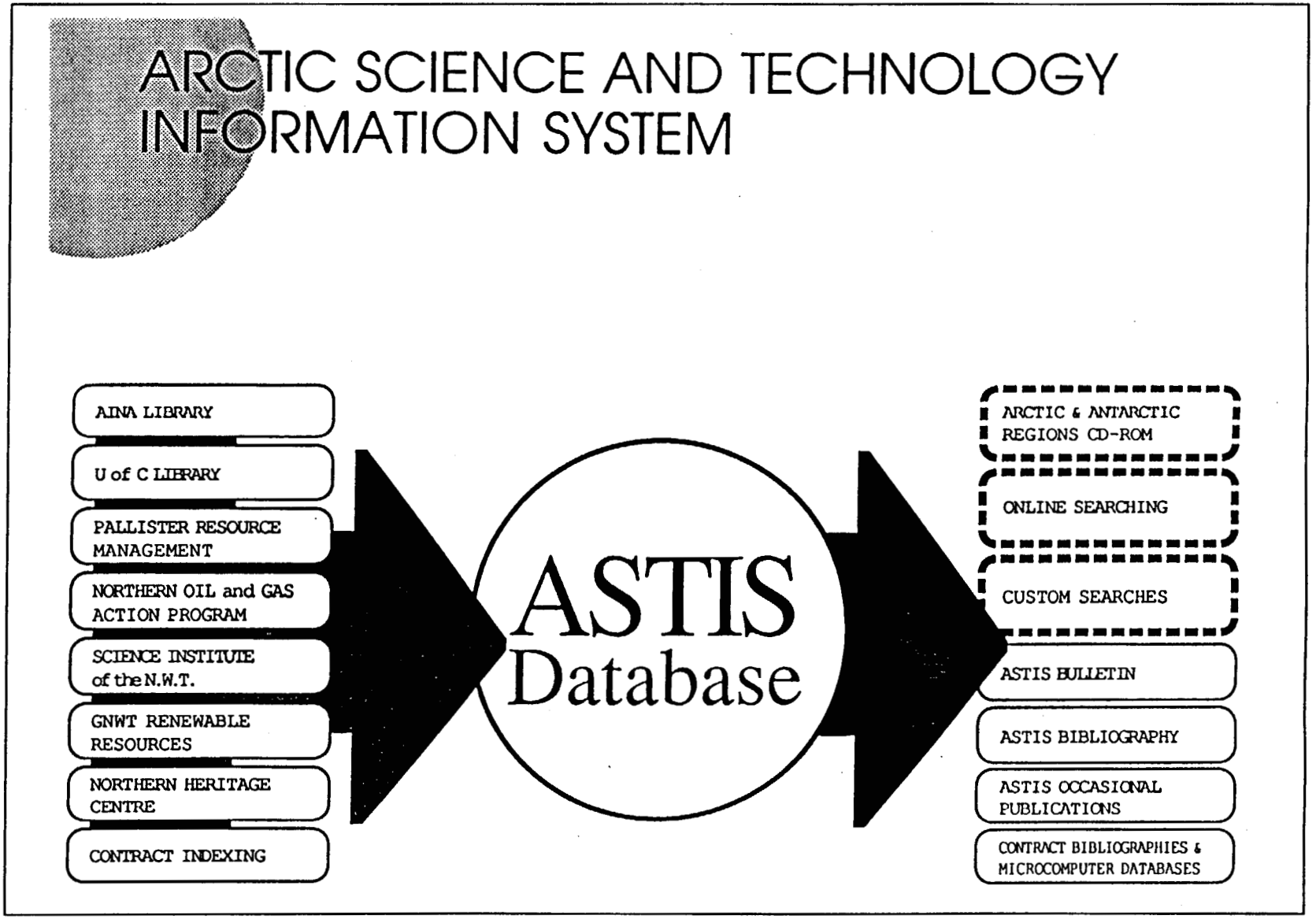
Contract indexing projects for industry and government are a major source of both information and revenue for ASTIS, which is mandated to recover all of its costs through contracts, grants and sales of products. ASTIS can produce camera-ready bibliographies and microcomputer databases in a variety of formats. By making use of our software and expertise, as well as the thousands of citations and abstracts already contained in the ASTIS database, an organization can have customized databases and bibliographies produced very cost-effectively.

ASTIS is actively involved in an effort by a group of Canadian polar information centres to create a Canadian Polar Information System (CPIS). ASTIS, the Canadian Circumpolar Library in Edmonton, and a group of other organizations with an interest in polar information have, with funding from the DIAND Circumpolar and Scientific Affairs Directorate and the Canadian Polar Commission, completed much of the preliminary design of a CPIS. Further progress on a CPIS awaits the commitment of funding for implementation and operation of the system. All information currently contained in ASTIS will be included in any future CPIS database.

The Northern Granular Resources Bibliography and Database

Over the next six months ASTIS will be preparing a comprehensive bibliography and microcomputer bibliographic database on granular resources in the Yukon and the Northwest Territories. This project is funded partly by the DIAND Land Management Division and partly by the Northern Oil and Gas Action Program (NOGAP).

Figure 1. Arctic Science and Technology Information System (ASTIS): Database Components and Services



ASTIS already contains much of the required literature because of two indexing projects that it has recently completed. Under a contract from the NOGAP Secretariat all NOGAP-funded reports to October 1991, including those of Project A4 - Granular Resources Inventory, have been added to ASTIS. These citations were used to produce a NOGAP Cumulative Bibliography and a corresponding microcomputer database. Also in 1991, under a contract from Esso Resources (now Imperial Oil Resources), ASTIS added 800 reports to its database from a proprietary collection donated to AINA by Canadian Arctic Gas Study Limited (CAGSL). The reports to be indexed were selected from the CAGSL collection by Esso engineers, and the resulting citations were used to produce a microcomputer database. ASTIS also contains many of the reports produced for the Polar Gas, Maple Leaf and Alaska Highway natural gas pipeline proposals.

The preparation of this bibliography and database on northern granular resources will be undertaken in two phases, as described below.

Phase I

Phase I of the project, to be completed by March 31, 1993, consists of two tasks. The first of these tasks, the preparation of a draft Northern Granular Resources Bibliography, has recently been completed. The draft bibliography, containing 241 relevant citations that were already in the ASTIS database at the start of the project, is being distributed at this workshop. No sources other than ASTIS were checked during the preparation of this draft, and no new citations were added to ASTIS for inclusion in it.

Citations to be included in the draft bibliography were chosen by searching the appropriate ASTIS-controlled vocabulary terms, such as "Granular materials" and "Gravel", and by free-text searching for a broader group of terms in titles and abstracts. The search was then limited to the geographic area of interest and the resulting citations were examined online to select those that appeared to be relevant. Some additional irrelevant documents were eliminated while reading a preliminary printed draft of the bibliography. After checking preliminary versions of the bibliography indexes for consistency, camera-ready copy was produced and the bibliography was photocopied.

The draft bibliography has two purposes. The first is to allow potential users to comment on the scope and format that we are proposing to use. A questionnaire included in the bibliography asks some specific questions, but all comments and suggestions are welcome. A second purpose of the draft is to provide a tool that organizations can use to determine if their granular resources publications are already in ASTIS. The final bibliography can only be made comprehensive with the cooperation of the many organizations that have reports on northern granular resources. We would very much appreciate your help in this endeavour. Additional copies of the draft bibliography will be available from ASTIS at no charge until May 1993.

The second task of Phase I of this project will be to examine the overlap between the draft bibliography and the Land Management Division's database of granular resources reports, which includes a collection of citations prepared for DIAND by EBA Engineering Consultants. The DIAND database may be the largest single source of relevant citations that are not yet in ASTIS. This task will therefore give us an idea of how many reports may need to be added to ASTIS in Phase II of this project in order to produce a comprehensive northern granular resources bibliography and database.

Before turning to a discussion of the searching and indexing that will make up Phase II of the project I will describe the proposed subject and geographic scope of our work in more detail, as well as the proposed format of the finished bibliography as illustrated in the draft version.

Subject and Geographic Scope

This project will cover all aspects of granular resources, defined as gravel, sand and crushed rock for use in construction. Documents on the availability of granular resources will be covered, including descriptions of specific sources, inventories of granular resources and the management of this resource. Methods of extracting and transporting granular resources will also be covered, including the environmental and socio-economic impacts of such work and methods of mitigating these impacts.

Documents on future requirements for granular resources in all types of construction will be covered, including conflicting demands for granular resources. Documents on geological or geotechnical surveys will only be included if they contain information on possible sources of granular resources.

We will try to restrict the bibliography to only those documents that contain original information on the subjects covered. General documents that make passing references to granular resources without providing any hard information will be excluded.

The bibliography and bibliographic database will cover both the Yukon and the Northwest Territories, and adjacent waters. Documents that overlap into Alaska and the provinces will be included as long as they contain some information about granular resources in either of the two Territories.

Format of the Bibliography

The proposed format of the finished Northern Granular Resources Bibliography is illustrated in the draft version distributed at this workshop. Entries in the bibliography will consist of complete citations with full abstracts. In the main section of the bibliography citations will be sorted by author. Citations with no author will appear at the beginning. Citations with multiple authorship will be listed under their first author (usually a consulting company) and cross-referenced from all their other authors, including sponsors. The citations listed under each author will be sorted by title.

The bibliography will contain four indexes that refer back to the main section by citation number. Terms in the Subject and Geographic Indexes will be taken from the ASTIS Subject and Geographic Thesauri. A Title Index will provide access by report title, with leading articles (A, The, etc.) removed. A Serial Index will allow citations to be found under the title of the journal, report series or proceedings in which they appeared.

As mentioned previously, comments on the proposed scope and format of the bibliography are welcome.

Phase II

Phase II of this project will begin April 1, 1993, and should be completed by the summer of 1993. Tasks to be undertaken include the following:

1. Identify, locate, obtain (when possible) and add to the ASTIS database additional relevant documents.

2. Add unique DIAND identifier codes to ASTIS granular resources records to allow them to be linked to GIS applications.

3. Produce camera-ready copy for the final printed version of the Northern Granular Resources Bibliography. The scope and format will be the same as for the draft version unless potential users of the bibliography request changes.

4. Produce two versions of the Northern Granular Resources Bibliographic Database. One of these versions will be distributed publicly using the Folio Views retrieval software. Folio Views is a fast full-text retrieval package that compresses files to approximately one-half their original size during indexing, will run on PC-compatible computers, and allows run-time versions of the retrieval software to be freely distributed. This package was used to produce the NOGAP Infobase. The other version of the database will be a tab-delimited one for input into FoxPro for internal use at DIAND.

Four additional tasks could also be undertaken to improve the usefulness of the bibliography and database, and the accessibility of the documents that they cite:

1. Most of the citations selected for inclusion in the draft bibliography were chosen based on the subject terms assigned to them when they were originally indexed by ASTIS. For this reason some of the citations in the bibliography make no mention of granular resources in their titles or abstracts. Information on granular resources is only a part of such publications. ASTIS could revisit such publications to ensure that they contain significant relevant information, and to add a sentence or two to their abstracts summarizing what they have to say about granular resources.

2. Twenty-three of the citations in the draft bibliography contain the note *"Document not seen by ASTIS. Citation from ..."*. Such citations were taken from bibliographies prepared by organizations other than ASTIS, without ASTIS having seen the actual publication being cited. The purpose of the note is to warn users that such citations may not be as complete or as correct as if ASTIS

had seen the publication. ASTIS could attempt to obtain all such publications and upgrade their citations.

3. Seventy-six of the citations in this draft bibliography contain the note *"This is a proprietary report available only with the permission of Esso Resources Canada. Contact ASTIS for details."* These citations describe reports in a proprietary collection donated to the Arctic Institute by Canadian Arctic Gas Study Limited (CAGSL), access to which is now controlled by Imperial Oil Resources Limited. (We will change the note to read "Imperial Oil Resources" before the final version of the bibliography is produced.) While Imperial Oil Resources has so far never refused permission for someone to use these reports, it would be more convenient for users if as many of them as possible were shown as being available in publicly accessible library collections. We have noticed that some of these reports are not really proprietary, and are available from sources other than the CAGSL collection. ASTIS could attempt to identify publicly accessible locations for as many of these reports as possible.

4. The last line of most citations in the draft bibliography (i.e., the last line before the abstract) contains standard Canadian interlibrary loan symbols for one or more libraries that hold the document. (Except in the case of the proprietary CAGSL reports mentioned above, ASTIS does not supply documents.) Documents that have no interlibrary loan symbol may be available from a library or from their publisher. ASTIS could identify locations for all documents that will appear in the final bibliography and database.

The final printed bibliography, and the public microcomputer database containing the same citations, will be distributed by the Land Management Division in late summer 1993.

Sources of Additional Documents

Sources that will be checked in order to make the final bibliography and bibliographic database as comprehensive as possible include the following:

1. The database of granular resources reports maintained by the DIAND Land Management Division, including those citations prepared for DIAND by EBA Engineering Consultants.

2. The considerable amount of northern material at the University of Calgary that is not yet in, or not yet all in, ASTIS. This includes about half of the CAGSL collection, the AINA Library's Pipeline Room, and material in the DOBIS and NOMADS online catalogues.

3. The databases other than ASTIS that are included on the NISC Arctic & Antarctic Regions CD-ROM. The most useful of these databases will likely be BOREAL, the catalogue of the Canadian Circumpolar Library in Edmonton. On the basis of a preliminary search of the NISC disc, however, we only expect to find about 10 new citations within the scope of this project.

4. The catalogues of the DIAND Departmental Library in Ottawa and the DIAND Technical Library in Yellowknife.

5. Other databases, catalogues, lists and bibliographies, as well as individual reports, suggested by DIAND, by the participants in this workshop and by other potential users of this bibliography. Our success in finding reports in this category will determine how comprehensive, and how useful, the final bibliography and database are.

How You Can Help

Does your organization have relevant reports that are not included in the draft Northern Granular Resources Bibliography? If you are able to send us a list of your granular resources reports we will check it against the ASTIS database and the other sources that we are examining. If you have no way to easily produce a list we can work from photocopies of title pages. We may get back to you later to borrow some of the reports briefly for indexing if we cannot locate them elsewhere. Your help is essential to the production of a comprehensive final bibliography and database, and will be very much appreciated. Thanks in advance for your assistance.

I would also like to acknowledge the efforts of ASTIS staff members Lynda Howard, Lynne Howard and Iola Phillips for their work on the draft bibliography.

QUESTION PERIOD

Question #1. I'm interested in the downcutting process that's going on now. Is that a reflection of isostatic rebound as well as natural forces?

Duk-Rodkin. It could be but we don't have very good statistics on the isostatic rebound. The thing I do know is that the quantity of material that was moved by the ice sheet was incredible.

Question #2. The GIS maps that are available from the Geological Survey of Canada, where can you get them and how much do they cost?

Duk-Rodkin. They are not sold but available on request.

Question #3. So you'd have to request them from the Geological Survey in order to get them?

Duk-Rodkin. Not too many are available in Calgary, there's quite a few maps completed. The only thing that's not included in those maps are the small kame deposits.

Question #4. Are all the Arctic Gas reports available at the Arctic Institute Library - can you go look at them or are they unaccessible.

Goodwin. They're not in the Institute Library, they're in our office at ASTIS and we have to get permission from Imperial for each person that wants to look at one of the reports. That's one of the reasons why I'd like to find out which of the reports aren't proprietary because it's been a lot of work for us to call them and get permission. Esso never says no, they've been very good about letting people look at these reports. Many of the reports are not proprietary in the sense that Imperial doesn't want people to look at them, they just want the collection kept together, they don't want it to go into a public library because some of the reports are unique and the only copies they have and they don't want to lose track of them. Wherever you see that note, contact us and we'll arrange to get permission for you.

Question #5. On your database information on granular resources, particularly the environment of Alaska fisheries, how far can you go to that end?

Goodwin. We haven't decided yet. We list some specific places we think we should draw the line.

Question #6. Let's think about this in the Alaska scenario. There is quite a bit of information on existing impacts associated with pipelines. Not so much on the geological but the impacts associated with developments. I'm just curious, are you going into that area?

Goodwin. There will be reports about areas other than the Yukon and NWT that are relevant because they talk about impacts of construction or techniques of construction. I guess ultimately it's up to DIAND whether they want to pay for us to look a bit further into that area. I probably did exclude one or two studies on environmental impacts in Alaska. There may be things like that that should remain in the database.

Question #7. You mentioned that you were starting an inventory of remaining resources or remaining gravels. How do you perceive developing that and how current do you perceive keeping it?

Gowan. So far - we're pulling together information from reports. What we'd like to do now is to work with the resource management officers in various DIAND offices and also with the ILA to do a source-by-source checkup.

Stanley

SECTION 4.

TECHNICAL PANEL "B"

REGIONAL BORROW DEPOSITS INVENTORIES

REGIONAL BORROW DEPOSITS INVENTORY: SOUTH SLAVE REGION

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ABSTRACT

A 1987 study by Thurber Consultants, funded under the NOGAP Program, was undertaken to investigate granular aggregate supply and demand, and to develop a suitable management strategy for the granular resources of the South Slave Region of the Northwest Territories. The study also addressed the identification and rehabilitation of depleted sources. Total reserves in the order of 83,000,000 m^3, contained in a large number of sources, was identified with a projected maximum demand of only about 1,100,000 m^3 over a 5-year period (1988 to 1992, inclusive). However, while supply considerably exceeds current demand, conflicts and competition between sources and for different material classes were also identified.

A number of aggregate sources in the region were found to be depleted, or likely to be depleted in the near future. In addition, numerous borrow pits were opened up during highway and railway construction and have since been abandoned. Procedures for site restoration and rehabilitation were developed for clean-up, grading and contouring, overburden and topsoil replacement, drainage and erosion control, and natural revegetation. As well, recreational end uses for the depleted areas were considered such as picnic or camping areas, scenic viewpoints and road-side turnoffs. Some sites may be suitable for waste disposal, aggregate crushing, or temporary stockpiling.

Introduction

During 1987, the Department of Indian and Northern Affairs retained Thurber Consultants Ltd. to develop a Granular Resources Management Strategy for the South Slave Region of the Northwest Territories (NWT). The study was funded under the Northern Oil and Gas Action Program (NOGAP). The project was carried out by Thurber Consultant's Ian Jones as the Project Geologist, and Nick Hernadi as the Project Engineer.

The study region was subdivided into five Resource Management Areas, defined in relation to the existing transportation network, the supply/demand situation around various communities and the current pattern of resource usage. Figure 1 shows the study region and the five Resource Management Areas.

The principal components of the study included:

- review of available information;
- contacts with granular materials users;
- field investigations;
- laboratory testing;
- supply/demand analysis;
- formulation of development strategy; and,
- preparation of rehabilitation plans.

The scope of work under these tasks is described in the following sections of this paper.

Review of Available Information

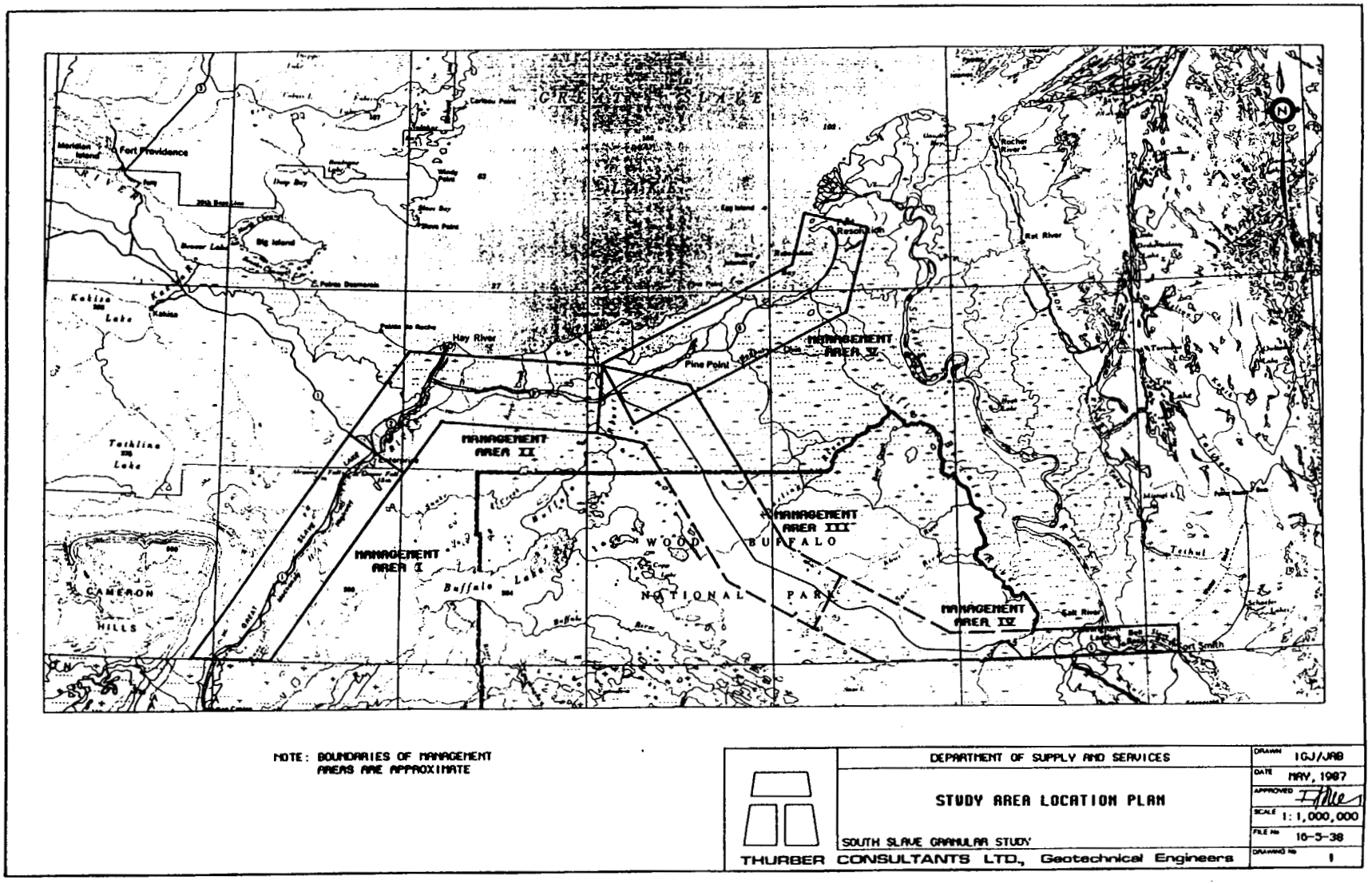
Initial research into the borrow deposits inventory of the South Slave region consisted of a review of:

- surficial geology and bedrock geology maps;
- a number of consultants' reports prepared between 1974 and 1986 for various areas within the study area; and,
- a terrain analysis using typically 1:50,000 airphoto coverage.

Contact and Interviews with Users and Managers of Granular Materials

The purpose of these interviews was to establish historic demands and forecasts of future demands, as well as to identify favoured past, present and future

Figure 1. **South Slave Region: Resource Management Areas**



sources for all types of material. Contacts included:

- Municipal, Territorial and Federal managers;
- Northern Transportation Company Ltd.;
- CN Rail; and,
- Pine Point Mines.

Field Investigations

The main purposes of the field investigations were:

- to conduct a field reconnaissance of all existing accessible granular sources;
- to sample granular materials from exposures and stockpiles;
- to photograph exposed granular materials and pertinent features of each source; and,
- to carry out an aerial survey of existing active, depleted and abandoned pits.

Laboratory Testing

In addition to grain size analyses, aggregates potentially suitable for concrete production were tested for L.A. Abrasion, sulphate soundness and petrographic analyses.

Supply/Demand Analysis by Management Area

The supply/demand analysis consisted of:

- analysis of the supply of proven, probable and prospective reserves of various quality aggregates;
- identification of depleted, nearly depleted or abandoned sources;
- analysis of the demand data for various types of aggregates; and,
- assessment of the suitability of available granular materials to supply the regional demands for concrete aggregates.

Formulation of Development Strategy

Based on the supply/demand analysis, and the identified areas of competition and conflict for specific deposits and material classes, a development strategy was formulated involving:

- requirements for additional exploratory work;
- dedication of sources to specific uses to promote conservation and effective usage of remaining resources; and,
- site development, environmental protection and source restoration.

Preparation of Rehabilitation Plans

Work under this task involved assessing the remaining potentially recoverable materials in depleted or nearly depleted sources and development of rehabilitation plans including:

- consideration of site end uses; and,
- preparation of site specific recommendations and conceptual sketches.

GEOLOGICAL SETTING AND SITE CONDITIONS

Types of Granular Aggregate Sources

Five main types of surficial deposit with potential as sources of granular aggregate have been identified in the South Slave Region. These are, in decreasing order of significance:

- glaciofluvial ridges (gravel and sand);
- glaciolacustrine and lacustrine beach ridges, spits and lag deposits (gravel and sand);
- alluvial floodplain and terrace deposits (sand and gravel);
- recent lacustrine beaches (silty sand); and
- eolian dunes and ridges (silty sand).

In addition, some bedrock sources have been identified for the production of granular materials.

Permafrost

The South Slave Region is located within the southern part of the discontinuous permafrost zone, hence permafrost occurrence is widespread in organic terrain, less prevalent in glacial tills and

glaciolacustrine soils, and usually absent in granular aggregate deposits.

AGGREGATE SUPPLY AND DEMAND

Within the entire study region a total of 104 aggregate sources were identified, which included 23 deposits actively being developed, 65 undeveloped deposits and 16 deposits which have been depleted or abandoned. Most of these sources are within 5 to 10 km of the transportation network and communities.

Total prospective reserves of all classes of materials in the order of 83,000,000 m^3 were identified. However, the distribution of the materials is such that not all classes of aggregates are available within a given management area, and the higher quality materials are frequently confined to a limited number of sources.

A brief summary of the material classification system used in the study follows:

Class 1: Excellent quality material, such as well graded sands and gravels suitable for use as asphalt or concrete aggregates with a minimum of processing.

Class 2: Good quality materials suitable for base and surface course aggregates or structure supporting fills. Production of concrete aggregates may also be possible with extensive processing.

Class 3: Fair quality aggregates consisting generally of poorly graded sands and gravels with or without substantial silt content.

Class 4: Poor quality materials generally consisting of silty, poorly-graded fine sand, with minor gravel.

Class 5: Bedrock of fair to good quality.

Based on the interviews with the users and managers of granular materials in the study area, 5-year high and low demand projections were developed for each Management Area for each class of aggregate for the 1988 to 1992 time frame.

A summary of the prospective supply versus 5-year high demand projection for each class of aggregate in each Management Area is shown in Table 1. As shown, the total supply greatly exceeds the total maximum 5-year demand projection of about 1,100,000 m^3, however, the higher class of aggregates are not available in all Management Areas.

GRANULAR RESOURCE MANAGEMENT STRATEGY

Based on the supply inventory and the projected aggregate requirements over the next 5 years, a granular resource management strategy was developed with specific recommendations given for each identified source.

The assumptions made in developing the strategy were as follows:

- conservation of aggregate, for the highest quality uses to which it is suited, is a priority, so as to minimize "high grading" and limit the continuing requirements to locate new sources of high quality material;
- logical and orderly development of individual sources (from preliminary exploration through extraction to site restoration) is essential, so that the extraction of different classes of material from any particular source is maximized;
- supply-demand conflicts within management areas and competition for sources and aggregate classes should be minimized;
- utilization of the concrete aggregate resources that are available in the Region should be optimized;
- restoration and rehabilitation of depleted sources should take place on a continuing basis as resource development proceeds; and
- adequate reserves of suitable material for specific community uses should be assured.

The recommended resource management strategy was summarized in a series of tables for each Management Area. An example is shown on Table 2.

Table 1. South Slave Region: Prospective Aggregate Supply and Demand

SOUTH SLAVE REGION SUMMARY OF PROSPECTIVE AGGREGATE SUPPLY AND 5-YEAR (1988 TO 1992) MAXIMUM DEMAND (M^3)					
Management Area	Aggregate Class				
	1	2	3	4	5
1 - demand - supply	100 --	275,000 --	500 1,800,000	-- 8,500,000	-- 1,500,000
2 - demand - supply	113,000 305,000	169,000 3,180,000	167,000 16,000,000	40,000 3,800,000	-- --
3 - demand - supply	-- --	61,000 3,760,000	10,000 5,050,000	-- 1,160,000	-- --
4 - demand - supply	7,500 --	110,000 --	9,000 12,750,000	28,000 --	-- --
5 - demand - supply	5,000 --	70,000 690,000	14,000 18,280,000	20,000 4,410,000	100 2,250,000
Total - demand - supply	125,600 305,000	685,000 7,630,000	200,500 53,880,000	88,000 17,870,000	100 3,750,000

SOURCE RESTORATION CONCEPTS AND PROCEDURES

Restoration concepts and recommended procedures included consideration of the following points:

Site Clean-up

- removal of buildings, machinery, fuel containers and related debris; and,
- where temporary abandonment is considered, some equipment could be permitted to remain on site, pending renewed extraction activity.

Verification of Source Depletion

- Where source boundaries are not defined by distinct ridges, source depletion must be confirmed by material thickness and quality. At least 0.8 m thickness should be available for economic extraction.
- Field testing outside of the pit boundaries may be necessary to confirm.

Determine Preferred End Uses

Due to the proximity of the sources considered in this study to transportation corridors in the South Slave Region, a number of potential end uses could be considered for depleted sites, including:

- road side rest areas;
- road side campgrounds;
- aggregate crushing or stockpile sites; or,
- waste disposal sites for community use.

Grading and Contouring

- Grading at sites to be abandoned only temporarily should be such that remaining aggregate reserves are not sterilized.
- Depleted sites should be graded and contoured to eliminate surface depressions as much as possible. Maximum slopes of 2 horizontal to 1 vertical are recommended and slope crests should be rounded and should blend into the surrounding terrain.

Table 2. Management Area II: Aggregate Supply and Demand Recommendations

AGGREGATE SUPPLY AND DEMAND MANAGEMENT AREA II B. Highway 5							
Deposit	**Location/Access**	**Landform and Material**	**Environment and Development Concerns**	**Aggregate Supply**	**Aggregate Demand (1988 - 1992)**	**Future Work**	**Comments**
5-1	1 km S of highway (km 3), 8 km S of Hay River; trail into site	Beach ridge; gravelly sand	--	--	--	--	Deposit long depleted, with good natural revegetation
5-2	S of highway (km 7), 10 km SE of Hay River; no access	Beach ridges; gravelly sand	Close to Sandy River valley	Class 4: 35,000m^3 (prospective)	None projected	None proposed	Development not recommended at this time
5-3 (HR-106)	8 km N of highway, 6 km E of Hay River; poor access through Indian reserve	Beach ridges; gravelly sand	On Hay River I.R. close to Sandy River and lake shore	Class 4: 1,000,000m^3 (prospective)	None projected	None proposed	Development not recommended
5-4	15 km S of highway (km 10); 25 km NE of Enterprise; no access	Glaciofluvial ridges; sandy gravel	None identified	Class 3: 375,000m^3 (prospective)	None projected	None proposed	Development not recommended at this time
5-5	14 km S of highway, 25 km SE of Hay River; no access	Beach ridges; sandy gravel	None identified	Class 3: 2,400,000m^3 (prospective)	None projected	None proposed	Development not recommended at this time; however, could be opened up after Deposit 5-6 is depleted
5-6 (HR-109A; Mile 12S)	6 km S of highway (km 18), 22 km SE of Hay River; access via Fort Smith winter road	Glaciofluvial ridges; sandy gravel	None identified	Class 1: 70,000m^3 (proven); Class 2: 95,000m^3 (proven); Class 3: 130,000m^3 (proven)	Class 1: 12,000m^3 Class 2: 48,000m^3 Class 3: 5,000m^3	Potential of ridges to SW of main deposit should be investigated; low priority	Source of good to excellent aggregate in Management Area II; continued development recommended

Control of Surface Drainage and Erosion

- Pit development has often resulted in poor surface drainage, including ponding of water in shallow depressions.

- Recontouring should aim to promote positive site drainage and eliminate closed depressions, where possible.

Replacement of Overburden and Topsoil

- Available stockpiled overburden and topsoil should be spread evenly over the graded and contoured site.

Revegetation

- Experience has shown that natural revegetation of abandoned sites in the forested areas of the southern NWT is relatively rapid due to the abundance of natural seed sources.

- Spreading of stockpiled topsoil will encourage this natural revegetation.

- Only limited use of seeding and application of fertilizer in this area is expected to be required.

All sources identified as abandoned, depleted or nearly depleted were considered for source restoration on a site specific basis. In presenting the recommended area restoration plans, annotated airphoto mosaics, oblique air photographs and conceptual sketches were prepared and utilized.

REQUIREMENTS FOR ADDITIONAL EXPLORATORY WORK

To complete the granular resource management strategy for the South Slave Region, recommendations were given for additional exploratory work to determine the distribution of granular materials remaining in developed sources, as well as to prove up probable and prospective aggregate reserves in undeveloped deposits.

The objective was to assist with planning and budgeting for future granular resource exploration plans, rather than to scope out detailed site specific exploration plans.

REGIONAL BORROW DEPOSITS INVENTORY: UPPER MACKENZIE VALLEY

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ABSTRACT

In 1988, EBA produced a computerized summary of existing granular resource data for the Upper Mackenzie Valley. The summary included over 50 granular resource studies that were conducted in the Upper (South) Mackenzie Valley prior to 1988 and covered an area of about 100,000 km^2 from Fort Providence to Norman Wells. Both sides of the Mackenzie River and adjacent regions outside the narrow pipeline and highway corridor were included. Geographic, geologic and engineering characteristics for 762 sites were summarized and an assessment of the potential value of each site was provided in the database. Five new Borrow Management Areas were proposed by EBA to be continuous with the seven areas developed in 1986 for the Lower (North) Mackenzie Valley by HBT AGRA.

In 1992, additional work was done to convert the granular resource databases compiled in 1988 for the Upper and Lower Mackenzie Valley to a consistent format. A computerized summary of the reports providing granular resource information was begun by EBA in 1991, and updated in 1992. An ESEBase borehole database containing about 12,500 boreholes for the Mackenzie Valley was converted from a GSC database by EBA in 1991. The database is currently being updated by EBA for the GSC.

Introduction

This presentation discusses the data compiled under NOGAP and related contracts for Indian and Northern Affairs Canada (INAC) in 1986, 1988, 1991, and 1992, by EBA Engineering Consultants Ltd. (EBA) and others. It also presents some information about related contracts for the Geological Survey of Canada (GSC) in 1992-93. These contracts relate to granular resource inventory databases and geotechnical borehole log databases.

In 1988, EBA and its subconsultant GVM Geological Consultants Ltd. (GVM) compiled a summary of over 50 granular resource studies that were conducted in the Upper Mackenzie Valley prior to 1988. The summary covered an area of about 100,000 km^2 south of Norman Wells, including both sides of the Mackenzie River and adjacent regions outside the narrow pipeline and highway corridor. EBA's study area is shown on Figure 1. The study developed as a by-product of EBA's study of the feasibility of developing granular borrow resources from the Mackenzie River bed, which Neil MacLeod of EBA discusses in a later presentation in this workshop.

As part of their 1986 work for INAC on the Lower Mackenzie Valley, HBT AGRA Ltd. (HBT) summarized data from 292 potential granular sources. HBT's study area is shown in Figure 2. A computerized summary for the Lower Mackenzie Valley was done by Mr. L. Bennett for INAC in 1988, including granular sources at 558 sites, covering much of the same area as HBT's study, as shown in Figure 3. EBA's database for the Upper Mackenzie Valley adopted a similar but not identical format to Bennett's database. Like EBA's work, both the HBT and Bennett studies were based on published and readily available data, and were intended to provide a framework for a regional granular inventory.

A computerized summary of the reports providing granular resource information was begun by EBA in 1991, and updated in 1992. This report catalogue database has 131 entries for the Mackenzie Valley. A less-detailed bibliographic summary database produced

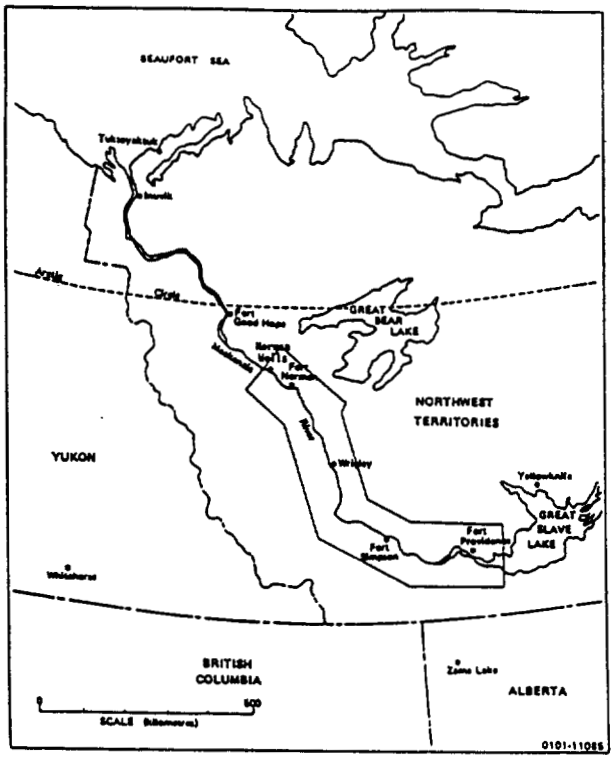


Figure 1. Upper (Southern) Mackenzie Study Area (EBA, 1988, 0306-34395)

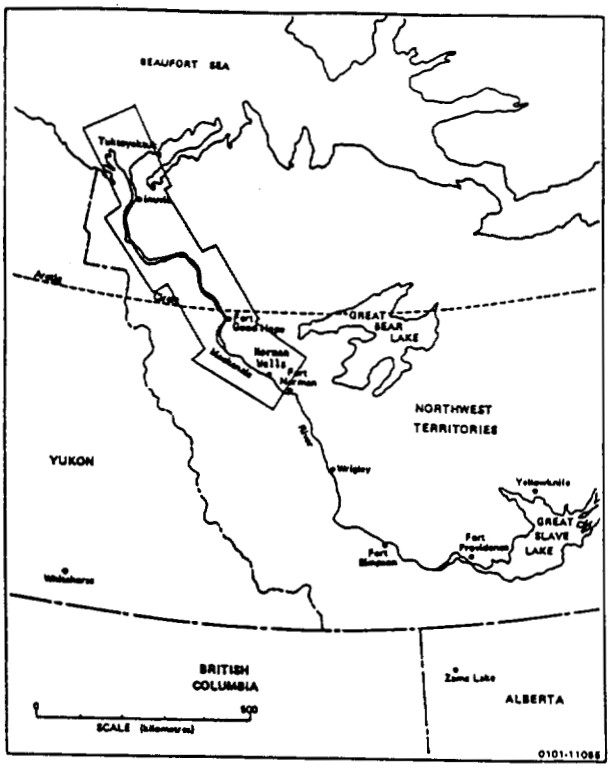


Figure 2. Lower (Northern) Mackenzie Study Area (Hardy BBT, 1986)

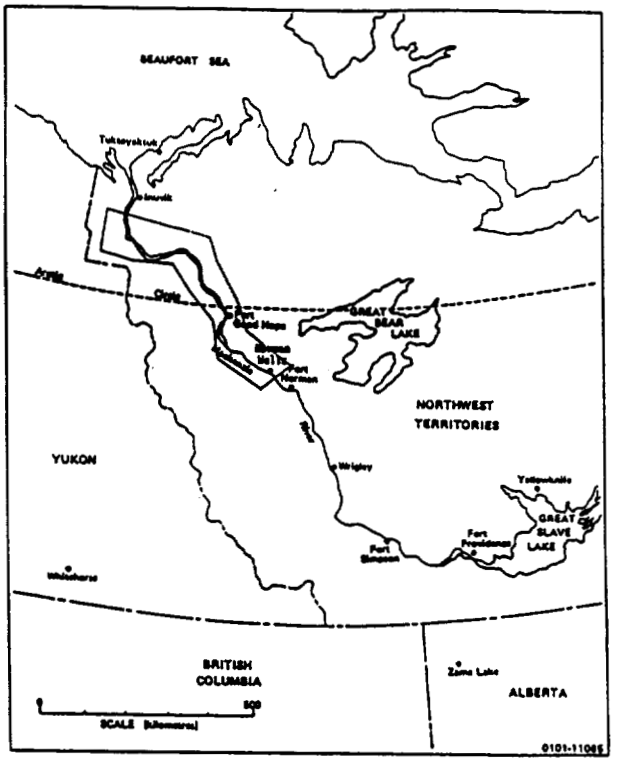


Figure 3. Lower (Northern) Mackenzie Study Area (Bennett, 1988)

by EBA includes reports, fieldwork, maps and other information and has 188 entries including the report catalogue entries. The standardized source databases can now be conveniently linked to the report catalogue database. The Arctic Institute of North America (AINA) at the University of Calgary is conducting further work in 1993 on a bibliographic database for the Mackenzie Valley.

In 1992, programming work was done by EBA to convert the granular source databases compiled in 1988 for the Upper and Lower Mackenzie Valley to a consistent format. These efforts were intended to facilitate linking of the databases. The new standardized databases are in a format consistent with the existing Yukon and Paulatuk databases which were previously compiled by EBA for INAC.

There is also a related database containing about 12,500 boreholes for the Mackenzie Valley, which EBA prepared in 1991. These logs were converted from a GSC database to an ESEBase format. This database is being updated to ESEBase Version 4.0 by EBA for the GSC in 1992-1993. Final linking of this database to the granular source databases and the report catalogue has not been addressed yet.

Report Catalogue Database

Information in the Report Catalogue Database

The objective of EBA's 1991 work, which was further extended in 1992, was to compile a report catalogue to identify sources of granular resource related information including reports, maps, field work and other data. This information was acquired from various government departments, major petroleum and pipeline companies, and geotechnical engineering consultants.

The report catalogue database summarizes general data for each report containing geophysical or geotechnical data in the Mackenzie Valley. The database now contains information from 131 reports. The report catalogue summarizes such items as the report title, the year and month of the field work, the sponsor and contractor of the work, contact names, the location coordinates and area name of the site, study type and size, a list of the granular sources names discussed in the report, the quality of the data obtained, numbers of samples obtained, where the reports and raw data are archived, and so on.

The database entries are in dBase III+ format, standardized according to the terms defined in the Data Dictionary. Figure 4 shows a sample page of the report catalogue data dictionary, which defines each of the fields contained in the database. Figure 5 shows the report catalogue database structure. A sample entry of the report catalogue is shown in Figure 6.

A brief description of the two main fields used for linking the report catalogue to other databases is as follows:

Study Number

The study number is a 12 character field which identifies the report from which borehole information is obtained, and is used as a link to other databases. The first four characters of the study number identified the contractor, the following two characters identified the year of the study, and (up to) the remaining six characters were allowed to identify the geographic area or local name. For example:

PEM 73 FG
Contractor = PEM (Pemcan)
Year of Study = 73 (1973)
Area Name = FG (Fort Good Hope)

Table 1 lists the abbreviations used for the contractor names. Table 2 lists the abbreviations used for the geographic/area names.

Source Number

The source number identifies the original source deposit number where information has been obtained and is also a link to other databases. The source number field is also twelve characters long. For most reports specific to source deposits, the original source numbers appear in the report catalogue entry. The granular source databases (discussed further below) include the original source numbers in the field "source_no".

Use of the Report Catalogue Database

The report catalogue can be used in conjunction with the existing source and borehole databases to evaluate granular resources for construction materials. The links to these other databases comprise the study number and source number fields. These fields are discussed further above.

Figure 4. Sample Page of Report Catalogue Data Dictionary: Granular Resources

PART A: STUDY REFERENCE AND LOCATION

AA - STUDY NUMBER: A unique study identifier number which serves as a link to other databases (e.g. Source Database, ESEBase Borehole Database).

AB - YEAR: The calendar year in which the majority of the field work on the study was complete (e.g. 1983).

AB1 - MONTH: The month in which the majority of the field work was completed (e.g. 07).

AC - SPONSOR: The name of the company, department, agency or organization sponsoring the study. (e.g. Indian and Northern Affairs Canada, Yukon Transportation Engineering, Public Works Canada)

AC1 - SPONSOR JOB/FILE NUMBER: The sponsor's job number.

AD - SPONSOR CONTACT NAME: The name of the person within the sponsoring organization who might be contacted to obtain additional information on the study and/or authorization for its use.

AE - CONTRACTOR: The name of the prime contractor, consultants or group contracted by the sponsor to undertake the study (e.g. EBA Engineering Consultants Ltd., Northern Engineering Services Company Ltd.)

Figure 5. Report Catalogue Structure

Structure for database: C:MACK92RC.dbf
Number of data records: 130
Date of last update : 12/10/92

Field	Field Name	Type	Width	Dec
1	STUDY_NO	Character	12	
2	YEAR	Numeric	4	
3	MONTH	Numeric	2	
4	SPONSOR	Character	50	
5	SP_JOB_NO	Character	15	
6	SP_CONTACT	Character	20	
7	CONTRACTOR	Character	65	
8	CO_JOB_NO	Character	16	
9	CO_CONTACT	Character	24	
10	MN_ZONE	Numeric	2	
11	MN_EAST	Numeric	6	
12	MN_NORTH	Numeric	7	
13	MN_LAT_DEG	Numeric	8	5
14	MN_LON_DEG	Numeric	9	5
15	CN_LAT_DEG	Numeric	8	5
16	CN_LON_DEG	Numeric	9	5
17	CN_ZONE	Numeric	2	
18	CN_EAST	Numeric	6	
19	CN_NORTH	Numeric	7	
20	MX_ZONE	Numeric	2	
21	MX_EAST	Numeric	6	
22	MX_NORTH	Numeric	7	
23	MX_LAT_DEG	Numeric	8	5
24	MX_LON_DEG	Numeric	9	5
25	LOC_MAP_NO	Character	40	
26	LOC_MAP_FM	Character	40	
27	LOC_MAP_SC	Numeric	10	
28	LOC_MAP_DN	Character	10	
29	LOC_MAP_AR	Character	60	
30	AREA_NAME	Character	40	
31	SITE_NAME	Character	40	
32	SIT_PLN_NO	Character	80	
33	SIT_PLN_FM	Character	120	
34	SIT_PLN_SC	Character	45	
35	SIT_PLN_DN	Character	20	
36	SIT_PLN_AR	Character	120	
37	SOURCE_NOS	Character	180	
38	NEW_SRC_NO	Character	180	
39	LINE_NO	Character	180	
40	STUDY_TYPE	Character	120	
41	STUDY_SCOP	Character	60	
42	SURV_LEVEL	Character	180	
43	STUDY_SIZE	Character	40	
44	SURV_PATT	Character	40	
45	SURV_SPAC	Character	50	
46	PGM_LEN	Character	30	
47	SEASON	Character	25	
48	EQUIP_TYPE	Character	120	
49	PENETRATN	Character	120	
50	RESOLUTION	Character	15	
51	SAMPL_RATE	Character	60	
52	SAMPL_QUAL	Character	80	
53	SAMPL_TYPE	Character	100	
54	SAMPL_SIZE	Character	60	
55	INTRP_LEVL	Character	120	
56	RPT_LEVL	Character	100	
57	RPT_ARCHIV	Character	100	
58	RPT_DIST	Character	120	
59	DAT_ARCHIV	Character	120	
60	OTHER	Character	100	
61	COMPILER	Character	120	
62	COMP_DATE	Character	8	
63	DC_PROJ_NO	Character	15	
64	UPDATE_BY	Character	120	
65	UPDT_DATE	Character	8	
66	DU_PROJ_NO	Character	15	
67	RPT_TITLE	Character	180	
68	PROPRI	Character	80	
69	RPT_OR_BIB	Character	10	
** Total **			3786	

Figure 6. Report Catalogue Sample Entry

MACKENZIE VALLEY TRANSPORTATION CORRIDOR
INDIAN AND NORTHERN AFFAIRS CANADA
CATALOGUE OF GRANULAR RESOURCE-RELATED INFORMATION

STUDY NUMBER: EBA74FGAR MONTH: 0 YEAR: 1973

SPONSOR : DIAND
JOB NO : OSR3-0053 CONTACT: BOB GOWAN
CONTRACTOR : EBA ENGINEERING CONSULTANTS LTD
JOB NO : E-666 CONTACT: NEIL MACLEOD
REPORT TITLE: GRANULAR MATERIALS INVENTORY,STAGE III V.1,GENERAL REPORT,1975 APRIL(SPECIFIC SITE EVALUATION AND DATA IN VOLUMES II,III,IV)

COORDINATES :

UTM: ZONE:	MINIMUM	CENTRE	MAXIMUM
EASTING:	8	9	9
NORTHING:	0	0	0
OR: LATITUDE:	0	0	0
LONGITUDE:	66.31666	67.30000	68.26666
	127.16666	130.50000	133.66666

LOCATION:

NAME : GENERAL LOCATION SITE PLAN
FORT GOOD HOPE TO ARCTIC RED R FT GOOD HOPE-LITTLE CHICAGO-RED
NUMBER: RIVER
1.1
SCALE : 1:1707000 SOUTH HALF,NORTH HALF
FORMAT: PAPER COPY 1:250000
ARCHIV: IN REPORT PAPER COPY
DIG NO: N/A IN REPORT
N/A

SOURCE NUMBER(S):
1001-1156

SURVEY LINES / LOCATION DETAILS:

DESCRIPTION OF STUDY AND SURVEY DETAILS:
TYPE : GEOTECHNICAL
SCOPE: REGIONAL-150 SITES
LEVEL: EXPLORATION,BORROW INVESTIGATION(GRANULAR AND BEDROCK),REVIEW OF EXISTING DATA

SIZE :
104 BHS,245 TPS,17400 KM
SURVEY PATTERN: UP TO 5 BHS PER SITE,IRREGULAR
SURVEY SPACING: IRREGULAR
SEASON: PROGRAM LENGTH: 41 DAYS,SEPT-OCT 1974

EQUIPMENT : MOBILE ARCTIC AUGER-CONTINOUS FLIGHT WITH SEISMIC TYPE AIR CIRCULATING OPTION,HELI-DRILL WITH BECKER DOUBLE WALL PIPE
PENETRATION:
0.9M-5.0M-9.1M FOR BHS,0.9M FOR TPS
RESOLUTION :
GOOD

INFORMATION ON SAMPLES OR SURVEY RECORDS:
RATE : 0.6M-1.5M
QUALITY: GOOD
TYPE : DISTURBED
SIZE : N/A

LEVEL OF DETAIL: INTERPRETATION/ANALYSIS/REPORTING:
INTERP : CLASSIFICATION OF BORROW,RECOMMENDATIONS FOR DEVELOPMENT AND RESTORATION
REPORT : FORMAL GEOTECHNICAL,MAPS,ASSESSMENTS,SITE DESCRIPTIONS
DISTRIB: SPONSOR/CONTRACTOR
OTHER : PWC74FGDH,MVPL72NM,RMH73FSIN,CASSL,CN-CP ARCTIC RAILWAY STUDY GROUP

ARCHIVING OF INFORMATION:
REPORT : SPONSOR/CONTRACTOR
DATA : SPONSOR/CONTRACTOR,FOOTHILLS PIPELINES

DATA COMPILATION AND UPDATING:
COMPILED BY: EBA ENGINEERING CONSULTANTS LTD.
DATE : 91/03/13 COMPILATION PROJECT NO.: 0306-34693
UPDATED BY : EBA
DATE : 92/12/10 UPDATE PROJECT NO.: 0101-11085

Table 1. (part of)
Contractor Names and Abbreviations

CONTRACTOR NAME	ABBREVIATION
Acres Consulting Services Ltd.	ACR
BBT Geotechnical Consultants and GVM Geological Consultants Ltd.	BBT
J.M. Blackwell	BLK
J.M. Blackwell and G.H. Watson	BW
Canada North Engineering Ltd.	CNE
Canadian Arctic Gas Pipeline Ltd.	CAG
EBA Engineering Consultants Ltd.	EBA
Elmer W. Brooker & Associates Ltd.	EWB
Gas Arctic/Northwest Project Study Group	GSNP
Gas Arctic Systems Study Group Ltd.	GAS
Gentile, D.J., and Zaturechy, J.W.	GENT
Golder Associates (Western Canada) Ltd.	GAL
Hardy Associates (1978) Ltd.	HAL
Hardy BBT Ltd.	HBT
Nesbitt, T.H.D., and Howell, J.D.	NH
Inuvialuit Development Corporation	IDC
Klohn Leonoff Consultants Ltd.	KLC
Klohn Leonoff Ltd.	KLL
Lombard Group North	LNG
Mackenzie Highway Granular Materials Working Group	MHG
Mackenzie Valley Pipe Line Research Ltd.	MVPL
MacLaren PlanSearch	MLP
J.D. Mollard and Associates Ltd.	MOL
not available	NA

Table 2. (part of)
Geographic Region or Local Names and Abbreviations

GEOGRAPHIC NAME	ABBREVIATION
Aklavik	AK
Arctic Red River	AR
Axe Point	AX
Big Smith Creek	BS
Bosworth Creek	BC
Blackwater River	BR
Campbell Creek	CC
Campbell River	CR
Camsell Bend	CB
Canot Lake	CL
Canyon Creek	CY
Caribou Hills	CH
Central Mackenzie Valley	CM
Cristine Creek	CR
Dempster Highway	DH
Enterprise	EN
Fort Good Hope	FG
Fort McPherson	FM
Fort Norman	FN
Fort Simpson	FS
Francis Creek	FC
Great Bear (River)	GB
Great Bear River Alternate Crossings	GBA
Hanna River	HR

The report catalogue is useful for determining what has been done in a specified area. For example, a researcher can use the report catalogue to search for all the reports discussing a specified area or region (for example, Fort Good Hope) of the Mackenzie Valley. Or, a listing of all reports with a specified UTM zone, minimum and maximum northings and eastings can be made. As another example, the researcher could search for all the reports done for a specified sponsor (for instance, Esso Resources) between the years 1982 and 1988, with the data quality listed as "good". Selected report catalogue summary sheets (database entries) can be printed using the program Relational Report Writer.

Using the list of granular source numbers given in the report catalog entry, the researcher could refer to the source database for the summarized data on a particular granular source. The researcher can also use either the study number of each report found by the search, or the source numbers listed to find the related boreholes in the ESEBase borehole database. Numerous operations can be done in ESEBase to provide an evaluation of the specified area of interest. Finally, the researcher could obtain the original reports to obtain the detailed background information.

Granular Resources Databases

Information in the Granular Resources Databases

Geographic, geologic and engineering characteristics for granular resources at 762 sites in the Upper (South) Mackenzie Valley were summarized and an assessment of the potential value of each site was provided in EBA's 1988 database. HBT and Bennett provided similar information for 292 sites and 558 sites in the Lower (North) Mackenzie Valley, respectively, though HBT's information was not stored in a database.

Data was available in a variety of studies compiled by pipeline firms, government, and highway agencies. Granular deposits, potential quarry sites and existing pits described in these studies were located and presented on a series of 1:250,000 maps.

Quantitative information was interpreted by EBA for the Upper (South) Mackenzie Valley from site investigation data or original estimates, if available. Quantities removed by Public Works Canada for the Mackenzie Highway and by Interprovincial Pipe Line for the Norman Wells to Zama Crude Oil Pipeline were included, if applicable, and where they were available.

Five new Borrow Management Areas were proposed by EBA to be contiguous with the seven areas developed in 1986 for the Lower (North) Mackenzie Valley by HBT AGRA. These areas generally encompass similar geologic materials and resource availability. Regional requirements and shortages of granular materials were broadly addressed by considering future community, highway, pipeline and airstrip demands relative to the distribution of the previously identified deposits. Recommendations were presented to address concerns raised in the Fort Providence, Fort Simpson and Fort Norman areas, and south of River-Between-Two-Mountains.

The following information is presented in the granular source databases:

- Summaries of granular sources based on published and unpublished reports relating to surficial geology and granular materials of the Upper Mackenzie Valley.
- Data from various reports related to a single granular deposit, condensed into a single entry for the South Mackenzie database. (It is not certain how much or how little condensing of data was done for the North Mackenzie database).
- A unique identification number (South Mackenzie database only).
- Summary of the previously documented characteristics of each deposit including quantity of granular material, where possible.
- Summary of the previously documented development history and/or development constraints (environmental) that have been identified for each deposit.
- Provision of additional geologic and geomorphic data which can be readily interpreted from the reports and maps.
- Assessment of the level of reliability for the existing data.
- Assignment of a priority for further study to each deposit.

Figure 7 shows a sample page of the source database data dictionary, which defines each of the fields contained in the database. Figure 8 shows the source database structure. A sample entry of the source database is shown in Figure 9.

There are still a few minor differences between the North and South Mackenzie databases. For instance, the North Mackenzie source database entries had only one "primary" study number assigned. However, in the South Mackenzie source database, the entries in the source database were intended to be a compilation of information from all the references listed for each source, therefore, a "primary" study (report) reference was not used. In some cases, sources which were listed as separate sources in the original reports have been combined. Thus, choosing one report as taking priority over another in the South Mackenzie database may be misleading.

Also, because they are part of the same geologic feature, numerous sources described in the South Mackenzie source database cross geographic boundaries such as creeks or rivers. One report may be more applicable for one side of the creek, whereas another may be more applicable to the other side of the creek. Presumably a researcher with a more than cursory interest in a specific source would obtain all of the original references to any particular granular source.

With these considerations in mind, a single unique study number was also assigned to each source in the South Mackenzie database, for the purpose of creating a convenient link to the report catalogue. Table 3 shows a list of EBA's 1988 reference numbers correlated to the new 1992 study numbers. Table 4 lists Bennett's 1988 reference numbers correlated to the new 1992 study numbers. Where more than one report applies to a particular granular source, these additional reports are listed in the study reference field.

For the South Mackenzie Valley, there are unique EBA-assigned source numbers. For the North Mackenzie Valley, only the original source numbers appear in the source database. EBA has not assigned source numbers to the North Mackenzie database. This is a task which could be done at some later date, perhaps by use of UTM grid coordinates, correlating HBT's and Bennett's work.

Use of the Granular Source Databases

In total, 1320 sources have been described in the source databases compiled by EBA (1988) and Bennett (1988). These databases thus far have been kept separate; however, they could be merged if desired. The study number and source number fields are used as links to other databases. Entries can be printed using Relational Report Writer.

From the source database, a printout (as shown on Figure 9) can be made of a specified source or sources. Details on soils in an area can be obtained, including numbers of boreholes, type and thickness of overburden, details on proportions of gravel/sand/fines in the granular resource, and test result summaries can be obtained. Or, the relevant study numbers can be used to refer to the report catalogue, perhaps to acquire information on other related sources. Or, all the sources with an overburden layer of less than 0.5 m thick could be printed. Or, one could print all the sources which are described as fluvial deposits, or all those sources with a "high" development potential.

Various parameters can be calculated using dBase commands, including historical demand for granular material, as shown in Table 5. For the Upper Mackenzie Valley, more demand data is available, because the volumes of granular material used for the Mackenzie Highway and the pipeline were recorded if found in the original source reports. The Lower Mackenzie database does not have this information.

The study and source numbers, or the UTM northings and eastings, can also be used to link to the ESEBase borehole database, to obtain very detailed information on a specific site.

ESEBase Borehole Database

Information in the ESEBase Borehole Database

As a separate project in 1991, an ESEBase borehole database containing about 12,500 boreholes for the Mackenzie Valley was converted from a GSC database by EBA. It is about 24.5 MB in size and covers the entire Mackenzie Valley. The main objective for EBA's 1992-1993 work on this database was to update it to ESEBase Version 4.0. Final linking of this database to the granular source databases and the report catalogue has not been addressed.

Figure 7. Sample Page of Source Database Data Dictionary: Granular Resources

PART A: DEPOSIT LOCATION AND STATUS

AA1 - OLD STUDY NUMBER: The sources listed in Bennett's 1988 source database have an old study number which was the original study number assigned to the report reference for the source by Bennett.

AA2 - STUDY NUMBER: Each source has been assigned a unique study identifier number, to serve as a link to other databases (e.g. the report catalogue, and ESEBase borehole database). This number identifies the study in which the source was first described in detail and provides a link to INAC's granular resource study catalogue database. The number consists of an alphabet prefix representing the sponsor of the report (4 characters), the year of the study (2 digits, and the geographic location or area (up to 6 characters), (e.g. INAC87PL).

AA3 - ASSIGNED SOURCE NUMBER: The sources listed in EBA's 1988 source database have a unique source number which correlate to mapped source locations. These source numbers refer to granular deposits which may comprise one or several of the original source numbers. This number is a numeric sequence with the Land Management Area as a prefix, and an arbitrarily assigned source number as a suffix (e.g. 7.043).

AA4 - SOURCE NUMBER: Each source has been assigned a unique source identifier number, normally the number of the source in the original study which located the source, which will serve as a link to other databases (e.g. ESEBase borehole database). This number consists of an alphanumeric sequence of up to twelve digits (e.g. 87-P-12).

Figure 8. Database Structures for North and South Mackenzie Valley: Granular Sources

Structure for database: C:SRCE92NM.dbf
Number of data records: 558
Date of last update : 12/07/92

Field	Field Name	Type	Width	Dec
1	O_STUDY_NO	Character	12	
2	STUDY_NO	Character	12	
3	ASN_SRC_NO	Character	6	
4	SOURCE_NO	Character	12	
5	STUDY_REF	Character	132	
6	SOURCE_REF	Character	125	
7	NTS_REF	Character	15	
8	LOCAL_NAME	Character	25	
9	MAP_DIG_NO	Character	5	
10	LOC_MAP_SC	Character	8	
11	LOCATION	Character	100	
12	CN_LAT_DEG	Numeric	8	5
13	CN_LON_DEG	Numeric	9	5
14	CN_ZONE	Numeric	2	
15	CN_EAST	Numeric	6	
16	CN_NORTH	Numeric	7	
17	COR_NO_NAM	Character	50	
18	KILO_POST	Numeric	6	1
19	OFST_DS_DR	Character	37	
20	DISTANCE	Character	10	
21	ACCESS	Character	150	
22	CONDITION	Character	40	
23	AREA	Numeric	4	
24	SIT_PLN_SC	Character	8	
25	PLN_DIG_NO	Character	5	
26	LND_TENURE	Character	30	
27	STATUS	Character	22	
28	STOCK_TYPE	Character	30	
29	STOCK_QUAN	Character	15	
30	PAST_USE	Character	75	
31	EXC_VOL_MH	Numeric	9	
32	EXC_VOL_PL	Numeric	9	
33	PERF_RATIN	Character	50	
34	INVEST_LEV	Character	25	
35	LAST_DATE	Character	4	
36	GEPHYS_DAT	Character	60	
37	THDENSITY	Character	10	
38	BHOLE_NO	Numeric	4	
39	BHOLE_DEPT	Character	14	
40	TESTP_NO	Numeric	3	
41	TESTP_DEPT	Character	14	
42	EXPOS_NO	Numeric	3	
43	EXPOS_DEPT	Character	14	
44	DATAQUALIT	Character	40	
45	GENERIC_OR	Character	25	
46	LANDFORM	Character	50	
47	TOPOGRAPHY	Character	20	
48	SLOPE	Character	25	
49	DRAINAGE	Character	40	
50	VEGETATION	Character	75	
51	PERMF_FEAT	Character	60	
52	ACTV_LAYER	Character	11	
53	ACTV_DATE	Date	8	
54	GRANULR_TP	Character	150	
55	GRANULR_TH	Character	14	
56	OVRBURD_TP	Character	30	
57	OVRBURD_TH	Character	14	
58	UNDRBUR_TP	Character	30	
59	DEV_CONSTR	Character	180	
60	DEV_POTENT	Character	20	
61	USC_NO	Numeric	3	
62	USC_CLASS	Character	30	
63	MC_NO	Numeric	3	
64	MC_RESULTS	Character	14	
65	SIZANAL_NO	Numeric	3	
66	OVERSIZE	Character	8	
67	GRAVEL	Character	8	
68	SAND	Character	8	
69	FINES	Character	8	
70	D_50	Character	17	
71	PETRO_NO	Numeric	3	
72	PETRO_RESU	Character	11	
73	OTHERTESTS	Character	152	
74	CLASS_1	Character	32	
75	CLASS_2	Character	32	
76	CLASS_3	Character	32	
77	CLASS_4	Character	32	
78	CLASS_5	Character	32	
79	TOTAL_VOLU	Numeric	9	
80	PROV_VOL	Numeric	9	
81	PROB_VOL	Numeric	9	
82	PROS_VOL	Numeric	9	
83	TOTAL_RECO	Numeric	9	
84	ANNUAL_REC	Numeric	8	
85	STDY_PRIOR	Character	15	
86	COMPILER	Character	120	
87	COMP_DATE	Date	8	
88	CO_PROJ_NO	Character	15	
89	UPDATE_BY	Character	120	
90	UPDT_DATE	Date	8	
91	UP_PROJ_NO	Character	15	
** Total **				2760

Structure for database: C:SRCE92SM.dbf
Number of data records: 762
Date of last update : 12/08/92

Figure 9. Source Database Sample Entry

```
                    MACKENZIE VALLEY TRANSPORTATION CORRIDOR (MVT)
                              GRANULAR RESOURCES DATABASE
                              SOURCE DATABASE DATA SHEET

========================================= PART A: LOCATION AND STATUS ==========================================
SOURCE NUMBER       : 100        STUDY NO. : EWB73MH1          ASSIGNED SOURCE NUMBER:  7.043
NTS MAP REFERENCE   : 96-E(6)    DIGITIZ NO: NR                MAP SCALE   :  1:NR
UTM   ZONE-EASTING  : 9 - 584500                               LOCATION    : W of Billy Creek N of Mac
UTM       NORTHING  : 7249900
LOCAL NAME(S)       : NOT RECORDED
CORRIDOR NO./NAME   : 03 - MACKENZIE VALLEY
KILOMETRE POST      :          OFFSET(m)   : SEE AC
CROSS REFERENCES    : HAL86NM,EWB73MH1,EWB73MH2

SOURCE ACCESS       : Mackenzie Hwy
ACCESS DISTANCE (m): SEE ACCESS  CONDITION : SEE ACCESS
AREA   (ha)         : 1        SITE SCALE:  1:NR          DIGITIZ NO: NR

LAND TENURE         : NOT RECORDED                              STATUS     : NOT RECORDED
PAST USE - SOURCE   : SEE EXC_VOL_MH (HIGHWAY) AND       STOCKPILE - TYPE : NOT RECORDED
                      EXC_VOL_PL (PIPELINE) IN M^3              - QUANTITY : NOT RECORDED
PERFORMANCE RATING : NOT RECORDED

============================PART B: SOURCE INVESTIGATION AND DESCRIPTIVE INFORMATION ============================
INVESTIGATION LEVEL: NOT RECORDED                          LAST INVEST DATE        : NR
GEOPHYSICAL  DATA   : NOT RECORDED                         TEST HOLE DENSITY (#/ha):   5.
BOREHOLES - NUMBER : 8            TEST PITS - NO. : 0      EXPOSURES  -  NO.       : 0
       - DEPTH (m) :   5.50 (MAX)       - DEPTH (m):   0.00 (MAX       -  DEPTH (m) : NOT RECORDED
      DATA QUALITY : fair
SOURCE TOPOGRAPHY  : NOT RECORDED            SLOPE: NOT RECORDED
AREA DRAINAGE      : -
SOURCE VEGETATION  : NOT RECORDED
PERMAFROST FEATURES: ICE CONTENT - high
ACTIVE LAYER   (m) : NOT REC'D                      DESCRIPTION DATE :
GENERIC ORIGIN     : aeolian                        LANDFORM(S)      : sand dunes
GRANULAR  -  TYPE  : SAND                           OVERBURDEN-TYPE  : peat & silt
   - THICKNESS (m) :     3.50                        - THICKNESS (m) : 0-0.8
                                                    UNDERBURDEN      : NOT RECORDED
DEVELOP. CONSTRAINT: -
DEVELOP. POTENTIAL : poor to unsuitable

=================================== PART C: TEST RESULTS AND MATERIAL QUANTITY ===================================
USC    -    NUMBER :                                          MOISTURE CONTENT-NUMBER : 32
            CLASS  : NOT RECORDED                        SAND (%): NOT RECO   -RESULTS: NOT RECORDED
SIZE ANALYSIS-NO.  : 2              GRAVEL (%)  : NOT RECO                  FINES (%): NOT RECO
    - OVERSIZE (%) : NOT RECO       D-50 (um)   : NOT RECORDED

PETROGRAPHIC ANALYSIS-NO. OF TESTS: 0      RESULTS: NOT RECORD

OTHER TESTS (see the DATA DICTIONARY) :          0

MATERIAL QUANTITY (All in cubic metres)          CLASS 1:
                                                 CLASS 2:
TOTAL RECOVERABLE  : 50000                       CLASS 3:
ANNUAL RECOVERABLE :                             CLASS 4:          0/     50000/         0
TOTAL VOLUME       : 50000                       CLASS 5:
PROVEN             : 0           PROBABLE : 50000         PROSPECTIVE : 0

================================================== UPDATE INFORMATION ==================================================
RECORD UPDATED BY  : EBA ENGINEERING CONSULTANTS LTD.
LAST UPDATE        : 12/07/92
UPDATE PROJECT NO. : 0101-11085
```

Table 3. (part of)
EBA 1988 Reference Numbers and EBA 1992 Study Numbers

EBA 1988 REFERENCE NUMBER	EBA 1992 STUDY NUMBER
1	NES75FGAB
2	PEM73FSWR
3	NES74MV
4	PEM73WRFN
5	PEM73FS
6	NES75MDFS
7	PEM73FNNW
8	PEM73FN
9	PEM73WR
10	PEM73NW
11	PEM73FS
11A-19	GSC73SM5 - GSC73SM13
20	ESP73SM
21	EBA80MV
22	PAAG74MV
23	IPL80NW
24	PWC75MH1
25	PWC73MH
26	PWC76FSRM
27	PWC81MH
28	PWC86MH
29-36	GSC73SM14 - GSC73SM21
37	IPL80NW
38	EWB73MH1

Table 4. Bennett 1988 Study Numbers and EBA 1992 Study Numbers

BENNETT 1988 STUDY NUMBERS	EBA 1992 STUDY NUMBERS
A-0101-1	EBA74FGAR
A-0102-1	PEM73FG PEM73NWFG PEM73NW
A-0103-1	RKL73AR RKL73MV
A-0104-1	NES76NM *
A-0105-1 A-105-01	TEC76MV

*Report not seen by EBA at time of writing, preliminary entry done in report catalogue dated 1975, 1976; designated NES76NM.

Table 5. Summary of Numerical Data from SOURCE Databases

PARAMETER CALCULATED	UPPER MACKENZIE	LOWER MACKENZIE
Sum of source areas (ha)	177,097	73,801
Average area of source (ha)	232	132
Sum of boreholes drilled	1491	357
Sum of testpits excavated	363	313
Average number of boreholes/site	2	< 1
Average number of testpits/site	< 1	< 1
Sum of proven volumes (m^3)	290,535,000	1,314,722,000
Sum of probable volumes (m^3)	372,038,000	1,911,871,500
Sum of prospective volumes (m^3)	15,367,671,000	3,668,946,500
Sum of volumes for highway (m^3)	3,196,000	not recorded
Sum of volumes for pipeline (m^3)	999,000	not recorded

The ESEBase borehole logs contain information such as location of the borehole, soil classification data and description, ground ice description, and so on. A sample borehole log as printed from ESEBase is shown in Figure 10. Figure 11 shows a scatterplot of borehole locations in the Mackenzie Valley.

Use of the ESEBase Borehole Database

The researcher can use the borehole database to call up, for example, boreholes from a specified region, or boreholes with a specified gravel content. The researcher can then produce area plots showing the boreholes, stratigraphic cross-sections, plots of laboratory data versus depth, individual borehole plots, and so on. Improved mapping features will be available with the new *Infocus/FoxPro* implementation of ESEBase.

Summary

This presentation has summarized the information available in each of the report catalogue database, the granular source databases, and the ESEBase borehole database for the Mackenzie Valley. The most probable uses of each of the databases has been discussed, and some sample outputs have been presented. These databases should be a useful tool for future granular resource research in the Mackenzie Valley.

Figure 10. Sample ESEBase Borehole Log

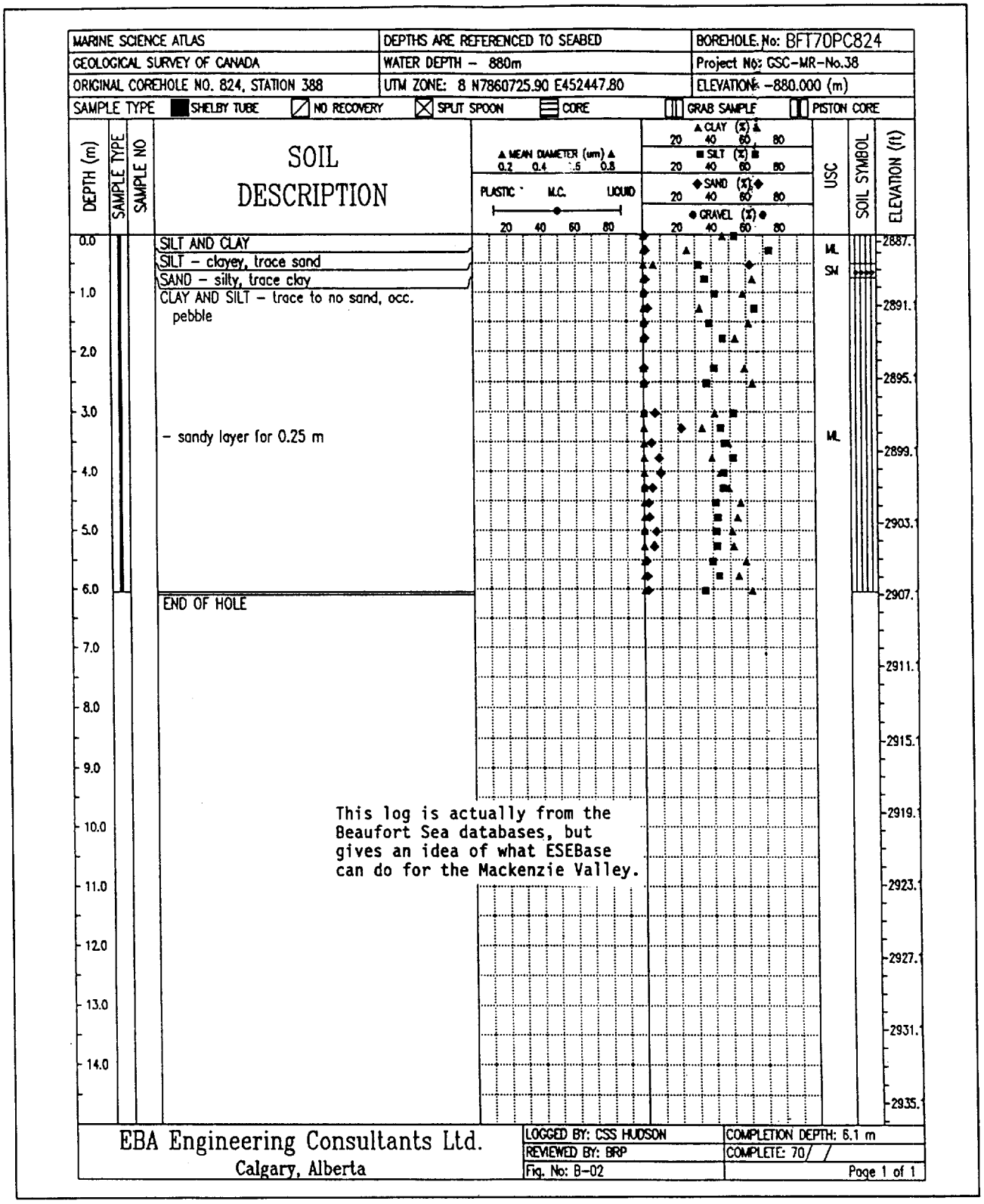
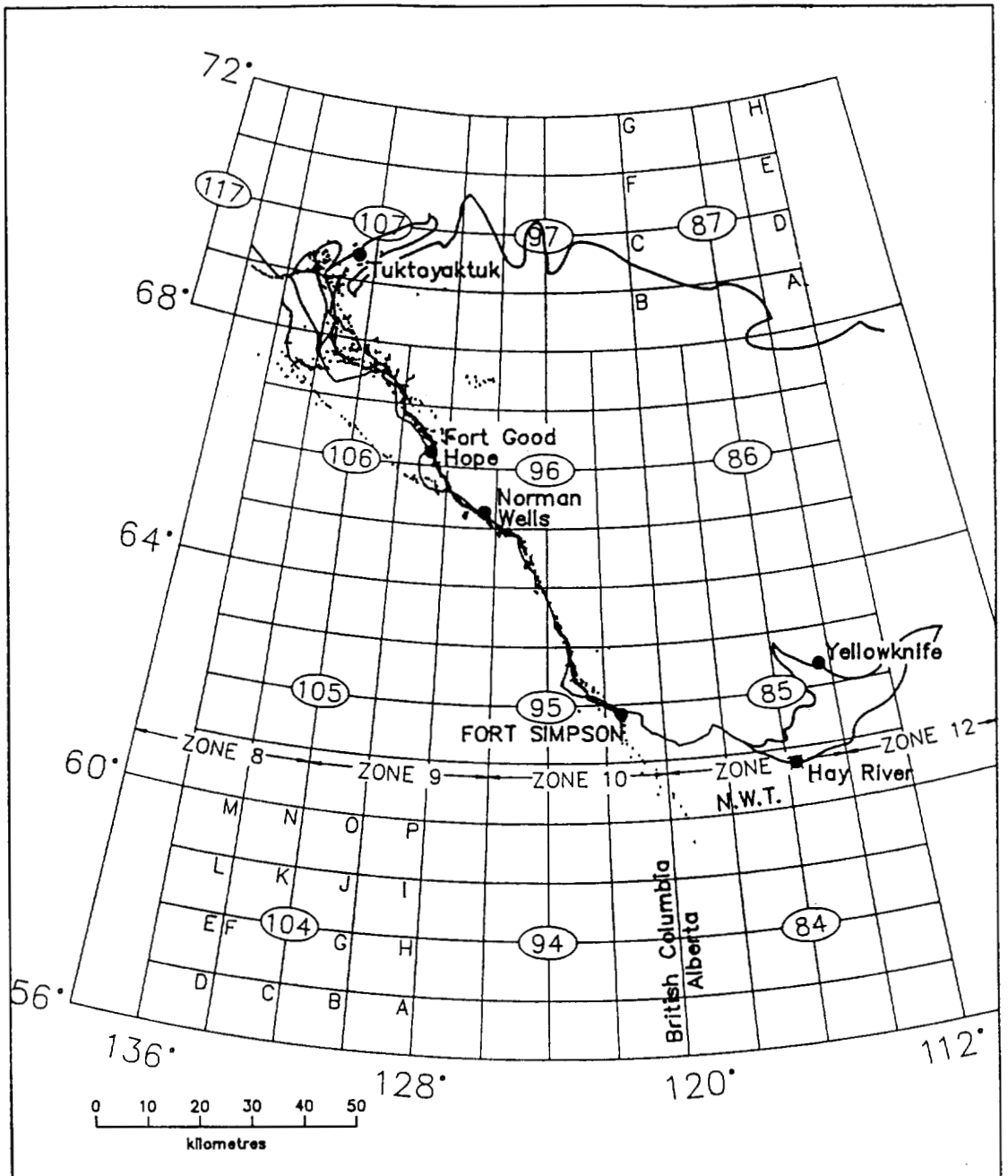


Figure 11. Scatterplot of Borehole Locations in the Mackenzie Valley



GRANULAR RESOURCE POTENTIAL: LOWER MACKENZIE VALLEY

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ABSTRACT

The study was centred on the Lower Mackenzie River Valley, between Richards Island in the north, and Norman Wells in the south. Six management areas were identified. The study was compiled from previous granular borrow studies in the area.

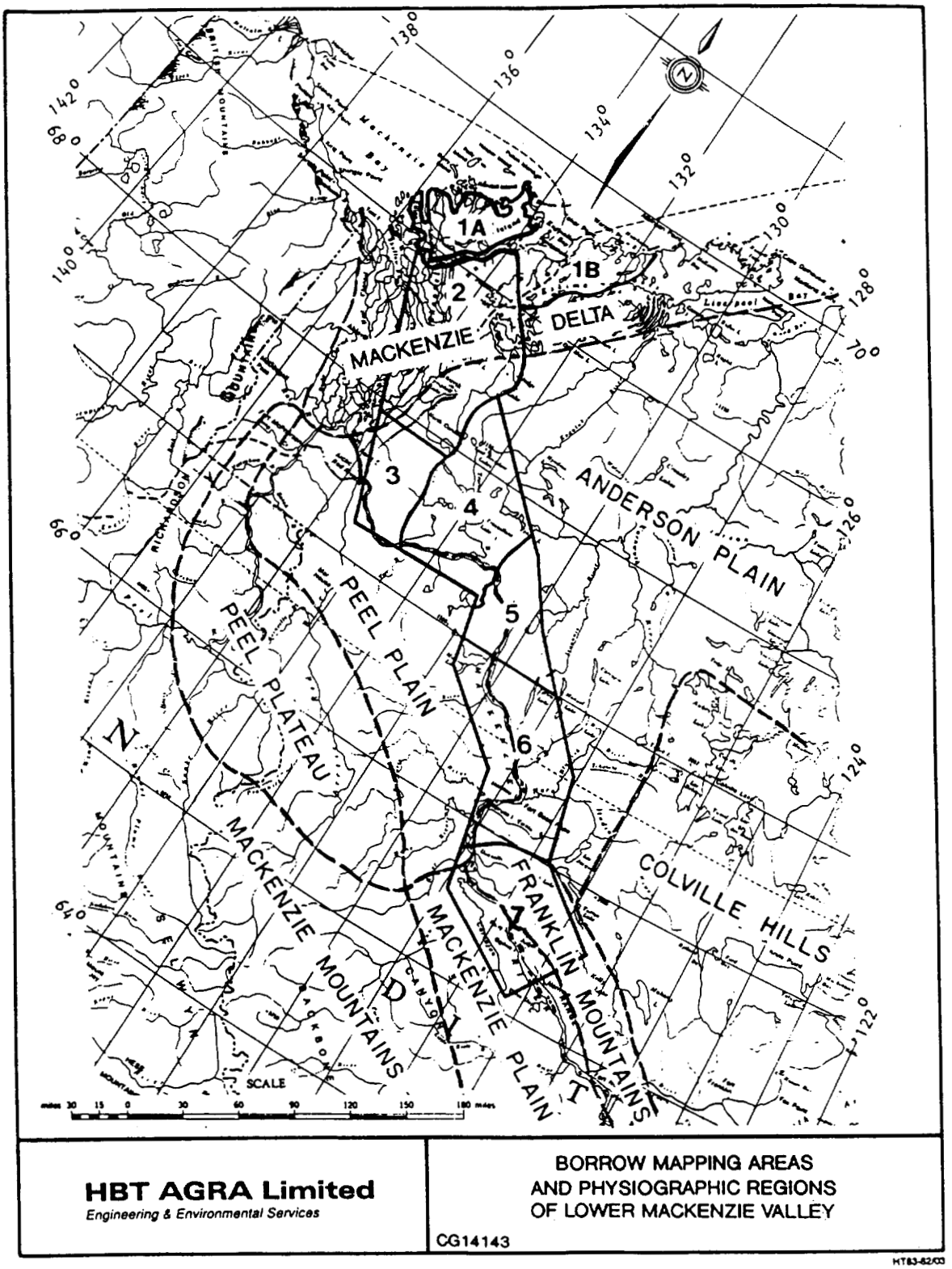
The study identified over 300 potential granular sources in the Lower Mackenzie Valley and provided a summary of all pertinent geological and geotechnical parameters for each source. An overall assessment of these sources has further identified 52 deposits that are excellent or good prospects by virtue of the quality of granular material that they contain (excluding those within the Inuvialuit Land Selection areas).

This study was conducted under contract No. OST85-00393 for Indian and Northern Affairs Canada (INAC). The terms of reference were as follows:

- conduct a review of published and unpublished geological and geotechnical literature pertinent to the distribution of surficial materials along the proposed Mackenzie Valley pipeline route;
- identify and delineate, on the basis of the literature review, knowledge of the area and selective airphoto interpretation, all potential granular resource deposits along the pipeline route;
- subdivide the pipeline corridor into several proposed borrow management areas based on physiographic regions, the regional supply/demand situation, and/or likely pipeline construction spreads;
- prepare preliminary estimates of proven, probable, and prospective quantities of various granular material types in each of the proposed borrow management areas;
- assign a priority rating for additional field testing of each borrow source based on estimated quantity and quality, anticipated ease of access, and anticipated level of local borrow demand;
- identify any known physical/environmental constraints that are encountered in delineating the source;
- identify the extent of additional exploration work required to prove up granular resource quantities and quality at selected high priority sites in each segment of the study area; and
- summarize the results of the study by preparing a table, or series of tables, for each proposed borrow management area indicating all sources identified, location, access, landform and generic origin of deposit, environmental concerns, quantity and quality of materials, additional work required, priority rating for field testing, and an overall assessment of the prospect.

Geological and geotechnical data was compiled from previous granular borrow studies in the Lower Mackenzie Valley. The sources of information included: Granular Material Inventories for DIAND, pipeline route investigations for industry, geotechnical investigations for the proposed northward extension of the Mackenzie Highway (Department of Public Works) and Geological Survey of Canada reports and maps. Figure 1 shows the numbered borrow mapping areas of the Lower Mackenzie Valley.

Figure 1. **Borrow Mapping Areas of the Lower Mackenzie Valley**



The deposit outline and location of each potential borrow source were plotted on composite 1:250,000 scale map sheets. Where more than one study had been conducted on a particular deposit, the largest interpreted outline was plotted.

The sources of information were:

- EBA Engineering Conslts. (1973, 1973, 1976)
- Inglis (1976)
- Klohn-Leonoff Consultants (1974)
- Lawrence *et al.* (1972a, 1972b, 1973))
- NES (1974, 1976)
- Pemcan Services (n.d.)
- PWC (1975, 1976, 1981)
- Owen (1985)
- Ripley, Klohn and Leonoff (1973a, 1973b)
- Techman (1976)

Each potential borrow source was identified with a number which defines the following:

i) the borrow management area in which the source occurs;

ii) the source number; and,

iii) the class of material which occurs in the source (in parentheses).

The borrow resource management areas were as follows:

Area	Description
1	Richards Island • outside scope of study • separate study by Hardy BBT Ltd.
2	Inuvik - Noel Lake • Mackenzie Delta and Anderson Plain Physiographic Subdivisions • Inuvialuit Land Area
3	Arctic Red River - Rengleng River • Anderson Plain and Peel Plain Physiographic Subdivisions
4	Travaillant Lake • Anderson Plain and Peel Plain Physiographic Subdivisions
5	Little Chicago - Tutsieta Lake • Anderson Plain and Peel Plain Physiographic Subdivisions
6	Fort Good Hope - Teida River, Loon River, Hare Indian River • Anderson Plain and Peel Plain Physiographic Subdivisions
7	Norman Wells • Franklin Mountains, Peel Plain and Mackenzie Plain Physiographic Subdivisions

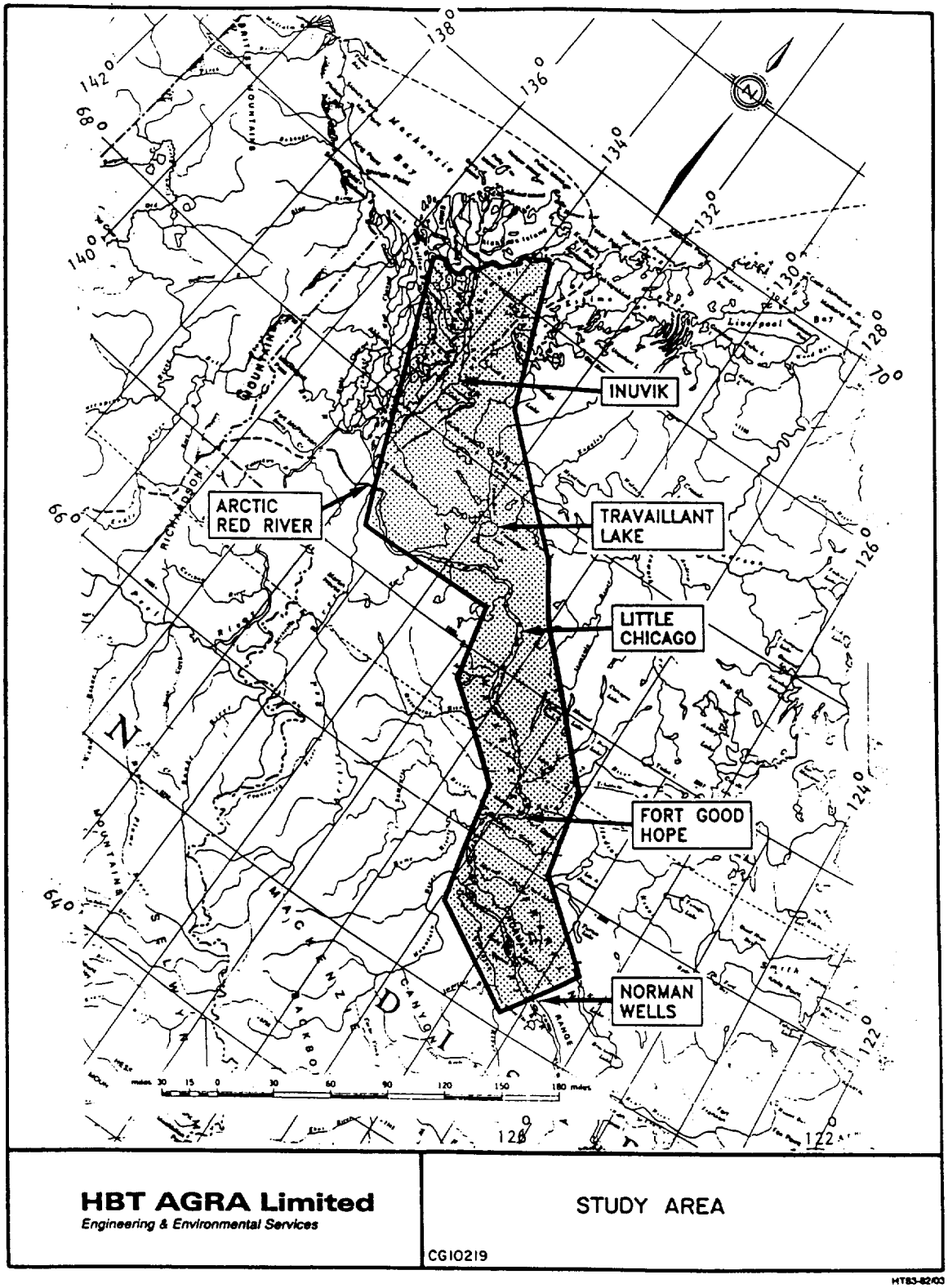
The resources were classified according to the following system, developed by DIAND:

Class 1	Excellent • suitable for concrete aggregate with minimal processing
Class 2	Good • well-graded sands and gravels • potential silt or deleterious content • good quality embankment fill
Class 3	Fair • poorly-graded sands and gravels • fair quality general fill
Class 4	Poor • fine- or poorly-graded sands • minor gravel • generally unsuitable for construction
NG	Non-Granular • fine-grained • bedrock

The names and general spatial limits of Management Areas 2 to 7 are shown in Figure 2.

The granular resource potential for each Management Area is summarized in the series of eight tables following Figure 2. Only Class 1 to 3 prospects are indicated in the Management Area tables, with estimated volumes tabulated for proven, probable and prospective sources.

Figure 2. Resource Management Areas: Lower Mackenzie Valley



Management Area 2 (Inuvik - Noel Lake)				
Class	Proven	Probable	Prospective	Details
1	1.4	4	12	68 potential sources
2	15.3	59	173	2 excellent
3	33.5	295	1248	9 good
				33 favourable
				23 unsuitable

Management Area 3 (Arctic Red River)				
Class	Proven	Probable	Prospective	Details
1	0	0	0	23 potential sources
2	0	50	0	0 excellent
3	0.27	6.4	7.7	0 good
				9 favourable
				14 unsuitable

Management Area 4 (Travaillant Lake)				
Class	Proven	Probable	Prospective	Details
1	0	0	0	112 potential sources
2	5.5	80	175	0 excellent
3	5.8	145	534	18 good
				63 favourable
				31 unsuitable

Management Area 5 (Little Chicago)				
Class	Proven	Probable	Prospective	Details
1	0	0	0	47 potential sources
2	12.3	98	207	0 excellent
3	3.7	146	390	11 good
				30 favourable
				6 unsuitable

Note: All values are estimated total volumes (x 10^6 m^3)

Management Area 6 (Fort Good Hope)				
Class	Proven	Probable	Prospective	Details
1	0	0	0	92 potential sources
2	2.8	17	66	1 excellent
3	3.5	91	418	13 good
				47 favourable
				31 unsuitable

Management Area 7 (Norman Wells)				
Class	Proven	Probable	Prospective	Details
1	0	0	0	52 potential sources
2	4.6	19	34	0 excellent
3	2.2	30	95	4 good
				26 favourable
				23 unsuitable

Summary - All Borrow Sources				
Class	Proven	Probable	Prospective	Details
1	1.4	4	12	
2	40.5	273	709	
3	48.9	713	2693	

Summary - Excellent/Good Borrow Sources				
Class	Proven	Probable	Prospective	Details
1	1	3	11	
2	32.5	247	590	
3	19.2	118	303	

Note: All values are estimated total volumes (x 10^6 m^3)

Table 1. Projected Granular Material Demand: Lower Mackenzie Valley Communities

Community	REQUIRED VOLUME (m^3)					
	1986	1987	1988	1989	1990	Total
Arctic Red River	4,500	22,900	5,450	16,850	—	49,700
Fort Good Hope	900	200	650	—	2,650	4,400

Source: Government of the Northwest Territories, 5 Year Capital Plan.

Table 2. Granular Material Forecast: Lower Mackenzie Valley Communities

Community/ Material Type	REQUIRED VOLUME (m^3)					
	1986	1987	1988	1989	1990	5 Year Total
ARCTIC RED RIVER						
Embankment	3,450	15,150	2,250	11,800	—	
Sub-base	350	800	1,400	—	—	
Base	500	4,500	1,300	3,400	—	
Surface Material	200	2,250	500	1,500	—	
Concrete Aggregate	—	—	—	—	—	
Riprap	—	200	—	—	—	
Totals:	**4,500**	**22,900**	**5,450**	**16,850**		**49,700**
FORT GOOD HOPE						
Embankment	—	—	—	—	—	
Sub-base	300	—	450	—	1,050	
Base	600	200	200	—	800	
Surface Material	—	—	—	—	800	
Concrete	—	—	—	—	—	
Aggregate	—	—	—	—	—	
Riprap	—	—	—	—	—	
Totals:	**900**	**200**	**650**		**2,650**	**4,400**

In order to establish the granular demands, enquiries were made of the Government of the Northwest Territories in Yellowknife, plus the towns of Inuvik and Norman Wells. The data obtained is presented in the preceding two tables. Table 1 presents total granular materials demands for two Lower Mackenzie Valley communities (Arctic Red River and Fort Good Hope) and Table 2 includes a breakdown of the requirement for various material types (material classes) where these were available.

The granular material requirements for a future pipeline project between the Beaufort Sea and Norman Wells may be estimated for each of the Borrow Management Areas. According to various industry and government sources, two extremes of possible material requirements are 500 m^3/km and 4,000 m^3/km, and using these upper and lower bound values the following pipeline granular resource volume requirements for the Lower Mackenzie Valley region may be projected (Table 3).

Table 3. Pipeline Granular Resource Demands: Lower Mackenzie Valley

Management Area	Approximate Pipeline Length (km)	Total Granular Material Requirements, m^3	
		500 m^3/km	4,000 m^3/km
2	130	65,000	520,000
3	—	—	—
4	125	62,500	500,000
5	90	45,000	360,000
6	140	70,000	560,000
7	120	60,000	480,000

THE FEASIBILITY OF DEVELOPING GRANULAR RESOURCES FROM THE BED OF THE MACKENZIE RIVER

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ABSTRACT

Prior to 1987, much work had been done to identify and assess prospects for granular resource supply along the Mackenzie Valley. This work indicated that supplies of good quality material were locally deficient and in places access would be difficult because of sensitive northern terrain to be crossed. An alternative source area which was largely unexplored until then was the Mackenzie river bed. Esso Resources had shown that granular sediments could be developed from the river bed when constructing production islands at Norman Wells in the mid-1980s.

EBA in association with GVM and ESL undertook a study of the Mackenzie river bed for DIAND in 1986-87. The study considered several aspects of the feasibility of developing river bed borrow resources. Mackenzie river bed potential was assessed by examining hydrological and geological data for 19 river sections. Economic data was compiled to demonstrate the feasibility of river bed dredging and in particular the practicability of long haul distances by barge. The impact of dredging on fish populations and their migration was also reviewed. Eleven river reaches were identified with a significant potential for supplying granular materials where there are shortages of terrestrial deposits within 15 km of the river. It must be recognized, however, that there is little direct data from the river bed to identify specific source areas or dredging sites.

Introduction

This presentation discusses a study that was conducted in late 1986 and early 1987 by EBA Engineering Consultants Ltd. (EBA) on contract to Indian and Northern Affairs Canada (INAC). Previously, numerous programs had been conducted to identify and evaluate potential sources of granular materials along the Mackenzie Valley. Over 1,300 prospects along the valley have been identified. Unfortunately, the distribution and quality of these deposits are somewhat irregular. Clearly, some areas are deficient in good quality granular resources. Furthermore, access to some deposits can only be achieved by crossing environmentally or thermally sensitive terrain.

EBA's assignment was to evaluate the potential for useable granular resources in the Mackenzie River bed and to assess the feasibility of producing these resources. The concept of river bed borrow production had been previously demonstrated by Esso Resources Canada Ltd. (Esso) on the Norman Wells Oilfield Expansion Project. About 1.8 million cubic metres of river bed sand and gravel were dredged by Esso's contractors to construct six production islands in the river. This success suggested that granular resources deficiencies elsewhere along the river might be reduced by local dredging of river bed sediments.

EBA's project team for this work included Gretchen Minning of GVM Geological Consultants Ltd. (GVM), ESL Environmental Sciences Ltd. (ESL) and Hydrocon Engineering (Continental) Ltd. (Hydrocon). EBA's work focused on the potential supply and demand, and economic issues related to river bed dredging. GVM addressed the geologic regime of the valley with respect to the potential for granular materials to be in the river. Hydrocon put together data pertaining to the hydrologic characteristics of the river. This was used to indicate where preferentially-sorted sediments might be found and where fine-grained overburden sediments might be insignificant. ESL's part in the project was to consider the impact of dredging on river water quality and fish in the river.

EBA's report includes a review of data from Esso's dredging at Norman Wells that is not discussed herein. Similarly, the report provides much more information

than the present summary about fish population studies and related environmental issues which were addressed by ESL.

Study Methodology

Some specific tasks addressed by the study team included the following:

- Assessment of the potential for the river bed to contain useable deposits of sand and gravel.
- Assessment of local alternatives to river bed granular resource production (i.e., conventional valley deposits).
- Assessment of the economics of dredging and barge haul versus conventional pit and trucking operations.
- Assessment of potential granular resource demands by communities, government departments and pipelines.
- Assessment of environmental damage that might result from dredging.
- Rating the feasibility of producing river bed granular sediments from individual sections of the river.

On-Land Alternatives

It was assumed by the study team that wherever good granular resources could be obtained within 15 km of the river, it was unlikely that river bed deposits would be developed. Therefore, the location of all known deposits on either side of the river and within 15 km of it was plotted. Most of the data upon which this was based comes from two original studies; one by Hardy & Associates in 1986 for the Lower (Northern) Mackenzie Valley and the other by Pemcan in 1972 for the Upper (Southern) Mackenzie Valley.

The older Pemcan report was somewhat incomplete, but it gave a reasonable overview of on-land prospects. A year after the river bed study, EBA with GVM prepared a more complete inventory of the Upper Mackenzie Valley for INAC. Unfortunately, the assessment of river bed granular resource production has never been re-examined in light of the updated inventory.

To evaluate where deficiencies in on-land borrow prospects existed, the deposits within 15 km of the river were tabulated on a kilometre-post basis. The Canadian Hydrographic Service navigation charts for the river were used to identify kilometre-age. These tables were set up for individual zones of the river, 19 of which were defined on the basis of river morphology. Table 1 shows typical information for Zone XI, which extends for 57 km south of Wrigley.

Subsequently, the volume of available coarse granular within 15 km of the river was plotted for each 25 km section of the river. Large deposits of fine-grained sand were excluded from the summary because they are only marginally useful. Based on 59 sections of 25 km each (1,475 km total between Great Slave Lake and Point Separation at the south end of the Mackenzie Delta), there is a potential demand for river bed borrow, if it exists, in four long sections including:

- Kilometre 0 to 500 - Great Slave Lake to McGern Island.
- Kilometre 750 to 875 - Near the Great Bear River.
- Kilometre 1,000 to 1,100 - Sans Sault Rapids to Fort Good Hope.
- Kilometre 1,325 to 1,475 - Thunder River to Point Separation.

This may or may not be a conservative assessment of where shortage occurs. On one hand, large deposits may exist just beyond the 15 km river setback limit that was arbitrarily selected. On the other, deposits on both sides of the river were considered together; whereas, one side may be completely deficient in on-land prospects. Furthermore, the large fine-sand deposits, which were excluded from the summary, may have some potential such as pipe bedding (if unfrozen) or road embankment core, but they couldn't be used for road surfacing or in erosion sensitive areas.

Potential Demand

A brief summary of potential demand was conducted to determine if there were any major granular resource shortages affecting Mackenzie Valley residents or government consumers. Contacts were made with representatives of:

Table 1. **Mackenzie Valley Upland[1] Granular Resources and Granular Channel Deposits (River Zone XI – km 520 to km 577)**

Kilometre Posting (km)	Deposit Number	Reserves of Known Granular Materials[2]					River Bed Data	
		Bank						
		Right (R)	Left (L)	Material	Distance From River (km)	Estimated[3] Volume (m^3)	Boreholes[4]/ Hydrographic Observations	Material
532	P142	R		Sand & Gravel	5	3,000,000		
536	P143	R		Sandy Gravel	7	1,000,000		
537	P144	R		Sand & Gravel	3	N/D		
540	P146	R		Sand & Gravel	4	600,000		
540	P148	R		Sand & Gravel	7	N/D		
542	P147	R		Sand & Gravel	1	N/D		
547	P151	R		Sand & Gravel	3.5	1,500,000		
549	P150	R		Sand & Gravel	6	N/D		
550	P152	R		Sand	1.5	N/D		
551							Left Bank	Sand & Gravel
553	P153	R		Gravel	4	3,000,000		
554.3	P154	R		Sand & Gravel	0.5	10,000,000		
556	P155		L	Sand & Gravel	0.5	N/D		
556	P156	R		Silty Sand & Gravel	4	N/D		
560	P157	R		Silty Sand & Gravel	8	N/D		
560-565							Left Bank-Isle	Sand & Gravel
562.5	P158	R		Silty Sand & Gravel	7	N/D		
564	W1	R		Sandy Gravel	0	5,000,000		
565.5	W20		L	Gravel	0.5	200,000		
566	W3	R		Silty Gravel	1.5	1,000,000		
567.5	W11	R		Sandy Gravel	0	150,000		
569	W2	R		Sandy Gravel	0.5	40,000,000		
571-582							Left Bank-Wrigley R. Intersection	Gravel
573	W5	R		Sandy Gravel	0.5	10,000,000		
574								
575	W6	R		Sandy Gravel	0.5	1,000,000		
576	W10	R		Sandy Gravel	2	300,000		
577	W7	R		Sand & Gravel	4.5	250,000		

1) Upland deposits greater than 15 km from the river have not been considered.
2) Pemcan 1972.
3) N/D - Quantity not determined.
4) Public Works Canada, 1976.

- Indian and Northern Affairs Canada community resource management officers.
- Government of the Northwest Territories granular resource managers.
- Public Works Canada for highway demands.
- Transport Canada for airports.

From the information provided, it appeared that projected demands (to 1991) could be satisfied with available resources for all areas except the community of Arctic Red River.

The potential demand for pipeline users of granular resources was also considered. Contacts were made with Interprovincial Pipe Line (IPL), who had built a northern oil pipeline, with Gulf Canada Resources who had just completed a paper pipeline study of a 508 to 610 mm oil line, and information previously prepared by Canadian Arctic Gas Pipeline Ltd. (CAGPL) and summarized for Polar Gas was used. Quantity estimates were found to vary from 1,350 to 7,500 m^3/km. This information was not directly tied into the river bed borrow study, however, because there was not enough detail to link pipeline demand to sections of the pipeline that were likely to be within 15 km of the river.

Cost of Development

It was necessary to demonstrate that dredging of river bed granular materials could be done at a reasonable cost. To define "reasonable", development costs for conventional (on-land) pits were considered. Several different contractors, government departments and planners were contacted to establish an estimate of pit costs. Unit prices in the order of those shown on Table 2 were developed.

For a 15 km haul distance, the cost of granular materials on site is about $25 to $31 in the southern Mackenzie Valley and about $35 to $39 in the northern Mackenzie Valley.

The cost for developing river bed granular deposits similarly contains many variables. The size and type of equipment is related to the desired output. Big dredges can produce 8,000 to 10,000 m^3/day or more. To compare with conventional on-land operations, the study also considered a dredge producing at 1,400 m^3/day. That is the focus of the following discussion.

The equipment required for dredging includes the following:

- Barge loading dredge.
- Haul barges or floating pipeline.
- Tug support to move barges and reposition dredge.
- Loaders on the dock to empty barges and load trucks.
- Trucks to move the borrow inland.

It was not easy to directly compare on-land versus dredging borrow operations because they are so different. Table 3 gives some unit rates for comparison to Table 2, and Figure 1 graphically shows the comparison. For a long haul of 35 km, the dredge and barge method can be up to 40% cheaper.

Environmental Considerations

As indicated previously, ESL provided more information on the potential environmental impact of dredging in the Mackenzie River. Some of the items considered by ESL included:

- Hydrologic regime.
- Suspended sediment concentrations (natural and after dredging).
- River morphology (width, depth, shape).
- Dredging impacts such as:
  - Increased suspension load.
  - Downstream sedimentation.
  - Changes to channel morphology.
  - Water quality with respect to heavy metals and absorbed hydrocarbons.
  - Fish population.
  - Fish spawning and migration areas.
  - Direct interference of migrating fish.
  - Damage to spawning areas.

ESL concluded that the large dilution factor offered by the high year-round flow in the Mackenzie would likely reduce the impacts of dredging to short term, minimal levels and, in many cases, to negligible

Table 2. Cost for Conventional Borrow Development

Item	Unit Cost ($/m³)		For 15 km Haul ($/m³)		Average for 35 km Haul
	Southern Valley	Northern Valley	Southern Valley	Northern Valley	
A. Pit Development and Reclamation	$ 1.00	$ 1.00	$ 1.00	$ 1.00	$ 1.00
B. Excavation	$ 4.00	$ 4.50	$ 4.00	$ 4.50	$ 4.25
C. Access & Heritage (per kilometre)	$ 1.70	$ 2.20	$ 25.50	$ 33.00	$ 68.25
		Total	$ 30.50	$ 38.50	$ 73.50

Table 3. Cost of River Bed Dredging for Granular Resources

Item	Unit Cost[1] ($/m³)	Example 1 10 km River Haul Plus 5 km In Land Haul ($/m³)	Example 2 30 km River Haul Plus 5 km In Land Haul ($/m³)
A. Equipment Mobilization	$ 6.00	$ 6.00	$ 6.00
B. Excavation	$ 2.00	$ 2.00	$ 2.00
C. River Haul (per kilometre)	$ 0.75	$ 7.50	$ 22.50
D. Over Land Haul (per kilometre)	$ 1.70	$ 8.50	$ 8.50
E. Dock Site Rehandling and Stockpiling	$ 3.50	$ 3.50	$ 3.50
Total		$ 27.50	$ 42.50

[1] For 1,400 m³/day operation.

Figure 1. **The Relative Cost of Conventional and Riverbed Borrow Production**

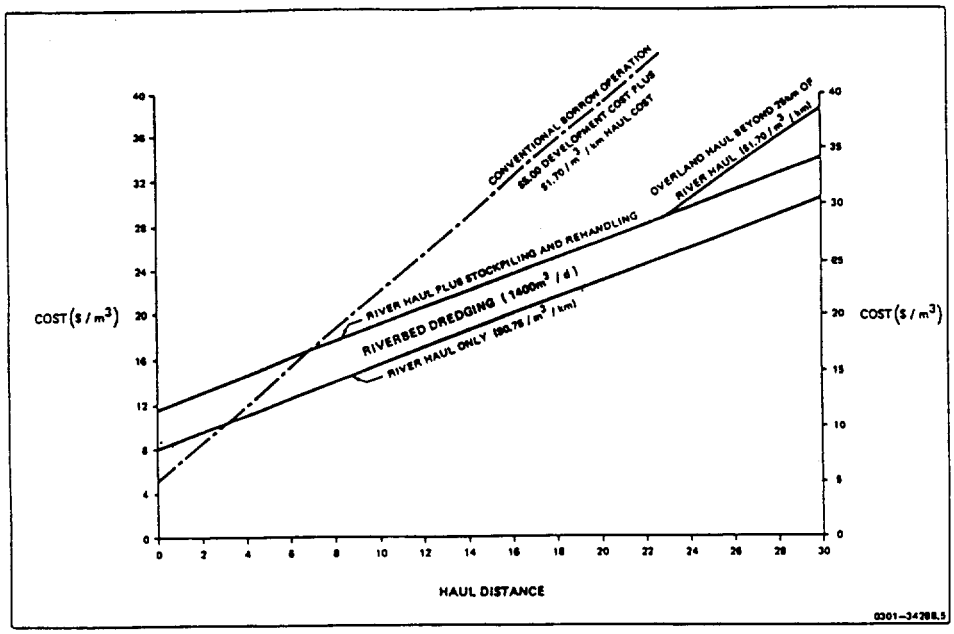
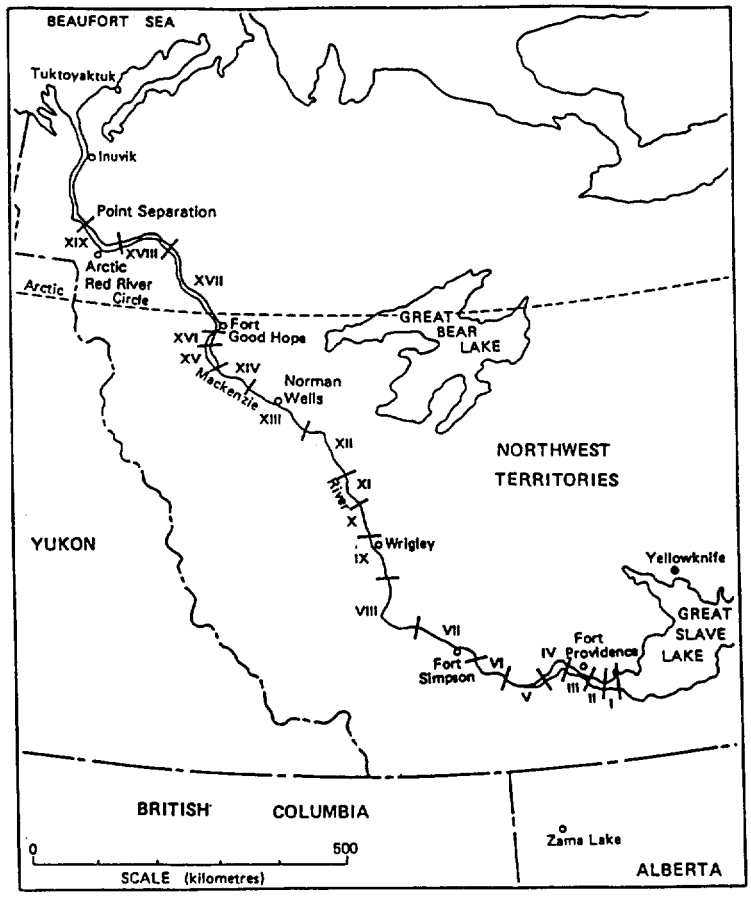


Figure 2. **Mackenzie Riverbed Granular Resource Study Zones**



levels. They cautioned, however, that site specific concerns related to fish migration and spawning would have to be considered. In some cases, negative impacts would occur if inappropriate time windows for dredging were used.

Dredging Feasibility

It was shown that dredging was economically feasible in some practical cases. It was shown that environmental impacts of dredging are manageable, if not negligible. It was shown, at Norman Wells, that suitable reserves exist in at least one area of the river. It was also shown that some sections of the valley along the river do not have locally available, conventional granular resource prospects. What remained to be shown was that granular sediments exist where they might be a feasible alternative to conventional sources. Unfortunately, there is very little to almost no direct data pertaining to the river bed strata for most of the Mackenzie River.

To assess the potential for finding granular resources, the following steps were undertaken:

- The river was subdivided into 19 zones of 26 km to 176 km each, based on reaches of similar channel morphology.
- Hydrologic data was compiled including flood frequency, ratio of peak to low flow rates and suspended sediment loads.
- River bed borehole information (270 borehole logs) were obtained from Public Works Canada.
- Geologic background data including bedrock (source rock potential) and surficial geology (granular sediment potential) was compiled for each zone.
- Each zone was evaluated for its potential to contain deposits of granular sediments based on characteristics such as hydrologic gradient and tributary channel bed sediments.

Figure 2 shows the 19 zones and Table 4 provides a brief description of each. Table 5 illustrates typical data considered for River Zone VII (4.2) which is located in the Fort Simpson area.

A rating system was developed to assess the relative characteristics of each section of the channel. Table 6 shows the characteristics considered to be most important and how they were rated. The potential demand in each section, primarily related to conventional (on-land) reserves and ESL's environmental considerations were also factored into the rating. Table 7 shows the overall potential rating for each of the 19 zones. Subsequently, this was refined by focusing on local variations (25 km sections) in on-land resources versus the potential of the river to supply granular deposits. Table 8 shows the areas where it was concluded that river bed borrow development has the highest potential.

Conclusions

The study team concluded that producing granular resources from the Mackenzie River bed was technically feasible, that it was economically feasible in some areas and that there is a moderate to high potential for some river reaches to have bed deposits which would be suitable for engineering uses. Unfortunately, the direct data to support these conclusions was weak, particular with respect to the river bed deposits. It was not possible to identify specific source areas or potential dredge sites to substantiate these conclusions. Additional geological and fisheries related data is needed, before such reserves of granular material can be considered developable.

Table 4. Identification of Mackenzie Riverbed Granular Resource Study Zones

River Zone No.	Start[1] Kilometre Post	Geographic Boundaries	NTS Map Sheets	Geographic Features
I	0	Great Slave Lake	85F	South Channel
II	26	West Side of Big Island	85F	Beaver Lake
III	60	West End of Beaver Lake	85E & F	Providence Rapids, Fort Providence (km 79)
IV	107	Horn River and Mills Lake	85E	Mills Lake
V	130	West End of Mills Lake	85E, 95H	
VI	229	Trout River	95H	Jean-Marie R. (km 270), Green Island Rapids (km 320)
VII	300	Rabbitskin River	95H & J	Liard River, Ft. Simpson (km 340)
VIII	410	East of Burnt Island	95J	Camsell Bend (km 461) McGern Island (km 492-514)
IX	520	Willowlake River	95J & O	River Between Two Mountains (km 538) Wrigley (km 574)
X	580	Wrigley River	95O & N	Ochre R. (km 605), Johnson R. (km 635)
XI	665	Blackwater River	95N, 96C	Dahadinni River (km 678)
XII	714	Redstone River	96C	Saline Is. (km 724), Keele R. (km 737) Fort Norman (km 827)
XIII	828	Great Bear River	96C, D & E	Norman Wells (km 905)
XIV	966	Patricia Island	96E, 106H	Mountain River (km 1015)
XV	1017	Sans Sault Rapids	106H & I	Dummit Island (km 1020-1026)
XVI	1087	Extrance to Ramparts	106I	Fort Good Hope (km 1101)
XVII	1098	Exit to Ramparts	106I, J & O	Ontaratue River (km 1200)
XVIII	1261	North of Little Chicago	106O & N	Thunder R. (km 1299) Travaillant R. (km 1327)
XIX	1438	Lower Ramparts	106N	Arctic Red River (km 1454)
End	1475	Point Separation		

1. Kilometre postings are interpreted from the Mackenzie River Navigational Charts prepared by the Canadian Hydrographic Service. Chart Numbers 6404 to 6426.

Table 5. **Mackenzie River Terrain and Borrow Summary (River Zone VII – km 300 to km 410)**

River Topography	River Land Forms	Upland Topography	Upland Land Forms
A) Elev: East of Rabbitskin 137 m to east of Burnt Island <120 m.	A) Straight Channel: Three minor multi-channel streches.	A) Undulating to flat plain west of river.	A) Bedrock: Shale, sandstone in low land near river.
B) Width: 1.5 - 3 km.	B) Alluvial deposits to 153 m.	B) Flat plain with dunes south of river.	B) Shale and sandstone in Ebbutt and Martin Hills.
C) Depth: 1 - 10 m usually 2 - 7.	C) Near Rabbitskin River three terrace levels representing old river.	c) 152 m represents glaciolacustrine/ till boundary north of river; 213 m on south side of river.	C) Morainal deposits above 152 m north of river; above 213 m south of river.
D) Tributary Rivers: Liard Harris Martin Trail Several Unnamed Creeks	D) Islands (all small) Green, Hanson, Martin, Ft. Simpson, five unnamed.	D) Martin Hills rise above plain to south.	D) Glaciolacustrine deposits thickest south of river.
	E) Alluvial plain and terrace deposits and sand and silt.	E) Ebbutt Hills rise above plain to north.	E) Dunes on glaciolacustrine plain.
	F) River bottom in till; boulder pavement (6 m till/bedrock).		F) Quaternary deposits 12 m thickn north of river, 12 - 20 m south of river.
	G) River banks high and steep, particularly south side.		G) Intermittent high ice content permafrost beneath organics in fine-grained deposits.
	H) Green Island Rapids.		H) *Only several upland granular deposits associated with glaciofluvial and alluvial terraces.
	I) Some boreholes show gravel near Green Island Rapids.		
	J) *Low potential for granular material in river except downstream of Green Island Rapids.		

*Comments relative to granular material sources.

Table 6. Rating System for the Granular Materials Potential of the River Zones

Rating Points	
	A. River Channel Characterisitics
	Type of Channel:
4	Braided
3	Braided Transitional to Straight
2	Braided Transitional to Meandering
2	Straight
1	Meandering
0	Expanded
	B. River Gradient
	Gradient:
1	.001 - .09 m/km
2	.1 - .19 m/km
3	.2 - .29 m/km
4	.3 - .39 m/km
	C. Type or Number of Tributaries
	Description:
5	Three or more large gravel bed tributaries and five or more small gravel bed tributaries.
4	Three large gravel bed tributaries and no or a few small gravel bed tributaries.
3	One to two large gravel bed tributaries and many small gravel bed streams.
2	One to two large gravel bed tributaries and a few or no gravel bed tributaries.
1	No large gravel bed tributaries, but several small gravel bed streams.
0	No gravel bed tributaries.
	D. Cummulative Ratings (total of points from A, B and C)
	Rating:
1 - 4	Low
5	Low to Moderate
6 - 7	Moderate
8	Moderate to High
9 - 13	High

Table 7. Mackenzie Riverbed Borrow Potential for Each River Zone

River Zone (km)	River Regime Rating[1]	Upland Borrow Deposits[2] Sand (m^3)	Sand & Gravel (m^3)	Fisheries Activities[3]	Potential for River Borrow Sources
I (0-26)	Low	None		D F M (Moderate)	Low
II (26-60)	Low	None		D F M (Moderate)	Low
III (60-107)	Moderate	None		D S R M (Moderate)	Borehole data (Drawing 4.1) suggests Moderate-High potential between km 75 and 100.
IV (107-130)	Low	None		D M (Low)	Low
V (130-300)	Low	Some Near Trout & Redknife Rivers		M D (Moderate)	Low-Moderate between km 170 and 299.
VI (229-300)	Low	None		D M	Moderate near Jean-Marie Creek (km 270), otherwise low.
VII (300-410)	Low	Unlimited	2,000,000	M D S	Moderate between km 310-330, otherwise low.
VIII (410-520)	High	Unlimited	<500,000	D M S R (Moderate)	High near McGern Island (km 490-520) Camsell Bend (km 460)
IX (520-580)	Moderate-High	Unlimited	>67,000,000	D M	High near Wrigley River (km 580) and River Between Two Mountains (km 539)
X (580-665)	Moderate-High	Unlimited	>56,000,000	D M (High)	High near Ochre River (km 605) and Blackwater River (km 664)
XI (665-714)	High	Unlimited	>65,000,000	M S R (Low)	High
XII (714-828)	Moderate	Unlimited	>36,000,000	D M S R (High)	Moderate between km 725 and 780, high near Fort Norman (km 825)
XIII (828-946)	High	>40,000,000		M D E S R (High)	High (proof is at Norman Wells) (km 905)
XIV (966-1017)	Moderate	15,000,000	$5\text{-}25\times10^6$	S R M (Moderate)	High near Sans Sauk Rapids, moderate between km 966 and 1000
XV (1017-1087)	Moderate		>2,000,000	M R S (High)	High between km 1017-1030, low beyond
XVI (1087-1098)	Low		Limited	M (Low)	Low
XVII (1098-1261)	Low	Some large and many small deposits		D S R M (High)	Moderate near Tieda River (km 1163), Loon River (km 1136) and Hare Indian River (km 1105), low between km 1140
XVIII (1261-1438)	Low-Moderate	Unlimited	$12\text{-}115\times10^6$	M D S R (Moderate)	Moderate near Thunder River (km 1299), otherwise low
XIX (1438-1475)	Low		2,000,000	M S D (High)	Low to moderate below Arctic Red River (km 1454), otherwise low

Note: (1) From Table 7.2
(2) From Table 5.1
(3) From Appendix B, Symbols are:
D - Domestic Fisheries, F - Sport Fisheries,
S - Spawning Areas, R - Rearing Areas, M - Migratory Routes
Where high level of sensitivity is known, it is indicated by underlined symbol (e.g., D)

Table 8. Mackenzie River Sections Where River Bed Granular Resources Development May be Feasible

River Section (km)	River Bed[1] Potential	Upland[2] Reserves	Prospects[3]
50 - 75	Moderate to High	None	Good
75 - 100	Moderate to High	None	Good
250 - 300	Moderate	None	Fair
300 - 325	Moderate to High	None	Good
400 - 425	Moderate	Some to None	Fair
450 - 475	Moderate to High	None	Good
475 - 500	High	Some to None	Fair to Good
700 - 725	High	Fine Sand	Fair to Good
775 - 800	Moderate	Fine Sand	Fair
850 - 875	Moderate	Some to None	Fair
1000 - 1025	High	None	Very Good
1025 - 1050	High	None	Very Good

1. River Bed Potential: Interpreted probability that suitable material can be found.
2. Upland Reserves: Extent of previously identified land sources.
3. Prospects: Subjective assessment of prospects for success by dredging.

REGIONAL BORROW DEPOSITS INVENTORY: MACKENZIE DELTA REGION

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ABSTRACT

The Mackenzie River Delta Region is typified by a scarcity of granular material resources and any identified sources are remote from established communities in the region. The competition for readily available granular material resources between industrial needs and communities is acute. Major granular material sources have been identified on Richards Island, the Caribou Hills, and in the southern portions of the Tuktoyaktuk Peninsula. The potential sources of granular materials in the Mackenzie Delta Region are of glaciofluvial origin and consist of kames, eskers, outwash plains, terraces, beaches and delta deposits. Fine-grained sources of *aeolian* dunes have also been recorded. Numerous studies and investigations have been undertaken by industry, DIAND, and more recently, by the Inuvilauit Land Administration to quantify the extent and location of these granular material resources. A comprehensive database to summarize the various investigations completed to date is currently underway.

During the 1970s and the 1980s, significant quantities of granular resources from the Mackenzie Delta were used in the construction of artificial islands for use in Beaufort Sea offshore oil and gas exploration activities. Uniquely, these same artificial islands may be considered as future sources of granular materials through the implementation of prudent reclamation plans.

Introduction

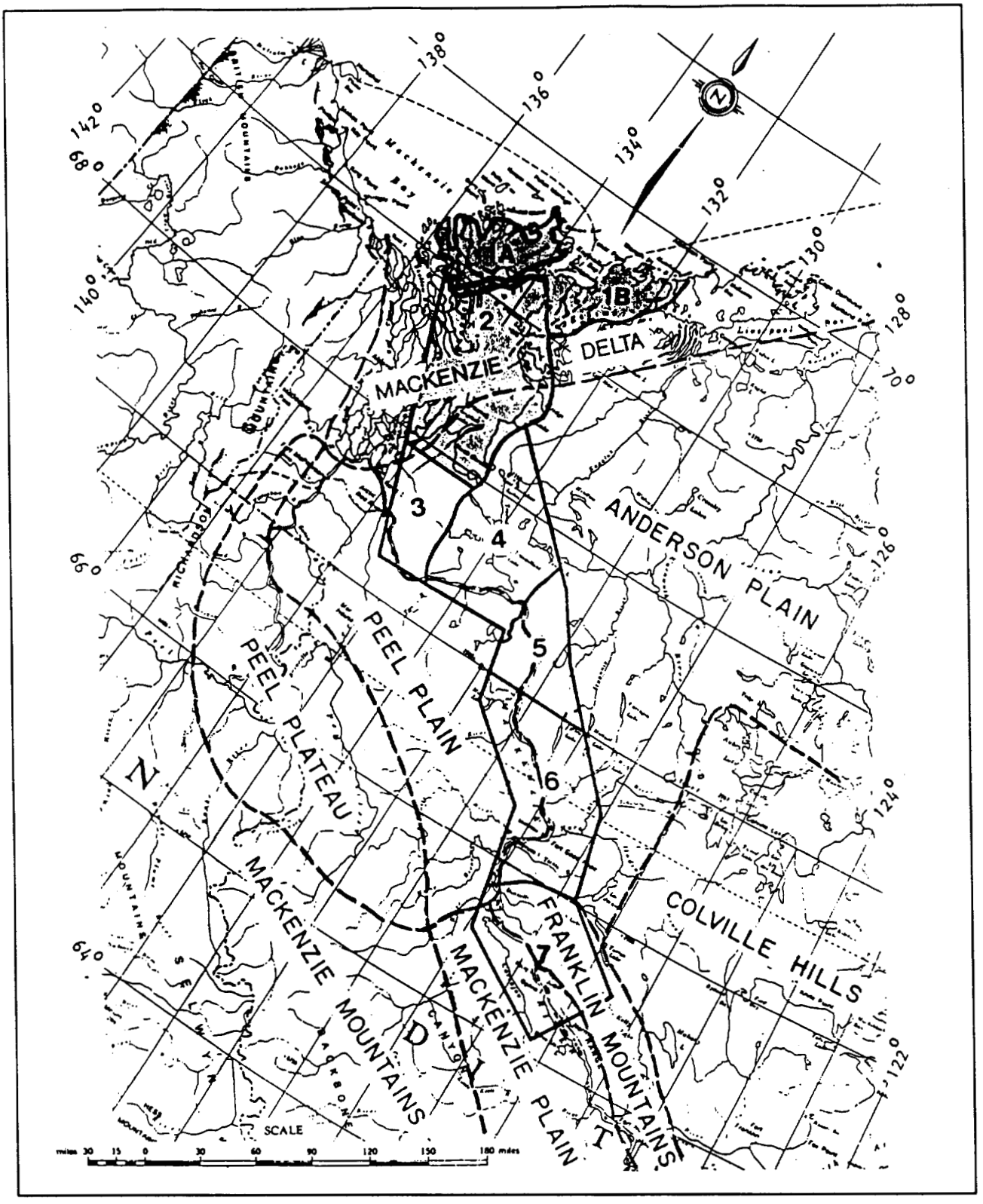
The Mackenzie Delta Region of the Western Canadian Arctic is typified by the scarcity of granular material resources and any identified sources of granular materials are very remote from established communities. The Mackenzie Delta Region, for the purposes of this paper, encompasses the area bounded by the Richardson Mountains in the west (i.e. Yukon/NWT border), Arctic Red River to the south (i.e. Dempster Highway crossing of the Mackenzie Delta), the Canadian Shield to the east and the Beaufort Sea to the north. This expansive region includes Richards Island and the Tuktoyaktuk Peninsula.

This presentation has been based on the assessment and compilation of data from the various reports on granular material studies and investigations completed in the Mackenzie Delta Region. A complete bibliography of the reports reviewed is provided at the conclusion of this paper. It should be noted that these reports represent the essential documents considered relevant for a summary of the Regional Borrow Deposit Inventory in the Mackenzie Delta Region.

The Mackenzie Delta Region represents only two of the seven proposed Borrow Management Areas in the Lower Mackenzie Valley Corridor (Figure 1) which were identified in the early 1980s on the basis of physiography, location of existing communities and administrative boundaries (Hardy 1986). The major granular material sources have been identified on Richards Island, the Caribou Hills, and the southern portions of the Tuktoyaktuk Peninsula.

Four northern communities, Fort MacPherson, Aklavik, Inuvik and Tuktoyaktuk are located within the Mackenzie Delta Region. The Inuvialuit Final Agreement (IFA) has granted the Inuvialuit ownership of the granular resources within the major portion (91,000 km^2) of the Western Arctic which includes much of the Mackenzie Delta Region. The Inuvialuit Land Administration (ILA) is responsible for the

Figure 1. **Mackenzie Delta Borrow Management Areas**



management of granular resources on Inuvialuit lands. Indian and Northern Affairs Canada (INAC) will continue to manage the granular resources on the surrounding Crown Lands.

Background

The early work in the investigation and evaluation of granular material resources in the Mackenzie Delta Region was carried out by Roger Brown and Hank Johnston of the National Research Council (NRC) during the planning, development and construction of the new town of Inuvik and its related infrastructure in the 1950s. Due to the scarcity of granular materials within reasonable access of the proposed Inuvik townsite, construction aggregates were produced from quarried and crushed limestone bedrock from the DPW Quarry located on the eastern shoreline of Campbell Lake.

During the next decade, the 1960s, generic sources of granular materials were identified in the Mackenzie Valley and Delta Regions as part of the surficial geology and terrain mapping activities by E.B. Owen, V.N. Rampton and G.V. Minning of the Geological Survey of Canada (GSC). This mapping work by GSC served as an important and valuable foundation for future studies and investigations for granular materials conducted by industry and government agencies.

One of the first detailed airphoto interpretation exercises to identify and delineate potential sources of construction materials in the Mackenzie Valley and the upper (southern) reaches of the Mackenzie Delta was carried out by Jack Mollard of J.D. Mollard and Associates Ltd. This work was carried out in 1969 and 1970 for the Mackenzie Valley Pipe Line Research Limited as a part of the initial feasibility studies for the Mackenzie Valley Oil Pipeline route from Prudhoe Bay, Alaska to the NWT/Alberta border. Subsequently, in 1971-72 J.D. Mollard and Associates completed an airphoto interpretation of the Mackenzie Delta Region (Elliot Creek to Richards Island and Travaillant Lake to the NWT/Yukon border) for Canadian Arctic Gas Study Limited's proposed Mackenzie Valley gas pipeline project.

From these modest beginnings, as the "World Oil Shortage" crisis developed in the 1970s to the early 1980s, numerous and extensive granular material investigations were undertaken by private industry resource development groups and government agencies, primarily under the direction of the Department of Indian and Northern Affairs (DIAND). The industry groups, who had significant interests in the development of energy resources in the Mackenzie Delta Region with parallel demands for granular materials, included Esso Resources Canada Limited, Shell Canada Resources Limited, Gulf Canada Resources Limited, Canadian Arctic Gas Pipelines Ltd., Mackenzie Oil Pipe Line Research Ltd., Maple Leaf Pipe Line Group (precursor of Foothills Pipe Lines), Beaufort Delta Pipeline Group, Polar Gas Pipeline Limited, Northwest Pipeline Study Group, Dome Petroleum Limited, Interprovincial Pipe Line Limited and others.

During the late 1970s and early 1980s, considerable quantities of granular materials were consumed in the construction of artificial islands for offshore oil and gas programs. The majority of these granular materials were extracted from gravel sources on Richards Island during the early period of offshore activities in near-shore, shallow waters. Subsequently, in the latter days of offshore exploration, in deeper water depths, dynamically anchored drill-ships were used. Today, some of these abandoned artificial islands could be considered as a potential source of granular materials, if prudent reclamation procedures are applied.

During the 1980s and early 1990s, the focus of the various studies and investigations of granular material information was directed to issues dealing with aboriginal land claims. In this regard, the work in the Mackenzie Delta Region was primarily directed to the Inuvialuit Final Agreement (IFA). The extensive information available for the Lower Mackenzie Valley has been compiled in a computerized data base by Lorne Bennett for INAC in 1988.

Granular Source Summary

The initial detailed "Stage I - Community Granular Materials Inventory" investigation carried out by Ripley, Klohn, Leonoff International Ltd. (RKL) in 1972-73 for INAC has served as a comprehensive data base for subsequent granular material investigations by numerous groups. The information developed by RKL has been assembled in seven reports, Zones I to VI, identified as: Tuktoyatuk, Tuktoyaktuk Peninsula, Richards Island, Caribou Hills, Aklavik - Inuvik, Fort MacPherson, and Arctic Red River. Subsequent investigations by EBA Engineering Consultants Ltd., Hardy Associates (1978) Ltd., Terrain Analysis and

Mapping Services Ltd. (V.N. Rampton), Golder Associates Ltd., Northern Engineering Services Ltd., Public Works Canada, and Hardy BBT have provided detailed ground truthing and confirmation of selected granular material sources and potential quarry sites in the Mackenzie Delta Region.

The 1991 report published by Hardy BBT, entitled "Evaluation of Granular Resource Potential - Mackenzie Delta Region", which was prepared for INAC, represents a comprehensive compilation of all historically available data from the numerous investigations conducted in the Mackenzie Delta Region. This report has formed much of the basis for this presentation.

The Hardy BBT report itemized a total of 135 potential granular material sources from the total of 292 prospective sites mapped by various investigators in the past. Furthermore, 28 deposits were classified as having excellent or good prospects by virtue of the quality of granular materials which they contain. On the basis of reasonable ground truthing information such as borehole or test pit data, some 38 million cubic metres of granular materials were considered proven quantities of excellent to good quality sources (Class 1, 2, and 3 material).

The 135 potential "good prospects" may represent an additional 139 million cubic metres of "probable" and "prospective" granular material sources in the Mackenzie Delta region. Further investigation of these sites is recommended by Hardy BBT for exploratory work to confirm availability of granular material resources. When all the mapped borrow sources in the Mackenzie Delta Region, 292 in total, are considered as prospective sources of granular materials, the quantity of Class 1, 2 and 3 construction materials is in the order of 1,809 million cubic metres.

A tabulated summary of the granular material borrow sources in the Mackenzie Delta Region are presented in Table 1A and 1B.

Bedrock Quarry Sources

Golder Associates were retained in 1986 by INAC, to evaluate and identify technically feasible quarry sources in the vicinity of the Mackenzie Delta. The rock from these quarry sources would be used in the development of shore protection for port facilities, concrete structures associated with off-shore facilities, or for the construction of artificial drilling islands in the Beaufort Sea.

A total of six potential quarry sites (Mt. Sitton, Mt. Davies Gilbert, Mt. Gifford/Roche Moutonee, Gull Creek Quartizite, Gull Creek Dolomite, and Delta Outliner) and three other marginal sites were investigated by Golder. The following five grades of rock were considered:

a) Armour Stone - large blocks of intact and durable rock (in excess of 5 tonnes) that would be used on production structures in deep water to resist wave erosion.

b) Rip-Rap - smaller blocks of durable rock (1 to 5 tonnes) that would be used to resist wave erosion of shoreline structures and at between -10m and -20m depth on deep water structures and caisson-type structures.

c) Blast Rock - blocks of intact rock of up to 1 tonne that would be used in filters and in protected-water construction.

d) General Fill - the lowest grade of rock that would be used as a substitute for gravel; durability is not essential.

e) Concrete Aggregate - durable, clean and chemically compatible with Portland Cement; crushing and washing would be normal processing.

A total of 116,525,000 cubic metres of quarried rock of various categories were identified as recoverable from the six potential quarry sites in the Mackenzie Delta Region by Golder Associates.

The preliminary and recoverable volumes of quarried rock from the sites investigated by Golder are summarized in Table 2.

The Campbell Pit, located at the extreme northeast end of the Campbell Hills and currently identified as the "town quarry" for Inuvik, is being mined by North Star Service and Construction (Inuvik) Ltd. It is estimated that approximately 1 million cubic metres of rock has been removed from this quarry which represents less than 10 percent of the recoverable reserves in the quarry. The EBA (1976) study recommends that approval be given for the expansion of this quarry as a continued rock source in the immediate Inuvik area.

Table 1A. Mackenzie Delta Region: "Good Prospects" Granular Resource Volumes

SUMMARY OF GRANULAR RESOURCE VOLUMES

MACKENZIE DELTA REGION
GOOD PROSPECTS (,000 CUBIC METRES)

BORROW MAPPING AREA	GRANULAR MATERIAL CLASS	PROVEN	PROBABLE	PROSPECTIVE	TOTAL
1A ILA	1				
	2	13,200	13,200	13,200	39,600
	3				
1A CROWN	1, 2 & 3				
1B ILA	1	600	600	150,000	151,200
	2		29,800	31,900	61,700
	3	800	4,600	4,700	10,100
1B CROWN	1, 2 & 3				
2 ILA	1	400	1,000	1,000	2,400
	2	1,400	9,500	64,000	74,900
	3	15,200	59,000	172,000	246,200
2 CROWN	1				
	2	6,500	26,000	54,000	86,500
	3				
SUB-TOTAL	1	1,000	1,600	151,000	153,600
ILA	2	14,600	52,500	109,100	176,200
	3	16,800	68,200	181,400	266,400
SUB-TOTAL	1				
CROWN	2	6,500	26,000	54,000	86,500
	3				
TOTAL	1	1,000	1,600	151,000	153,600
STUDY AREA	2	21,100	78,500	163,100	262,700
	3	16,800	68,200	181,400	266,400
TOTAL ALL CLASSES:		**38,900**	**148,300**	**495,500**	**682,700**

Table 1B. Mackenzie Delta Region: "All Borrow Sources" Granular Resource Volumes

SUMMARY OF GRANULAR RESOURCE VOLUMES

MACKENZIE DELTA REGION
ALL BORROW SOURCES (,000 CUBIC METRES)

BORROW MAPPING AREA	GRANULAR MATERIAL CLASS	PROVEN	PROBABLE	PROSPECTIVE	TOTAL
1A ILA	1				
	2	23,800	23,800	23,800	71,400
	3	200	200	200	600
1A CROWN	1				
	2	200	200	200	600
	3	100	1,400	1,400	2,900
1B ILA	1	600	1,300	150,700	152,600
	2		31,300	34,100	65,400
	3	800	162,600	162,600	326,000
1B CROWN	1				
	2		3,800	3,800	7,600
	3		5,200	5,200	10,400
2 ILA	1	400	1,000	1,000	2,400
	2	9,300	35,300	124,000	168,600
	3	23,300	190,000	717,000	930,300
2 CROWN	1				
	2	6,500	26,000	54,000	86,500
	3	10,200	105,000	531,000	646,200
SUB-TOTAL ILA	1	1,000	2,300	151,700	155,000
	2	33,100	90,400	181,900	305,400
	3	24,300	352,800	879,800	1,256,900
SUB-TOTAL CROWN	1				
	2	6,500	29,800	57,800	94,100
	3	10,200	110,200	536,200	656,600
TOTAL STUDY AREA	1	1,000	2,300	151,700	155,000
	2	39,600	120,200	239,700	399,500
	3	34,500	463,000	1,416,000	1,913,500
TOTAL ALL CLASSES:		**75,100**	**585,500**	**1,807,400**	**2,468,000**

Table 2. **Mackenzie Delta Region: "Bedrock Quarry Sites" Recoverable Volumes**

BEDROCK QUARRY SITES

RECOVERABLE VOLUMES – (,000 CUBIC METRES)
MACKENZIE DELTA REGION

SITE NAME	RECOVERABLE VOLUMES					
	TOTAL	ARMOUR ROCK	RIP–RAP	BLAST ROCK	GENERAL FILL	CONCRETE AGGREGATE
MT. FITTON	25,000	5,000	5,000	5,000	5,000	5,000
MT. DAVIES GILBERT	25,000	500	1,000	10,000	7,000	6,500
MT. GIFFORD	18,000	400	800	5,000	6,000	5,000
ROCHE MOUTONEE	125	40	30	25	30	
GULL CREEK QUARTZITE	5,400	500	1,000	1,500	2,000	400
GULL CREEK DOLOMITE	28,000	5,600	5,600	5,600	5,600	5,600
DELTA OUTLIER	15,000	600	500	5,000	5,000	4,350
SUB–TOTAL GOOD PROSPECTS	116,525	12,640	13,930	32,125	30,630	26,850
DPW QUARRY	3,500	450	800	1,500	400	350
CAMPBELL PIT	5,000	500	1,000	2,000	1,000	500
TOTAL ALL SITES:	125,025	13,590	15,730	35,625	32,030	27,700

Summary and Conclusions

The numerous investigations of granular material resources in the Mackenzie Delta Region have identified extensive, but widely dispersed, reserves of available construction materials of varying quality. A total of 292 prospective granular sources have been mapped and identified totalling more than 1.8 billion cubic metres of varying quality of construction materials. However, as noted, the distribution of these sources of granular material are extensively dispersed throughout the Mackenzie Delta Region and economic development of the identified sources are constrained by the very limited and difficult access.

As indicated in Hardy BBT's 1991 report, the 135 "good prospects" of granular sources selected on the basis of more detailed ground truthing information, reduced the reliably "usable" granular material quantities to approximately 139 million cubic metres or less than 10 percent of the identified "prospective sources". Therefore the need for detailed and in-depth exploration and investigation of the identified sources is important to fully address the supply/demand scenario for granular construction materials in the Mackenzie Delta Region. It would appear that the relatively modest demands for granular materials for community needs in the Mackenzie Delta Region can be reasonably met from the borrow sources identified.

The acute and extensive demands for granular materials forecasted in the late 1970s and early 1980s by the various energy resource development projects has waned. Because of the current over-abundance of existing world oil and gas supplies, development of Northern frontier oil and gas reserves have been, more or less, postponed indefinitely.

In equal context, it may be prudent to re-evaluate the reduction of previously identified and exploited granular material sources on Richards Island and the numerous, but small deposits, in the vicinity of Tuktoyaktuk, as these deposits may have been severely depleted during the exploratory offshore drilling activities in the Beaufort Sea. Priorizing granular material development plans will not be possible without a comprehensive investigation of these deposits as they represent some of the most accessible and economic sources of construction materials.

The bedrock quarry sources identified by Golder Associates in 1987 represents very specialized requirements of construction materials for offshore resource development projects and, currently, significantly contributes to the supply/demand analysis for the Mackenzie Delta Region. The modest requirements for specialized quarried rock can be supplied from the DPW or Campbell Lake Quarry in the immediate vicinity of Inuvik. An existing all-weather road provides reasonable access to Inuvik or to transportation by barge if small quantities are required for specialized onshore or offshore applications. In excess of 10 million cubic metres of quarried rock for various construction applications can be recovered from these two quarries. A total of 116 million cubic metres of recoverable quarried rock is available from six potential quarry sites in the Mackenzie Delta Region.

All and any planned future developments for the development and exploitation of granular and/or quarried rock sources for construction materials in the Mackenzie Delta Region will also need to be cognizant of potential environmental, social, economic, and logistical constraints.

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QUESTION PERIOD

Question #1. Those pipeline quantities that you quoted ranged from small lines to large lines. What diameter pipeline are we looking at here?

Oswell. Off hand I can't recall the exact size of lines assigned to each category.

Question #2. Are all of the sites looked at terrestrial and if not what percentage on an area basis would be submerged in the creeks?

Oswell. My understanding is that they were essentially all terrestrial.

Question #3. Have you included the information on your database on Richardson Mountains? It's just that I can show it to you in the manner we want it shown.

Oswell. Some of it may be in there.

Question #4. Were tertiary gravels included in your figures?

Fujino. Those are included in the figures, I think, in a very modest way. The reports that Ripley, Klohn, Leonoff . . . originally mapped that Caribou Hills area. I think the quantities estimated were very marginal.

Question #5. I was wondering, if in your economic modelling, you included the site specific environmental impact assessment within your model, would it still be as economic as terrestrial?

MacLeod. I don't think that the impact of an environmental assessment is a great one. It's a question of where you are, how much information is available.

Question #6. Are these databases in the public domain?

Gowan. For each of these projects we've done there have been reports. The distribution of the reports is variable. Most of them are in the DIAND offices. A lot of this work was done under NOGAP. The databases themselves are in an evolutionary phase and their availability is not as wide spread and available.

Question #7. It was very interesting to see some of the costs associated with borrow development. Any comments from our other panel members as to their specific region that they looked at and do they have a ballpark figure for development of those resources?

MacLeod. I can recall costs for hauling gravel from the Ya Ya pits being in the order of anywhere from $25 per yard to $50 per yard. The main factor is hauling costs.

Hernadi. No we didn't look at costs. They were pretty conventional type developments in South Slave region with all the deposits close to highways.

MacLeod. The big costs would be building access roads to take the gravel out.

Stanley

SECTION 5.

TECHNICAL PANEL "C"

TYPICAL BORROW MATERIALS USAGE

TYPICAL NORTHERN TRANSPORTATION BORROW REQUIREMENTS

Bryan Peterson, P.Geol.

Project Engineer, Geotechnical
GNWT - Transportation, Yellowknife, NWT

ABSTRACT

By far the largest demand for granular resources in the Mackenzie River corridor would come from the completion of the Mackenzie Highway from Wrigley to the Dempster Highway near Inuvik. In order to construct the approximately 1,000 km of new highway, about 350,000 m^3 of pit run gravel would be required for capping over fine-grained embankment materials. Surfacing to an acceptable gravel surface standard would require an additional 850,000 m^3 of processed granular material. An estimated 30 to 40 percent of this processed material would have to be produced from quarried limestone sources in areas where potential granular sources are scarce. Actual testing and selection of granular deposits would be completed after embankment construction.

Maintenance requirements for a gravel-surfaced Mackenzie Highway from Wrigley to Inuvik would require an additional 3,000,000 m^3 of processed material over a 20-year period. If the highway were to be upgraded at some stage in the future, up to 9,000,000 m^3 of granular material would be required to pave the 1,400 km gravel surface of the Mackenzie Highway from Inuvik to the Yellowknife Highway junction.

Within the Mackenzie River Valley corridor, the Government of the Northwest Territories (GNWT) currently does not have a lot of transportation facilities. The GNWT does maintain approximately 500 km of gravel surface road between Fort Providence and Wrigley, eight community airstrips and some 270 km of Dempster Highway. This paper briefly outlines the typical requirements for those facilities and future transportation expansion needs.

In terms of airstrips, new construction on an airstrip may require up to 150,000 m^3 of fill. Typically that fill is granular material. The site selection for the airstrip generally puts it close to a source of good granular fill where 15,000 m^3 of material would be processed for surfacing. The long term maintenance needs for airstrips is minimal, about 10,000 m^3 over a 20-year period. GNWT Transportation does not maintain the Norman Wells and Inuvik airports, as yet. New airstrips are expected to be built at Fort Good Hope and Fort Franklin, and possibly one at Arctic Red River. Nahanni Butte is also in the Mackenzie Valley corridor and, in the future, will also have a new airstrip.

In terms of highway maintenance requirements, between Fort Providence and Wrigley, the ideal quantity for maintenance material would be about 100 m^3/km per year. These figures may appear high and it's probably more like 50 or 75 m^3/km right now but if we did get up to 100 m^3/km, we'd be using 1,000,000 m^3 of material over the next 20 years for that 500 km section. There is also the Dempster Highway which would require another 500,000 m^3 of process granular material.

Future transportation requirements that are potentially quite large include an extension of the Mackenzie Highway from Wrigley to meet the Dempster Highway south of Inuvik. In 1972, the federal government announced they were going to build the highway (pre-engineering, design and construction) from Fort Simpson to the Dempster in four years. Well that didn't happen. By 1976 they had built the highway to a few kilometres south of Wrigley but there was some opposition to the highway from the Dene Band at Wrigley. The project was then shelved and funds were diverted to the building of the Liard Highway. The Mackenzie Highway ended south of Wrigley. It was then completed to Wrigley in the early 1980s and now in the next couple of years, we're finally getting around to putting in a ferry at Camsell Bend on the

Mackenzie River and a bridge at Willowlake River. By 1994, there will be year-round road access to Wrigley.

Going north of Wrigley to the Dempster Highway is another 800 km of highway to construct and that is in the GNWT Transportation Strategy. However, building 800 km of new highway just isn't within the GNWT's current capital funding. It's going to require a large commitment on the part of the federal government for that portion of highway to be built.

I thought that would be the biggest demand for granular materials, the extension of the Mackenzie Highway, but with recently cited pipeline figures of about 7,500 m^3 per kilometer, highway construction does not come near that level of demand.

The federal government had put together preliminary contract packages and survey estimates. My estimates from available information suggest 350,000 m^3 of pit run gravel would be required for capping some areas where fine-grained soils have been used. But surfacing material requirements would only be 850,000 m^3 processed material for the 800 km of new highway.

Probably 60 to 70 percent of that would come from natural granular deposits, the other 30 or 40 percent would come from blasted fresh limestone. Maintenance of the Mackenzie Highway extension, if it ever gets built, would be about 3,000,000 m^3 of process material over a 20-year period. In it's early years, the Liard Highway was constructed of alluvial materials and just a light surfacing gravel which didn't stand up at all.

At some stage in the future, another 9,000,000 m^3 of process granular material would be required for paving from the junction of the Yellowknife Highway to Inuvik. That's a big number to me but it still doesn't give me 7,500 m^3 per kilometre, that's only about 7,000 m^3 per kilometre. The average amount of granular material required, 7,000 m^3 per kilometre, is large for highways but less than the 7,500 m^3 per kilometre cited for pipeline construction.

Note: The text of this presentation has been transcribed from an audio-tape recording of the workshop presentations. If necessary, we would suggest that the reader verify the accuracy of these comments with the presenter.

TYPICAL NORTHERN COMMUNITY BORROW REQUIREMENTS

Jim Nicholson

GNWT - Public Works and Services, Yellowknife, NWT

The Community Granular Program was initiated in 1985 with a mandate to assess the need of the non tax-based municipalities. Under this program, granular material refers to all types and sizes of material. At this point in time, the program does not operate in any of the tax-based communities such as Inuvik and Norman Wells.

The program's mandate is strictly to locate sources that are close to the community that are of a reasonable quality and sufficient quantity to warrant development. Where the material is insufficient or doesn't exist, material will be hauled in to stockpile. The granular requirements of the communities is difficult to estimate, as compared to the requirements for a highway which are fairly standard. What we have to do is take a 20-year needs assessment and 5-year capital program for the GNWT and pull the granular requirements from all the departments and all the projects that are ongoing or are proposed. We also look at the granular requirements of proposed federal government projects and the private sector as best we can. Unfortunately, it seems that a lot of times they really don't know for sure what they're going to do until the day before it happens.

Essentially that forms the basis for everything that we do in terms of production and management of the resource. In a lot of cases, we simply don't have to crush or produce at all because the materials are usually accessible from the private sector anyway.

It's a fairly nebulous process in terms of what the numbers really mean. Typically, your needs in a small community are going to run from 70,000 to 80,000 m^3 over 20 years. Fort Norman and Fort Franklin are a bit larger and may have requirements of up to 100,000 m^3 over 20 years. The figures that we are speaking about are very low and perhaps some have little or no bearing in terms of the megaprojects and master plans you are looking at.

Note: The text of this presentation has been transcribed from an audio-tape recording of the workshop presentations. If necessary, we would suggest that the reader verify the accuracy of these comments with the presenter.

NORMAN WELLS PIPELINE BORROW MATERIALS USAGE

John Smith, P.Eng.

Manager, Quality Control
Interprovincial Pipe Line Inc., Edmonton, Alberta

This paper presents an overview of IPL's business, a brief description of our system, our long range program and how it eventually will affect our activity in the north, and a description of construction of the Norman Wells pipeline.

I'll throw out the essence of my crystal ball and what I think the projected use would be if we extended our pipeline further north. I'll discuss a little bit of the evolution of my numbers and it's up to debate after that. I have a very poor resource for numbers in that we don't have anything in our archives. We're pretty silent right now in northern pipeline development.

IPL is in the business of transporting liquid petroleum products. They are transported from western Canada to points in the mid-western United States around the Chicago area, and on into western Ontario, Sarnia and Toronto area. Three pipeline systems extend out of Edmonton, the smallest of which is a 16-inch line. A 20-inch line carries refined products, NGLs and condensates, and transports them to markets within western Canada and on into Ontario. A 24-inch line and a 34-inch line extend from Edmonton to Superior, Wisconsin and they take the remainder of the crude products. From Superior, a 30-inch pipeline travels north of Lake Superior and a 34-inch goes south. They all meet again at Sarnia and extend east to Toronto and Montreal.

The capacity of our system in Cromer, Manitoba, which would be at peak pumping capacity, is about 1.4 million barrels/day. Forecasts for 1996 estimate about a 120,000 barrel/day shortfall which would exceed our sustainable pumping capacity. What's notable about that statement is that this forecast increase in crude volumes does not include an increase in northern crude deliveries. Conventional crudes, from non-frontier sources, projected price is likely to remain quite steady which would discourage any further extension of our system northward from Norman Wells.

The Norman Wells pipeline and the system facilities consist of a buried, 12-inch diameter pipeline, extending from Norman Wells south for 868 km to Zama, Alberta (Figure 1).

The question is will now attempt to answer is: What were the granular requirements for the construction and maintenance of the Norman Wells pipeline?

Engineered slopes required granular volumes of about 17,000 m^3, as a calculated number. There were 155 designed slopes and where the design called for less than 7°, we would go with the selected backfill. In terms of facilities, there are 48 valve sites along the Norman Wells system and 40 are in the NWT. Small volumes of granular material for fill are associated with valve sites locations.

The Norman Wells Pump Station is constructed on a rocky surface which has been levelled using shales from the Norman Wells quarry. Going further south, the pad for the construction camp at KP78 (Bear Rock), used hauled rock, about 500 m^3. Most of the concrete involved in the construction of the Wrigley Station was on-site granular. Another maintenance base, at KP447 near Camsell Bend also had on-site granular. The Mackenzie Pump Station was built on a mudstone base. Some surficial rock was brought in for a walking surface but again not for structural requirements.

The mainline construction camps were the biggest users of granular. However, this gravel was as recoverable, since it was repurchased and used for remedial works on our slopes. Granular material was also used at our stockpile sites. The purpose of stockpiles is for pipeline temporary storage and that granular is also recoverable. Pipe stockpile sites were only used north of Willowlake River. Some of the river crossings required rock rip rap and we also developed aggregate for the construction of river weights, about 100 m^3 total. This summarizes the borrow needs for the construction phase of the Norman Wells pipeline.

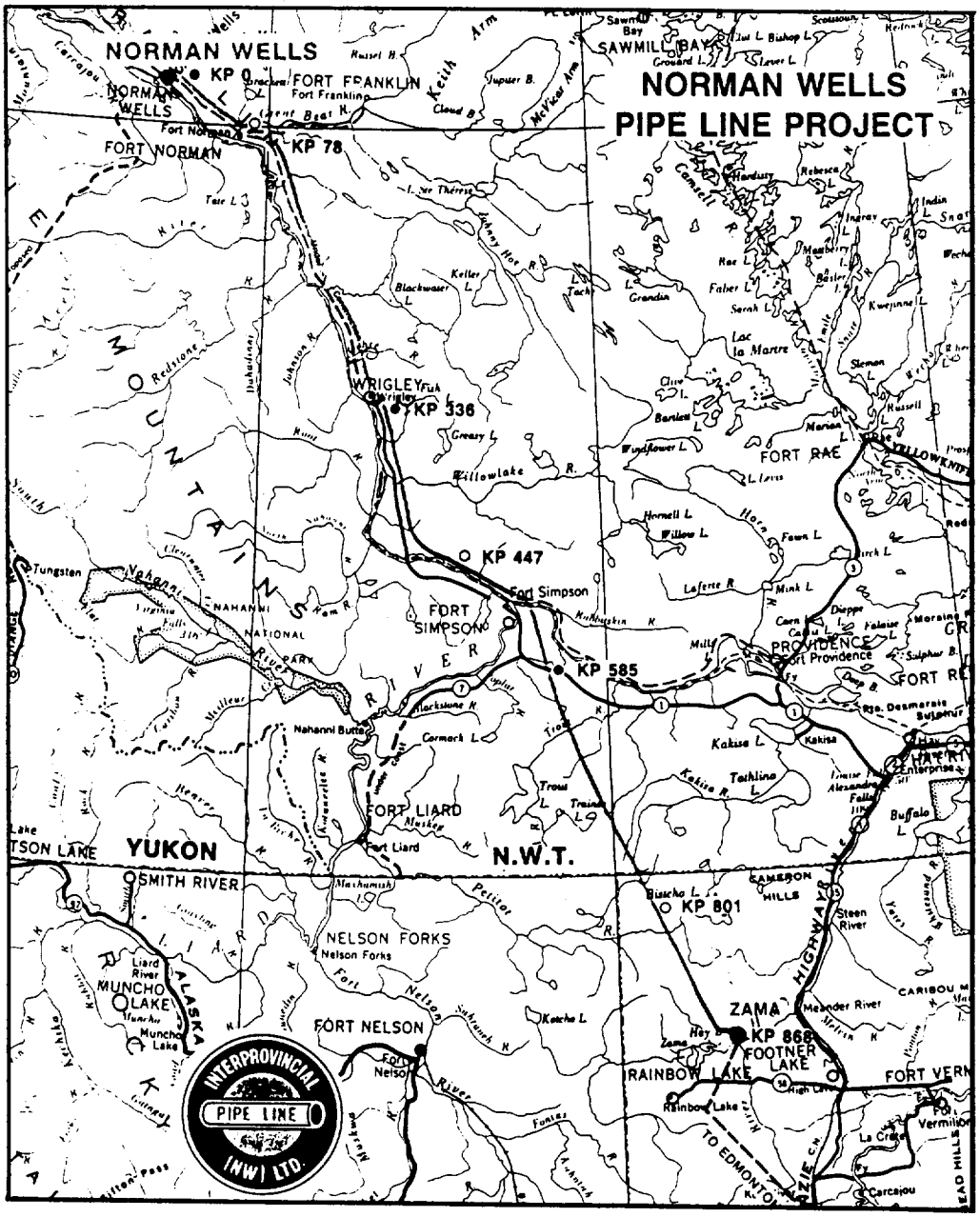
After commencement of pumping operations in May 1985, a fair amount of granular was used, although it

didn't have to be granular, for re-roaching the pipeline ditch. In 1986, there was approximately 35 km of subsided ditch which was re-roached. Figures for 1986 and 1987 were unavailable although about 500 m^3 was used to repair slopes near Fort Norman.

Norman Wells crude has a very light viscosity and therefore we can bury and don't have to insulate it. Typically, Norman Wells crude flows around 0° but I don't have detailed information about the crude types north of Norman Wells.

Note: The text of this presentation has been transcribed from an audio-tape recording of the workshop presentations. If necessary, we would suggest that the reader verify the accuracy of these comments with the presenter.

Figure 1. Norman Wells to Zama Pipeline Route



HISTORICAL BORROW DEMAND FORECASTS: MACKENZIE VALLEY CORRIDOR

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ABSTRACT

Prior to the late 1960s, resource development in the Arctic had not gained any momentum and the demands for granular materials for community gravel airstrips, community infrastructure projects, small isolated mining projects, and winter access roads were easily met. There were few competing needs for the granular resources in the Mackenzie River Valley and Delta areas.

In the early 1970s, with the pending world oil shortages, major resource development and transportation projects were conceived for the Mackenzie Valley and detailed feasibility investigations were undertaken. In view of the extremely disturbance sensitive permafrost terrain in the Arctic, each of these industrial megaprojects required substantive quantities of granular materials to support major engineered facilities. Significant demands for granular materials were identified for oil and gas pipelines, oil and gas processing plants and related facilities, Beaufort Sea developments, the extension of the Mackenzie Highway system, deep seaports on the Beaufort coast, and extensive infrastructure upgrading in Mackenzie Valley communities. The demands for granular materials in the Mackenzie Valley came to a sudden and abrupt halt in the early to mid-1980s with the drop in world oil prices and postponement of megaproject activity in the region.

Introduction

The demand for granular resources in the Mackenzie Valley, prior to the 1960s, was quite modest. The general requirements were for local community needs, for minor upgrading of winter access roads, and for occasional utilization for exploratory oil and gas seismic activities. After reaching peak demand forecasts in the late 1970s and early 1980s, because of the numerous hydrocarbon development projects for both onshore and offshore facilities, the need for extensive quantities of granular material appears to have diminished. Current demands for granular material resources are now centered around the specific needs of the individual northern communities.

Extensive information has been collected on borrow materials by northern frontier petroleum operators, oil and gas pipeline companies and government agencies. Under the Northern Oil and Gas Action Program (NOGAP) Granular Resources Inventory and Management Project, most of the existing information has been compiled and catalogued into a series of computer databases which have been linked with a digital mapping system. Therefore, the location, accessibility, quality, available and recoverable quantities, development constraints and ownership of these numerous granular material resources in the Mackenzie Valley corridor has been catalogued in detail and is readily retrievable.

Historical demand forecasts for granular materials are not as readily accessible nor available in the public information domain. The various demand forecasts developed by pipeline operators and hydrocarbon developers during the application phase for these developments are difficult to retrieve because most records have been archived. The collective and cooperative information shared at this workshop will be used to update this historical granular resource information base.

This presentation of the historical demand forecast information focusses on the following:

a) Oil and gas pipeline projects.
b) Onshore gas processing facilities.
c) Beaufort Sea offshore oil and gas developments.
d) Major transportation facilities.

Community documents and reports used as reference material in the preparation of this presentation are listed in the bibliography section at the conclusion of this paper.

Historical Demand Scenarios

Neither a detailed and comprehensive examination of existing and available industry and government documents and records, nor the integration of comments from the numerous individuals who had participated in the development and planning of the major energy and infrastructure projects in the Mackenzie Valley Corridor and Beaufort Sea was possible within the constraints of this review. Based on personal knowledge and past involvement in energy resource development projects in the late 1970s and early 1980s, the historical demand forecasts for granular materials in the Mackenzie Valley have been extrapolated.

A summary of the "Historical Demand Forecasts" for Mackenzie Valley granular resources are presented in Tables 1 and 2. Table 1 shows, where information was available, the total of proposed pipeline and oil and gas processing facility granular requirements.

The most detailed studies of "potential demand" for granular material resources were carried out by the Department of Public Works Canada and Canadian Arctic Gas Pipeline Limited during the planning process for the Mackenzie Highway and the Arctic

Table 1. Historical Granular Demand Forecasts: Private Industry Developments

MACKENZIE VALLEY CORRIDOR

HISTORICAL DEMAND FORECASTS
PRIVATE INDUSTRY DEVELOPMENTS
(,000 Cubic Metres)

TYPE OF DEVELOPMENT	ORGANIZATION	HISTORICAL DEMAND	CURRENT DEMAND
1. PIPELINE PROJECTS			
ALASKA GAS PIPELINE	C.A.G.P.L.	27,743	
ARCTIC ISL. GAS P/L	POLAR GAS	27,743	
MACKENZIE DELTA OIL P/L	BEAUFORT DELTA GRP.	47,163	
NORMAN WELLS OIL P/L	INTERPROVINCIAL P/L		
2. OIL & GAS PROCESSING FACILITIES			
TAGLU GAS PLANT	ESSO RESOURCES CANADA	1,500	
NIGLINTGAK GAS PLANT	SHELL CANADA RESOURCES		
PARSONS LAKE GAS PLANT	GULF CANADA RESOURCES		
NORMAN WELLS REFINERY	IMPERIAL OIL CANADA		
3. BEAUFORT SEA OFFSHORE DEVELOPMENTS			
ARTIFICIAL ISLANDS	DOME/ESSO/GULF		
STAGING AREAS	DOME/ESSO/GULF		
TOTAL		102,649	

Table 2. Historical Granular Demand Forecasts: Public Sector Developments

MACKENZIE VALLEY CORRIDOR

HISTORICAL DEMAND FORECASTS
PUBLIC SECTOR DEVELOPMENTS
(,000 Cubic Metres)

TYPE OF DEVELOPMENT	ORGANIZATION	HISTORICAL DEMAND	CURRENT DEMAND
1. COMMUNITIES			
INUVIK	INUVIALUIT		178
AKLAVIK	INUVIALUIT		221
TUKTOYAKTUK	INUVIALUIT		316
FORT MacPHERSON	INUVIALUIT		
ARCTIC RED RIVER	INUVIALUIT		
FORT GOOD HOPE			
NORMAN WELLS			
FORT NORMAN			
FORT FRANKLIN			
WRIGLEY			
FORT SIMPSON			
ENTERPRISE			
FORT RESOLUTION			
HAY RIVER			
2. TRANSPORTATION INFRASTRUCTURE			
MACKENZIE HIGHWAY	PUBLIC WORKS CANADA	41,557	
MACKENZIE VALLEY RAILWAY	CNR – CPR	246,041	
DEMPSTER HIGHWAY	PUBLIC WORKS CANADA	330	
LIARD HIGHWAY			
3. MISCELLANEOUS DEMANDS			
HYDROELECTRIC DEVELOPMENTS			
OTHER (1975 CUMULATIVE)		117,742	907
TOTAL		**405,670**	**1,622**

Gas Pipeline projects. Estimated quantities for the, then, proposed "Mackenzie Valley Railway Project" were assembled by the Mackenzie Highway Granular Materials Working Group.

Detailed quantities for historical demand forecasts were not available to the author for the Beaufort Sea Offshore developments. The artificial drilling islands for exploration of oil and gas reserves in the shallow near shore locations of the Beaufort Sea have consumed considerable quantities of identified and available granular material reserves. These reserves, located on Richards Island, were identified during the development of traditional borrow pit operations and by the dredging of suitable coarse grained granular materials from shallow waters in and around Richards Island. Quantities actually used and demand forecasts for future needs of these offshore energy resource

developments may be compiled through workshop sessions with industry participants at this granular materials workshop.

Concurrent with the studies and investigations being carried out by industry for the demands of these energy resource development projects, the Federal Government had initiated planning and feasibility studies into the development of transportation infrastructure projects. The Mackenzie Highway project, Dempster Highway project, and the Mackenzie Railway project were the three major projects under consideration. The Mackenzie Railway project was envisaged as the single largest consumer of granular materials, if the project were to proceed.

The historical demands for the granular material needs for the various communities in the Mackenzie Valley Corridor were, essentially, demands classified as "Other" in the 1975 Mackenzie Valley Granular Materials Working Group. Subsequently, as part of the land claim settlement process in the Northwest Territories, additional studies and evaluations for granular material requirements for each community in the Mackenzie Valley have been undertaken for Indian and Northern Affairs Canada (INAC). The historical and current demands for community and public sector developments, where available, are shown in Table 2.

Summary and Conclusions

The total historical demands for granular material resources for private industry developments were in the order of 104 million cubic metres. The majority of the private sector demands were related to "Pipeline Projects", totalling 102.5 million cubic metres (shown in Table 1). Current demands of granular materials for private industry developments remain uncertain, either in terms of quantities or schedules.

The total historical demands for public sector developments were in the order of 405.6 million cubic metres. Of this total, in excess of 246 million cubic metres were identified as the potential requirement of the Mackenzie Valley Railway (Table 2). Current demands of granular materials for public sector developments are about 1.6 million cubic metres.

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QUESTION PERIOD

Question #1. On the material needed for the Mackenzie Highway, you said it was about 1,100,000 m^3. How did you come up with that number?

Peterson. That doesn't include embankment. It's not inclusive of any embankment material unless the route is going through granular areas, then the embankment would be constructed of granular. The embankment would be of bedrock materials and fine grained soils, clays and granular materials. But those numbers don't include any embankment quantities in terms of blasted, bedrock or shale to construct the embankment.

Question #2. You are assuming that the areas going through the soil are sufficient for capping.

Peterson. Yes. They've done very extensive geotechnical investigations through most of the route and I have to believe them - there seems to be pretty thorough work completed. It was 20 years ago, but I don't think it's changed much.

Question #3. So you just took a look at the smaller communities? Not Inuvik or Norman Wells?

Nicholson. No, strictly non tax-based municipalities. So, Inuvik and Norman Wells, regional centres, would not get involved in the program.

Question #4. Can you give us a rough indication of cubic metre prices for process of fines within the community?

Nicholson. They're so different from community to community. A community on the highway system will be substantially lower than a community without an access road.

Question #5. Are there particular communities that keep restrictions for them as far as access? You mentioned Fort Franklin and Fort Norman as having potentially extraordinary requirements compared to some of the other communities. Are there any communities that have restricted access?

Nicholson. In the corridor, no.

Question #6. Is IPL going to replace the wood chip slopes? I understand they have caused a lot of problems.

Smith. It's not our intent to replace them. Not so far as slope stability - we've had a slope around KP160 that has shown a reduced factor of safety. The most recent number generated by our consultants, I think are around a factor of safety of 1.3, which says we're not having a red light flashing yet. I think if any remedial work is employed it probably would be to put in horizontal drains to relieve the excess head and groundwater.

Question #7. I understand that the composting of the wood chips has created, locally, very high temperatures that will have an effect on the active layer.

Smith. Normally the thaw bulb is generated around the pipe itself. The most active thaw could be energy transported by the pipeline although there's little energy generated by heat from ambient gain. There seems to be a thaw gain around the pipe but that doesn't really contribute to slope instability, it's only if you have a broad thaw. I think it's only in the case of about 3 or 4 slopes that we've seen this thaw. I'm not so sure that the heating has contributed to a broad thaw because the heating appears to be very localized.

Question #8. I thought that if a new pipeline was built from Norman Wells to Inuvik, then the pipeline would cross sections of glaciolacustrine origin and then we would have part of the pipeline crossing and affecting the active layer.

Smith. I really couldn't comment what kind of design we would look at for slopes going north. We would have reevaluate the whole design. But I do know there is nothing to do south of Norman Wells to rehabilitate the wood chip slopes, apart from draining.

Question #9. Would you use the Aleyeska Pipeline mode north of Norman Wells...above-ground and with an all-weather road?

McDougall. I wouldn't think so, not if its a small-diameter line.

Question #10. Is there a relationship between line diameter and the need for a road?

Smith. I don't think they're actually related whether they're above ground or below ground in terms of whether you need a road or not. If thaw settlement is found due to elevated temperature, you go above ground on stilts. But how do you access it, how do you maintain it? I guess that's a project decision. But if it's small diameter, I don't think the revenue is going to justify the building of a road.

Question #11. When you say small diameter, how small are you talking about, 12-inch and under?

Smith. Up to 16-inch. Mid-size would be 16- to 30-inch and then big is in excess of 30-inch.

Question #12. I was wondering if anybody was aware of what gravel requirements are going to be for the proposed Hondo Pipeline?

McDougall. I met the proponents of the Hondo Pipeline last week and I think it's fair to say that that proposal is in a very preliminary stage, a lot of work has to be done to flush that idea out and it would be very premature for me to guess what their requirements might be.

Question #13. During pipeline construction on your project - material sand that was used for sandbagging and also for bedding the pipe and padding - did you include that in your numbers?

Smith. No. My numbers were exclusive of that in that I didn't have any records of it. The requirements for material for the sandbags were fairly substantial. I do know that at some point in the early phases of construction, we decided to use sandbags for pipe protection.

Question #14. How many sandbags?

Smith. There were 2,000,000 sand bags used on the Norman Wells pipeline.

Question #15. Would you give a guesstimate of 2,000,000 bags at about 50 lb. a bag? That's significant.

Smith. IPL's numbers indicated 70,000 cubic metres and if we add another 20,000 cubic metres for sandbags, that is significant in comparison with the other numbers.

Question #16. Any estimates on the gravel requirements for the extension of the highway from Inuvik to Tuk?

Fujino. It would be in the order of 85 kilometres long.

Peterson. It would require 100,000 to 200,000 m^3. The problem is that the Inuvik to Tuktoyaktuk section doesn't have suitable borrow material. If the embankment has to be constructed out of granular

materials then you have higher granular requirements.

Question #17. In the cases where you're talking about embankment fill would that be basically taken right from the right-of-way? Or would they be the active borrow pits?

Peterson. Halfway between Norman Wells and Fort Good Hope there would be predominantly borrow pits. South of that area we would likely use some right-of-way cut and fill operations.

Question #18. In your figures, I don't recall seeing anything about rip rap or erosion protection for slope control?

Peterson. We took the total rip rap requirement which was 32,000 m^3 for the 800 km of new highway.

Question #19. Wouldn't that volume depend on how extensive the rip rap protection would be?

Peterson. Yes. Although I don't know what the design calls for.

Stanley

SECTION 6.

TECHNICAL PANEL "D"

POTENTIAL INDUSTRIAL DEMANDS

GRANULAR RESOURCE REQUIREMENTS FOR POTENTIAL HYDROCARBON DEVELOPMENT IN THE WESTERN NWT

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ABSTRACT

Historically, granular material has been used in the construction of roadways, airfield runways, embankments to support buildings and other physical structures, and in the construction of drilling pads and temporary offshore exploration structures in the shallow waters of the Beaufort Sea. Granular resources in the Mackenzie Delta are limited in supply. One of the key variables in managing the resource is the identification of potential requirements. The land use studies in the region have identified local needs for the communities. Industry requirements have also been assessed. On the oil side, development scenarios have ranged from the optimistic production levels of 700,000 barrels per day in the early 1980s, to today's current thinking that additional onshore reserves need to be discovered before oil development occurs. Development of the large gas reserves in the region has been proposed, but again, under the existing price regime, onshore gas cannot compete with gas reserves in Alberta and the continental United States.

Despite the pessimistic outlook, future hydrocarbon development in the region will likely occur. This paper reviews historical exploration and development planning in the region and identifies potential development scenarios. Granular resource requirements for the potential development scenarios will also be identified.

Introduction

North of 60 Engineering Ltd. has identified, in collaboration with industry, granular resource requirements for a number of oil and gas development scenarios in the Beaufort/Mackenzie Delta region. These scenarios have the potential to be economic under current price outlooks, given plausible technological and fiscal uplift. This paper summarizes the potential development scenarios, their possible timing, and granular resource requirements.

The motivation for this work is driven by the ongoing need of the Department of Indian Affairs and Northern Development (DIAND) to assess granular resource requirements in the region. This work has been sponsored under the Northern Oil and Gas Action Program (NOGAP) Project A4: "Granular Resources Inventory and Management".

Hydrocarbon Exploration

The western region of the Northwest Territories (NWT) represents one of the major undeveloped petroleum frontiers of Northern Canada (GSC, 1983). Exploration in the NWT started in the early 1920s, when oil seeps into the Mackenzie River led to the discovery of the Norman Wells Oilfield in 1921. Over 1,000 wells have been drilled in the area since 1921 which has resulted in a number of discoveries in the mainland region of the NWT and in the Mackenzie Delta - Beaufort Sea area.

Exploration in the Mackenzie Delta - Beaufort Sea region began in the early 1960s. The first well was drilled at Winter Harbor on Melville Island in 1962 and this was followed by wells in the Mackenzie Delta and Tuk Peninsula region. Oil was first discovered at Atkinson Point on the Tuktoyaktuk Peninsula in 1969 by Imperial Oil Limited. In 1971, large gas deposits were discovered in the Taglu area of Richards Island by Imperial Oil and in 1972 in the Parsons Lake area by Gulf Canada. In 1973 Shell Canada made several oil and gas discoveries in the Niglingtak and Kugpik areas of the Mackenzie Delta.

The first offshore well in the Mackenzie Delta - Beaufort Sea was drilled from an artificial island in 1973. Drilling from near shore artificial islands, Esso discovered oil at Adgo in 1974, at Issungnak in 1980,

West Atkinson in 1982, Itiyok in 1983 and Nipterk in 1985. In the deeper waters, Dome Petroleum/Canmar Marine Drilling undertook an ambitious exploration program using drill ships. Between 1976 and 1980, Dome encountered oil at the Nektoralik, Koakoak, Kopanoar, Ukalerk and Tarsuit locations. In intermediate waters, Gulf found oil at Pitsiulak and Amauligak. These wells were drilled from a mobile arctic caisson which was placed on the sea floor, or a berm (depending on the water depth), and then filled with a sand core to provide sliding resistance against moving ice in the winter. Several gas discoveries were also made in the offshore regions. Dingwall (1990) provides an overview of Beaufort Sea/Mackenzie Delta hydrocarbon reserves.

Over 200 wells have been drilled in the Mackenzie Delta - Beaufort Sea area including about 90 wells offshore. Estimated discovered reserves to date and potential for the region are given in Table 1. The significant oil and gas discoveries in the region to date are shown in Figure 1.

Current Outlook

It took sixty-five years after oil was discovered at Norman Wells, before oil production finally flowed to southern markets (although the oil field had been tapped to produce refined product for the region for several decades). At the commencement of production in 1985, the expanded Norman Wells reservoir was estimated to contain about 200 million barrels of oil. Norman Wells is Canada's most northerly oil field with sustained year round production. The Norman Wells field currently produces about 35,000 barrels of light crude per day.

Production from the Mackenzie Delta - Beaufort Sea region has yet to occur despite the considerable investment by industry into development planning, engineering studies, as well as regulatory and environmental reviews. In fact, exploration drilling in the area has dropped to a twenty-year low and there has been little interest shown in obtaining new frontier exploration leases.

A major factor in this low activity is the current price of oil which has fluctuated in recent years around $20 US per barrel. The prevailing industry view is that the existing oil reserve base in the Mackenzie Delta is not large enough to support a costly pipeline transportation system to southern markets. Industry's efforts are therefore focused on identifying and discovering onshore oil prospects.

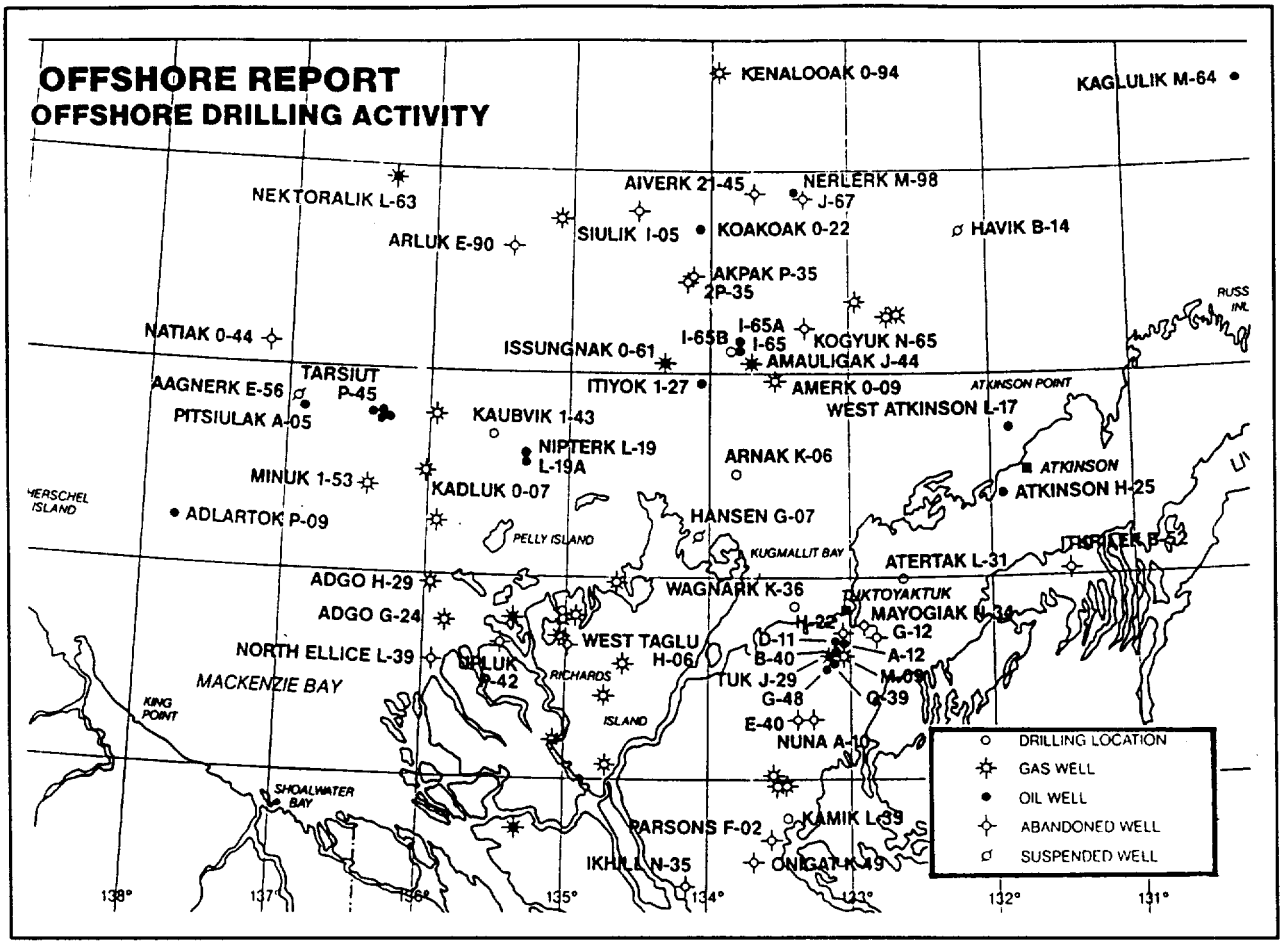
Frontier natural gas discoveries, while significant in size, are currently not competitive with the existing reserves in southern Canada due to the costly transportation system that would be required to move the gas to market. Given current low gas prices and the unexpected near term growth in those prices, it is unlikely that the discovered reserve base will be developed within the next decade although significant changes in fuel use (i.e. increased conversion from oil to natural gas by industry and consumers) could alter this outlook.

Table 1. Mackenzie Delta/Beaufort Sea: Discovered and Potential Reserves

	Oil (billion bbls)		Gas (Tcf)	
Region	**Discovered**	**Potential**	**Discovered**	**Potential**
Onshore-Shallow Offshore	0.22 to 0.26	0.82 to 1.18	6.6 to 8.3	9.4 to 19.7
Offshore Delta	0.8 to 1.0	1.0 to 1.3	3.0 to 4.0	12.0 to 15.0
West Beaufort	0.05 to 0.35	1.35 to 2.15	0.0	12.0
Deep Offshore	0.2 to 0.4	0.9 to 1.3	0.4 to 0.8	13.0 to 19.0
Total	**1.27 to 2.01**	**4.07 to 5.93**	**10.0 to 13.1**	**46.4 to 65.7**

Source: GSC, 1988

Figure 1. Beaufort Sea/Mackenzie Delta: Significant Oil and Gas Discoveries



Source: Oilweek, 1986

Foreseeable Granular Requirements

Despite the pessimistic outlook, the oil and gas industry has identified a number of ongoing or potential projects that will require granular material in the near term. They include the following:

- Shell Canada will potentially require up to 15,225m³ to support their ongoing exploration activities in the Mackenzie Delta during the 1993-94 period, however they will attempt to utilize surplus material currently stockpiled in the area.
- An annual requirement of 500m³ rock, and 750m³ sand to support ongoing operations by Imperial Oil at Norman Wells.
- Imperial has planned a number of small projects for 1993 that will require 3,000m³ rock, 10,000m³ gravel and 1,300m³ sand.
- A new well pad at Norman Wells is planned for 1994 which would require 40,000m³ of rock and 53,000m³ of gravel.
- An estimated 500,000m³ of granular would be required for a 40 to 50 km access road into the Cameron Hills area to support potential resource development in the area.
- An estimated 90,000m³ of granular for a potential refinery and access road in the Jean Marie River area.

Future Development

The key to future development in the current economy is finding innovative ways of reducing the high costs associated with oil and gas development and transportation.

Towards that end, North of 60 Engineering Ltd. in association with K.R. Croasdale and Associates Ltd. recently completed a study to identify key research and development thrusts, which, if successful, would significantly improve the potential of oil and gas development in the region. A number of generic oil and gas development scenarios were considered:

- A 100 million barrel (recoverable reserves) onshore field utilizing the 12-inch extension of the Interprovincial Pipe Line system from northern Alberta to Norman Wells.
- A 350 million barrel offshore pool producing at a rate of 80,000 barrels per day into a 16-inch pipeline from the offshore location to northern Alberta.
- A 350 million barrel offshore pool producing at a rate of 80,000 barrels per day utilizing year-round ice-breaking tankers to transport the product to market.
- A 350 million barrel offshore pool producing at a rate of 35,000 barrels per day utilizing the 12-inch extension of the Interprovincial Pipe Line system from northern Alberta to Norman Wells.
- A 350 million barrel offshore pool producing seasonally into a tanker which would transport the product to market.
- A gas scenario to produce only the onshore reserves at a rate of 800 mcf/day through a 30-inch pipeline constructed from Taglu to northern Alberta.

The study identified the cost, economic viability, and economic sensitivities associated with each of the above scenarios. In addition, it outlined a number of potential research initiatives which could reduce costs and thus improve project economics.

One of the important conclusions from the study was that small scale oil development using either an extension of the Norman Wells pipeline or tanker transportation could be economically attractive without additional reserves if technology advancements could achieve lower costs. The study also recommended a framework to focus future research into areas that could potentially make development a reality.

Potential Development Scenarios

Based on the results of the previous work by the author, a number of potential development scenarios have been considered for this study. They include:

- The development of a small onshore oil or gas field to provide a fuel source to meet local energy demands.
- The potential for seasonal production from the Amauligak reservoir.
- A generic 200 million barrel onshore field.
- The processing of onshore gas for sale to southern markets.

The timing of these scenarios has been phased to reflect the ongoing level of exploration, the time required to develop a particular scenario and the current economic outlook.

The initial development scenario is shown in Figure 2. It assumes that development of local energy sources, or seasonal oil production from an offshore discovery could take place in the 1995-2000 time frame. It also assumes a discovery, and the development of an onshore 200 million barrel pool by the year 2000. As initial production started to decline additional onshore fields would be brought on stream. The timing of these additional developments would depend on available pipeline capacity and the actual timing of gas development.

The author has assumed that sufficient demand and growth in gas prices will occur by the year 2005 to justify development of the three major onshore fields. This would trigger the construction of a gas pipeline, development drilling and production facilities which would come on stream in the year 2010. A possible development scenario for the year 2010 is presented in Figure 3. And finally, as additional capacity in the transportation system is established additional onshore fields would be added.

Figure 2. **Beaufort-Mackenzie Oil Development Scenario: Year 2000**

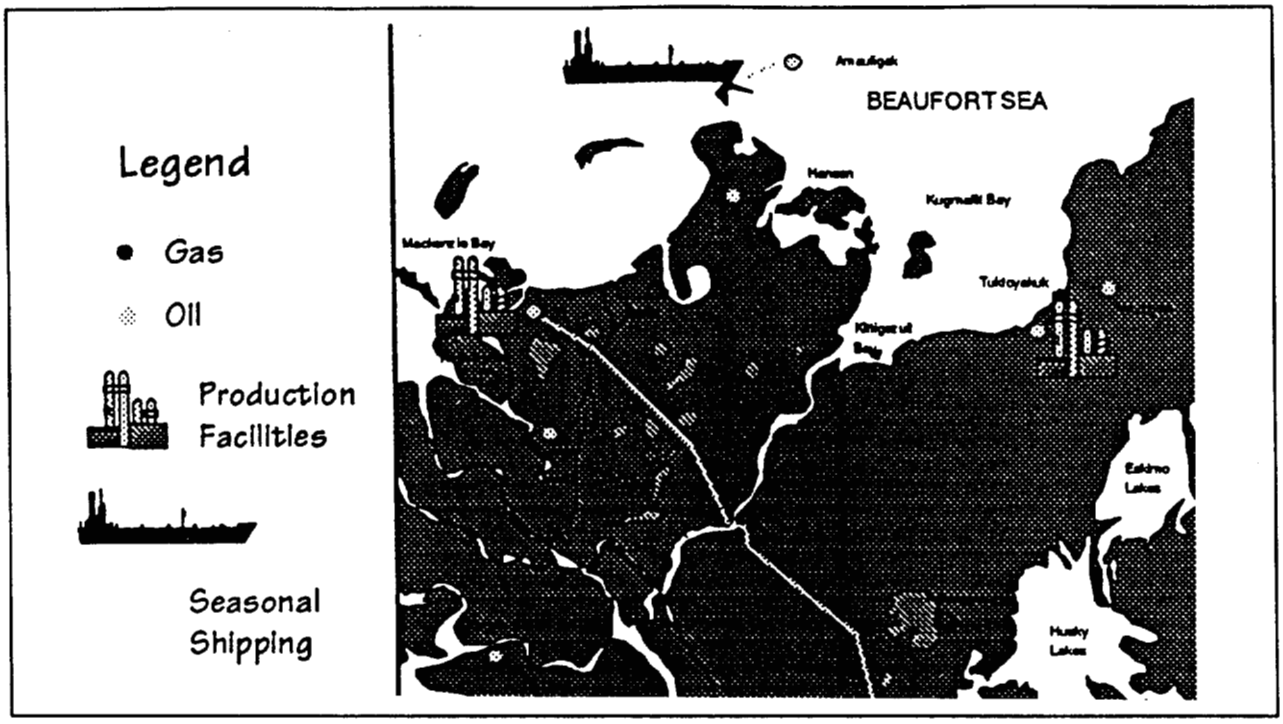
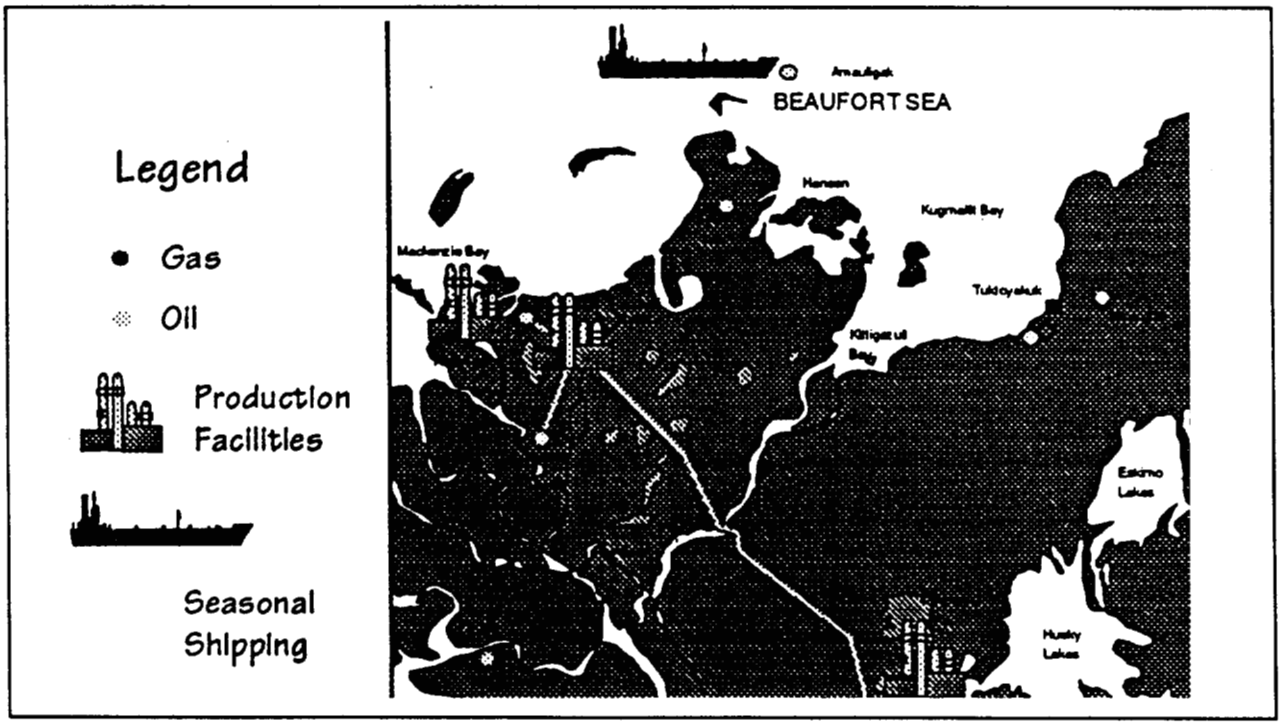


Figure 3. **Beaufort-Mackenzie Oil and Gas Development Scenario: Year 2010**



Granular Requirements

The general scope of each development scenario was established in order to identify the associated granular resource requirements. Generally, the scope was based on inputs from a variety of sources including industry, the experience of the author, and past studies available in the public domain. In some cases, where data was unavailable for a particular scenario, the scope was established using NORCOST, a Northern Regions Venture Cost Model developed by North of 60 Engineering. The NORCOST model establishes the scope and cost of facilities necessary to produce and transport oil and gas from frontier regions to southern markets. As a subset of the output it also quantifies the granular resources required for the development.

Total granular resource requirements for the various development scenarios discussed in the previous section are summarized in Tables 2 and 3. Table 2 represents a breakdown of the granular requirements for oil development while Table 3 summarizes the requirements for gas development. A more detailed breakdown of these granular requirements is contained in the final report of this study to the Department of Indian and Northern Affairs.

Granular resource requirements for a 12-inch extension of the Interprovincial Pipe Line (IPL) crude oil system from Norman Wells to the Mackenzie Delta are relatively small. According to IPL, approximately 50,000 m^3 of granular resource material would be required for construction of the line north from Norman Wells. This small volume (when compared to the gas pipeline requirements discussed below) is likely attributable to the small diameter of the line.

Granular resource requirements for the gas pipeline development are significantly larger. The gas scenario considered in this study consists of a 914 mm diameter, 2,330 km long, pipeline stretching from the Mackenzie Delta to Edson, Alberta where it would connect into existing distribution systems.

General fill would be required for work pads, access roads, airstrips and other associated pipeline facilities. Select fill would be required to improve the durability of subgrade surfaces and for trench bedding and packing around the pipe. Finally, a limited quantity of aggregates would be required for manufacture of concrete pipe weights and structural foundations. Granular resource requirements for the pipeline, by type, and construction spread, are summarized in Table 4. Operating and maintenance facilities to support the pipeline would require an additional 244,073 m^3 of general and select material.

Total granular resources requirements are therefore estimated to be 2 million m^3 for Mackenzie-Beaufort oil development and 8 million m^3 for gas development.

Conclusions

A number of conclusions can be made from the study:

- The static hydrocarbon reserves that have been discovered in the region are significant.
- Future oil development in the region will likely require additional reserves. Gas development will depend on the economic outlook and future demand.
- Technology and fiscal uplift will enhance the likelihood of development.
- Granular resources required to support ongoing operations at Norman Wells, the southern region of the NWT and ongoing exploration in the Mackenzie Delta-Beaufort Sea are relatively small.
- A number of development scenarios have been identified that are potentially viable given technology and fiscal uplift. Granular resources requirements for these scenarios are significant, but considerably lower than historical estimates for larger developments.

Acknowledgements

The work described in this paper was supported by the DIAND under the NOGAP Project A4: "Granular Resources Inventory and Management". Scientific Authority for the work was Mr. Robert J. Gowan, Geotechnical Advisor, DIAND. The author wishes to thank him for the guidance and support that he provided during the study. Also acknowledged are the valuable inputs and advice received from the numerous companies within industry who were consulted during the study. This study would not have been possible without their valuable input. However, the opinions and recommendations given in this report are those of the author and do not necessarily represent the views of the organizations who provided input or of DIAND.

Table 2. Granular Material Required for Mackenzie-Beaufort Oil Development (m^3)

Period/Years	Onshore Facilities	Offshore Facilities
1993-1995	716,275	0
1996-2000	575,447	650,000
2001-2005	6,250	0
2006-2010	6,250	0
2011-2015	388,525	2,700,000
2016-2020	235,615	0
Total	**1,928,362**	**3,350,000**

Table 3. Granular Material Required for Mackenzie-Beaufort Gas Development (m^3)

Period/Years	Onshore Facilities	Offshore Facilities
1993-1995	0	0
1996-2000	40,000	0
2001-2005	0	0
2006-2010	2,048,986	0
2011-2015	573,413	0
2016-2020	0	0
Total	**2,662,399**	**0**

Table 4. Granular Material Required for Mackenzie-Beaufort Pipeline Development (m^3)

Pipeline Spread	Spread Length (km)	General Fill (m^3)	Pipe Protection (m^3)	Aggregate (m^3)	Total (m^3)
1	210	432,840	345,585	948	794,845
2	245	674,806	331,207	1,228	1,054,443
3	250	539,338	321,863	32,780	931,002
4	260	571,607	342,556	62,025	1,020,739
5	275	278,318	318,104	47,956	662,904
6	395	262,217	216,467	44,740	566,105
7	485	237,263	184,610	35,464	495,957
Total	**2,120**	**2,996,389**	**2,060,392**	**225,141**	**5,525,995**

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QUESTION PERIOD

Question #1. In your NORCOST model there is no variable for environmental reviews or environmental panels involved in any consultations. Does that seem so insignificant in terms of a common-sense point of view that it doesn't?

McDougall. No I shouldn't say that. I mean those costs in NORCOST are treated as a percentage of the total capital costs and so there's a component in there to reflect that, but I don't break it out directly.

Question #2. In terms of developing contingency plans as in previous developments, we've been quashed in that area. So I'm just wondering if it's still insignificant? That may affect your cost per barrel.

McDougall. It potentially could add to the cost. Guarantees do have an impact on the economics for sure. The economics we ran for the proposed scenarios do not include guarantees.

Question #3. Do you want to just elaborate a little more on the recent Hondo Pipeline proposal? It's seems to be a hot topic to talk about. Can you give us any further details on the project?

McDougall. I met with Mr. Anderson the President and CEO of Hondo and their Vice President last week in Calgary. They were there to talk to the gas producers and other proponents. In a nutshell, they are proposing to take Canadian Beaufort Gas west via pipeline to the Alaska-Yukon border to Circle, Alaska, cross the Yukon River there and then down from Circle to Fairbanks. From Fairbanks the pipeline would continue south along the highway that exists between Anchorage and Fairbanks to an existing liquefaction plant in the Kenai Industrial area. It's a year-round port at Kenai. The product would then be liquefied and transported by ship to markets in Japan and China for use in power co-generation. I think it's safe to say though that they're at a very preliminary stage of thinking in this project. They've got a lot of homework to do and they need to look at the economics, run them and see if they really have a potential viable project. Certainly they have to compete. The competing market is coal and you need a significant price for that gas to be able to back it through that chain of events to make it economical to the producers.

Stanley

SECTION 7.

DISCUSSION PANEL "A"

INDUSTRIAL BORROW DEMAND ISSUES

INUVIALUIT PETROLEUM CORPORATION BORROW DEMAND ISSUES

Jim Herbert

President
Inuvialuit Petroleum Corporation, Calgary, Alberta

The Inuvialuit Petroleum Corporation (IPC) is currently investigating ways to use oil and gas technology to benefit the communities in our regional area. The two main communities are Inuvik and Tuktoyaktuk in that they're close to potential oil and gas supplies. We started this back in 1986 with the first Tuk gas project. The object was to take initial wells and turn them into supply gas for the townsite, either for co-generation or direct heating requirements. At that time, industry was still quite active.

We've revisited this project several times but still the goal is to take an exploratory well and use the shallow gas from the exploratory well and turn it into a fuel source. In this case the community we've done the most work on is Tuktoyaktuk. This would apply to a similar project at Inuvik if and when a well is drilled proximate the town. We believe that anything within about 10 km of the site could be economic.

The gravel and borrow we used has changed greatly since we started in 1985-86, mainly influenced by new technology that we've seen coming out from Alaska on downsizing of pads, thermal syphons, and piles, modular construction and remote operations. We would take two wells--two are needed so you have a guarantee of supply for the townsites--or two zones and one well. We need about a 40-year supply to make it worth while. IPC would put in a processing facility to take the water out and refrigerate the gas.

We've looked at only seasonal access to the sites and putting a small housing facility on the site so we could have it manned. In the summer months we would complete crew changes by helicopter similar to an offshore operation. The projects are uneconomical by commercial standards but the Inuvialuit believe the significant local benefits could make it viable.

We looked at some of the older wells that were drilled on the Tuk Peninsula and found that the surface casing and casing requirements for exploratory wells were considerably different than what we found we should have for a producing well. So when Esso drilled the last well on the Tuk Peninsula two years ago, we increased the casing requirements on the upper section so it would withstand what we believe to be the strengths required to make it a producing well. We had the misfortune of finding the shallow zones coming up oil and the deep gas zone coming up wet so after quite a bit of work, we found the well was uneconomical for the project. There's another well coming up from Exxon in the 1993-94 or 1994-95 drilling season and we'll reevaluate at that time.

We've been doing some work with the Deh Cho Regional Council on a project we are seriously considering for the Cameron Hills, a project which would require significant volumes of granular for an access road. The numbers there were a total fill requirement not just an aggregate or gravel requirement, that was total volume. We're waiting currently on the testing in the Hills this winter to determine whether its a viable project. There's another small project we are looking at for the Cameron Hills--a topping plant and refinery on the Norman Wells crude oil pipeline at Jean Marie River. That summarizes IPC's activities in the north.

For those who don't realize our current production capability, I might add that IPC started in 1989 and currently we're producing just under 4,000 barrels a day of oil and gas equivalent in Alberta. We employ 27 people of which we're 18% Inuvialuit staff. I'd like to see that being 50% and we have some very aggressive training programs on in that regard. Maybe in two to three years, we will reach our goal of 50% Inuvialuit staff. I'd like to see our projects go sooner rather than later, but as we know with Arctic development, it was always "We're going to have the pipeline in 5 years" and it seems it's the same now as in 1969.

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GAS PIPELINE BORROW DEMAND ISSUES

Ollie Kaustinen

Vice-President, Engineering
Polar Delta Pipeline Project, Calgary, Alberta

I was asked to present the method Polar Delta used in determining the borrow requirements for the proposed gas pipeline. This information is extracted from the National Energy Board application for the gas pipeline in 1984-85. Some 5.5 million m^3 of borrow material would be required for the line from the Mackenzie Delta to the Caroline-Edson areas of south-central Alberta (Figure 1). About 4.6 million of that granular requirement is in the Northwest Territories (NWT), along the 1,500 km of right-of-way.

The Polar Gas line more or less follows the Norman Wells pipeline route from Norman Wells to Zama. In our consortium with the other producers (note Alaska Natural Gas Transport System/Dempster Lateral routes which have been proposed by Foothills Pipelines in Figure 1). Foothills and Polar Delta has looked at other pipeline routes and so the Mackenize Valley proposal might not be the ultimate routing.

Also, in order to determine the borrow requirements, we also have to examine the preferred and required design elements. The aggregate needs are really based on how you design the pipeline. As mentioned earlier, very high numbers for aggregate and granular material were generated in the original pipeline concept because of how we were to design and build that pipeline. When I now talk about the borrow requirements, they relate, for the most part, to pipeline stress.

Also, granular requirements will depend on the soil conditions enroute. What Polar Delta has said is that a gas pipeline in the continuous permafrost areas will be a buried pipeline operating at minus 0°C. In the discontinuous zone, we require more pipeline weights because of above freezing conditions. A large gas pipeline will float under those conditions.

We do not intend to have a gravel pad to work from. In earlier concepts for pipeline, we had a granular pad and also, on the Polar Gas Project, we had to have a road to bring all the equipment up along the right-of-way. The cost of building that pad in the Mackenzie Valley was almost as much as installing the pipeline itself. The costs were considerably higher and the granular requirements were much, much, higher as a result. What we need now is only for the pipeline itself, padding along the pipe which was not used on the Norman Wells pipeline because it is a smaller line and more flexible. So we need much more select fill for the pipeline itself. This is a concept that's used in the TransCanada PipeLine system in northern Ontario, where the whole pipeline is padded in the rock areas. We do not need it for our pipeline project except for slope protection.

So looking at the Norman Wells oil pipeline versus the Mackenzie Valley gas pipeline, you'll notice that we've got a sand pad that's 46% of the pipeline route. No protection--only one third of the pipeline route.

Here are the aggregate requirements. This is in linear feet, not in metric. Granular for weights is 145,000 cubic metres. These are very heavy weights and they do not necessarily have to be cast in that area. They can be brought from other areas if local aggregate is not available.

There's also the pipeline facilities: the airports, the operator maintenance facilities, compressor stations, and stockpile sites. A lot of the granular material is required off the pipeline right-of-way for access roads and logistics facilities. As far as the pressure station sites and all operation maintenance facilities, what we require is mostly sand and gravel.

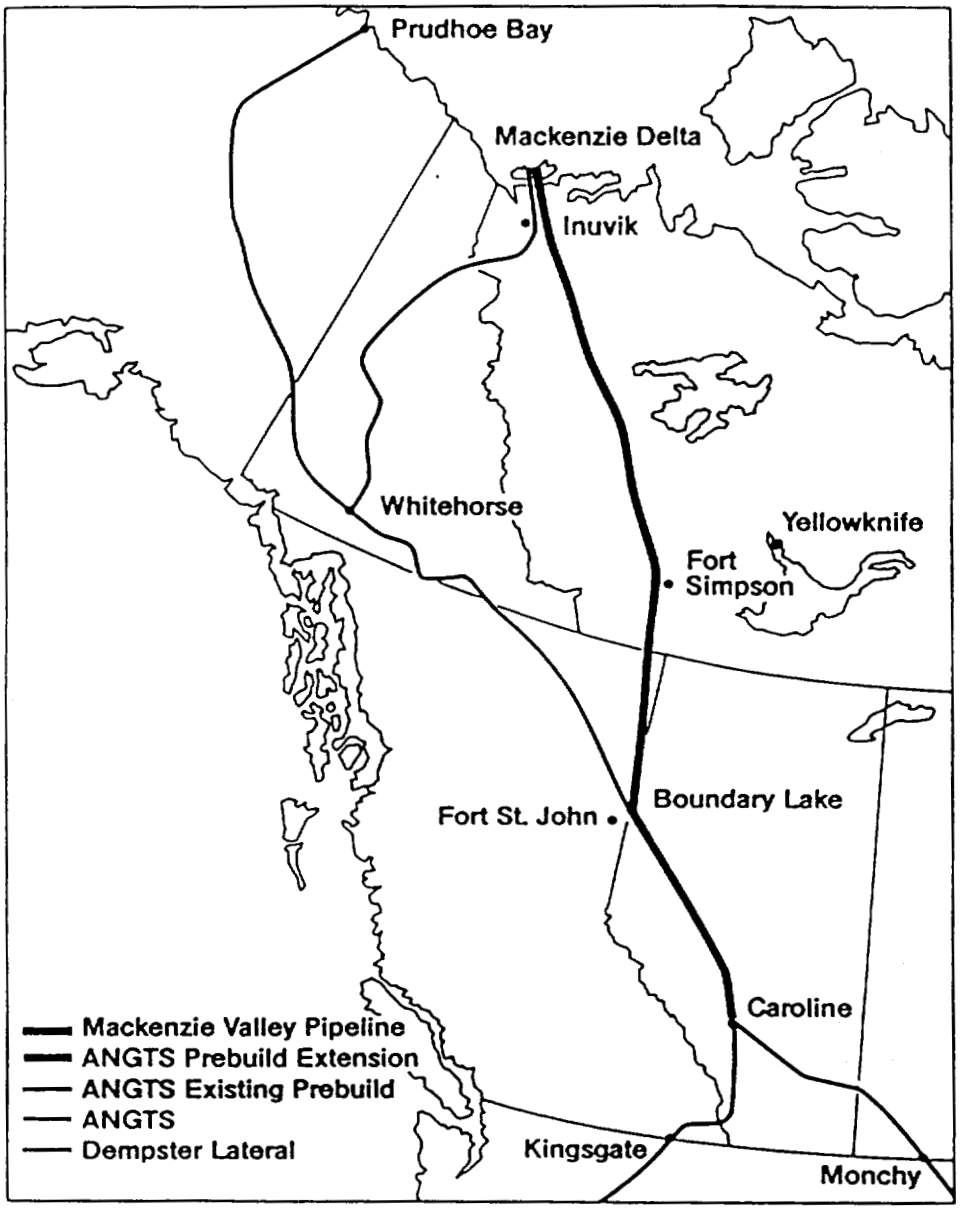
In our application to the Board we identify the number of borrow sites. We don't say where we're going to take it from as we did not drill the sites. So, we don't really know how much is there, but we listed enough sites that we knew that there should be more than enough material available to build. For spread 3 in year 3, these are the sites (shown on overhead transparency) and we have actually done the length of haul, just to get a cost estimate. First we get a cost estimate of constructing a pipeline, we do not combine how much we would take from each site whether we use that site or not, these are potential sites.

For spread 3, year 3, about 250,000 m^3 for the two month period including preparation for pipe padding and site material, weight casting, and site preparation.

To summarize, how do we arrive at these numbers for granular requirements? Well, we have a "book" of all pipeline material and supply requirements that can be cross-checked by construction spread. It tells you exactly how to get a cost estimate so it's not just "taking numbers out of the air". That detailed information is, however, confidential and proprietary to Polar Delta.

Note: The text of this presentation has been transcribed from an audio-tape recording of the workshop presentations. If necessary, we would suggest that the reader verify the accuracy of these comments with the presenter.

Figure 1. Mackenzie Valley Gas Pipeline and Prebuild Extension Projects



OIL PIPELINE BORROW DEMAND ISSUES

John D. Smith

Manager, Quality Control
Interprovincial Pipe Line Inc., Edmonton, Alberta

As I had noted in my earlier presentation, Interprovincial Pipe Line (IPL) currently operates the Norman Wells to Zama crude oil pipeline but is not actively pursuing any big-inch northern oil pipeline projects. After the completion of the Norman Wells line IPL did complete engineering and economic evaluations of a big-inch line from the Mackenzie Delta to Edmonton (Figure 1). The cost of this line, at about $3-billion is not economic at this time.

I don't really have anything more to add in terms of granular requirements for a small-inch line extended into the Mackenzie Delta area. However, I might make some commentary perhaps on differences on Polar Gas pipeline versus an oil pipeline. One difference is with respect to the use of concrete river weights. IPL did use a fair number of weights in the first stage of the Norman Wells pipeline with the idling of the line for one year before production and, predictably, an empty pipeline tends to move upwards. The second year I believe is where the rule was--"If you can put it in dry, put it in dry". That cut down our weight consumption considerably and we did not have any construction or operations problems by doing it that way. That was not as impacting on our liquids line as it might be for a gas line.

I think again the resistance of the pipeline to denting or buckling is a major factor. North of KP 440, the pipeline wall thickness is really driven by straining due to frost settlement. For the southern sections of the system, internal pressure resulted in pipe stress of up to 72% of yield. In the more northerly sections, it diminishes to around 60% of yield. We protected the pipeline mechanically by installing cathodic protection. This has been determined to be quite effective in protecting the pipeline. On a semi- or alternate year basis, we're also completing calibration of thaw-frost settlement on the pipeline. Finally, we've also concluded that there's no damage to the coating. To verify his, we have run an internal magneto-flux tool looking for internal and external corrosion.

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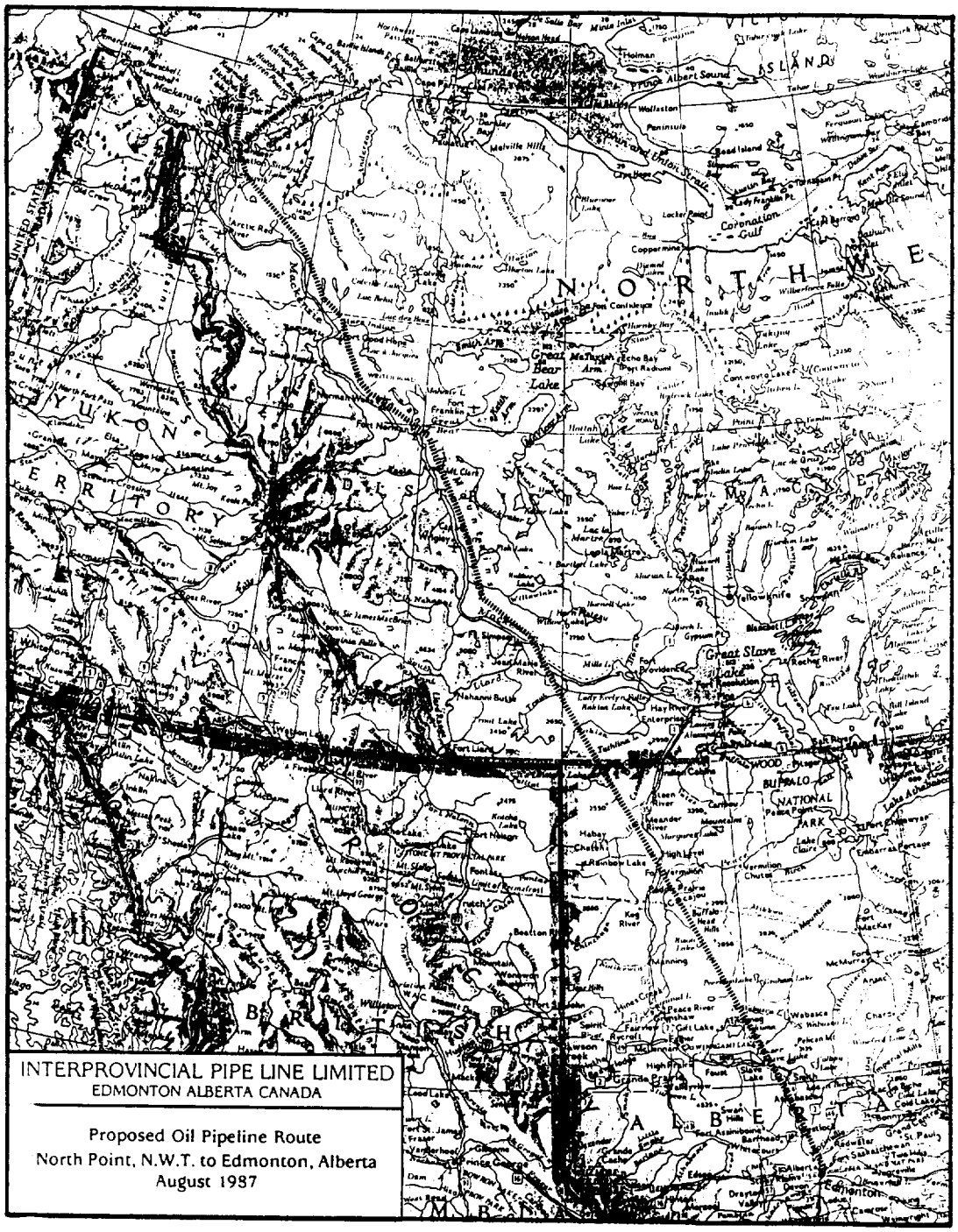
Figure 1. **Proposed Mackenzie Valley Oil Pipeline Route**



QUESTION PERIOD

Question #1. For select fill...does that have to be sand or can that be till?

Kaustinen. Select fill is mostly sand. No, it doesn't have to be sand. It's for a pipe trench so there could be some silt in it as long as there is no ice.

Question #2. The Cameron Hills project...is that a gas project?

Herbert. No. That is in conjunction with Paragon Resources for their oil. We're looking at an oil haul tanker operation to hook up with the Norman Wells pipeline near Jean Marie River. The economics simply aren't there initially for a pipeline connection. We are looking at an oil haul road initially. Once the road is there then a gas development will could probably take place but it's the oil that's going to drive the development. You need the all-weather road to develop more of the oil and it's kind of a snowball effect. But we need the initial wells to test out and that's what they're doing this winter and hauling the oil out over winter roads. The proposal that we have put forth is that the road will be totally inside the NWT where the current road is down into Alberta and out near the community of Indian Cabins.

Question #3. This would be a new road then? Do you have any estimates on the granular that you would need for the access road project?

Herbert. Yes. This would be entirely new construction. That was the 500,000 m^3 I had talked about earlier, and that's total construction material. We don't have a total route selection picked as yet because it depends on which wells will test out the best and some then we will have to complete some surface-survey work to determine what is the best way to put a road in there.

Question #4. What potential volumes are you looking at..production volumes?

Herbert. Production volumes would be only 900 to 1,000 barrels a day that we'd be trucking. Having been involved over the years in the Arctic development of oil and gas, I've seen a great decrease in the amount of gravel and aggregate used. Technology has really reduced the amounts. You can take the developments at Prudhoe Bay from the first drill pad to the ones that they've just done in the last few years and they've reduced their requirements almost 100-fold. We saw it in our initial estimates in 1975 for our requirements to what we actually used during the Foothills line and the other proposals.

Question #5. Is it technology or economics that will reduce the amount?

Herbert. I think economics drives technology.

McDougall. To some extent it has been technology and in some instances it has been experience. The drill pads at Prudhoe Bay started with 120-foot spacing. Now with experience, you realize that they can reduce that spacing down to 25- or 30-feet. So if you can do that you can shrink the size of the aggregates significantly. Production facilities have become more compact and again that's reducing the borrow requirements.

Minning. There is the question though of a large diameter gas pipeline in discontinuous permafrost. In the big quantities of material required in the days of Arctic Gas, you had to contend with permafrost with a chilled gas pipeline with frost heave and that type of thing.

Question #6. I think you'd probably have a big diameter oil pipeline in the

Mackenzie Delta area crossing permafrost. Is that an ambient temperature pipeline?

Smith. I really can't say what the crude types are. I'd really be guessing on what type of design they'd ultimately be using.

Kaustinen: For the Aleyeska pipeline the crude oil has a high pour-point and therefore the crude has to be heated so it will flow through the pipeline. The pipelines in southern Canada operate below freezing in the wintertime so it does not necessarily have to be an Aleyeska pipeline design. In fact, the Norman Wells oil pipeline operates below freezing.

Smith: Certainly, the Norman Wells crude oil is chilled before entering the pipeline.

Question #7. Although the IPL pipeline crude goes in chilled, it's getting heated as it's going down the line. Any comments?

Smith. As the crude oil goes further south, it's certainly governed by the ambient conditions of the ground. The energy generated by the flowing crude dissipates by up to 700 hp in the course of 320 km of which one-third of that energy is to gain elevation to Wrigley station. There is very little energy dissipation *per se*. Whatever solar energy goes into the right-of-way is what drives the temperature in the crude oil.

Stanley

SECTION 8.

DISCUSSION PANEL "B"

POTENTIAL CONSTRAINTS TO BORROW DEVELOPMENT

POTENTIAL ENVIRONMENTAL IMPACTS: BIOPHYSICAL

Gary White

Manager, Inuvik Research Station
Science Institute of the NWT, Inuvik, NWT

This paper provides an overview perspective of some of the scientific activities currently being conducted in the Mackenzie Delta. Presented below are issues and biophysical constraints that may greatly affect your industry and in fact, all development in the NWT. Before presenting these issues, I will provide a brief review of who we are and where we are going.

The Inuvik Research Centre has been operating since the early 1960s to provide logistical support for research in the western Arctic. The logistical research support includes laboratories, accommodation, library facilities, offices and secretaries for researchers working in the western Arctic. The researchers are from government, both territorial and federal, university professors and students, as well as industry researchers. In 1992, the Centre supported nine projects and approximately 300 researchers involved in those projects. They range from research on archaeology and geology, to sociology and anthropology. The people who have used our centre come from across Canada and from around the world. The Science Institute also has a research centre in Igloolik and another one in Iqaluit.

This workshop is concentrated on establishing what granular reserves are along the corridor of the Mackenzie Valley, where potential granular reserves are, pipeline and highway transportation systems and other factors in the borrow industry. This paper is a brief presentation on the physical constraints that might affect your industry.

You've probably all heard through the media something about the topic of climate change. Many of the researchers that I have talked to in the different sciences simply cannot be certain that global climate is changing. They don't know if it is changing and if so, is it only a regional phenomenon. But they'd like to know because obviously if climate change is occurring, it is going to have a dramatic effect on the north. For example, it will affect the boundary of the continuous and discontinuous permafrost zones, as well as the ice regime. With warming, the polar caps are going to melt and sea levels are going to be raised. This has happened throughout time. It is likely to affect slope stability in corridors like the Mackenzie Valley where more slumping would occur and that, of course, would be a hazard to pipeline development. It would also affect flood cycles in places like the Mackenzie Delta and it's going to affect the regional ecology as well. If the temperatures are warming up, new species of plants would be found, particularly in any disturbed areas where there have been forest fires. So climate change could have a dramatic effect on your industry. If there is climate change, certainly pipelines would have to be designed differently and that policy will effect your plans.

At the Inuvik Research Centre, we support the research community and recognize that climate change should be looked at. Last year we had 19 projects set up by different government agencies and the university researchers to address global climate change. I'd like to list a few of them. You'll recognize that they'll have implications for your industry.

When we think of research, many of us who are physical scientists, we think of geology and engineering but there are some social research studies that are looking at oral history of flooding events, by talking to the native elders and other people in the region. Scientists are also investigating ground ice developments in sediments in the Mackenzie Delta; particularly frost heave in small lakes. The constuction of future pipelines through parts of the Delta have to cross some of these lakes and this work pertains to that. Dr. Stewart Cohen, with Environment Canada, is part of a group called the *Mackenzie Basin Impact Study* and they are looking at the Mackenzie Basin as a whole and this would include parts of the territories, Alberta, northeastern British Columbia and parts of the Yukon. This group is doing quite a bit of modelling of climate change and potential climate change scenarios. These models will assist the pipeline industries in predicting what will happen at certain temperature changes.

The Geological Survey of Canada (GSC) has also been very active in the western Arctic. Some of the

projects are quite important in better understanding climate change. Currently, the GSC is monitoring landslide mechanisms along the Mackenzie River between Norman Wells and the head of the Mackenzie Delta; looking at past slides, recording their frequencies and documenting just what slides have occurred. Mark Nixon of the GSC is monitoring the permafrost active layer from Richards Island in the Delta all the way down to the Alberta border. He has set up monitoring stations to quantify the amount of permafrost thaw in the active layer.

There are also biological studies, and studies of time change, not just the geophysical sciences. The University of Alberta's, Dr. Ross Wein, and some of his graduate students are studying vegetation changes along the tree line and they are specifically looking for new species. They feel that if there is a climate change, new species of plants will appear in burn areas. Those are just a few of the projects that have been set up to address this concept of global climate change. However, research projects take time and many of these projects that are being set up are long-term projects. They have to be long term, in order to obtain a more accurate documentation of what is happening. This author feels that this information gathered in the field when applied in models, can certainly assist pipeline, transportation and shipping companies in the north and can help companies adapt to a changing environment, if in fact, global change does happen.

A lot of research concerning weather is also being conducted in the Mackenzie Delta. In fact, in 1994 Environment Canada is proposing a project called *Arctic Storms* to study storms in the Arctic through the September-November period. They expect to have an international team of Japanese, Germans, other Europeans and Canadians, of course, to study Arctic storms and how these storms are generated and what effects they have. The reason they have picked the Beaufort Sea is because of its potential for future hydrocarbon development. I think that will be a very interesting project. Global and regional climate change will have a profound impact on the construction industry.

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POTENTIAL ENVIRONMENTAL IMPACTS: FISHERIES

Stephen Harbicht[1] and Brian Ferguson[2]

[1]Area Habitat Management Biologist, Yellowknife, NWT
[2]Habitat Biologist, Inuvik, NWT
Fisheries and Oceans Canada

This paper describes the developmental impacts on fisheries. At the same, it covers some aspects that the Department of Fisheries and Oceans (DFO) has in carrying out its mandate.

The DFO in the Northwest Territories (NWT) is split into three operating areas: Western Arctic, South-Central Arctic and Eastern Arctic (Figure 1). When the various land claims come into play, these boundary lines will change. There are three offices that are dealing with each of these areas: Yellowknife deals with South Central, the western Arctic office is in Inuvik and the Eastern Arctic is handled from Iqualuit.

Regulatory requirements are basically the "hammer" that DFO has to monitor and control the development of fisheries. The main piece of legislation is the *Fisheries Act* which allows us to maintain our mandate, the management of fish marine mammals and their habitats. The following paragraphs briefly describe the *Act*.

The definition of a fish includes shellfish, crustaceans and marine animals, and the egg, spawns, spat, and the juvenile stage of fish, shellfish, crustaceans and marine animals. So, whales are thus considered fish in a "legislative sense". As well, all the different stages of fish--salmon eggs, any fish eggs, juvenile stages--we protect all their habitats and at different life stages. That could have serious implications in terms of time constraints for any pipeline development.

The definition of fish habitat under the *Fisheries Act* is: spawning grounds, nursing, rearing, food supply, and migration areas in which fish depend, directly or indirectly. And the indirect habitat areas (feeder tributaries) are fairly important, in carrying out the life processes. Consider a feeder tributary which is blocked off to any migration and does not contain any fish *per se* but does provide downstream food for fish producing invertebrates, and that food in turn flows downstream and is eaten by a fish, then that also is considered to be fish habitat.

There are several sections of the *Fisheries Act* dealing with the management of various fish and fish species. Some of them will be directly involved with your work and some will not.

- The federal Fisheries Minister may require that a fishery be constructed around construction works to allow fish migration to spawning habitat.

- *Section 28* deals with explosives, such that, unless authorized by the Minister, the proponent is not allowed to use explosives in the work in areas where fish may be disrupted by the explosives; either killed outright or if it affects their habitat at all.

- *Section 29, Fish Passage.* Any developments including construction or installation of culverts. The culverts and bridges or whatever structure placed across the water body, must allow for passage of the fish.

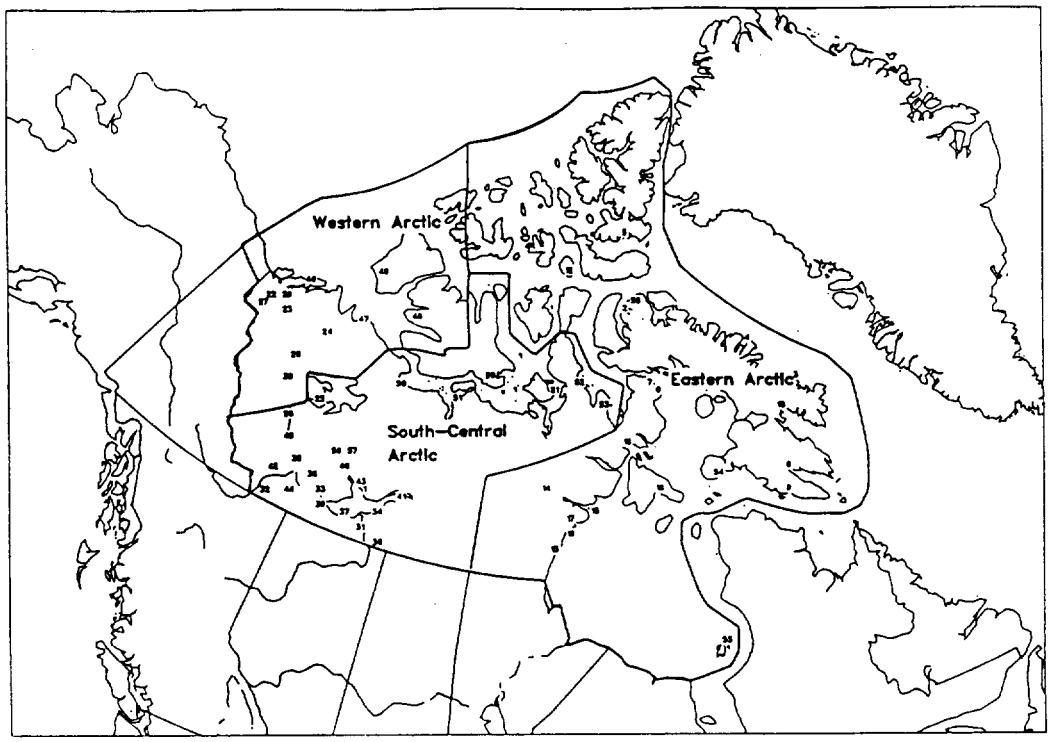
- *Section 32, Destruction of Fish.* It is unlawful to destroy fish by any means other than licensed angling or fishing.

- *Section 35, Habitat Destruction.* Deals with harmful alteration and destruction of fish habitat and *Section 35.1* states that people are not allowed to do that. Under *Section 35.2*-- one could be authorized to destroy fish habitat given a suitable compensation package or mitigation.

- *Section 36.3* deals with the deposit of deleterious substances and that's recently become a shared responsibility of the Department of Environment and DFO.

- *Section 37.1* states that the Minister may request any analyses, plans, engineer's drawings, plans, description of project, on

Figure 1. DFO Operating Areas



projects which could potentially affect fish and fish habitat, so fisheries can make requests for more information.

DFO OPERATIONS AND POLICIES

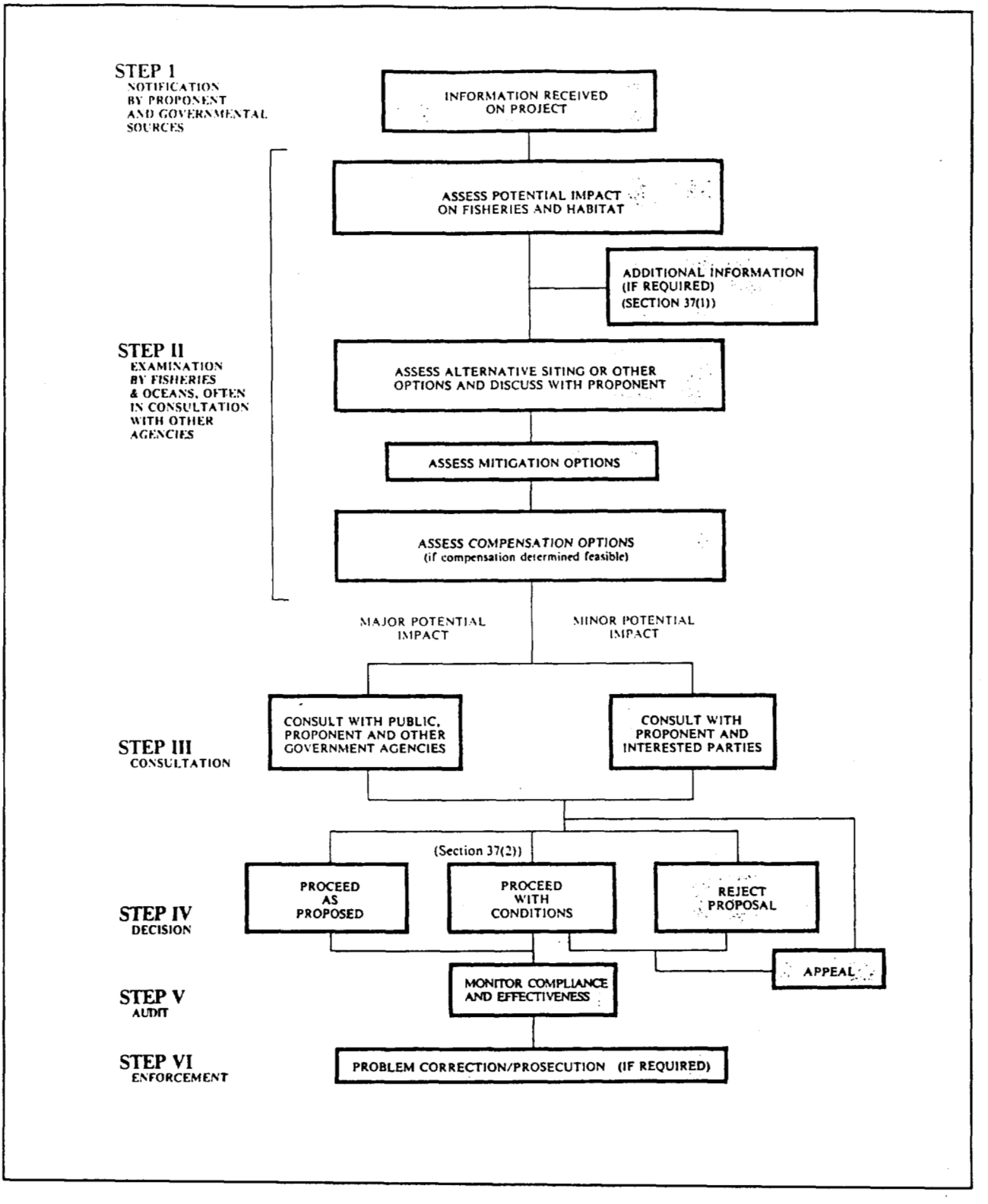
The Federal government is quite serious about their protection of fish habitat. The amended *Fisheries Act*, in terms of the penalties sections, was amended in February of 1991 and fines were substantially increased. For example, *Section 35* and *Section 36* offences, went from a range of $5,000 to $10,000 to up to $300,000 for the first offence and up to $1,000,000 for subsequent offences, as well as associated jail terms for indictable offences.

In 1986 DFO developed a policy framework under which to work with project proponents, as well as what our overall objectives were. The overall objective is certainly a net gain because we have lost a great deal of fish habitat in the previous years. This objective is to be reached through the implementation of DFO's three goals in habitat conservation: first, habitat restoration for degraded habitats that we want to redevelop; second, habitat development into areas which weren't previously utilized by fisheries; and, third, the achievement of no net-loss of productive capacity of habitats. Productive capacity basically means that you don't want to lose what you already have, and this is done with an integrated approach with proponents and developers and the DFO. There are six implementation strategies to achieving no net-loss, including: protection and compliance, integrated resource planning and research, public consultation, public information/education, cooperative action and monitoring of the fisheries resources. The procedural "steps" to achieving no net-loss are shown in Figure 2.

The procedural steps are:

- notification that the information is received on a project. If there isn't enough information, we'll certainly ask for more.
- assessment of the potential impact of the development on fisheries and habitat. If we aren't quite sure what's going to go on, or if there is a stream crossing, or we aren't sure of how much gravel is to be extracted or the timing of it, then we'll go back to the proponent and ask for that information.

Figure 2. No Net-Loss Procedural Steps



- Assess alternative siting or other options and discuss it. If there are problems with that particular location, then we'll go back to the proponents and ask--Why this one? Does it have to be here? Can you get the same quality of gravel elsewhere?

- Assess mitigation options. If all anticipated impacts can be mitigated against, DFO issues a letter to the proponent indicating the necessary mitigation and the project will be allowed to proceed.

- Assess compensation. If a project is going to cause fish habitat loss, it is quite difficult to compensate elsewhere in most cases. There is a hierarchy of compensation which DFO applies; the most desirable being on-site compensation. In most cases, this means protect the area, protect the same fish stock, and the same gene pool. At the next level of the hierarchy DFO would look at off-site compensation and at the bottom of the list of alternatives, a choice we don't even really want to consider, is the buy-out option. The buy-out option was allowed in the past, but is not encouraged any longer. If there is a minor potential impact the DFO would consult the proponent and interested parties.

  In the NWT, we are in consultation with the Inuvialuit, and now with the Gwich'in. The Inuvialuit have established an Environmental Impact Screening Committee and examine each proposal prior to authorization of any construction which might impact fish habitat. DFO must also seek agreement with the Environmental Impact Screening Committee prior to issuance of any authorization.

- In terms of consultation, we're going to get into review boards and panels which also involve the local people, as well as any other interested parties. At that time, the decision comes out--proceed as proposed; proceed with conditions; or, reject the proposal. The proponent has the option to appeal the decision.

Much of the north has very little information on fisheries resources. So, if we haven't got the background data, enquire. This is something to consider when you're setting out your timelines for your projects. It could take two spawning seasons or up to two years to determine what impacts are going to be on any particular fisheries resource.

Fish Life Cycle

The main thing to consider are the elements that fish depend on in order to survive--from eggs right through to the end of their lifetime. Fish require certain things in water. That will vary with fish species but generally they require: a temperature range to live in; a certain amount of O2--dissolved oxygen in the water; some clarity to the water, clear for vision so they can see their food or so that the water's clean enough that they're not clogging their gills and then dying as a result; and, a medium for production of food--either invertebrates or other fish species. If you start tp modify that habitat and altering one or more of those facets, the fisheries will be affected.

For example, if a proponent is completing a coring operation on a stream bed, the stream flow will likely be reduced. As a result, you would have taken away a lot of the fish habitat providing food for them aswell as the habitat that's providing cover for them which is either to protect them from sunlight, protect them from other fish or just providing a medium that holds the water temperature constant. You may have removed access for the fish--there may not be enough water left for the fish to move up to another stream or another portion of the stream or into another lake that supplies either food resources that they need or their spawning habitat. Sediment in a stream can also be classified as a deleterious substance which is chargeable under two sections of the *Fisheries Act*.

There will be an alteration of the food that's available within the stream simply because modifications have been done on what was there. A completely different habitat can result and that is going to either cause a complete shift in organisms into something else or a complete loss of organisms. Fish have to see their prey so an increase or decrease in turbidity will cause vision problems. Abrasion of gills through high sand flows in a stream will also affect gill performance.

Finally, an increase in water temperature could affect the fish physically and it also reduces the oxygen content in the water. The hotter the water becomes, the less oxygen is able to be maintained within the water and it may reach a level that could be toxic to the fish. Changes in stream flows can occur and these can be damaging to fish habitat. If a proponent is

boring in a stream that was originally a small channel of a well defined stream the stream may be caused to open from a smaller, deep channel to a wider, shallower channel. The impacts on fisheries can be significant. First, the water depth is reduced. Second, you probably reduce the water flow. This is why it is important to assess your operations carefully. If you don't have the information available, studies must be done to determine how that stream bed is going to be used.

The authors searched for available material on granular studies and fish habitats within Canada, and, unfortunately, DFO's library does not appear to have much information on this topic. A few studies have been completed in Alaska, however.

We also find that, in many instances, a contractor in the area may not be aware of all of the conditions and agreements that have been made. Instead he is concentrating more on getting the job done without full awareness of what he is doing to the environment. It will be important that the project proponent establish a better link between the construction foreman and his crew. They must be made fully aware of the fact that your company has agreed to protect the fisheries in that stream. Too often we see a contractor out on site, a major pile of gravel sitting in the middle of the stream, and the vegetation around the stream all stripped-out. He clears out all the quarry material and away he goes. We need better communication between proponents and contractors working in fisheries areas. That link is vitally important.

Note: The text of this presentation has been transcribed from an audio-tape recording of the workshop presentations. If necessary, we would suggest that the reader verify the accuracy of these comments with the presenters.

POTENTIAL CULTURAL IMPACTS: HERITAGE AND ARCHAEOLOGICAL SITES

Tom Andrews

Manager, Archaeological Studies
Prince of Wales Heritage Centre, Yellowknife, N.W.T.

This paper outlines the regulatory aspects of Heritage and Archeological Resources Management in the Northwest Territories (NWT). The Prince of Wales Northern Heritage Centre is the agency responsible for heritage resource management and protection in the NWT. This responsibility flows from the *NWT Act* and regulations pursuant to the *NWT Act* concerning heritage resources.

The agency operates through the *Historic Resources Act* which is NWT legislation pertaining to Commissioners Land and also through our participation in the review committees in the Northwest Territories, known as CLRK, RERC and FLAC. CLRK is the Commissioners Land Review Committee; RERC is the Regional Environmental Review Committee; and, FLAC is the Federal Lands Advisory Committee. All of these boards and committees review development proposals throughout the NWT and report to the regulatory agencies responsible for managing the resources.

In terms of inventory, the Heritage Centre employs a national database called CHIN, the Canadian Heritage Information Network, which is managed by the Canadian Museum of Civilization in Ottawa. All archaeological and historic sites in Canada are reported in this inventory. For the NWT, there are at present about 6,000 sites reported in inventory. It's really just the beginning in terms of research, since there is much more to do. In the Mackenzie Valley, we're probably looking at several hundred archeological and historical sites that have been officially reported.

Research in the Mackenzie Valley began, in terms of inventory work, in the 1970s with the initial Mackenzie Valley gas pipeline studies and it has continued in recent years through several projects sponsored by the Northern Oil and Gas Action Program (NOGAP).

The managers at the Northern Heritage Centre also have a research responsibility. The research is directed at filling in gaps in knowledge and inventory, primarily in areas where there has been no prior research done in the NWT.

In terms of access to this information, the CHIN inventory is a proprietory database. Access is restricted and this is primarily to undercut unscrupulous "pot hunters" who often go out looking for archaeological sites to steal the archives and then sell them on the black market. There is a huge market for these types of artifacts, especially in the United States. The Heritage Centre does, however, permit access to the database for other government departments and industry, based on the specific needs of the environmental review process.

Our goal is to protect heritage resources in the NWT. As a result, the Centre works very closely with developers and community interests and are always able to find a reasonable mitigative response to any development that happens in the Territories. There are guidelines for developers pertaining directly to heritage resources in the NWT (a copy of the guidelines are included in Appendix B to these workshop proceedings).

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QUESTION PERIOD

Question #1. How long do you anticipate a study like this for climate change would have to take to give any sort of reliable results or forecasts?

White. That's a good question and I've asked many of the researchers that same question. The response that they've given me is some feel that after a few years, 3 or 4 years, you can start to get some data that is suitable for preliminary analysis. But, we really should be looking at 10-, 15-, 20-year cycles--a very long time. Obviously the longer you are able to collect your data, the more meaning the data is going to have. But, I know some of the researchers are starting to say that at least 3 or 4 years of data are needed, especially in regard to permafrost active-layer monitoring. There will be some results after 3 to 4 years but after 30 years the results will be much better.

Question #2. Maybe just a note that you can make here is that most of the research at Inuvik Research Station is available in reports that are provided by the researchers.

White. That's a good point. Right now we're very fortunate we don't have user pay at the Research Station. So the researchers that use our facilities do so at no cost to their budget. We do, however, ask that whatever they publish, they send us a copy and we now have about 5,000 volumes relating to the research of the western Arctic--some of it directly related to your industry. It's available and hopefully at the end of this summer we'll have the catalogue on computer disk. We also have an extensive collection of university theses; students give us a copy and we have kept it in our permanent collection.

Question #3. I wonder, is that information part of the Boreal Database or ASTIS?

White. Some of it would certainly be contained in those databases but I'm sure there's material in our collection that is in no other collection. Once we get the information on disk I'll certainly send it to those organizations. The main message that I would like to get out to groups like yours is that we need to think of research as providing a net benefit. I think in the case of research such as the monitoring global climate change you can see real benefits. Often in hard times the first thing that's cut back is research and I think its important that we keep in mind for our politicians that research is very important.

Question #4. What do you think about major extraction of granular materials from rivers and streams?

Harbicht. As pointed out in some other talks that were presented here, it has been done before. Certainly with the Norman Wells situation it was done and with the artificial islands up in the Beaufort Sea its been done. Those are large, major rivers or delta areas. I think the important thing is that at the initial stages, you need to know what the proposal is, you need to know what fisheries information is there. If there's no fisheries information available, its going to have to be obtained. Once we have that information at hand, then we can assess whether or not there's going to be an impact, whether its going to be critical. If its going to be critical, then adjustments are going to have to be made. If impacts are mitigable, a proposal will be presented and there may be situations where we're going to have say, no--you cannot extract gravel from that stream.

Question #5. Would two years be enough lead time--it doesn't sound like it--is four years more appropriate for

100,000 m^3 to 200,000 m^3?

Harbicht. It depends on the scale of the project. If it is a 2 or 3 km stretch of quarry material on a smaller tributary river, I think you're going to need at least 2 years to evaluate the variations that may occur naturally from fish moving in and out. As you indicated, 2 years may not be sufficient but I think its going to give us a fairly good handle.

Ferguson. And also a fairly large issue of the Mackenzie River at Norman Wells is the re-suspension of contaminants that are trapped in the sediment.

Harbicht. The Alaska publication I mentioned in our presentation also gives some information on what they see as being options for working industries. One of the preferred options is to check the stream channel itself--work on the high flood plains that are now elevated and out of any potential risk of flooding.

Our department, over the last several years, has been putting together a database of all available fisheries information on the Mackenzie basin. It's near completion. It is an evolutionary process because we all seem to be consumed with finding information.

Question #6. Have you been monitoring the changes at Norman Wells?

Harbicht. No we haven't. Our department is resource-limited much like most of the federal departments are now. The monitoring of a lot of different projects has, unfortunately, fallen by the wayside. We're trying to correct that situation. We're trying to get out to some of these sites and do a followup investigation, if we can. To answer your question on Norman Wells, no we don't have any further information unless Esso Resources is doing it on their own.

Question #7. I was wondering whether you'd comment on Greg MacKinnon's DFO work at Hodgson Creek. Is that study now complete?

Harbicht. That project is completed and he's got a report out now. Greg had conducted 2 years of fisheries research work in relationship to Hodgson Creek and the Norman Wells pipeline crossing. I think they found some short term grayling population impacts due to the pipeline construction.

Question #8. How do you determine if an archaeological site is significant?

Andrews. Given that we know very little about the nature of archaeological sites in the Northwest Territories due to incomplete inventories and research, right now we regard every site as significant. This is especially true in the Mackenzie Valley where sites tend to be small and scattered over huge areas. Because of that, we can't really put a different level of significance on any one site. So significance is not something that we consider, we view them all to be equal in value.

Question #9. You commented about a photo-slide that I showed in my presentation saying it was an archeologically significant site. I wonder if you would comment on that?

Andrews. The slide that you were showing was the exit of the Mountain River from the Mackenzie mountains and that particular area is considered a sacred site to the Mountain Dene, the aboriginal people who now reside primarily in Fort Norman. We consider sacred sites, such as spiritual sites, as heritage sites. They too are protected, if they are inventoried in the database. In terms of gravel extraction or aggregate sources, red flags pop up for us when we see a development

involving eskers or developments involving shorelines; these are areas where you typically find human habitation or movement across the landscape in the past. Those are the areas that we typically review.

Question #10. How much lead time do you need for a review process (archaeological review)?

Andrews. It really depends on the scale of the project. The other aspect of the regulatory side of our work is that archaeologists have to apply for and receive a permit before they are able to go out and do research. That usually takes a year. So, if a proponent is looking at contracting an archaeologist to do a survey of the development area, they will have to plan to have at least a year in advance so that the contractor can confirm it. That also is good for us because it gives us a year's worth of time to work with the developer in developing terms of reference for the contractor and to try and minimize the amount of work that that contractor has to do in terms of doing a survey in the area.

Question #11. How many archaeologists do you have on staff now?

Andrews. We used to have 3 and we have 2 now. We lost one recently through the recent cutbacks in the GNWT. Our management areas are loosely divided between arctic and sub-arctic. One of my colleagues is responsible for managing the Arctic area and presently we have a third person on staff who's known as the "NOGAP" archaeologist. This person's job is tied to the life of the NOGAP project and her research is in the Beaufort/Delta areas.

Question #12. Do you also have a summer student program?

Andrews. We have a training program for native northerners. There have been many people through that project.

Question #13. Who bears the cost of the archaeological investigation?

Andrews. Our principle is that the proponent pays when it comes to doing field research directly related to reviewing or mitigating any development.

Question #14. Are you going to continue with the work in the Mackenzie Mountains?

Andrews. Presently my own research area is in the area north of Great Slave Lake and I'll be tied up there for the next 4 or 5 years. We do have from time to time small research projects here and there and we are planning to do some work in the Keele River Valley in the next 2 years but it will be just a small project. The Mackenzie Mountain research is on hold for the time being.

Question #14. How complete is your inventory of sites?

Andrews. It's very incomplete. The cost of doing heritage resource research in the NWT is very high and, as a result, we really have a very poor picture of the distribution and nature of sites in the Territories. Fortunately, as I mentioned, we have a better handle in the Mackenzie Valley corridor because of the projects during the early 1970s, and more recently in the Delta area because of the availability of NOGAP funding.

Question #15. The project I'm concerned with is the development in Cameron Hills area. What has been done there?

Andrews. We know absolutely nothing about the heritage resources of the Cameron Hills. There has never been a research project or survey in that area and that goes for both the Alberta and NWT sides.

Question #16. I wonder if you could comment just briefly on the Bear Rock issue. I'm not sure whether you are aware of some of the granular resource issues in the Bear Rock-Fort Norman area and the location of the pipeline construction camp in that area during IPL's work?

Andrews. If I remember correctly, there was a proposal to open a gravel pit at Bear Rock from IPL. Bear Rock is one of the most significant sacred sites in the entire Mackenzie Valley area. It is a landmark that centers a series of legends that are shared by all of the language groups in the Mackenzie Valley. For those of you who are familiar with the Dene Nation logo, the centrepiece of the Dene Nation logo is Bear Rock and its been that series of legends in that landmark that has been chosen to represent not only the social and cultural ties between these groups but has now begun to surface as the symbol of political unity as well. So, Bear Rock is a very important site. Fort Norman, and indeed, all of the communities in the valley and throughout the Dene realm were all extremely concerned about any development in that area and as a result of that the pit was not allowed to go ahead.

Regarding sacred sites, we have found also that the communities tend to keep the knowledge of these sites quiet and private. It's not something that they readily share and there is good reason for that. Consequently, in terms of doing my work these sites don't show up in inventories, they don't show up in any other sources, and it's usually somewhere well into the review process that these things crop up as happened with IPL at Fort Norman. In the process in my research with the Dogribs, the communities there have decided that they very much want the sacred sites recorded. Slowly, over probably the next 20 years, you'll see a switch to that type of thinking, I suspect. We've been spending 2 years with the Dogribs now recording all of their heritage sites.

Stanley

SECTION 9.

DISCUSSION PANEL "C"

LAND CLAIMS AND BORROW SUPPLY: ABORIGINAL PERSPECTIVE

THE INUVIALUIT LAND ADMINISTRATION AND BORROW RESOURCE MANAGEMENT ISSUES

Charles Klengenberg

Assistant Land Administrator
Inuvialuit Land Administration, Tuktoyaktuk, NWT

ABSTRACT

In 1984, the Government of Canada signed a comprehensive land claim agreement with the Inuvialuit of the Western Arctic. The Inuvialuit Final Agreement (IFA) significantly changes land ownership and resource development procedures in the traditionally used and occupied 435,000 km^2 area now termed the Inuvialuit Settlement Region. The Inuvialuit have been granted 91,000 km^2 of lands of which 13,000 km^2 of 7(1)(a) Lands include surface and subsurface rights to all minerals and 78,000 km^2 of 7(1)(b) Lands include surface rights and rights to all granular resources.

The Inuvialuit Land Administration (ILA), a division of the Inuvialuit Regional Corporation, has the mandate to administer access to and across Inuvialuit Lands. The ILA has established a land management system, whereby, all access and developmental activities are subject to the ILA Rules and Procedures which decree the approval process and fees. Approval and licencing is largely dependent on the applicant receiving the support and approval from the community level. Through the IFA, the ILA shall reserve and make available adequate granular resources to meet public and community needs in the Western Arctic based on 20-year forecasts. These forecasts are jointly prepared between the Inuvialuit and appropriate levels of government on the basis of community estimates of requirements.

Introduction

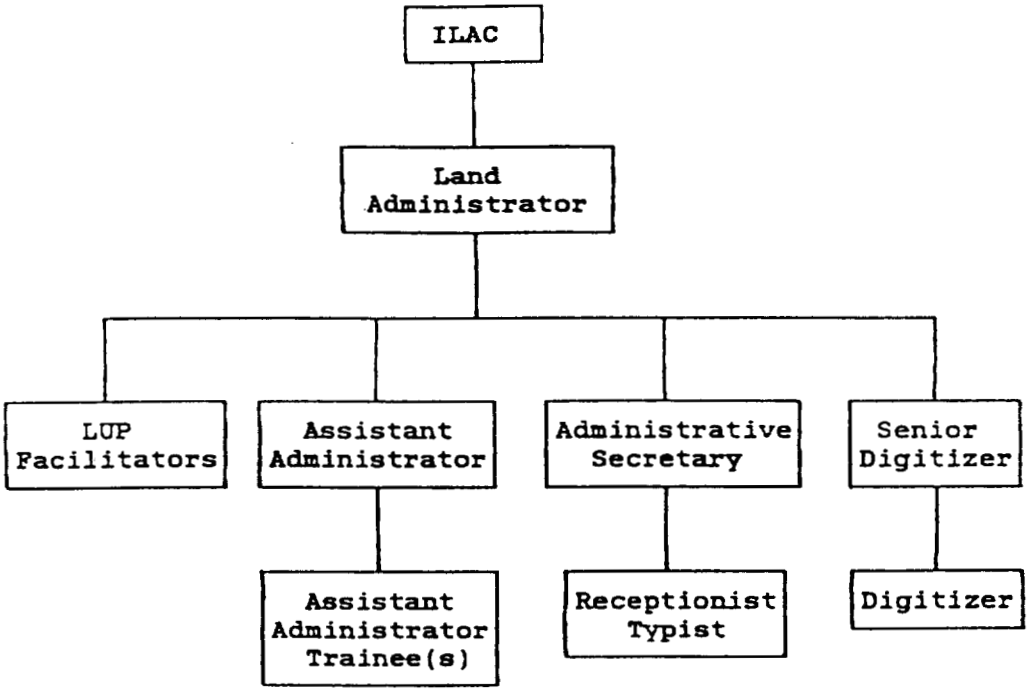
This paper provides background information on the ILA's organizational structure and rules and procedures for granular resource development applications. As a result of land claims, the ILA are entitled to 91,000 km^2 of land, of which 13,000 km^2 are around each of the six communities in 800 km^2 blocks. The ILA own both subsurface and surface rights. Within the 7(1)a lands, the ILA hold all rights to sand and gravel, while on the 7(1)b lands, the ILA own the surface and controls access.

The ILA's first priority on sands and gravels is to reserve granular resources for community needs based on a five-year forecast. They have the right to set aside certain areas that are culturally important. The organizational structure is as follows. First, we have Community Corporations which were established with our land claim. The Community Corporations attend to our socio-economic interests within each land block. Each community is responsible for development within their land blocks and that is also important to our community consultation process. The Hunters and Trappers Committees (HTCs) are also a part of the seven Community Corporations. The HTC's were an option of the community corporations and they attend to wildlife and environmental issues and report directly to the Inuvialuit Game Council. The Community Corporations also formed a regional corporation where they elect chairman of the IRC. The ILA fits in as a division of the IRC. Figure 1 shows the structure of the ILA. The Inuvialuit Land Administration Commission is a three-member Board that approves or rejects applications. No approval is given unless there has been a community review and approval from both the Community Corporations and the HTCs.

ILA Rules and Procedures

I'll now explain some of the general provisions of our ILA rules and procedures. These are the documents that we use as guidelines for application for land access. Our application process includes time for consultation--we like to receive applications as far in advance as possible as we include the Community Corporations. We then complete a review in about 6 to 8 weeks. Following our review, we will forward it

Figure 1. Structure of the Inuvialuit Land Administration



ILAC Commissioners:

Albert Elias, Chief Commissioner
Les Lee Carpenter
Randall Pokiak

ILA Staff:

Jane Bicknell	Land Administrator
Martina Jacobson	Assistant Land Administrator
Stephen Kerr	Assistant Land Administrator
Charles Klengenberg	Assistant Land Administrator Trainee & Beaufort Facilitator
Bessie Hagen	Administrative Secretary
Lorna Gruben	Receptionist/Typist
Robert Gruben	Senior Digitizer
Eleanor Young	Delta Facilitator

to the Community Cororations and any other interested parties. If we don't have approval from the Community Corporation or the HTC, most likely the application will be deferred until those requirementsare met. Our our fee schedule is from July 1 to June 30 and we also have a slight increase in our fees each year based on the Bank of Canada rate.

For any applications, the following are the basic requirements.

First, we require a secured deposit in the form of a promissory note, certified cheque, bonds, or letter of credit. The deposit is kept in trust until final inspection is conducted and a letter of clearance is issued by the ILA. When you recieve the letter of clearance you have access to the security deposit.

Second, the issue of compensation. We require the applicant to compensate for any damage. If there is any damage to the land and wildlife, the applicant is responsivle to pay for any damage.

The ILA is involved in many projects through our corporations or local hire. Through participatory agreements we expect a large percentage of the work force to be Inuvialuit. One of the factors we look at before we consider an application is--Are they going to use our businesses? Are they going to hire our people for these projects on our land? That's really important to the Inuvialuit. A few applications have been turned down because of lack of Inuvialuit involvement or use of Inuvialuit businesses.

Inspections are done during the course of the program and at the completion of the project. The costs involved for inspections are usually paid by the developer. We will also suggest the use of local trappers as these people are familiar with the areas. Before our land claim, it was the oil companies that paid our environmental monitors. Now, we don't want our monitors reporting directly to the company. The monitors should report directly to ILA and not the oil companies or the companies involved. We have had some orientation workshops during projects, like the recent Shell Canada program. It improves our reporting system.

The ILA Rules and Procedures are used to strike a development agreement to specify the terms and conditions under which access will be permitted with the emphasis on employment participation through business and training opportunities. (Note: a brief summary of the ILA Rules and Procedures regarding Quarry Licences is attached to these proceedings as Appendix C).

ILA Rights Approval Process

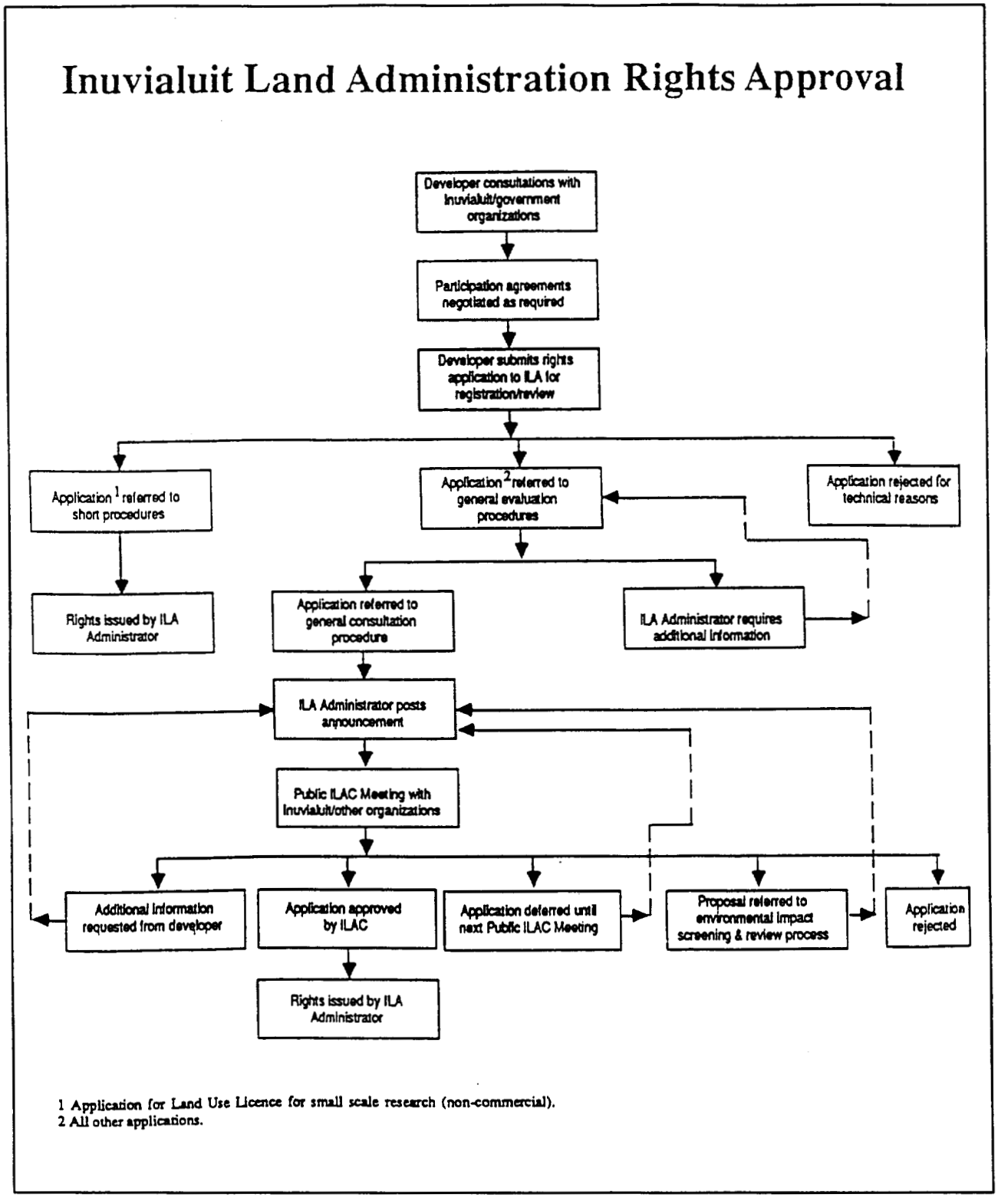
A flow chart of the ILA Rights Approval Process is shown in Figure 2. In summary, there will be a public consultation/review session if it is a proposed large scale development. We'll require the applicant to be there to explain what they will be doing, when they will be doing it, and how they anticipate involvement by the Inuvialuit. These sessions are usually attended by the HTCs, the Community Corporations, or any other interested parties. If there are any outstanding requirements that have to be met, the application is usually deferred for a later decision. Applications for further review are deferred until the next ILAC meeting (ILAC meetings are the second Wednesday of every month).

Our fee schedules are based on access. We cannot charge for access over lakes and waters because we don't have the rights to lakes and waters but for any land access, we have two forms: Class A or temporary permits. Our 1992-93 fees include an access and administration fee, wildlife compensation fee, land occupancy rent, and land use rate. For a base of 1,000 m^3, the cost is $18,000 and that doesn't include road construction. All fees are negotiated between the proponent and the contractor being hired to get the gravel out. You're looking at about $40 m^3. For example, the road to Source 155 which is 12 or 13 miles out of Tuktoyaktuk--just to maintain the ice road and access route--costs almost $40,000. Our inspection costs for the road to Source 155--all the costs referred back to the holder--are $593 plus all transportation costs. We can do any inspection whenever we want.

The availability of granular to Inuvialuit is through a personal quarry license. They are allowed free gravel, up to 50 m^3 a year. They pay the transportation costs. This is a new program that we implemented recently. So far the communities are looking at it and so in the future we will probably see it used a lot more.

Most of the gravel requirements are quite close to the communities with the exception of Inuvik and Aklavik. They have access to the Ya Ya Lake source and with Tuktoyaktuk there is also some distance involved to access the gravel sources. With Sachs Harbour and Paulatuk, the sources are right by the community.

Figure 2. Inuvialuit Land Administration: Rights Approval Process



access the gravel sources. With Sachs Harbour and Paulatuk, the sources are right by the community. We have started negotiating an umbrella agreement with the GNWT for allowing their leases on our lands. That covers their lease agreements, fees, etc. but it excludes gravel; they have to apply for gravel and all of the same costs as a private developer would.

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GWICH'IN LAND CLAIM AND BORROW RESOURCE ISSUES

Sue Heron-Herbert

Senior Negotiator
GNWT - Land Claims, Yellowknife

To start my presentation, I would like to go back just a little bit to a Dene Nation meeting held in 1990. In the summer of 1990, when the original Dene/Metis comprehensive land claim fell apart, the Gwich'in Region walked away from the Dene Nation meeting adamant they were going to have a land claim one way or the other. To that end, they lobbied the federal government who agreed that they could negotiate a regional claim.

How the original Dene/Metis comprehensive claim impacts each of the regions is quite significant. First of all, let's look at how they divided up the quantum. Under the original Dene/Metis claim, the joint leadership of both Dene and the Metis agreed that they would divide the land quantum according to a per capita basis. When there was a comprehensive claim that covered the entire Mackenzie Valley that was not such an important issue as it is now. The regions agreed that they would share the land quantum. They would probably first select the various areas which were very rich in gas or oil potential. Other regions such as the Lower Slave which had mining potential would then be selected for that reason. But when the Dene/Metis claims fell apart, the government went in for a percentage of the total Dene/Metis quantum.

The Gwich'in had 15% of the population base of the total NWT Dene/Metis. That has, of course, caused problems for many of the regions. The Gwich'in occupy a small region and there was a question whether or not the Gwich'in could select all of the lands within their region. They couldn't because the region was too small--in fact their land selection of 10,000 square miles. covers 14% of the entire region. Because they couldn't select all of it, they were allowed an increase in their sub-surface to about 2,500 square miles. And they were also allowed to select lands from the Yukon.

Moving southward down the Mackenzie Valley, we come to the Sahtu Region. They also had around 14% of the population, but it was significantly different in this region because they had the largest area-wise settlement region in the NWT. Their quantum would only give them about 9% of lands in the region. Their subsurface again was 10,000 square miles.

All of the subsurface areas were to be divided evenly among the five Dene/Metis claim regions. Originally the Gwich'in had intended to allow the Sahtu to select lands within the Sahtu region even though they were entitled to be Gwich'in lands but because of the claim, it didn't matter now that they were no longer together. The Sahtu lobbied the federal government long and hard saying that this only gave them 9% of the region's land area. Most often land claimant groups received about 15% of their region. Therefore, the Sahtu argued that this was going to be a very difficult thing to stop. The federal government has agreed to increase their quantum to 15,000 square miles, but they will still only receive 700 square miles of sub-surface entitlement.

The North Slave region is an entirely different kettle of fish again. There are several things that can happen in this region to make its claim different although the 1990 agreement is based on regional claims. The difference here is that the Yellowknife Band which used to be Yellowknife "A" Band actually signed Treaty 8. The rest of the region signed Treaty 11. So they have agreed that they will split their claims negotiations. Now Treaty 8 Bands are seeking land entitlement under specific claims rather than comprehensive claims. That left the balance of the region, excluding Yellowknife, in Treaty 11. So they formed a new tribal council to help to negotiate their land claim. This group should be in negotiations in April of 1993.

There are several problems that have to be settled before then and that is again with admission of quantum. In the North Slave region, we would have received the largest amount of quantum, about 29% of the total. How we are going to divide that now of course is up to the Tribal Council and, as well, what everyone will accept as their percentage of quantum. If it is based on current population figures, they would only have about 2,000 or 3,000 people bringing them back down to the level which the Sahtu population

base was. Presumably, this brought their land quantum down to around 14 or 15%. We don't know how they are going to handle that with Yellowknife and the Yellowknife Band.

So, let's look at the amount of land that was left for quantum impacts on their selection and the reasons for selection. Rather than the regions selecting for a specific economic purpose, they now have to select lands for every purpose. There were some regions that were very strong about selecting for absolute protection over their selected lands, for instance the South Slave region. It appears non-aboriginal people in the region were very adamant that they protect land for historic reasons. That was their deepest concern, I think, was to have absolute protection of their lands and allowing other regions then to pick up land selection for other purposes.

Under the Dene/Metis comprehensive claim, under the individual land quantum, there were provisions for sand and gravel. This, of course, has been changed by the regional claims settlement process. The Gwich'in claim is somewhat different than the Sahtu claim. First, the impact of the Inuvialuit Final Agreement on the Gwich'in region where in 1984 there was a selection known as the "Aklavik Land" selection--700 square miles that was given to the Gwich'in at the time of the Inuvialuit settlement but not included in their quantum. The only source of gravel for the Aklavik community is at Willow Creek and there was provision made, not in the agreement but in the implementation plan, that the GNWT would have access to the sand and gravel, that the federal government would negotiate the cost of it, and that the GNWT would have free access. We have just recently completed those negotiations. I believe the royalty fees are around $1.83 or $1.89 m^3. We won't pay access fees, we won't pay actual rent or fees, but I believe that they did come to an agreement on the administration fees. Of course, the interesting part of this is the Gwich'in claim has just been enacted into legislation in December. None of the resource management boards are set up yet. There was also an issue whether or not the access that was discussed in the chapter on sand and gravel was in fact access. That impacted on whether or not contractors could have free access that was given under the land chapter because there is no surface rights board or arbitration panel. Luckily we did come to an agreement. At first, it looked like there would have to be an arbitration panel or we would have appeal under current legislation. The other method of dealing with sand and gravel is under the land selection. In the Gwich'in area we managed to protect two other sites other than the sand and gravel sites for government use. Again this was done in the claim because of the scarcity of sand and gravel sites in the region.

In the Sahtu, it is a somewhat different situation. We are not protecting any areas with specific sites for sand and gravel. Most of this will be done through the land selection process. It's a bit different because we don't know exactly what the requirements will be over the next 20 years. Other than that, the claim only provides for free government access when there are no other sites available and the Sahtu agree that there aren't any alternative gravel sites. We would then have to negotiate with the region and, in the case of the Sahtu, the Sahtu Tribal Council.

We have tightened up, I think the sand and gravel provisions from the Inuvialuit claim. The impact of that agreement was that we realized that there are all these things that we thought we had adjusted for and, actually, we didn't. When it comes to an actual agreement people don't remember what you meant or were not clear about. You have to stand by your negotiations. The Sahtu negotiations are, I think, an improvement over the Gwich'in negotiations.

Comment: Bob Gowan, DIAND

I spoke to Robert Alexie of the Gwich'in yesterday who informed me that they would be unable to attend the workshop. He had a few comments regarding the size of their land quantum. They also referred to the land and water board which will review all applications for sand and gravel use within the Gwich'in region. The Gwich'in also have a 50% participation on the land and water management board once its set up for Crown Lands.

In the case of costs of materials on Gwich'in-Aklavik lands, I was in Edmonton a couple of weeks ago for negotiations. The agreement reached on prices was for a particular problem. It has no effect on further negotiations of access. The royalty portion of it was based on a formula that was used for the amount owing from the Inuvialuit lands since 1984. That fee structure was based on the fee structure used in the Inuvialuit region. It starts at $0.75 a cu.yd., with an inflation factor based on 1982 cost of living to present. I believe that brings the royalty portion up to $1.38 a cu.yd. There is a $0.56 per cu.yd. administration fee

added to that. I believe it's consistent with the Inuvialuit fee schedule as well. There is also a reclamation cost of $0.50 per cu.yd., so the total fee actually is $2.50. There still is negotiation of further costs and access to it. In terms of general costs, what Robert Alexie said was that their standard rate is given but they would evaluate certain public projects or community-based projects where the community receives further economic benefits. In those instances the royalty may be reduced.

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SAHTU LAND CLAIM AND BORROW RESOURCE ISSUES

George Cleary

President
Sahtu Tribal Council, Yellowknife, NWT

I'd like present a quick review of where we are in terms of the Sahtu land claim. As you are well aware, the Sahtu has come to an agreement with the government on the Sahtu claim. We're having a special assembly next week in Fort Good Hope to have the first run through with our communities. The Sahtu Tribal Council represents four Indian bands and three Metis locals in five communities. These communities include Fort Franklin, Fort Norman, Norman Wells, Fort Good Hope and Colville Lake. Although our negotiators agreed on the main elements of Sahtu claim on January 10, nothing was signed or initialled by our Chief Negotiator, Norman Yakeleya, who was undecided when we first started negotiating regional claims. He decided to bring it back to our people before signing or initialling any final agreement. It was decided that we should discuss it at a special assembly and if we had approval from the boards and the locals, we'd bring it forward for ratification. That's the process that we'll go through next week in Fort Good Hope. I'm expecting between 30 and 50 people from the other Sahtu communities to gather in Fort Good Hope. If the claim is acceptable to our community representatives, we will bring it up for ratification in late April, 1993.

I will now provide an overview of the main elements of the claim. As indicated under the old Dene/Metis comprehensive agreement, the Sahtu got to select about 9,800 square miles of land quantum in the Sahtu region with 700 square miles being subsurface. We would have collective ownership of 70,000 square miles of land that would be selected by the claimant regions. Although the Sahtu people were always supportive of a comprehensive claim for all Dene/ Metis in the NWT and the Mackenzie Valley, we did have some concerns on how the claim was going to be implemented. The main concern that we had was that we would create a large bureaucracy of Dene/Metis in Yellowknife. Everything was being centralized and very little authority was being exercised at the community and regional levels. But those were issues that we were to work out internally.

When the Dene/Metis comprehensive claim broke apart, a lot of people saw that as weakening of the parent organizations. The Sahtu took a different position. We and the Gwich'in took a position two years ago that the parent organizations were never to speak on land claims or constitutional issues on our behalf. We would speak on those issues ourselves. I think it's all part of self-awareness. As the regions get stronger, we are able to act collectively and will be much stronger than having one person speak on behalf of each of the regions on issues that a lot of regions are disagreeing on in the first place.

When we start negotiating a regional claim, one of the things that we discussed with our people is that, as far as the money goes, if we can get that increase that's great, but the land is the key issue in Sahtu negotiations. The mandate that myself and my negotiators received from the Sahtu region people is that we have to try and increase the land quantum. We've increased the quantum of the Sahtu claim by up to 16,000 square miles. As far as the dollars go, we've been able to increase that up to $75,000,000 payable over a 15-year period.

One of the key issues in the claim is the issue of management. We must have representation on the various management boards. There are some issues that we weren't able to make very much headway on and one of these issues is self-government. The other thing is that we don't have participation agreements that the Inuvialuit have in their agreements, as well TFN has in its agreements. The government has always taken a position with the Dene/Metis that they would not negotiate participation agreements with us and that those would be worked out under Northern Accord negotiations. We have letters from the Minister of Indian Affairs and the Territorial Government Leader indicating that as soon as the claims negotiations are finalized, our provisions and benefits to the Sahtu claim will kick in.

As far as our time schedule--ratification is expected on April 26 - 29 and cabinet will deal with it in late May or early June. Then we've got our fingers crossed that the claims settlement legislation will be passed

through Parliament before an election is called. We've got a very tight time schedule. The priority work that has to be done for the next 6 to 8 months is ratification. This involves working with our communities to try to inform our people as much as possible. I also have been working to try and complete an implementation plan by March 31. The other thing that's going on right now is land selection. We didn't start our lands until about 4 weeks ago. We decided to leave the main elements of the Sahtu agreement to the end. We didn't deal with the land quantum, financial compensation or subsurface resources until now. We wanted to get all of the small issues out of the way. We've had land selection meetings in Fort Good Hope, Fort Franklin and Fort Norman.

The main problem areas are along the corridors of the Mackenzie River and the Great Bear River. The big problem here is the gravel sites. In our claim, we did not identify any gravel sources in our claim like the Gwich'in. We are taking a harder line on gravel sites. Our position has always been that we want to sit down with the government to negotiate this issue. We know the public, mainly our own people, need gravel resources for airports and roads. We have no problem in terms of ensuring that the supply is there. We must remember that there is not that much economic activity at the community levels and that we will secure any economic resources our communities that we can. In the next few weeks, we will know where we stand in terms of all the gravel sites along the Mackenzie River corridor and the Great Bear River corridors. I'm not sure exactly how much gravel resource is going to be included in the claim settlement.

The way that we are proceeding as far as the implementation of our claims is quite different than the way the Gwich'in are approaching things. The Gwich'in have a strong centralized organization and the Sahtu has taken a completely different approach. We want to have the authority exercised at the community level and to do this we are proposing to delegate authorities from the tribal council.

We don't have collective ownership of the land base at the regional level. The Sahtu region is basically divided into three aboriginal districts. Fort Good Hope district, which includes Fort Good Hope and Colville Lake. They have had a group trapping area in that area since the 1950s. It's a pretty established area. The Fort Norman District would include Fort Norman and Norman Wells, while Fort Franklin is a district by itself. We decided that the land quantum would be divided equally among the three aboriginal districts. So, Fort Good Hope and Colville Lake together as a district will get 5,333 square miles. Norman District will get the same amount, and Fort Franklin will get a similar-sized land base. Although the land will be owned by either the community or by the communities in the aboriginal districts, any benefits on subsurface lands would be shared equally by all the communities. For benefits on surface lands, the community that lets control of the lands will get the benefits up to a certain amount and then beyond that, it is to be shared equally between the other communities. Although we have community or aboriginal district land ownership, we still want to share the wealth so it won't create a situation where one community is rich and the others are poor.

Under the Gwich'in claim, they are able to create a regional land and water board but with the option that if the territorial board has established sometime down the line that the territorial board would apply. However, the territorial board's influence would not be as strong as region's. That is the same position the Sahtu has taken. A working committee has been formed between two governments and the Gwich'in in terms of discussing how this can be implemented. We've been involved in those discussions and our position is still that we should have a regional land and water board established and then later on when the territorial land and water board is established for the Mackenzie Valley we would participate in that process.

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QUESTION PERIOD

Question #1. What is the control process outside of the Inuvialuit 7(1)a and 7(1)b lands?

Klengenberg. That goes to DIAND for review as they are considered Crown Lands.

Question #2. Do you get input from the environmental screening committee?

Klengenberg. Yes, the review process applies plus the local hunters, trappers, and community corporations have to be consulted.

Question #3. Is there a guideline or set of conditions that you follow for your site inspections?

Klengenberg. Yes, we do a pre-inspection and several monitoring inspections with the rights holder during the course of their operation. If any other inspections are required, we'll do more. That's why we implemented our environmental monitors to better watch what's happening out there, and then they report directly to us.

Question #4. What are the annual volumes of granular being extracted from Inuvialuit lands?

Klengenberg. Well, it's pretty slow right now. The only real gravel work that's happening right now is with the Paulatuk airstrip. We haven't seen an application for a quarry license this year from Tuktoyaktuk.

Question #5. Do you have any timeframe of when the territorial water board will be set up for the Mackenzie Valley corridor?

Cleary. Our last meeting was in Edmonton about three weeks ago and one of the problems that we have is that there's pretty long time lines--five years or so. That is why we're looking at that for further down the road from our claim. We can wait 5 years but that's one reason that we're saying that we want to make sure that regional boards are implemented first. But the concern that government and industry have is that they are telling us they don't want to create a situation where we have different regimes in different regions. This would affect the building of a Mackenzie Valley pipeline. I think we've showed them that our position has always been pro-development but we want to make sure that the communities get some benefit from development.

Question #6. You have indicated a territorial water board. Are you referring to both western and eastern?

Heron-Herbert. Just the Mackenzie Valley. Just the Dene/Metis land claim areas.

Question #7. Do you see some conflict developing between the TFN and the western Arctic regarding water management?

Heron-Herbert. No, I don't think so. I think it was always intended that there would be two water boards even though we may have the same legislation and we may have the same regulatory regime.

Cleary. In our regional claim negotiations, when we discussed the boundary issues between TFN and ourselves, between the Gwich'in and ourselves, and the Deh Cho and ourselves, we tried to negotiate the boundaries on the basis of the watershed boundaries.

Question #8. Do the Inuvialuit have any involvement or say in this proposed water management board?

Heron-Herbert. I think that it will be an integrated management board.

Question #9. The only group that has not been represented at this workshop of the main aboriginal groups in the Mackenzie Valley is the Deh Cho

region. I'm wondering if you could just briefly give us an update of the status or the "non-status" of the Deh Cho claim?

Heron-Herbert. As I understand it, there is some discussion within the region about whether or not they have a claim to be put on the table. First of all, the government has a certain number of comprehensive claims on the table with British Columbia. I suspect that the regional claims in the NWT are going to take a back seat to those negotiations. But I understand that the new Chief in Fort Simpson is looking at a possible regional claim. The other part of it is looking at a domino effect. We've seen in the past with the Inuvialuit settling their claim, the Gwich'in settling theirs...and it comes down the valley. With the North Slave now considering negotiations, we suspect the Deh Cho region will probably be the next to lobby for a regional claim.

Question #10. There was mention of the Cameron Hills development. Have you made any initial investigations of that development with the Deh Cho Regional and Tribal Councils?

Herbert. Yes, we have a joint venture with the Deh Cho Council to set up an oil corporation.

Question #11. Have they been discussing specific borrow issues at this point?

Herbert. No. They have not.

Question #12. Informal discussions I had last winter with the Chief of Fort Simpson indicated that without a claim the Deh Cho region was still thinking of having some type of agreement to accrue some royalties to them in terms of gravel sources. Could you comment on that?

Heron-Herbert. The Deh Cho has wanted to have a different kind of title than would be available under a comprehensive claim and still be able to take advantage of the economic benefits provisions.

Question #13. The other question I have is in regard to any specific pipeline-related terms in either of the three agreements. The Inuvialuit have included specific economic terms with regard to the diameter of pipelines across Inuvialuit lands. Could you comment on that with respect to the Gwich'in and Sahtu claims?

Herbert. I don't have that information.

Mahnic. Well, perhaps it was more a comment than a suggestion. Yes it does happen and it is based on whether it be a 12-inch line, 24-inch line, etc. This is a different method of assessment from any municipal assessments of pipeline operations in southern Canada.

Question #15. Is there a land use plan for the Mackenzie Valley which identifies gravel resources?

Heron-Herbert. No, not specifically. One of the provisions of the claim is the development of a land use plan. The Delta did have a land use plan already developed. It's going to be different for the Sahtu because the Sahtu land use plan was incomplete at the time the program was shut down. So that's an implementation problem.

Question #15. In terms of the Sahtu claim--are there some specific negotiations for right of way access for the IPL system?

Cleary. No. There is nothing specific at this point of the negotiations.

Stanley

SECTION 10.

WORKGROUP PLENARY SESSION

WORKGROUP PLENARY SESSION

(Presented by Bob Mahnic, Communiplan/Stanley)

To this point, this NOGAP workshop on Mackenzie Valley granular resources has primarily consisted of both technical and discussion panel presentations. Each of the panel sessions was concluded with a question and answer period. To conclude this workshop I would suggest that we proceed through a plenary group problem solving exercise to identify any outstanding issues or concerns. This has been a unique workshop in that we are dealing with the results of past research and development initiatives and how they might affect future program and policy development for a long-heralded series of granular resource-dependent projects--development of a major gas or oil pipeline system through the Mackenzie Valley and the northward extension of the Mackenzie Highway from the Wrigley area to the Mackenzie Delta.

This workshop has concentrated on the importance of information--northern granular resources information. One of the questions that needs to be addressed during the group plenary session relates primarily to northern granular resource information gaps that need to be filled. I suggest that we use a simple problem solving model as a framework for these discussions.

There are at least seven steps identified for effective problem solving:

Step 1. Define the problem--exactly what is the problem you're trying to solve or to work towards?

Step 2. List symptoms of the problem--what do we see now?

Step 3. Review possible causes of the problem--why are we seeing that type of behaviour or that type of activity?

Step 4. List the alternative solutions--what are some of the possibilities of addressing this particular problem?

Step 5. Evaluate the alternatives--can you list potential ways to deal with the problem? Which alternatives seem most appropriate?

Step 6. Priorize appropriate alternative solutions. Choose the best alternative to address that problem.

Step 7. Develop an action plan leading to problem resolution.

In recognition of the time constraints that we have today, it is quite unlikely that we will be unable to complete a full seven-step problem solving process. Nonetheless, we should try to use this as a framework for the group plenary discussion over the next one or two hours. Given the considerable technical and practical expertise assembled at this workshop we may provide Bob Gowan with several strategic objectives leading to a new NOGAP granular resources program action plan. We should consider the following:

1. Are there significant gaps in the current northern granular resource information? Are these information gaps primarily database related? Is there a need for more ground-truthing, inventory related research, or other issues.

2. Can the "future research requirements" identified in the workshop plenary session be completed within the short-term NOGAP timeframe (1 or 2 years) or are they longer-term projects of at least 5 to 10 years in duration, projects which may require other non-NOGAP funding? By examining the anticipated funding requirements and timelines of these projects, alternatives can be priorized.

3. Do we have enough information to form an action plan? Alternatives need to be priorized and evaluated. It may be useful for the participants of this workshop to suggest one or two recommended actions to be implemented in future NOGAP granular research.

Based on the excellent presentations of the past two days, and my own experience in workshop facilitation, I would suggest there are at least two ways to look at northern granular research. One view is that granular research is primarily technical and physical environment-oriented. This kind of activity has been conducted traditionally--inventory programs; ground-truthing programs; and database programs are concentrated on the technical and the physical side. The second broad area of granular research attention needs to focus on the human environmental effects. As we are all aware, there is a growing need to also consider the social, cultural, and economic issues and consequences of northern granular resource development. Future granular resource development will require that effects on both the human and physical environments be carefully considered.

The group plenary session consisted of an informal discussion and brain-storming session to identify outstanding concerns or issues. The workshop agenda was used as topical outline to facilitate the plenary session discussions. Flip chart information and audio-tape recordings were used to record the comments made by plenary session participants. This information was edited and grouped for easier issue/problem identification purposes. The reader should also note that other research recommendations were made by several of the technical and discussion panel members in their individual presentations. In some instances, these comments were not re-iterated in the plenary session and therefore, despite their potential applicability, do not appear in this listing.

Through the course of the plenary session discussions, eight major granular resource topical issue areas were identified:

1. Sources of borrow information.
2. Regional borrow inventories research.
3. Borrow materials usage.
4. Competing uses for borrow materials.
5. Tracking/monitoring of actual borrow use.
6. Industrial demands for borrow resources.
7. Potential constraints to borrow development.
8. Need for monitoring studies of quarry sites adjacent to or in watercrossings.

Each of the eight issue/topics is highlighted below and plenary session participant comments are indicated in each case.

Issue #1. Sources of Borrow Information

One of the main issues participants identified concerned the lack of dissemination of the extensive northern granular resources database and mapping information. This problem has been recognized and information "holders" indicated they are examining various methods of information delivery to resolve the problem. Obstacles such as the status of proprietary information and financial costs associated with product dissemination also require attention. A summary of related comments included:

- Lack of dissemination of information to stakeholders:
  - ASTIS Bibliography;
  - DIAND Reports/Information; and,
  - NOGAP Reports.
- User-Pay (development costs).
- Proprietary information (completeness of inventory, *Access to Information Act*).

- Expanded geographical area for database coverage (Yukon and other NWT):
  - GSC Mapping; and,
  - Northern Land Use Planning.
- Have we already "got it all"?
- Need to match informational needs on a supply/demand basis.

Issue #2. Regional Borrow Inventories Research

Most plenary session participants felt that the regional borrow inventories research program has been thoroughly addressed in earlier NOGAP work programs. There was consensus that the regional borrow inventories should be updated to reflect environmental and cultural/heritage resource concerns. While better cost information concerning various modes/regions of granular resource development was indicated as an area in need of further research; others indicated that in the absence of a major project such information may not be critical at this time. A summary of related comments included:

- There are "no gaps left".
- We are already "choking on information".
- Need better supply/demand matching.
- "What we really need is a project".
- Need to get available information into the public domain (e.g., DIAND's "QuickMap" computerized northern granular database program).
- Need to update inventories to reflect environmental concerns and archaeological/cultural impacts.
- Small projects require information on site-specific concerns on borrow availability.
- Need better information on costs:
  - Project dependent;
  - Access/hauling costs in different borrow management areas; and,
  - New royalties/royalty regimes with land claims.

Issue #3. Borrow Materials Usage

Several plenary session participants identified the need for more research and investigation into borrow materials usage including the identification of suitable re-use situations, better management of the existing resources and the use of replacement technologies such as foam padding or other types of fill material. A summary of related comments included:

- Identify where borrow materials can be re-used:
  - Camp pads or stockpile sites;
  - Airstrips;
  - Former access roads;
  - Offshore and near shore drill islands; and,
  - Note environmental concerns related to re-use.
- Examine the suitability of rock chips/shale as alternatives to opening new pits.

- Evaluate the use of geotextile materials, etc. in areas suitable for re-use.

- Establish and implement sound management of resources (especially for highway embankment construction and other large-volume construction uses).

- Examine replacement technologies that may be suitable substitutes:
  - Foam or other synthetics;
  - Other types of fill; and,
  - Cost is a major factor.

Issue #4. Competing Uses for Borrow Materials

It was noted that much of the NOGAP-funded research has had, by definition, a bias towards the identification of oil, gas, and pipeline granular needs in the Mackenzie Valley and Delta areas. It was suggested by several plenary session participants that the scope of northern granular research be expanded to include other uses such as highways and airports. A summary of related comments included:

- Expand existing database to include other non-energy uses:
  - Highways;
  - Airports; and,
  - Protected areas.

Issue #5. Tracking/Monitoring of Actual Borrow Use

It was noted that regional borrow material inventories may require updating as this information does not recognize recent extraction of granular resources by communities, government and industry. Several suggestions were made in relation to improving quarry return statistical information. A summary of related comments included:

- Need for better statistics on quarry returns:
  - GNWT;
  - DIAND;
  - ILA Permits; and,
  - Others.

- Former pit sites to be re-evaluated for remaining borrow potential.

- Pit exhaustion needs to be more closely monitored.

Issue #6. Industrial Demands for Borrow Resources

A significant portion of the plenary discussion related to potential industrial demands of Mackenzie Valley and Delta area granular resources. It was suggested that industry keep government, the communities and aboriginal groups apprised of any granular-dependent developments well in advance of the commencement of field construction. Industry representatives indicated the need for better haulage, royalty and regulatory regime information to help with project economic and logistical planning. Adopting a "team" approach to northern development planning was suggested and strongly supported by the plenary session participants. A summary of related comments included:

- "What if" questions need to be answered, especially project timing:
  - Cameron Hills/IPC developments (50 km truck/tanker haul road);
  - HONDO pipeline project;

- Norman Wells extension to Beaufort/Delta area; and,
- Polar-Delta Gas project.

- Better information is needed to determine granular needs.

- The size of a project will have an impact on granular needs:
  - Approvals process for granular access needs to be streamlined;
  - Cost implications need to be better understood (haulage, royalties, etc.); and,
  - Borrow sources available to industry need to be identified.

- Sand versus foam issue requires further analysis and study (for pipeline ditch padding).

- Economic "window of opportunity" needs to be understood and addressed by regulators and aboriginal groups:
  - Regulatory delays can force cancellation or termination of projects;
  - Volatile commodity prices can cause uncertainty in lending markets; and,
  - Other competing countries are producing produce more cheaply or more quickly.

- Team approach to development is recommended.

Issue #7. Potential Constraints to Borrow Development

Future borrow development must address significant constraints such as biophysical impacts, fisheries and wildlife interactions, heritage and cultural resource impacts, land claims jurisdictional changes and other resource management issues. It was strongly suggested that the lack of sufficient or appropriate granular development impact information could trigger costly and time-consuming environmental assessments or reviews. A summary of related comments included:

- Biophysical constraints (permafrost, flooding, slumping).

- Fisheries/wildlife impacts during and post-borrow removal.

- Information gaps that may trigger reviews or assessments:
  - Site-specific locations/conflicts;
  - Cultural/archaeologically significant sites;
  - Community/local knowledge; and,
  - Mackenzie Valley has some areas of incomplete data collection.

- Land Claims:
  - New regulatory regime; and,
  - New royalty structures.

- Land Use Planning:
  - Potential land use conflicts.

- Resource Management:
  - potential resource management conflicts.

Issue #8. Need for Monitoring Studies of Aquatic/Quarrying Areas

Some interest was indicated by plenary session participants for more long-term studies of quarrying effects, especially those that are in close proximity of water sources. A summary of related comments included:

- Monitoring of Norman Wells production islands; and,
- Monitoring of Aklavik-area pits.

Potential Funding Sources

Following the identification and discussion of the previously-noted issue/topics, plenary session participants were asked to identify some of the potential alternative sources of funding that might be available to conduct further borrow research in the Mackenzie Valley and Delta regions. The following is a preliminary listing of potential sponsors:

- Grants, etc. (NSERC);
- NOGAP funding;
- Industry sponsors;
- Aboriginal groups;
- Academic research community; and,
- Consultant groups.

Recommendations for Future NOGAP Sponsorship

The time constraints of the plenary session allowed for the preliminary identification and discussion of perhaps 10 or 15 future research studies that might be considered for NOGAP funding. Several excellent suggestions are noted in the preceding "issue" reviews. Two projects were noted for possible short-term NOGAP support:

1. Cameron Hills/IPC development proposal for 50 km truck/tanker haul road--need for borrow resource inventory and terrain evaluation study.
2. Mackenzie Valley Environmental Atlas--opportunity to consolidate/compile fisheries, archaeology, and other studies of potential limitations concerning borrow resource areas.

As noted, this is only a preliminary identification of NOGAP-related granular resource study needs. Further assessment, evaluation, priorization and action planning will be required.

Stanley

SECTION 11.

WORKSHOP CLOSING REMARKS

WORKSHOP CLOSING REMARKS

(Presented by Bob Gowan, DIAND)

This has certainly been a busy two day session. We've heard some excellent presentations from some of the consultants who have worked on the NOGAP-sponsored granular resources studies. Several departments of both the federal and the territorial governments have also given very informative presentations on their activities. The short term and future prospects for northern pipeline construction, from the industry perspective, have been clearly outlined. We also have some useful, updated granular resources demand information. The importance of these essential resources to aboriginal land owners has also been well presented. Throughout, there has been thoughtful and well-informed discussion of the great quantity of information that has been presented.

As Bob Mahnic indicated in the opening plenary session, the main reason for having a workshop is to communicate. One of our purposes was to present the results of NOGAP research. Another was to collect information, and to determine what else needs to be done. This workshop has achieved these goals. I'd like to thank everyone who participated and helped us realize success. I'm especially pleased with those who, on very short notice, put together such well-prepared and well-presented talks.

It is reassuring that we have not identified any serious gaps in our program or any major problems. We did, however, receive guidance from the workshop participants regarding future granular resource research efforts. This will help in our planning to make the best possible use of the remaining NOGAP funding.

Finally, I would like to thank Stanley Associates, and Colin Anderson, Jack Fujino and Bob Mahnic. They have done an excellent job of organizing, coordinating and facilitating this workshop. In the past few weeks they have on more than one occasion performed some "magic" to overcome unexpected organizational or other difficulties to make this a successful workshop.

To everyone, a sincere thank you.

Stanley

APPENDICES

APPENDIX 'A'

LIST OF WORKSHOP PARTICIPANTS

ALEXIE, Robert Jr.*	Gwich'in Tribal Council	Fort McPherson, NWT
ANDERSON, Colin	Stanley Associates Engineering	Yellowknife, NWT
ANDREWS, Tom	Prince of Wales Heritage Centre	Yellowknife, NWT
BOUTILIER, Arthur	DIAND - Land Resources	Yellowknife, NWT
BURLINGAME, Todd*	GNWT - Energy, Mines and Petro. Res.	Yellowknife, NWT
CLEARY, George	Sahtu Tribal Council	Yellowknife, NWT
COOK, Rob	Thurber Engineering	Yellowknife, NWT
DUK-RODKIN, Alejandra	Geological Survey of Canada	Calgary, Alberta
FERGUSON, Brian	Fisheries and Oceans Canada	Inuvik, NWT
FUJINO, Jack	Stanley Associates Engineering	Edmonton, Alberta
GOODWIN, Ross	Arctic Institute of North America	Calgary, Alberta
GOWAN, Bob	DIAND - Land Management	Ottawa, Ontario
HAGEN, Willard	Gwich'in Tribal Council	Inuvik, NWT
HARBICHT, Stephen	Fisheries and Oceans Canada	Yellowknife, NWT
HEDBERG, Anne	DIAND - Land Claims	Yellowknife, NWT
HENKLE, Barry*	RTL Enterprises	Yellowknife, NWT
HERBERT, Jim	Inuvialuit Petroleum Corporation	Calgary, Alberta
HERNADI, Nick	Thurber Engineering	Calgary, Alberta
HERON-HERBERT, Sue	GNWT - Land Claims	Yellowknife, NWT
HOEVE, Ed	EBA Engineering Consultants	Yellowknife, NWT
KAUSTINEN, Ollie	Polar Delta Gas Project	Calgary, Alberta
KIMBLE, Ken	Two Way Enterprises	Yellowknife, NWT
KLENGENBERG, Charles	Inuvialuit Land Administration	Tuktoyaktuk, NWT
MacLEOD, Neil	EBA Engineering Consultants	Calgary, Alberta
MAHNIC, Bob	Communiplan/Stanley Assoc. Engineering	Edmonton, Alberta
MATTHEWS, Lorne	GNWT - Energy, Mines and Petro. Res.	Yellowknife, NWT
McDONALD, Marvin*	Deh Cho Tribal Council	Fort Simpson, NWT
McDOUGALL, Jim	North of 60 Engineering	Calgary, Alberta
MINNING, Gretchen	GVM Geological Consultants	Calgary, Alberta
MURRAY, Sandy	GNWT - Transport	Yellowknife, NWT
NICHOLSON, Jim	GNWT - Public Works	Yellowknife, NWT
OLTHOF, Rita	EBA Engineering Consultants	Calgary, Alberta
OSWELL, Jim	HBT AGRA Engineering	Calgary, Alberta
PETERSON, Bryan	GNWT - Transport	Yellowknife, NWT
RAIL, Betty Anne*	DIAND - Land Management	Ottawa, Ontario
SHERSTONE, David*	NWT Science Institute	Yellowknife, NWT
SMITH, John	Interprovincial Pipe Line	Edmonton, Alberta
SORELL, Jay Dee*	Beaver Enterprises	Fort Liard, NWT
TRAYNOR, Steve	DIAND - Land Management	Ottawa, Ontario
WHITE, Gary	NWT Science Institute	Inuvik, NWT
YAKELEYA, Dan*	Sahtu Tribal Council	Fort Norman, NWT

** indicates registered for workshop but unable to attend*

APPENDIX 'B'

GUIDELINES FOR DEVELOPERS FOR THE PROTECTION OF ARCHAEOLOGICAL RESOURCES IN THE NORTHWEST TERRITORIES

INTRODUCTION

The following guidelines have been formulated to ensure that the impacts of proposed developments upon heritage resources are assessed and mitigated before ground surface altering activities occur. Heritage resources are defined as, but not limited to, archaeological and historical sites, burial grounds, historic buildings and cairns. Collaboration between the developer, the Archaeology Programme of the Prince of Wales Northern Heritage Centre (PWNHC), and the contract archaeologist(s) will preserve heritage resources in the Northwest Territories. The roles of each are briefly described.

The Prince of Wales Northern Heritage Centre (PWNHC) is the Territorial Government agency which oversees the protection and management of heritage resources on Federal Crown and Commissioner's Lands. Briefly, its role in mitigating impacts of developments on heritage resources is: to identify the need for an impact assessment; set the terms of reference for the study depending upon the scope of the development; suggest the names of qualified individuals prepared to undertake the study to the developer; issue an archaeologists permit authorizing field work, if required; assess the completeness of the study and its recommendations; ensure that the developer complies with the recommendations.

A developer is the initiator of a land use activity. It is the obligation of the developer to ensure that a qualified archaeologist is hired to perform the required study and that provisions of the contract with the archaeologist allow permit requirements to be met; i.e. fieldwork, collections management, artifact conservation, and report preparation. On the recommendation of the contract archaeologist in the field or the PWNHC, the developer shall implement avoidance or mitigative measures to protect heritage resources or to salvage the information they contain through excavation, analysis, and report writing. The developer assumes all costs associated with the study in its entirety.

Through his or her active participation and supervision of the study, the contract archaeologist is accountable for the quality of work undertaken and the quality of the report produced. Facilities to conduct field work, analysis, and report preparation should be available to this individual through institutional, agency, or company affiliations. Responsibility for the curation of objects recovered during field work while under study, and for documents generated in the course of the study as well as remittance of artifacts and documents to the depository specified on the archaeologists permit accrue to the contract archaeologist. This individual is also bound by the Northwest Territories Archaeological Sites Regulations under which the archaeologists permit is issued.

TYPES OF DEVELOPMENT

In general, those developments which cause concern for the safety of heritage resources will include one or more of the following kinds of surface disturbances. These categories, in combination, are comprehensive of the major kinds of developments commonly proposed in the Territories. For any one development proposal, several kinds of these disturbances may be involved.

Linear disturbances: including the construction of highways, roads, winter roads, transmission lines, and pipelines;

Extractive disturbances: including mining, gravel removal, quarrying, and land filling;

Impoundment disturbances: including dams, reservoirs, and tailings ponds;

Intensive land use disturbances: including industrial, residential, commercial, recreational, and agricultural siting, wood cutting, land reclamation work, and use of heritage resources as tourist developments.

PROCESS OF ASSESSING AND MITIGATING IMPACTS ON HERITAGE RESOURCES

The need to conduct a heritage resource impact study is identified by the PWNHC through one of several screening mechanisms. When a developer applies for a Land Use Permit, or otherwise announces its intentions, the application is reviewed by the PWNHC which identifies the need for further study of an area before ground surface alteration can proceed. The intention of the regulatory agency is to ensure that development projects are compatible with the preservation of heritage resources.

TYPES OF STUDIES UNDERTAKEN TO PRESERVE HERITAGE RESOURCES

Overview: An overview study of heritage resources should be conducted at the same time as the development project is being designed or its feasibility addressed. They usually lack specificity with regard to the exact location(s) and form(s) of impact and involve limited, if any, field surveys. Their main aim is to accumulate, evaluate, and synthesize the existing knowledge of the heritage of the known area of impact. The overview study provides managers with baseline data from which recommendations for future research and forecasts of potential impacts can be made. An archaeologists permit is not required for this study.

Reconnaissance: This is done to provide a judgemental appraisal of a region sufficient to provide the developer, the consultant, and government managers with recommendations for further development planning. This study may be implemented as a preliminary step to inventory and assessment investigations except in cases where a reconnaissance may indicate a very low or negligible heritage resource potential. Alternately, in the case of small-scale or linear developments, an inventory study may be recommended and obviate the need for a reconnaissance.

The main goal of a reconnaissance study is to provide baseline data for the verification of the presence of potential heritage resources, the determination of impacts to these resources, the generation of terms of reference for further studies and, if required, the advancement of preliminary mitigative and compensatory plans. The results of reconnaissance studies are primarily useful for the selection of alternatives and secondarily as a means of identifying impacts which must be mitigated after the final siting and design of the development project. An archaeological permit may be required, depending upon the scope of the field work.

Inventory: The inventory is generally conducted at that stage in a project's development at which the geographical area(s) likely to sustain direct, indirect, and perceived impacts can be well defined. This requires systematic and intensive field work to ascertain the effects of all possible and alternate construction components on heritage resources. All heritage sites must be recorded on Archaeological Survey of Canada site survey forms. Sufficient information must be amassed from field, library and archival components of the study to generate a predictive model of the heritage resource base which will: allow the identification of research and conservation opportunities; enable the developer to make planning decisions and recognize their likely effects on the known or predicted resources; and, make the developer aware of the expenditures which may be required for subsequent studies and mitigation. An archaeologists permit is required.

Assessment: At this stage, sufficient information concerning the numbers and locations of heritage resources will be available, as well as data to predict the forms and magnitude of impacts. Assessments provide information on the size, volume, complexity, and content, of a heritage resource which is used to rank the values of different sites or site types given current archaeological knowledge. As this information will shape subsequent mitigation programme(s), great care is necessary during this phase.

Mitigation: This refers to the amelioration of adverse impacts to heritage resources and involves the avoidance of impact through the redesign or relocation of a development or its components; the protection of the resource by

constructing physical facilities; or, the scientific investigation and recovery of information from the resource by excavation or other method. The type(s) of appropriate mitigative measures are dictated by their viability in the context of the development project. Mitigation strategies should be developed in consultation with the PWNHC. It is important to note that mitigation activities should be initiated as far in advance of the construction of the development as possible.

Surveillance and monitoring: These may be required as part of the mitigation programme. A surveillance may be conducted during the construction phase of a project to ensure that the developer has complied with the recommendations. Monitoring involves identification and inspection of residual and long-term impacts of a development (i.e. shoreline stability of a reservoir); or the use of impacts to disclose the presence of heritage resources, for example, the uncovering of buried sites during the construction of a pipeline.

REPORTING PROCEDURES

By law, a holder of an archaeologists permit must submit a report on the work performed by the end of the calendar year in which the permit is issued. Copies of the report are normally submitted to the PWNHC and the Archaeological Survey of Canada, in Ottawa. Should the developer wish to withhold submission of this report beyond the end of the calendar year, then a separate report dealing with the archaeology must be forwarded by the specified time. This report should document the baseline archaeological information recovered in the course of the project, but need not refer to the proposed developments with which they are associated, nor to any of the anticipated impacts of the development on heritage resources. This information can be released according to the development schedule, with the proviso that information concerning impacts must be forthcoming in good time for mitigation studies and programmes to be implemented.

For further information contact:

Director
Prince of Wales Northern Heritage Centre
Department of Culture and Communications
Government of the Northwest Territories
Yellowknife, NWT X1A 2L9
Telephone: (403) 873-7551
Fax: (403) 873-0205

APPENDIX 'C'

QUARRY LICENCE

A brief summary

of the

Inuvialuit Land Administration

Rules & Procedures

Activities on private Inuvialuit Lands are subject to the Inuvialuit Land Administration Rules & Procedures. All access to Inuvialuit Lands, other than casual and individual recreation, requires a Licence, Permit or Lease (called a Right) with the Inuvialuit Land Administration. Approval and licencing by the Inuvialuit Land Administration is dependant upon the applicant consulting with and receiving the support and approval of the local Community Corporation and the Hunters & Trappers Committee.

This document is a brief summary of the most applicable sections of the ILA Rules & Procedures as they relate to Quarry Licences. Because the Rules are a lengthy and complex document, all details cannot be included. If there are any questions regarding this brief summary or the ILA Rules & Procedures, please contact:

Land Administrator
Inuvialuit Land Administration
P.O. Box 290.
Tuktoyaktuk, N.W.T.
XOE 1CO

Telephone: (403) 977-2202
(403) 977-2466
Fax: (403) 977-2467

For a fee, complete copies of the rules and procedures are available. Make cheque or money order payable to the "Treasurer of the IRC, c/o ILA" in the amount of $25.00.

QUARRY LICENCES

TYPES OF RIGHTS

6(2)(h) Quarry Licence: the non-exclusive right to extract Surface Materials from a specific location on Inuvialuit Lands;

TERMS OF RIGHTS

6(4) The term of a right shall be for the reasonably estimated or actual duration of the proposed activities or occupancy, provided, however, that the maximum term of the various right shall not exceed the following periods:

(h) a Quarry Licence - 1 year

AREA THAT MAY BE USED

6(8) Where the right includes the right to use certain lands the total surface area of such lands shall not exceed the following:

(b) Quarry Licence - 10 ha

11(1) No person shall extract, quarry, mine or take Surface Materials from Inuvialuit Lands without a valid Quarry Licence.

QUARRY LICENCE

11(2) A Quarry Licence is a non-exclusive Right to remove a certain volume of Surface Materials specified in the Licence for a specific purpose during a period not exceeding one year from a specific pit, quarry or area.

11(3) The Holder of a Quarry Licence shall not carry out any operations which require another Right unless he has obtained such a Right.

11(7) A Quarry Licence ... cannot be issued unless the applicant has:

a) provided evidence to the satisfaction of the Administrator that the volumes of Surface Materials are required for a project that has been approved by the appropriate level of government; and

b) submitted his contract for the delivery of the said Surface Materials.

11(9) A Quarry Licence cannot be renewed. However, any Holder may apply for a new Licence prior to the expiration of the term of the current Licence.

11(11) A Quarry Licence can be used for the purpose of stockpiling or for sale to any other party than an end user, with the authorization of the Administrator. The Administrator may authorize a Quarry Licence for stockpiling for a purpose approved by any level of government and where a contract exists for this purpose. In the case of stockpiling, royalties shall be payable upon the removal of the Surface materials from the quarry. Royalties shall not be refundable for any unused material from a stockpile or for any loss of material from the stockpile.

GRAVEL ROYALTIES

11(20) Any Licence shall be subject to the royalties established for Sand and Gravel pursuant to subsection 7(32) of the Agreement....

11(22) Any royalties shall be calculated on the basis of the gross volume of the Surface Materials removed from the pit, quarry or mine and shall include ice where such ice is being removed but shall not include any overburden removed and retained in the pit, quarry or mine area for possible later land reclamation operations.

In addition to the Quarry Licence, a Land Use Permit Class A for the use of heavy equipment and a Temporary Right-of-Way for access to the source are required. The following sections refer to these two Rights.

6(39) Any operation related to a Quarry Licence requires the necessary Land Use Permit.

CLASS "A" LAND USE PERMIT OR LAND USE PERMIT CLASS "A"

10(6) ... no person shall, without a Class A Permit, carry out any operation on Inuvialuit Lands that involves:

(a) the use ... of explosives;

(b) the use of any vehicle that exceeds 10 t (22046 lbs.), net vehicle weight;

(c) the use of any power driven machinery for earth drilling purposes whose operating weight, excluding the weight of drill rods or stems, bits, pumps and other ancillary equipment, exceeds 2.5 t (5512 lbs.)

(d) the establishment of any campsite ...

(e) the establishment of any petroleum fuel storage facility exceeding 80,000 L (17598 gal.) capacity or the use of a single container for the storage of petroleum fuel that has a capacity exceeding 4,000 L (880 gal.)

(f) the use of any self-propelled power driven machine for moving earth or clearing land of vegetation;

6(2)(m) Temporary Right-of-Way: the right granted for the non-exclusive use of a strip of Inuvialuit Lands for a limited period of time for the purpose of commercial transportation of people, goods and materials by road ...;

MAXIMUM WIDTH OF A RIGHT-OF-WAY

6(9) The maximum width that can be granted for a Right-of-Way is 50 metres.

TEMPORARY RIGHTS OF WAY

15(1) A Temporary Right of Way is granted for the specific purpose specified in the Right, for a period of up to two years. The Temporary Right of Way may consist of a continuous strip of land or successive strips of land in a single corridor, where (as in the case of ice roads or power lines) the corridor consists partially of waterbodies or where parts of the corridor are outside Inuvialuit Lands. Each strip of land shall be subject to the maximum width provided for in subsection 6(9).

TEMPORARY RIGHTS OF WAY DO NOT INCLUDE WATERWAYS

15(2) For the purpose of determining any fees, the length of the Right of Way shall not include any length across any waterbodies.

15(3) A Temporary Right of Way may consist of a main corridor and several branches leading into or from the main corridor. Such branches may also be a separate Temporary Right of Way granted to a different Holder.

15(4) The term of a Temporary Right of Way cannot be renewed.

15(5) Where a Temporary Right of Way consists of a winter road or other temporary road, the Holder shall be responsible for creating the Right of Way in such a manner that traffic can proceed safely on such road. This responsibility shall include the erecting of such signs as would normally be erected on similar public roads. Any Temporary Right of Way can be used by any Person who has access to or has been given access to Inuvialuit Lands, provided such Person acts and proceeds in a manner as though the traffic laws generally applicable in the Northwest Territories were in force, provided however, that such Person shall not have access (subject to subsections 13(16) hereof) to any area which is subject to Land Occupancy without the approval of the Holder or Administrator.

15(6) Where it is expected that a road may be subject to significant traffic, or where significant impact or wildlife or wildlife harvesting may occur, the Temporary Right of Way may include a provision that obligates the Holder to erect a gate at the entrance of such road and provide for suitable control of the access to the road in accordance with guidelines of the Administrator.

APPLICATION PROCESS (7(14)-7(70))

Applications must be submitted on the appropriate form (Schedule 1) by the 22nd of any month to allow time for review by local Community Corporations, Hunters And Trappers Committees, and the Inuvialuit Land Administration Commission in order to be heard at a public meeting of ILAC the second week of the following month. The application may also require review by the Inuvialuit Regional Corporation, Inuvialuit Game Council or Inuvialuit Development Corporation.

ILA encourages all potential applicants to initiate consultation with the local HTC and CC prior to submitting an application. Major developers are advised to contact the Land Administrator to

determine if they should consult and negotiate with IRC, IGC or IDC prior to and/or during application.

Sufficient time (roughly 6-8 weeks) is allowed for the Inuvialuit organizations to review the application and to notify ILA in writing of their concerns, conditions, approval or rejection before it is formally put on the ILAC meeting agenda. An application received on or near the deadline may not allow enough time for review by the Inuvialuit organizations. This is especially true for those applicants who have not done consultation with the communities prior to applying. Therefore, the earliest such an application would be scheduled is the second ILAC meeting following its receipt. To allow sufficient time for proper review, an application is best submitted as far in advance as possible.

The application is reviewed to ensure all pertinent sections are filled out accurately, proper scale maps and plans are provided, a security deposit is arranged and, at least, the Initial Application Fees are paid. Close attention is paid to opportunities provided by the applicant for Inuvialuit business, employment and training. If not already negotiated, an Access Agreement must be negotiated and signed. Further processing of the application is suspended until the applicant has provided all of the above.

The Land Administrator will determine and advise the applicant of the date of the ILAC meeting at which the application will be considered. A Public Session will be held at the ILAC meeting for the public review of the applications and may be attended by the applicant, HTC, CC, IRC or any other interested parties. Any attendee will be able to provide information or make a presentation to ILAC. This will be followed by a private Commissioner's session during which ILAC will render a decision.

ILAC will:

a) defer their decision if further information is required from the developer. The application will be rescheduled for the following ILAC meeting.

b) defer their decision if they require additional time to consider an application. The application will be rescheduled for the following ILAC meeting.

c) defer their decision if they feel there is cause for environmental concern. The developer will be advised to submit a proposal to the Environmental Impact Screening Committee. Once a decision from EISC is received, the application will be rescheduled for the next ILAC meeting.

d) reject the application. The applicant will be advised of the reasons for rejection and the process stops.

e) approve the application. The applicant will be advised of any special terms and conditions set by ILAC and a Right is issued.

An appeal process exists if any party disagrees with and wishes to challenge any ILAC decision.

FEES

ILA assesses fees on a yearly period of July 1 to the following June 30. Fees for a given yearly period are calculated by multiplying the original fee, set in the Rules & Procedures in 1982, by a factor based on the Gross National Expenditure of the previous calendar year (Schedules II - XII). This usually results in a slight increase in fees.

The most current fee schedule for a Quarry Licence, which includes a Land Use Permit Class A and a Temporary Right-of-Way, is attached.

Applications must be accompanied by, at least, the appropriate Initial Application Fees (Schedule II, 7(19)),a Security Deposit of $150,000 (Schedule IX) and royalties for the first 1308 cubic yards (1000 cubic meters) (Schedule XVIII). The Initial Application Fees are non-refundable. The remainder of the fees (Access Administration, Wildlife Compensation and Land Use/Occupancy Rents) will be assessed if ILAC approval is given to the application.

SECURITY DEPOSITS

7(95) A security deposit shall be in the form of:

(a) a promissory note guaranteed by a chartered bank and payable to the Treasurer of the IRC; or

(b) a certified cheque drawn on a chartered bank in Canada and payable to the Treasurer of the IRC, or

(c) bearer bonds issued or guaranteed by the Government of Canada; or

(d) a combination of the securities described in paragraphs (a) through (c) hereof; or

(e) with the approval of the Administrator, and only where the Administrator is of the opinion that the amount of the Security Deposit would effectively prevent the applicant from carrying out business

on Inuvialuit lands, a written commitment to make each year a grant to the Land Reclamation Fund equal to 4% of the value of the Security Deposit defined in Schedule IX, within three months of the granting of the Right or the Anniversary Date of such Right. Such payment for greater certainty does not in any way limit or restrict the obligations and liability of the Holder under the Rules.

7(96) A security deposit shall be returned by the Treasurer of the IRC, when the Administrator has issued a Letter of Clearance in respect of the Right, unless the security deposit is a general security deposit, provided however, that any grant pursuant to paragraph 7(95)(e) hereof shall only be returned for 50% of its value.

MAPS/PLANS

The Application should be accompanied by a 1:50,000 scale topographic map showing the location of the source and the access route. In addition, it should be accompanied by a plan of the area showing the location and extent of the quarry area, campsite, fuel storage, etc.

PRELIMINARY PLAN

7(22) Every Application shall be accompanied by a preliminary plan showing the intended Land Use Occupancy and an estimate of their area in hectares or square kilometers.

7(23) The preliminary plan with an Application shall identify the approximate location, with coordinates, of all:

(a) existing lines, trails, Rights of Way and cleared areas proposed to be used in the operations;

(b) new lines, trails, Rights of Way and cleared areas proposed to be used in the operations;

(c) buildings, campsites, air landing strips, air navigation aids, fuel and supply storage sites,waste disposal sites, excavations and other works and places proposed to be constructed or used during the operations; and

(d) bridges, dams, ditches, railroads, highways and roads, transmission lines, pipelines, survey lines and monuments, air landing strips, streams and other features, structures or works that, in the opinion of the applicant, may be affected by the operations.

PARTICIPATION & ACCESS AGREEMENTS

6(42) A Land Use Permit ... or Right of Way cannot be granted unless the Holder has previously entered into a Participation Agreement or Access Agreement.

Participation Agreements are negotiated for access to Inuvialuit Lands to reach valid subsurface rights or interests issued by Canada on 7(1)(b) lands.

Access Agreements are negotiated for all other access to Inuvialuit Lands or for access to or across Inuvialuit Lands to reach valid surface or subsurface rights or interests issued by Canada on crown lands.

Agreements are negotiated and concluded between the developer and the ILA to address variable terms and conditions under which access will be granted with emphasis on Inuvialuit employment, training, business opportunities and participation. The local Community Corporation may be involved in the negotiations.

OBLIGATIONS OF A RIGHT

6(14) Any Right shall contain the following obligations:

(g) the obligation to provide Inuvialuit employment;

(h) the obligation to provide opportunities for Inuvialuit businesses; and

6(16) Any Right ... may stipulate:

(a) the payments to the IRC where work commitments have been established in the Right and where such work obligations have not been fulfilled;

(b) the education and training programs undertaken for the benefit of Inuvialuit;

(c) equity participation by Inuvialuit in the undertaking or operations carried out.

The applicant shall address the issues of Inuvialuit employment, business opportunities and training in as much detail as possible (number of Inuvialuit employees, total number of man-days of employment, names of Inuvialuit businesses, approximate expenditures, on-the-job training or upgrading, courses, etc). If a Right is issued, the Holder will have to report actual figures for business, employment and training during and at end of project.

MODIFICATIONS

No modifications can be made to a right issued by the Inuvialuit Land Administration without a written request to and approval by Land Administrator.

INSPECTIONS

PRIOR INSPECTION (PRE-INSPECTION)

7(45) The Administrator may, before issuing a Right order an inspection of the lands proposed to be used thereunder. Where an Inspector makes an inspection pursuant to this subsection, he shall report to the Administrator particulars of:

(a) the existing biological and physical characteristics of the lands proposed to be used or occupied and the surrounding lands; and

(b) any disturbance that the proposed operations may cause on the lands proposed to be used and the surrounding lands, the biological characteristics thereof, and the potential interference with wildlife harvesting activities and the peaceful enjoyment by the Inuvialuit of their lands.

The Inspector will report his suggestions regarding the manner in which the disturbance may be minimized or controlled. The costs of such inspection shall be billed to the Applicant pursuant to Schedule IV.

INSPECTION COSTS

8(4) The Holder of any Right ... shall pay all travel and lodging costs related to an inspection by one or more ILA officials. The Administrator shall ensure, to the extent possible, that Inspectors make use of the regular transport and lodging facilities available to the Holder. Inspection fees shall be paid in accordance with Schedule IV.

8(5) Subject to subsection 8(6) hereof, the Administrator shall order not less than 3 and not more than 12 regular inspections per year, in total not exceeding a cost equal to 12 inspector-days, for Holders of any Rights ...

8(6) The Administrator may order inspections, additional inspections, more frequent inspections, or the continuing presence of Inspectors, where:

(a) the Administrator has obtained a written or other bonifide report from any Inuvialuit, that the Holder may be violating certain terms and conditions of his Right; or

(b) the Holder has violated during the year previous to the inspection, the terms and conditions of his Right; or

(c) the Holder is Holder of a Land Use Permit Class A ... or a Right-of-Way and the Holder is carrying out operations which have a major impact on Inuvialuit Lands.

A final inspection of the quarry area and access route is required during the late summer months following completion of the operation. A Letter of Clearance will not be issued nor the Security Deposit refunded until a satisfactory final inspection has been condcucted.