

VOLUME II

1975 PIPELINE BORROW INVESTIGATIONS

RICHARDS ISLAND TO FORT GOOD HOPE, N.W.T.

Northern Engineering Services Company Limited

CALGARY ALBERTA



ENGINEERS FOR

Arctic Gas



D003558

VOLUME II
1975 PIPELINE BORROW INVESTIGATIONS -
RICHARDS ISLAND TO FORT GOOD HOPE, N.W.T.

Prepared For
Canadian Arctic Gas Study Limited

By
Northern Engineering Services Company Limited
Calgary, Alberta

November, 1976

Project 13011

Northern Engineering Services Company Limited

635 - 6TH AVENUE S.W., CALGARY, ALBERTA T2P 0T5 - TELEPHONE (403) 265-8500-TELEX 038-24868-TWX 821-2283

17 December, 1976

Canadian Arctic Gas Study Limited
1270 Calgary House
550 - 6 Avenue S.W.
Calgary, Alberta
T2P 0S2

Attention: A.W. Wirth
Vice President
Engineering & Construction

Reference: Volume II; 1975 Pipeline Borrow Investigations
- Richards Island to Fort Good Hope

Dear Sirs,

We are pleased to submit this report which contains information on 48 borrow deposits along the Mackenzie Valley from Richards Island to Fort Good Hope in the Northwest Territories.

This work was undertaken as part of budget item 13011.

Yours truly,

NORTHERN ENGINEERING SERVICES COMPANY LIMITED



P.H. Dau, P.Eng.,
President

JKW:gj

PROJECT 13011CANADIAN ARCTIC GAS STUDY LIMITED
CALGARY ALBERTAVOLUME II
1975 PIPELINE BORROW INVESTIGATIONS -
RICHARDS ISLAND TO FORT GOOD HOPEDATE NOVEMBER 1976

TABLE OF CONTENTS	Page
1. SUMMARY	1
2. INTRODUCTION	3
3. EQUIPMENT AND PERSONNEL	7
3.1 Equipment	7
3.2 Personnel	12
4. LOGISTICS AND METHODOLOGY OF FIELD OPERATIONS	15
4.1 Logistics	15
4.2 Methodology	17
5. REGIONAL GEOLOGY AND GEOMORPHOLOGY OF THE RICHARDS ISLAND TO FORT GOOD HOPE AREA	23
5.1 General	23
5.2 Bedrock	24
5.3 Surficial Deposits	24
5.4 Permafrost and Ground Ice	28
5.5 Regional and Local Drainage	29
5.6 Granular Materials	30
6. GEOPHYSICAL INVESTIGATIONS OF GRANULAR DEPOSITS	31
6.1 General	31
6.2 Resistivity Results	33
7. BIOLOGICAL OVERVIEW - RICHARDS ISLAND TO FORT GOOD HOPE	39
7.1 Vegetation	39
7.2 Mammals	40
7.3 Birds	42
7.4 Fish	43
8. DATA PRESENTATION	45
8.1 Individual Site Reports	45
8.2 Strip Maps	47

PROJECT 13011

CANADIAN ARCTIC GAS STUDY LIMITED
CALGARY ALBERTA

VOLUME II
1975 PIPELINE BORROW INVESTIGATIONS -
RICHARDS ISLAND TO FORT GOOD HOPE

DATE NOVEMBER 1976

	Page
TABLE OF CONTENTS CONT'D	
9. CONCLUSIONS	49
10. RECOMMENDATIONS	53
11. INDIVIDUAL SITE REPORTS	55
12. BIBLIOGRAPHY	601
APPENDIX A	Terms and Symbols
APPENDIX B	Location Maps of 1975 Summer Borrow Investigations
APPENDIX C	Resistivity Measurement with inductive coupling equipment at several gravel pits in the Calgary area.

PROJECT 13011

CANADIAN ARCTIC GAS STUDY LIMITED
CALGARY ALBERTAVOLUME II
1975 PIPELINE BORROW INVESTIGATIONS -
RICHARDS ISLAND TO FORT GOOD HOPE

DATE NOVEMBER 1976

ILLUSTRATIONS	Page
Table	
I Summary Table of deposits investigated - Richards Island to Fort Good Hope	51
II Preliminary Environmental Design Guidelines	54
Figure	
6.4.1 Ranges of resistivity with soil types	35
6.4.2 Resistivity as a function of temperature	36
6.4.3 Resistivity of frozen silt as a function of ice content	37
Photograph	
3.1.1 Kenting Big Indian Heli-Drill	8
3.1.2 Kenting Big Indian Heli-Drill	8
3.1.3 Kenting Aviation Limited Sikorsky S58E helicopter	10
3.1.4 NTCL Barge Camp and Fuel Barge	12
4.2.1 Typical Test Pit Excavation	19
4.2.2 Typical Test Pit Side Wall	20
5.3.1 Potential Borrow Deposit in Tundra Area	25
5.3.2 Potential Borrow Deposit in Forested Area	27
6.1.1 Geophysical Resistivity Instruments Set Up at a Potential Borrow Deposit	32

PROJECT 13011

CANADIAN ARCTIC GAS STUDY LIMITED
CALGARY ALBERTA

VOLUME II
1975 PIPELINE BORROW INVESTIGATIONS -
RICHARDS ISLAND TO FORT GOOD HOPE

DATE NOVEMBER 1976

1. SUMMARY

Granular materials in the order of 260,000,000 cubic yards have been identified and investigated along the proposed Canadian Arctic Gas Cross Delta and prime pipeline routes in the Richards Island to Fort Good Hope portion of the borrow investigation. A total of 48 deposits were investigated during the summer of 1975 by Northern Engineering Services Company Limited between Richards Island and Fort Good Hope, N.W.T. of which 35 were investigated in detail by geophysics, test pitting and drilling. The remaining 13 were investigated by geological field reconnaissance only. Geological and biological reconnaissance was used to obtain information on the location and extent, quantity, quality, biological factors, and development parameters for each of the 48 borrow deposits. Archaeology, land use, land availability and socio-economic factors were not included in the scope of the study.

This report contains descriptions of the field and laboratory results that pertain to each borrow deposit that was investigated. The detailed site specific information for each borrow deposit is presented as a complete package in the respective "Individual Site Report" under Section 11. Separate sections describing the regional geological and biological setting of the Richards Island to Fort Good Hope area, the geophysical methods used to investigate the borrow deposits, and the logistics of this portion of the borrow investigation are included in this report.

As a result of this study, eight new granular material borrow deposits were located. These deposits, not documented in the Granular Materials Inventory, the Mackenzie Highway investigations or oil company borrow studies, represent approximately 16 of the 260 million cubic yards of available granular material between Richards Island and Fort Good Hope.

PROJECT 13011

CANADIAN ARCTIC GAS STUDY LIMITED
CALGARY ALBERTA

VOLUME II
1975 PIPELINE BORROW INVESTIGATIONS -
RICHARDS ISLAND TO FORT GOOD HOPE

DATE NOVEMBER 1976

2. INTRODUCTION

During the summer of 1975 a borrow exploration program was undertaken by Northern Engineering Services Company Limited (NESCL) for Canadian Arctic Gas Study Limited (CAGSL) along the proposed gas pipeline route north of latitude 60° N in Canada.

Territory covered by the program included the Yukon coastal plain portion of the Coastal Route, the Cross Delta Route and the Prime Route with the East of Fort Simpson realignment.

The program obtained preliminary site specific information on potential granular borrow deposits along the pipeline (for location of individual deposits see Appendix B). Emphasis was placed on investigating sources that were outside areas covered by the DIAND Granular Materials Inventory and on gathering further information on granular deposits in previously documented areas where shortages of good quality borrow have been identified. In addition, field visits were made to borrow sources which appear in the pipeline application and further information was gathered on surface and subsurface aspects of the terrain along the pipeline.

Prior to this borrow field study, airphotos, published surficial geology maps, and DIAND Granular Materials Inventory reports were assessed to obtain information on potential borrow sources that could be used in pipeline construction. Preliminary choices of borrow sources for the pipeline and its facilities are shown

in the pipeline application and in two NESCL reports entitled: "Pipeline Related Borrow Studies" (July, 1974); and "Pipeline Related Borrow Studies Cross Delta Alternative Route and East of Fort Simpson Realignment" (November, 1975).

The borrow investigation obtained preliminary information on the location of potential borrow deposits provided information concerning the nature of the deposit and provided a rough estimate of the insitu quantities of each deposit. For final design and contractual purposes this program will have to be followed by further detailed investigations. Data obtained during the 1975 field investigation are contained in this report which is preliminary and not intended for final design or contractual purposes.

The borrow field program consisted of a geological and biological reconnaissance of granular material sources followed by ground geophysical investigation, test pitting and drilling of promising deposits selected during the reconnaissance. Archaeology, land use, land availability and socio-economic factors were not included in the scope of the study. The borrow investigation from Richards Island to latitude 60° N was carried out concurrently with the 1975 wharf investigation to optimize the use of helicopters, tugboats, and fuel barges.

Organization, management, and supervision for this project were provided by NESCL. Engineering field support, field geophysical activities, and the geological reconnaissance from Fort Good Hope to latitude 60° N were carried out by NESCL personnel. The geological reconnaissance along the Yukon coastal plain and from Richards Island to Fort Good Hope was done by Dr. V. N. Rampton, P. Eng., of Terrain Analysis and Mapping Services Limited, Ottawa, Ontario. Biological reconnaissance was conducted by Mr. D. R. Wooley, Wildlife Biologist, of Renewable Resources Consulting Services Limited, Edmonton, Alberta. Samples collected in the field were tested by R. M. Hardy and Associates Limited, Calgary, Alberta. Drilling crews and equipment were supplied by Kenting

Big Indian Drilling, Calgary, Alberta, helicopter support in the Mackenzie Delta area by Kenting Aviation Limited, Calgary, Alberta, and barge facilities by Northern Transportation Company Limited (NTCL), Hay River, N.W.T. Other groups that provided support for the borrow field program are listed in the Equipment and Personnel section of this report.

The field investigation for the borrow study started at the Alaska/Yukon border July 12, 1975, and continued to the Fort Simpson, N.W.T. area, where it was completed September 21, 1975. The report on this program has been divided into the following three volumes:

- Volume I: 1975 Pipeline Borrow Investigations - Yukon Coastal Plain. (Published May, 1976).
- Volume II: 1975 Pipeline Borrow Investigations - Richards Island to Fort Good Hope, N.W.T.
- Volume III: 1975 Pipeline Borrow Investigations - Fort Good Hope, N.W.T. to Latitude 60° N.

Volume II describes the borrow investigation in the Mackenzie Delta and northern Mackenzie River valley portion of the pipeline route. The majority of this area had been previously investigated during the DIAND Granular Materials Inventory. This inventory indicated that shortages of good quality borrow material exist in portions of this region. Areas where shortages had been identified were investigated in greater detail in order to identify additional borrow sources, to obtain further information on previously explored deposits, or to locate alternative bedrock quarry sites. A total of 48 deposits were investigated during this phase of the borrow study. Thirty-five deposits were drilled and test pitted, and 13 were investigated on a reconnaissance basis.

3. EQUIPMENT AND PERSONNEL

3.1 Equipment

3.1.1 Drills and Ancillary Equipment

The Kenting Big Indian Heli-Drill was used to drill test holes in the selected borrow sites. The Heli-Drill is a helicopter-transportable Mayhew 200 drilling rig mounted on a detachable base which can be levelled by means of three hydraulic jacks. The power units for the drill and air compressor consist of two Wisconsin VH4D 30-horsepower air-cooled gasoline engines which operate independently of each other. The Heli-Drill is usually transported as two packages. The first package consists of the drill frame, rotary table, draw works, mast assembly, and one power unit, and the second package consists of the drill base upon which the air compressor and the second power unit are mounted. Each of these two components weighs approximately 3400 pounds and is equipped with custom slinging cables to ensure a properly balanced load for transportation by helicopter.

All ancillary drilling equipment and tools such as drill rods, drilling bits, hand tools, and spare parts were carried in a steel mesh tool basket weighing approximately 3500 pounds. A mud pump complete with power unit was also taken into the field to provide wet drilling capabilities for the Heli-Drill. The air compressor and mud pump units are easily interchangeable.

The Kenting Big Indian Heli-Drill was selected for this borrow investigation because it can be used either with the compressed air or water circulation modes for drilling. In addition, the Heli-Drill has more versatility for handling a greater number and variety of downhole sampling tools and drill bits. The Kelly and Sand line cables were modified by double lining to provide greater pulling capabilities in the event that either the drill bit or sampling tools became lodged during removal.

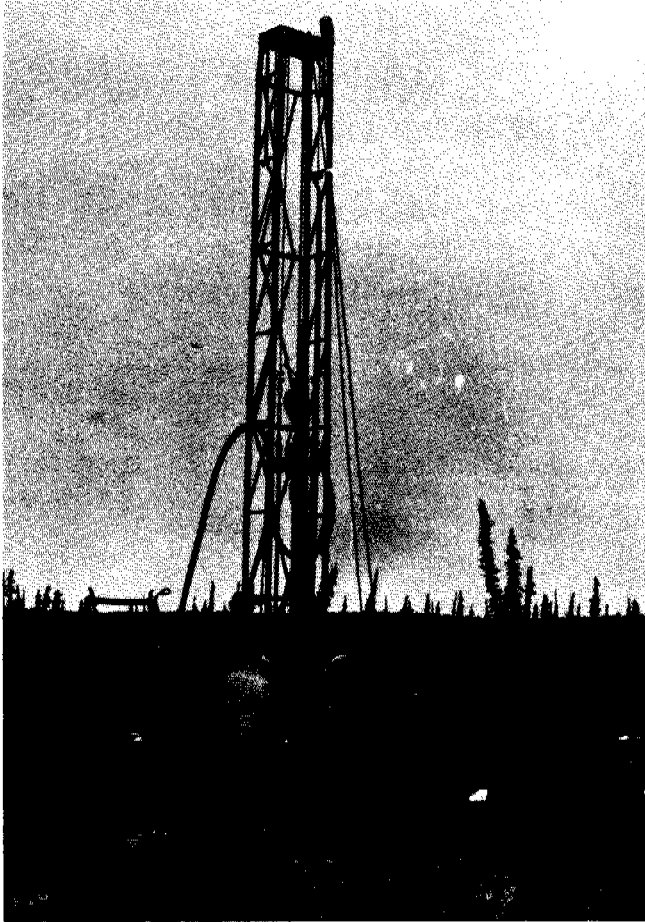


Photo 3.1.1

View of Kenting Big Indian Heli-Drill at deposit N75-107B-B15 drilling by means of airflush to prove out depth of granular material.

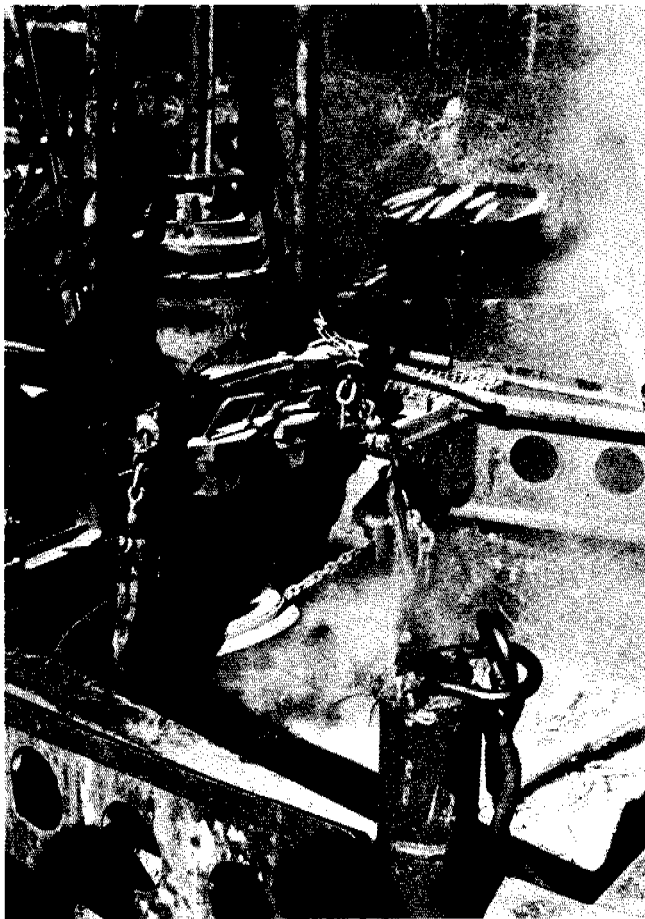


Photo 3.1.2

Close up view of drilling action while rig rotates on boulder.

3.1.2 Test Pitting Equipment

Two 150 cfm gas-powered Ingersol-Rand air compressors were used to facilitate the test pit excavations. Each air compressor was equipped with two 60-pound air hammers, 200 feet of steel reinforced rubber air hose, and an assortment of 3-inch wide clay spades and 2-inch wide asphalt spades. The air compressors and associated equipment were supplied by Modern Industrial Rentals Ltd., Calgary, Alberta and were equipped with an upper hook for slinging by helicopter. The air compressor with its complete complement of tools weighed approximately 3000 pounds.

Each test pitting crew of four men was provided with long handled spades and picks.

3.1.3 Geophysical Equipment

A complete description of the geophysical equipment used in this portion of the borrow source investigation is presented in Section 6 of this report entitled: "Geophysical Investigations of Granular Deposits".

3.1.4 Helicopters

A Bell 206B Jet Ranger helicopter, supplied by Kenting Aviation Ltd. from its Inuvik, N.W.T. base, was used for the geological reconnaissance crew. This helicopter is turbine-powered and has a capacity to carry four passengers, or sling up to 1100 pounds of cargo. In addition to ferrying the geological reconnaissance party, on occasion, the Bell 206B Jet Ranger helicopter was used to position the geophysical crew and equipment.

A Sikorsky S58E gasoline-powered helicopter provided by Kenting Aviation Ltd., with a maximum rated sling load lifting capacity of 4000 pounds, was selected to transport the Heli-Drill components,



Photo 3.1.3

Kenting Aviation Ltd. Sikorsky S58E helicopter hooking up to transport the Heli-Drill.

air compressors, bulky gravel samples, and the crews for the geophysical, test pitting, and drilling activities. The Sikorsky S58E helicopter has a very large cabin configuration which provides a very convenient, efficient and economical mode for transporting passengers, small equipment, and samples in a single air lifting operation.

3.1.5 Sampling Equipment

Test pitting was the principal method used to obtain representative granular material samples. Drilling was carried out to establish or confirm the depths of granular material at selected deposits and as a result sophisticated sampling and coring tools were not required. The air return cuttings and observation of the drilling action were used to assess the downhole conditions and evaluate the quality of material being drilled.

3.1.6 Radio Communications Equipment

The number of separate crews working concurrently at scattered locations away from the base camp necessitated a good communications network for both emergency purposes and efficient coordination of crew movements. Motorola Model PT300 lunch bucket type FM radios powered by rechargeable nickel-cadmium batteries were issued to the geological reconnaissance party, the geophysical party, the drilling crew, two test pitting crews, the Sikorsky S58E helicopter, and the base camp.

The S58E helicopter was used, almost entirely, to move the crews and their related equipment. As a result, the Motorola radio connected into the helicopter's intercom system became the field control centre for maintaining and coordinating the daily field program logistics. These portable radios proved to be invaluable for maintaining efficient operations during the course of the field program.

In addition, the base camp was equipped with "Very High Frequency" (VHF) and "High Single Side Band" (HSSB) radios to provide communications to the outside and southern population centres.

3.1.7 Accommodation and Support Facilities

The 24-man barge camp, 150-ton supply barge, Mark II Jetboat and casual tugboat charter were provided by Northern Transportation Company Limited (NTCL). The 24-man camp was specifically built and equipped to be mounted on a 300-ton river barge and contained sleeping quarters, kitchen, dinette, recreation area, radio room, washroom, laundry facilities, power plant, and general shop.

Support facilities from the Mackenzie Delta to south of Little Chicago consisted of Cessna 185 for light fixed-wing charters



Photo 3.1.4

NTCL Barge Camp along with the fuel barge at Inuvik N.W.T.

and fixed-wing Twin Otter charters for larger crew changes and bulkier supply transportation. These aircraft were provided by Corridor Air Limited and Kenn Borek Airways Limited of Inuvik, N.W.T., respectively. In the region between Little Chicago and Fort Good Hope, the fixed-wing support facilities were provided by Corridor Air Limited and Nahanni Air Limited of Norman Wells, N.W.T. in their respective Cessna 185 and Beaver aircraft.

3.2 Personnel

The following personnel were involved during the borrow source investigation from Richards Island to Fort Good Hope:

<u>Personnel</u>	<u>Affiliation</u>
1 Project Manager	NESCL
1 Project Engineer	NESCL
1 Project Geologist	Terrain Analysis & Mapping Services Ltd.

<u>Personnel</u>	<u>Affiliation</u>
1 Wildlife Biologist	Renewable Resources Consulting Services Ltd.
1 Junior Geologist	NESCL
1 Geophysicist	NESCL
2 Junior Geophysicists	NESCL
2 Geotechnical Engineers	NESCL
6 Test Pitting Northern Labourers	NESCL
1 Driller	Kenting Big Indian Drilling
1 Driller's Helper	Kenting Big Indian Drilling
2 Helicopter Pilots	Kenting Big Indian Drilling
2 Helicopter Engineers	Kenting Big Indian Drilling
1 Cook	NTCL
1 Cook's Helper	NTCL
1 Camp Attendant	NTCL
1 Camp Mechanic/Radioman	NTCL
1 Tugboat Captain	Keen Industries Limited
3 Tugboat Deckhands	Keen Industries Limited

The entire field party, with the exception of the tugboat crew, was billeted on the NTCL Camp Barge for the duration of the field program. The tugboat crew had their own quarters on their tugboat.

4. LOGISTICS AND METHODOLOGY OF FIELD OPERATIONS

4.1 Logistics

The detailed criteria regarding the logistics for the Richards Island to Fort Good Hope portion of the borrow investigation have been documented separately in a report entitled: "1975 Summer Wharf and Borrow Investigation Logistics Summary". The field operations for the borrow study were completely integrated with the 1975 wharf investigation on the Richards Island side of the Mackenzie Delta. The results of the 1975 wharf investigation have been recorded in a report entitled: "1975 Field Investigation - Wharf Report".

Although the detailed chronological documentation of the logistics for the borrow study has been compiled separately in the above captioned report, a brief description of the logistical planning and execution of the borrow source investigation for the Richards Island to Fort Good Hope portion of the study is listed as follows:

- (a) Following the completion of the field program for the borrow study along the Yukon coastal plain on August 7, 1975 (Ref. Volume I - 1975 Pipeline Borrow Investigation -Yukon Coastal Plain), the Richards Island to Fort Good Hope portion of the borrow study was commenced on August 8, 1975.
- (b) During the night of August 7, 1975, the Barge Camp 702 was moved from its mooring at Tiktalek Channel on the west side of Shallow Bay to a new mooring on Neklek Channel immediately south of Tununuk Point. The operational logistics of the borrow field program were fully integrated with the wharf site drilling operations which had been operating from this location using Barge Camp 21 as their base.

- (c) The field drilling, test pitting, and geophysics commenced on site N75-107C-B1 at 1.00 p.m., August 8, 1975. The borrow source field program for prospective sites on Richards Island and east to Parsons Lake was carried out from the Neklek Channel base camp.
- (d) During the night of August 11, 1975, Camps 702 and 21 were moved by the tugboat, Delta Eagle, from the Neklek Channel. Camp 702 was moored at its new location near Reindeer Station at 4.30 a.m., August 12, 1975 and the "Delta Eagle" continued to the Inuvik wharf site with Camp 21. The field program for the borrow study was carried out from Reindeer Station until the evening of August 12, 1975.
- (e) The "Delta Eagle" returned to Reindeer Station on August 12, 1975 and moved Camp 702 to the NTCL docks in Inuvik during the night of August 12, 1975 and arrived in Inuvik at 6.00 a.m., August 13, 1975. The borrow study was carried out from Inuvik until the evening of August 16, 1975.
- (f) The Camp 702 borrow field operations were moved from Inuvik on the night of August 16, 1975 and arrived at the Thunder River location on the evening of August 18, 1975. Inclement weather, which grounded the helicopters, curtailed any field operations during this two day move.
- (g) Borrow source field operations continued from the Thunder River location until August 26, 1975.
- (h) Camp 702 was moved from Thunder River to Wharf site 15, near the Loon River confluence north of Fort Good Hope, during August 26 and 27, 1975. The borrow source field operations were maintained during this two-day move.
- (i) The remaining field work on the selected borrow sites north of Fort Good Hope was carried out, using Camp 702 at Wharf Site 15 as a base of operations.

- (j) The field work on the Richards Island to Fort Good Hope portion of the borrow study was completed on August 29, 1975.

4.2 Methodology

4.2.1 Literature Review and Office Study

Pertinent geological information from various studies such as the Geological Survey of Canada maps and reports, the DIAND Granular Materials Inventory, pipeline alignment sheets, private industry reports, and previous NESCL project reports were compiled and assessed for the Richards Island to Fort Good Hope portion of the study area. These served as background for airphoto mapping of prospective granular material deposits. Deposits were selected for further investigation according to their position relative to the proposed pipeline right of way, their position relative to major stream valleys, the amount of overburden covering the granular material, and the anticipated quality of the insitu granular material. Special efforts were made to prove out granular deposits in areas previously identified as having shortages of granular materials.

4.2.2 Geological Field Reconnaissance

The airphoto interpretation and office studies served as a basis for planning and conducting the preliminary geological field reconnaissance. A senior geologist and a geological technician carried out the site by site ground check of each potential borrow source which had been selected by airphoto interpretation. The outlines of the prospective borrow sites were delineated on the corresponding airphoto along with any additional salient features of the deposit. The exact location of the test pits,

drill holes, and transects for ground geophysics was specified and designated during this reconnaissance for each borrow site selected for additional investigation.

A project biologist accompanied the geological reconnaissance group to provide a biological assessment. A biological overview of the region is provided under Section 7.

4.2.3 Field Investigation

On the basis of the geological reconnaissance and the time period available to complete the detailed field investigation for the Richards Island to Fort Good Hope study area, a total of 35 borrow deposits were selected for test pitting, drilling and geophysics. This schedule was based on the completion of two borrow deposits each work day. An additional 13 borrow deposits were ground checked during the geological reconnaissance.

Generally, two to three test pits per borrow deposit were completed by the two test pitting crews consisting of three northern labourers for each crew. The supervision of the two test pitting crews, sampling and logging was carried out by a junior geotechnical engineer. The test pits excavated were generally 4 by 6 feet in area, and extended from 4 to 10 feet in depth. The 60-pound hammers, powered by compressed air, were used to extend these test pits beneath the permafrost table. In general, the test pits were selected in areas where the active layer was thought to be the deepest to minimize the need for compressors. All organic peat and/or vegetation material on the surface of the test pit location was carefully removed and replaced after the test pit had been backfilled.

When the test pit had been excavated to the desired depth, a representative sample of granular material was taken from the exposed vertical wall of the test pit. These samples generally

weighed 400 to 500 pounds and were contained in six to ten sample bags. The material was retained in heavy plastic bags in order to minimize the loss of moisture content and fines. In addition to the samples, a photographic record of one vertical face of the test pit was taken in a series of frames from the surface to the bottom of the pit. These photos are on file at NESCL.

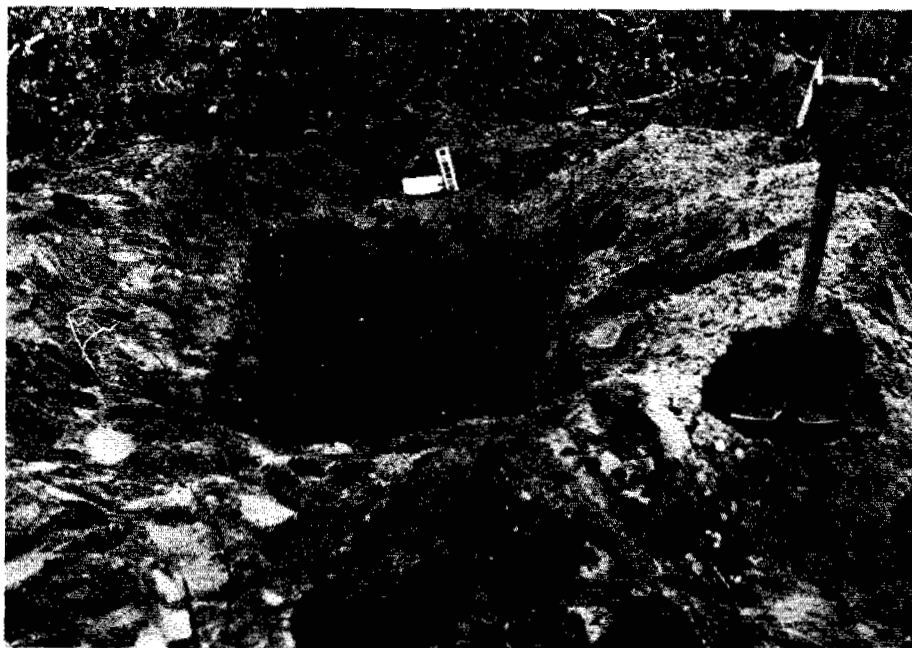


Photo 4.2.1

Typical view of a test pit excavation at deposit N75-106P-B3.

The depth of selected borrow deposits were checked by drilling in areas that were representation of the deposit. A helicopter-portable "Heli-Drill", which is described in detail in Section 3 of this report, was used. In general, the drill holes were located where the active layer was shallowest in order to minimize

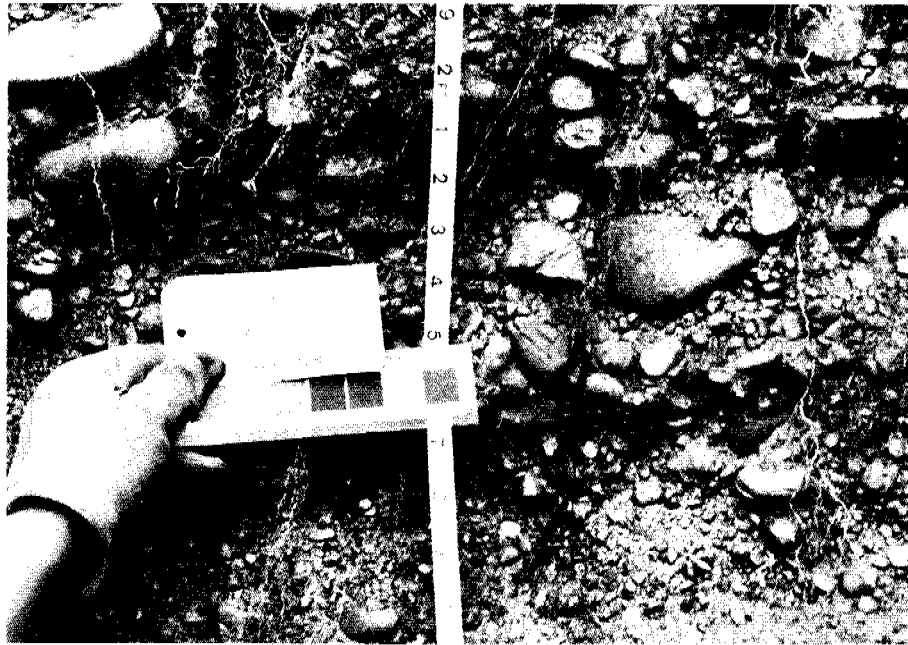


Photo 4.2.2

Typical view of a test pit side wall at deposit N75-107C-B2.

caving and "blow out" problems during the drilling operations. An open-hole air circulation technique was used primarily, although a wet circulation capability was available on this drilling rig. The subsurface logging was conducted by observing the air flushed cuttings and the downhole drill action.

The ground geophysics conducted at each borrow deposit were carried out by a three-man crew. The details and the results of the geophysical investigation are included in Section 6 and Appendix "C" of this report.

4.2.4 Laboratory Testing

The entire series of test pit samples obtained for this portion of the borrow study were forwarded to R.M. Hardy and Associates Limited, Calgary, Alberta. The following laboratory tests were carried out:

(a)	Mechanical Grain Size Analysis	ASTM C 136 - 71
(b)	Moisture Content	ASTM C 566 - 67
(c)	Petrographic Analysis	ASTM C 295 - 65
(d)	Los Angeles Abrasion Test	ASTM C 131 - 69
(e)	Sulphate Soundness Test	ASTM C 88 - 73
(f)	Organic Content	ASTM C 40 - 73

The schedule of samples to be tested, and the types of tests to be conducted on each sample, were provided to R.M. Hardy and Associates Limited by NESCL. The results of the laboratory tests are included in the individual site reports.

It should be noted that none of the drill hole logs were verified by laboratory testing.

4.2.5 Report Format

The site specific information for each potential borrow deposit is incorporated in the "Individual Site Reports", which is outlined in Section 1.1 of this report.

5. REGIONAL GEOLOGY AND GEOMORPHOLOGY OF THE RICHARDS ISLAND TO FORT GOOD HOPE AREA

5.1. General

The study area includes parts of the Arctic Coastal Plain and Anderson Plain. That part of the Arctic Coastal Plain covered by this study consists of three parts:

- (a) the Pleistocene Coastlands, an extensive lake dotted lowland 50 to 200 feet above sea level, which is underlain by thick Pleistocene deposits;
- (b) the Caribou Hills, a rolling upland, much of which is over 500 feet above sea level and which is underlain by relatively soft rock formations; and
- (c) the Mackenzie Delta, a flat, deltaic plain covered by a maze of lakes and channels, which is developed on postglacial fine-grained unconsolidated sediments.

The Anderson Plain north of 68° latitude is a gently undulating to flat upland, which rises from 200 feet at its northern edge to 800 feet plus near North Caribou Lake. The northern section, called the Campbell Lake Hills, is interrupted by a broad trench incised into bedrock and occupied by Campbell Lake. South of 68° latitude to near Yeltea Lake, the Anderson Plain is still broadly undulating, but is commonly above 1000 feet elevation. Bedrock is exposed along the edges of numerous broad valleys. The Anderson Plain is lower and flatter between Yeltea Lake and Fort Good Hope, generally between 200 and 700 feet elevation, and has fewer incised valleys. The southwest edge of the Anderson Plain is defined by the Mackenzie River trench, which is occupied by the river and adjacent low flat benches.

5.2 Bedrock

Tertiary strata lies well over a hundred feet below the ground surface in the Pleistocene Coastlands, but rises to near the surface under the northern part of the Caribou Hills, where interbedded, poorly consolidated Tertiary conglomerates, sandstones, and mudstones are exposed along most escarpments. The southern end of the Caribou Hills is underlain by Cretaceous shales.

The Campbell Lake Hills north of Campbell Lake are erosion resistant Precambrian quartzites and argillites and Paleozoic carbonates. South of Campbell Lake, the terrain is primarily underlain by Cretaceous and Devonian shales and sandstones with more competent sandstones often capping plateaus. East of Thunder River bedrock is middle Devonian limestones and shales, frequently capped by Cretaceous shales and sandstones. The Devonian limestones and more resistant Cretaceous sandstones are frequently cliff formers.

5.3 Surficial Deposits

The Mackenzie Delta is formed primarily of organic silts and sands. The surface of the Delta is marked by not only delta channels, but numerous thermokarst lakes and shallow depressions.

Most of the Pleistocene Coastlands and Campbell Hills are blanketed by either morainal or glaciofluvial deposits, or thermally modified versions of these materials as they were glaciated in early Wisconsin time. Outwash deposits are concentrated near Ya-Ya Lake, the East Channel of the Mackenzie River, the northern edge of the Caribou Hills, east of Parsons Lake, and adjacent to the Eskimo Lakes. Most of the remaining area is covered by 5 to 20 feet of till, or lacustrine deposits

of thermokarst origin. During deglaciation of the Caribou Hills, drainage was often blocked and a thin blanket of glacio-lacustrine silt and clay covers earlier glacial deposits in lower areas. Materials of variable texture are generally capped by 5 to 10 feet of ice-rich silt and peat in depressions and on flat areas.

Throughout the western part of the Pleistocene Coastlands and in the broad depressions within the Caribou Hills, the previously described glacial and postglacial sediments are underlain by a thick sequence of interbedded fluvial and deltaic sands and marine clays. The marine clays of this sequence are found mainly on the northwest part of Richards Island.

The hummocky topography of the Pleistocene Coastlands and parts of the Caribou Hills results from the variable ice content of surface sediments. Most hills are underlain by sediments



Photo 5.3.1

Potential borrow deposit located in the tundra area near Parsons Lake N.W.T.

containing very icy sediments or massive ice layers, whereas sediments underlying depressions contain less ice. The ice layers underlying the hills were melted by thermokarst processes during the formation of the depressions.

The Campbell Lake - Stitidgi Lake lowlands contains glacio-lacustrine clays capped by a blanket of peat. The southeastern flank consists of fluted bedrock and drumlinized till with a few eskers paralleling the northeast trending drumlins and flutes. A peat layer blankets the drift over much of this area.

Moraine ridges, kame complexes, and outwash deposits define the irregular margin of a former glacier ("classical Wisconsin" limit) from southeast of Sitidgi Lake east past Travaillant Lake to southeast of Tutsieta Lake. This glacial limit was largely controlled by bedrock relief. The outwash is generally in the form of valley trains that occupy broad valleys incised in bedrock and leading ultimately to the Kugulak and Anderson Rivers.

The terrain between Campbell Lake and Fish Trap Lake is rolling to hummocky moraine with patches of organic material. Southeast of Fish Trap Lake to near Yeltea Lake, till and colluvium varying in depth from 5 feet to greater than 50 feet cover a highly dissected bedrock surface. Surficial deposits are thickest in the broad incised valleys and depressions. Glaciolacustrine deposits are scattered throughout the lowlands and depressions. Peat is confined to poorly drained depressions and broad flat areas.

The hummocky to rolling nature of some glacial deposits between Campbell Lake and Yeltea Lake is most often due to the presence of icy sediments and massive ice under hills, and relatively low in content of sediments underlying intervening thermokarst depressions.

South of Yeltea Lake, most of the Anderson Plain is covered by till, 3 to 40 feet thick, in the form of a morainal plain. In

major valleys, such as those occupied by the Loon and Hare Indian Rivers, till overlies thick preglacial sands and gravels. Discontinuous glaciolacustrine sediments and glaciofluvial sands overlie the till in both these valleys and peat is common in poorly drained depressions. A major esker-kame complex parallels the lower Hare Indian River.



Photo 5.3.2

Potential borrow deposit located in the forested area north of Fort Good Hope.

Benches along the Mackenzie River trench are covered by up to 150 feet of glaciolacustrine silt and clay and are frequently capped by sand. On higher benches, hummocky moraine is present and only the lower areas of the benches are veneered by lacustrine deposits. Peat is common in poorly drained broad depressions. The previously mentioned glacial deposits often overlie preglacial sands and gravels. Alluvial fan deposits and kame terraces are often present adjacent to the base of the escarpment bordering the Mackenzie River trench.

5.4 Permafrost and Ground Ice

The study area lies within the zone of continuous permafrost north of Thunder River. Taliks exist under most water bodies. The active layer is generally one and two feet thick under areas with thick turf or peat cover. Under exposed gravels on south facing slopes it increases to about 6 feet thick just north of Inuvik, but is again shallower in the treed area just south of Inuvik. However, thaw depths in well drained gravels near Travaillant Lake often exceed 10 feet.

South of Thunder River widespread discontinuous permafrost is present. Active layers are shallow, 1 to 3 feet deep, in areas covered by thick turf or peat but are in excess of 12 feet under well drained gravel deposits. Some ridges and well drained slopes may be free of permafrost near Fort Good Hope. Imperfectly drained sand or gravel with a thin peat or organic cover have active layer depths of 3 to 10 feet.

Ground ice in the form of tabular bodies of massive ice is common under many hills and ridges in the area north of Inuvik. Although ice is most common at the contact between till or fine-grained deposits and the underlying sand or gravel, it is not restricted to this horizon and may occur within any unconsolidated material at variable depths to at least 200 feet. Many glaciofluvial deposits are known to contain or overlie massive ice of this type. Ice lenses, are common in tills and fine-textured materials in this area; commonly these deposits contain about 20 percent excess ice with somewhat higher ice contents near the base of the active layer. Sandy outwash also frequently contains thin ice lenses. Ice wedges occur in all materials.

Tabular bodies of massive ice, ice lenses, and reticulate ice are plentiful in lacustrine deposits as far south as Fort Good Hope. Till generally contains a concentration of ice lenses in the upper 5 feet that can form as much as 25 percent of the total

sediment volume. However, tabular bodies of massive ice in till seems to be confined to areas north of Thunder River. In this same area, irregular bodies of massive ice may also be present in sandy and silty fluvial and glaciofluvial material. Ice wedges are still present in materials having shallow active layers, but are absent or negligible in gravels having active layers of 8 feet or more.

5.5. Regional and Local Drainage

The Hare Indian and Loon Rivers are the only rivers of any significant size that drain into the Mackenzie River in the Richards Island to Fort Good Hope section. Other streams are minor as most of the drainage is north to the Anderson, Kugaluk, and Miner River systems. The Mackenzie River, itself, forms a maze of distributaries throughout the Mackenzie Delta, although major discharge is confined to larger channels. The East Channel of the Mackenzie River leaves the Delta at Tununuk separating Richards Island from the mainland.

On the Pleistocene Coastlands and flatter parts of the Caribou Hills, small beaded creeks flow between lakes and many areas seem to be drained through seepage along icewedge trenches. These trenches are characteristic of polygonal ground common to depressions and swales. On areas with gentle regional slopes such as higher portions of the Caribou Hills and much of the Anderson Plain, local drainage appears to be through seepage along fen-filled valley bottoms or shallow drainageways which lack a definite stream channel. In valleys where a clearly defined stream channel is present, low terraces are often not integrated into the stream drainage and are characterized by standing water on their surfaces. On outwash plains, old channels are also poorly drained and covered by fens and wet meadows.

5.6 Granular Materials

Granular materials in the study area are concentrated in the following environments:

- (1) The Ya-Ya esker and associated outwash deposits on Richards Island.
- (2) Kame terraces and complexes along the northern edge of the Caribou Hills.
- (3) Exhumed Tertiary gravels throughout the Caribou Hills.
- (4) Kame complexes between Parson's Lake and the Eskimo Lakes.
- (5) Eskers and kame terraces along the southeastern edge of the trench occupied by Campbell Lake.
- (6) Numerous kame complexes, kame deltas, and outwash plains that are associated with a glacier limit that can be traced from southeast of Sitidgi Lake past Travaillant Lake to southeast of Tutsieta Lake.
- (7) Kame terraces along the edge of the Mackenzie River trench.
- (8) Loon River fluvial terraces.
- (9) An esker-kame complex northeast of Fort Good Hope.

6. GEOPHYSICAL INVESTIGATIONS OF GRANULAR DEPOSITS

6.1 General

Gravel deposits can often be delineated from surrounding soils by measuring the electrical resistivity of the ground. Figure 6.4.1 shows the resistivity ranges of the soil types of the Unified Soil Classification System. Clean gravels (GP) have a resistivity in excess of 1000 ohm-m, gravels with fines (GC) have lower resistivities. It is often difficult to differentiate sands from gravels by resistivity measurements.

The relatively simple situation, shown in Figure 6.4.1, becomes considerably more complex in permafrost regions. Figure 6.4.2 shows the variation in resistivity with temperature for several soil types; when the ground freezes the resistivity increases; and for gravels, this increase is sudden. The trend of a resistivity increase, in going from clay to silt to gravel, is maintained when the ground is in the frozen state. However, in addition to temperature the ice content of the ground influences resistivity, as is illustrated in Figure 6.4.3. High resistivity (> 5000 ohm-m) in permafrost regions can, therefore, be due to low ground temperatures, high ice content and frozen gravel.

Thus, the resistivity of gravel deposits depends, in addition to soil type, on temperature and ice content. The value of resistivity over a frozen deposit can, therefore, not be used as a criteria for soil type without correlation to borehole data.

Often the best use of geophysics in borrow inventory programs is in delineating the extent of granular deposits and extrapolating subsurface information between boreholes. This requires that many geophysical soundings are made, so that a clear indication is obtained of the relative values of resistivity on and around granular deposits. During this investigation only a few (1 to 3)

measurements were made near or on a deposit, and the results of geophysical surveys were, therefore, often inconclusive.

Resistivity surveys, particularly in the Arctic, require electromagnetic rather than electrical methods. In electrical methods, the contact resistance of probes inserted in the ground has to be kept low. Establishing low contact resistance is difficult on permafrost. Also very small lateral variation in depth of active layer can have very large effects on electrical resistivity measurements. Electromagnetic methods have significant advantages over electrical methods in resistivity surveying in the Arctic. Electromagnetic methods for shallow exploration (~ 30 ft) were still under development at the time of the borrow program. Non-contact electromagnetic methods for shallow exploration became available shortly after the conclusion of the borrow investigation.



Photo 6.1.1

Geophysical resistivity instruments set up at a potential borrow deposit in the Noell Lake area just north of Inuvik N.W.T.

6.2 Resistivity Results

During the borrow investigation, two geophysical measurements were made:

- (a) vertical soundings with four probes (galvanic) in a Schlumberger array,
- (b) VLF radiohm resistivity measurements.

Because vertical soundings with probes is a relatively slow process, there was only time for a few soundings. From these data it has been difficult to draw a reliable interpretation about soil types at granular deposit sites.

The VLF radiation has a depth of penetration that is too deep for shallow exploration. VLF radiation in the area investigated in this volume mainly reflected depth of frozen ground or depth to bedrock.

Because the geophysical measurements, employed at the time of the survey, were of limited value to this program, and were not used in either determining the extent or depth of the deposits, the data are not included in this volume.

Shortly after the field program for the borrow investigation was completed, electromagnetic equipment designed for shallow exploration became available. The equipment was tested, for its ability to delineate granular deposits in five existing deposits in the Calgary area. The results of these tests are given in Appendix C. The equipment described and tested in Appendix C has the following advantages over the conventional methods used in the borrow investigation:

- (a) productivity of surveying increased by at least a factor 10, so that a deposit can be quickly scanned.

- (b) depth of exploration limited to depth of interest (20-30 ft),
- (c) local resolution of ground conditions (10-15 ft), so that changes in subsurface conditions are mapped with a resolution of 10-15 ft.

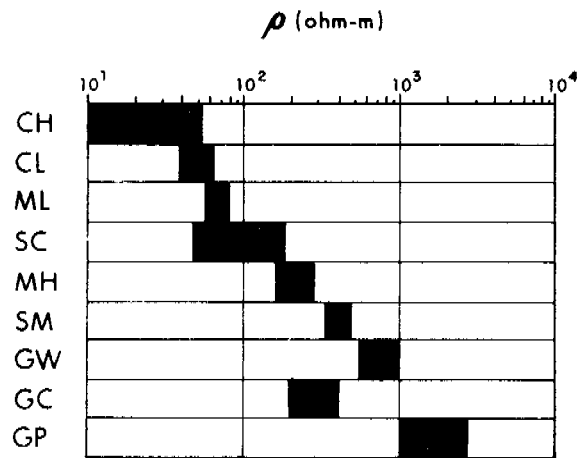


FIGURE 6.4.1
 THE RANGES IN RESISTIVITY ASSOCIATED WITH THE SOIL
 TYPES OF UNIFIED ENGINEERING CLASSIFICATION SYSTEM.
 (CH - FAT CLAY; ML - SILTY CLAY; SC - SANDY CLAY; MH - SILT;
 S - SAND; GW - WELL SORTED GRAVEL; GC - GRAVEL WITH
 CLAY; GP - POORLY SORTED GRAVEL).



NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

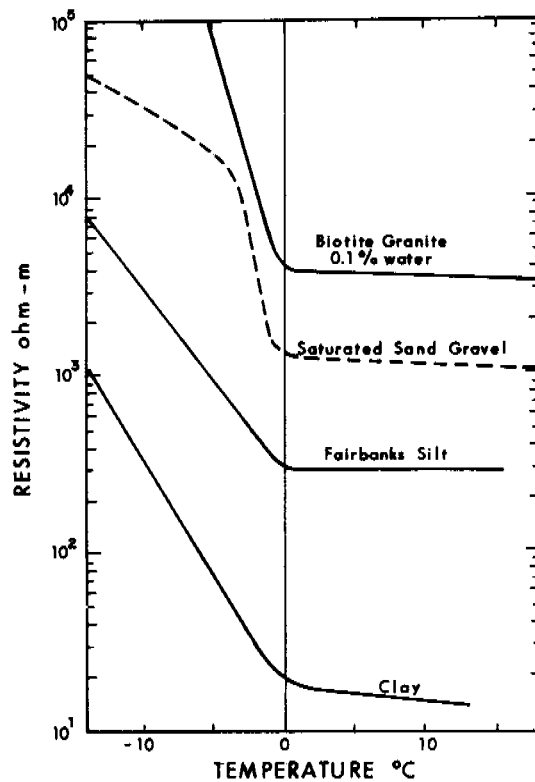



FIGURE 6.4.2.
 THE RESISTIVITY OF SEVERAL SOILS AND ONE ROCK TYPE,
 AS A FUNCTION OF TEMPERATURE (HOEKSTRA ET AL., 1975)²



NORTHERN
Engineering Services
Company Limited

**NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED**
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

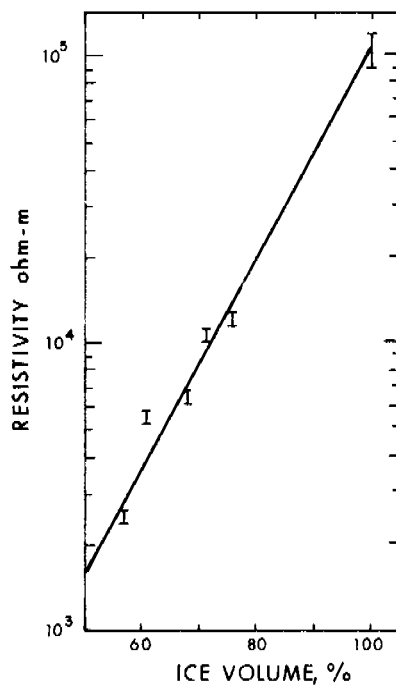


FIGURE 6.4.3.
RESISTIVITY OF FROZEN SILT AS A FUNCTION OF ICE
CONTENT (HOEKSTRA ET AL., 1975)²



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED

CALGARY ALBERTA

ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

7. BIOLOGICAL OVERVIEW - RICHARDS ISLAND TO FORT GOOD HOPE

7.1 Vegetation

The vegetation along the proposed route is transitional between treeless tundra on the Mackenzie Delta and coniferous boreal forest on the Anderson Plain, consisting mainly of open stands of low spruce with an extensive ground cover of lichen. A more detailed description of the vegetation of the Mackenzie Delta is found in Corns (1974), while Rowe (1972) and Zoltai and Pettapiece (1973) provided descriptions of the vegetation of the Anderson Plain.

The tundra vegetation of Richards Island and the Caribou Hills consists mainly of a low shrub-heath type on drier sites, with sedge-cottongrass-heath and raised centre polygon types in wetter depressional areas. Common species found here include dwarf birch, willow, alder, Labrador tea, lingonberry, crow-berry, sedge, cottongrass, lichen, and moss.

The forest-tundra transition extends south on the Anderson Plain from the Caribou Hills to the Thunder River. The vegetation consists of a mosaic of stunted forest usually along the shores of lakes, streams, and rivers, separated by patches of tundra vegetation including polygon areas. The primary species are black and white spruce and tamarack, accompanied by alder and willow shrubs. The pattern shows a gradual change from north to south as forest expands and tundra shrinks.

South from the Thunder River to Yeltea Lake an open subarctic woodland predominates. Areas of bog and fen are intermixed with open stands of dwarfed trees. Characteristic of the park-like coniferous stands on upland sites is a ground cover of light-coloured lichens. The most abundant species on all sites is

black spruce and associated with it on well drained soils are white spruce and white birch, while tamarack is usually found on poorly drained soils.

A closed coniferous forest is characteristic from Yeltea Lake to Fort Good Hope. On some well drained soils, especially beside the Tieda, Loon, and Hare Indian rivers, white spruce attains sawlog size, but in general, stunted white and black spruce with willow and alder prevail over large areas of poorly drained soils. White birch is commonly found on well drained upland soils. Non-forested land is made up of bogs, fens, and recently burned areas.

7.2 Mammals

The distribution of mammals in this area varies along the tundra-forest gradient. In the north, on Richards Island and in the northern portion of the Caribou Hills, grizzly bear, Arctic fox, reindeer and Arctic ground squirrel are found whereas moose, beaver, caribou and marten are found in the forested areas.

Richards Island is an important denning area for grizzly bears. Protection of denning habitat is important because of the low productivity and restricted range of the grizzly bear. Black bear dens have been identified in the Thunder River valley and along the banks of the Mackenzie River (Slaney 1974).

Muskrats are found in most lakes, but prefer lakes with high banks as found in upland portions of Richards Island and in the Parsons Lake area (Slaney 1974).

White foxes are common on the coast of Richards Island and red foxes are abundant inland. All dens found by Slaney (1974) on Richards Island were considered to be red fox dens. Of 45 dens located in 1972-73, 29 were found in sandy soil, 12 in sandy/loam soils and 4 in gravel.

Sparse beaver populations are found throughout the study area. Habitat near the proposed pipeline in the area north of treeline was designated by Dennington *et al.* (1973c) as Class IV (insignificant) with the exception of Holmes Creek. South of treeline wetland complexes such as the Campbell-Sitidgi Lakes lowland are Class III (poor quality) habitat. Class III beaver habitat is associated with wetland complexes which are more numerous south of Travaillant Lake. One such area north of Payne Creek is Class II (intermediate quality).

The best moose habitat in this region occurs on islands in the Mackenzie River which are Class I (good) moose wintering range (Prescott *et al.* 1973). Apart from these areas, moose habitat is generally of low quality along the proposed pipeline route north of Fort Good Hope. The Hare Indian River and a small wetlands complex immediately northwest of the Hare Indian River are Class III (poor) moose wintering habitat. The only other Class III moose habitat along the pipeline route between Fort Good Hope and Richards Island is found in the Campbell-Sitidgi Lake lowlands and in the Holmes Creek area. The balance of the area is Class IV (insignificant or nil) moose wintering range. Moose range throughout the area north of Holmes Creek during the summer period.

Three subspecies of caribou are found in this region. Woodland caribou are scattered throughout the forested portion of the region. A population of 1000-2000 caribou of undetermined subspecies has been estimated for the Travaillant-Husky lake area (Canadian Wildlife Service 1973). Part of the Bluenose herd winter in the Travaillant Lake area. Evidence presented in the Berger Inquiry (1975) relating to ongoing studies by the Canadian Wildlife Service, indicates an estimated population of 94,000 animals to be extending their winter range westward. Semi-domesticated reindeer are herded north of Inuvik and moved from summer range on the Tuktoyaktuk Peninsula to winter range near tree line in the Parsons Lake area.

Other species such as the marten, mink, and red squirrel are found primarily south of tree line.

7.3 Birds

The diverse vegetation types found in the area provide a variety of habitat for birds, with a pronounced north-south gradient in species diversity influenced by the transition from tundra to forest vegetation. Richards Island is a staging and migration area for waterfowl and is considered Class 2b (good) to Class 2a (very good) waterfowl habitat. Habitat quality declines southwards and is replaced by Class 3a (poor), 4a (marginal), and 4b (insignificant to nil). South of the Campbell and Sitidgi lakes, the quality of waterfowl habitat declines to Class 3a to 4b with small areas of better habitat becoming more scattered.

Land birds increase in species diversity from north to south, (Salter and Davis 1974) in response to increased diversity of terrestrial habitats. Although the diversity of land birds increases, the density does not increase.

Snow geese utilize the outer Mackenzie Delta as far as the western edge of Richards Island for staging (Tull 1975). The only breeding area for geese (predominantly white-fronted geese) recorded along the pipeline route outside of the Mackenzie Delta is the section from Richards Island to Noel Lake. Breeding whistling swans utilize portions of Richards Island. Densities of 1.2 swans per square mile were recorded in 1975 (Tull 1975).

Ducks are found in relatively high densities along the proposed route south of the Mackenzie Delta, south of Travaillant Lake and east of Travaillant Lake. Most common species include oldsquaw, goldeneye, greater and lesser scaup, widgeon (in forested areas), and pintail.

Loons, particularly the Arctic loon, are common along the route south of Richards Island and south of Travaillant Lake (Tull 1975). Numerous loons were observed during this field survey on lakes adjacent to potential borrow sources.

The only known peregrine falcon nests within two and one-half miles of the route or potential borrow sources are in the Campbell Lake Hills. There are no known gyrfalcon nests within two and one-half miles of the route (Tull 1975).

7.4 Fish

All major streams and rivers crossed by the route and in the vicinity of potential borrow sources support fish populations. Some rivers have potential for overwintering fish populations, including the East Channel of the Mackenzie River, Loon River, Thunder River and Hare Indian River. Other important fish habitat in the area is associated with large deep lakes, such as Noell Lake and Travaillant Lake where grayling, lake trout, whitefish, and cisco occur. Available fisheries information is provided in the individual site reports.

8. DATA PRESENTATION

8.1 Individual Site Reports

8.1.1 General

The data has been presented so that all information related to a given borrow deposit is available as an individual package. The information includes:

- (1) Airphoto and Summary
- (2) Site Report
- (3) Test Pit and Test Hole Logs
- (4) Laboratory Test Data

8.1.2 Airphoto and Summary

An airphoto and synoptic page introduces each individual site report. The physical outline of the borrow deposit, location of test pits and/or test holes, and the proposed pipeline route are noted on the airphoto. A brief summary outlining the Physical Setting, Material, Volume, and Assessment for each individual deposit is denoted on the airphoto page.

8.1.3 Site Report

All pertinent data and assessments which have been compiled for the potential borrow deposits investigated from Richards Island to Fort Good Hope are discussed and presented on a site specific basis under the following headings:

- (a) Physical Setting - location of deposit in relation to the pipeline right of way and the geological setting. Drainage is given (ref. Appendix A) as well as geomorphology, ice contents and organic soil cover.

- (b) Biological Setting - A general description of vegetation, observed and recorded mammal and bird use of the area, and fisheries potential of adjacent waterbodies are given for each site. These data were used to make an initial biological assessment of development of the site and will be used to identify sites requiring further investigation.

- (c) Materials - description of soils in the deposit according to the test hole logs which are classified according to the Terms and Symbols Section in Appendix A. In the Materials and the Development and Rehabilitation sections the materials are indicated as being sources of excellent, good, fair and poor quality granular material. These terms are based upon the definitions as found in "Appendix A" pp A-16 and A-17.

- (d) Volume - estimated total volume of granular material as calculated by planimetering the outline of the deposit and using a conservative depth of the deposit according to test hole logs and airphoto interpretation.

- (e) Development and Rehabilitation - the sections on Physical Setting, Biological Setting, Materials, and Volumes were used to describe the potential development of the deposit. A brief general plan for development of the deposit was formulated with the understanding that additional environmental concerns may alter final design.

8.1.4 Test Pit and Test Hole Logs

An individual test pit or test hole log has been prepared on the standard NESCL form and in accordance with the standardized "Terms and Symbols" section which is included in Appendix A. The test pit and/or test hole log data are presented within the respective individual site reports.

8.1.5 Laboratory Test Data

The grain size information for each sample tested is presented on the "Grain Size Distribution Curve", plotted and produced by R.M. Hardy and Associates Ltd. The remaining laboratory tests such as Los Angeles abrasion, sulphate soundness, organic content and petrographic analyses are summarized and tabulated on the form entitled: "Summary of Laboratory Tests to Determine Aggregate Suitability in Concrete". In those cases where the fine aggregate was also tested the results are similarly tabulated and cross-referenced to the coarse aggregate results. Each individual site report includes all test results which are pertinent to that specific borrow source.

8.2 Strip Maps

In addition to the site specific airphotos, the location and shape of each potential borrow source which has been investigated from Richards Island to Fort Good Hope have been plotted on the Project Strip Maps at a scale of 1:250,000. These project strip maps were produced using the National Topographic Surveys map series and are presented in Appendix B.

9. CONCLUSIONS

The 1975 CAGSL-NESCL borrow field program and previously documented studies have shown that adequate construction materials are present along the pipeline route between Richards Island and Fort Good Hope. Granular deposits and shallow bedrock are not evenly distributed and careful consideration in allocation and development of these resources will be needed to ensure that requirements by northern communities, highways, and industry can be met.

Forty-eight deposits were investigated in this area of the Mackenzie Valley during the summer of 1975. Seventeen of these deposits had not been documented in the detailed site investigations for the DIAND Granular Materials Inventory. Eight of the above 17 new deposits are recommended for potential development based on granular material quality. A total of approximately 260 million cubic yards of fair to excellent quality borrow material were found in the deposits investigated in 1975 (see Table I, page 51).

The DIAND Granular Materials Inventory has covered the area from Richards Island to Fort Good Hope. Additional field work has been done by the oil and gas producers (see Bibliography, page 601) on the Ya-Ya esker and by DIAND on several deposits in the Mackenzie Delta area between Richards Island and Parsons Lake. The CAGSL-NESCL study has provided further detail as required on certain deposits described in the DIAND Granular Materials Inventory and has added site specific information on seventeen sites which were not included in the detailed borrow site reports done for the DIAND inventory by Ripley, Klohn, Leonoff International Limited, EBA Engineering Consultants Limited, and Pemcan Services "72".

Granular deposits from Richards Island to Fort Good Hope are concentrated in outwash deposits (including eskers, kame terraces, kame deltas and kame complexes), exhumed Tertiary gravels, and fluvial terraces.

Granular deposits were investigated by airphoto analysis, field reconnaissance, geophysics, test pitting and drilling. The results of the airphoto analysis, field reconnaissance, test pitting and drilling appear in the individual site reports which make up Section 11 of this volume.

Geophysical investigations were done to supplement information obtained from airphoto analysis, field reconnaissance, and subsurface exploration of the individual borrow deposits. Electrical resistivity measurements were made at most borrow deposits investigated. The resistivity of the ground was determined by vertical soundings with probes in a Schlumberger array and with VLF radiohm. Both methods were of little value in helping to delineate the extent of the deposit or arriving at the depth of the deposit.

Shortly after completion of the field portion of the borrow investigation specially designed electromagnetic equipment for shallow exploration became available. This equipment was tested on 5 existing borrow pits in the Calgary area; the results show this equipment to perform well for delineating unfrozen granular deposits.

Following the field reconnaissance of borrow sources and a review of other available information, no biological factors were identified which would preclude development of the deposits recommended in this report. Development of the deposits will have localized impacts on the environment. Implementation of environmental design guidelines in the final location of borrow deposits and ancillary facilities, together with scheduling of activities, should maintain acceptable levels of impact.

TABLE T SUMMARY TABLE OF DEPOSITS INVESTIGATED
RICHARDS ISLAND TO FORT GOOD HOPE

DEPOSIT NO. (R) - denotes reconnaissance site only	DIAND DEPOSIT NUMBER	GRANULAR MATERIAL (NESCL Volume) x 10 ⁶ cu. yd.	NON-GRANULAR MATERIAL		SITES NOT RECOMMENDED (Major reasons)
			Till	Bedrock	
107C-B1	222	14.0			
107C-B2	226	1.0			
107C-B3(R)	225	7.9			
107B-B1	320	3.0			
107B-B2	319	5.4			
107B-B3	309	6.0			
107B-B4	315	10.0			
107B-B5	-	0.3			
107B-B6	-	-	X		till; thick overburden.
107B-B7	-	-			too silty; thick overburden.
107B-B8	-	1.0			too silty, thick overburden; massive ice.
107B-B9	452	5.8			
107B-B10	-	9.4			
107B-B11	-	0.8			
107B-B12	-	0.5			
107B-B13	1153a	4.6			
107B-B14	-	1.2	X		large amount of till in deposit.
107B-B15	1146	22.4			
107B-B16(R)	-	0.4			
107B-B17(R)	450	4.0			
106N-B1	-	-	X		till (frozen).
106N-B2	1141	2.0			
106N-B3	1139a	-		X	poor quality bedrock
106N-B4	1138	17.0			
106O-B1	1138	16.7			
106O-B2	1137	4.5			
106O-B3	1098	10.0			
106O-B4	1084, 1089	13.0			
106O-B5	1085	1.0			
106O-B6	-	5.0	X		large amount of till.
106O-B7	1057	12.0			
106P-B1	1049	1.4			
106P-B2	1050	5.5			
106P-B3	1047	4.2			
106P-B4	1045	9.3			
106P-B5(R)	1052	0.1			poor access and quality.
106I-B1	1035, 1036	35.0			
106I-B2	-	2.5			
106I-B3	1022	6.2			
106I-B4(R)	-	1.8			too silty.
106I-B5(R)	-	2.0			too silty.
106I-B6(R)	-	0.9			
106I-B7(R)	-	1.0			
106I-B8(R)	1025	0.7			
106I-B9(R)	1003	7.6			
106I-B10(R)	-	1.0			too silty.
106I-B11(R)	1006a	1.5			too silty.
106I-B12(R)	1153	12.0			
TOTAL Granular Material		271.6			
- TOTAL Not recommended Granular Material		13.6			
= TOTAL		258.0			million cubic yards.

NOTE: The DIAND deposit number refers to the number assigned to each deposit that was investigated during the granular materials inventory as outlined in the following two sets of reports.
For numbers < 1000 - Ripley, Klohn and Leonoff International Ltd. 1972 & 1973.
For numbers > 1000 - EBA Engineering Consultants Ltd. and F.F. Slaney & Co. Ltd. 1974.

10. RECOMMENDATIONS

The 1975 CAGSL-NESCL borrow field program and previous borrow inventory programs have shown the distribution and characteristics of borrow deposits along the pipeline route through the Mackenzie Valley and the Yukon Coastal Plain. As the location of the pipeline and facilities and decisions on construction modes are finalized, a more accurate determination of borrow requirements should be made. Also, during this final design stage, a detailed field and office study of specific borrow deposits chosen to supply these requirements should be undertaken.

Final design field studies should obtain information on the quantity, quality, and stratigraphy of materials available in each deposit. This data should be collected by on-site geological and engineering observations and by drilling and test pitting. Geophysical methods should be used where feasible to provide subsurface information between drill holes. Also at this time additional data should be collected on the occurrence of permafrost in the borrow materials, the position of the water table in the deposit, access from the deposit to the pipeline route, and engineering aspects which might be useful during development of the borrow source.

It is recommended that final design field studies including biological, archaeological, land use, land availability, and socio-economic factors of each deposit be conducted. A preliminary list of environmental design guidelines is given in Table II (see page 54).

Site specific borrow pit development plans using information from preliminary and final design studies should be produced prior to the exploitation of the borrow deposits.

TABLE II

PRELIMINARY ENVIRONMENTAL DESIGN GUIDELINES

1. Development activity in the vicinity of borrow deposits may be rescheduled during certain periods of the year to minimize disturbance of: migrating waterfowl (April-June) (August-October), wintering moose (December-April), staging waterfowl (August-September), spawning or migrating fish populations (April-September), migrating and calving caribou (April-June) fox and wolf (May-July), grizzly and black bears (May-October), and raptors (May-October).
2. In the final location of borrow deposits and facilities, productive forest land and merchantable stands of timber should be avoided, where possible, in favour of locations in lower productivity forest land.
3. Topsoil and/or the organic layer from all disturbed areas should be salvaged and stockpiled for use in deposit rehabilitation. Trees and shrubs may be salvaged either 'as cut' or chipped for use in erosion control, as dimension lumber or other project requirements.
4. A buffer strip should be maintained between waterbodies and the borrow deposit or support facilities such as roads, camps, etc. to minimize impact on aquatic ecosystems and to preserve important riparian wildlife habitat. The location and width of the buffer strip should be based on site specific data.
5. Any structure containing petroleum products or other toxic materials should be located so as to prevent the introduction of toxic materials into any waterbody inhabited by fish, waterfowl, and aquatic mammals, or any water course emptying directly into such water.
6. No borrow pits are proposed on active flood plain deposits in Mackenzie River tributaries. Where ancillary facilities such as haul roads cross active streams, precautions should be taken to protect stream banks and vegetation and to limit siltation.
7. Blasting operations at borrow deposits should be developed following den surveys at the site, to prevent adverse impact on denning species. Hibernating species should be relocated or taken by resident trappers if found in the proposed borrow deposit. Most blasting will be done during the winter period, thereby minimizing impact on the majority of wildlife.
8. Borrow deposits frequently represent prime denning habitat for bear, fox, wolf, and other denning species. During the final design field studies, active den sites and optimal potential denning habitats will be located. These areas should be protected where necessary from borrow development.
9. Adequate garbage handling and disposal measures will be required to prevent attracting bears and other scavenging wildlife to borrow deposits.
10. The likelihood of encountering archaeological sites is proportionately greater in well drained areas than in low-lying, poorly drained areas. Archaeological surveys will be conducted at all proposed borrow deposits prior to final design. Development activities will be monitored by an archaeologist in the event that archaeological sites are encountered during development of the borrow deposit.

11. The following is a list of individual site reports that are contained in this section.

<u>DEPOSIT</u>	<u>Page</u>
107C-B1	57
107C-B2	71
107C-B3(R)	87
107B-B1	93
107B-B2	111
107B-B3	131
107B-B4	149
107B-B5	163
107B-B6	175
107B-B7	191
107B-B8	197
107B-B9	205
107B-B10	219
107B-B11	231
107B-B12	239
107B-B13	249
107B-B14	263
107B-B15	273
107B-B16(R)	287
107B-B17(R)	291
106N-B1	295
106N-B2	301
106N-B3	313
106N-B4	319
106O-B1	331
106O-B2	343
106O-B3	359
106O-B4	373
106O-B5	393
106O-B6	411
106O-B7	427
106P-B1	443
106P-B2	453
106P-B3	467
106P-B4	483
106P-B5(R)	495
106I-B1	499
106I-B2	515
106I-B3	527
106I-B4(R)	561
106I-B5(R)	565
106I-B6(R)	569
106I-B7(R)	575
106I-B8(R)	579
106I-B9(R)	583
106I-B10(R)	589
106I-B11(R)	593
106I-B12(R)	597

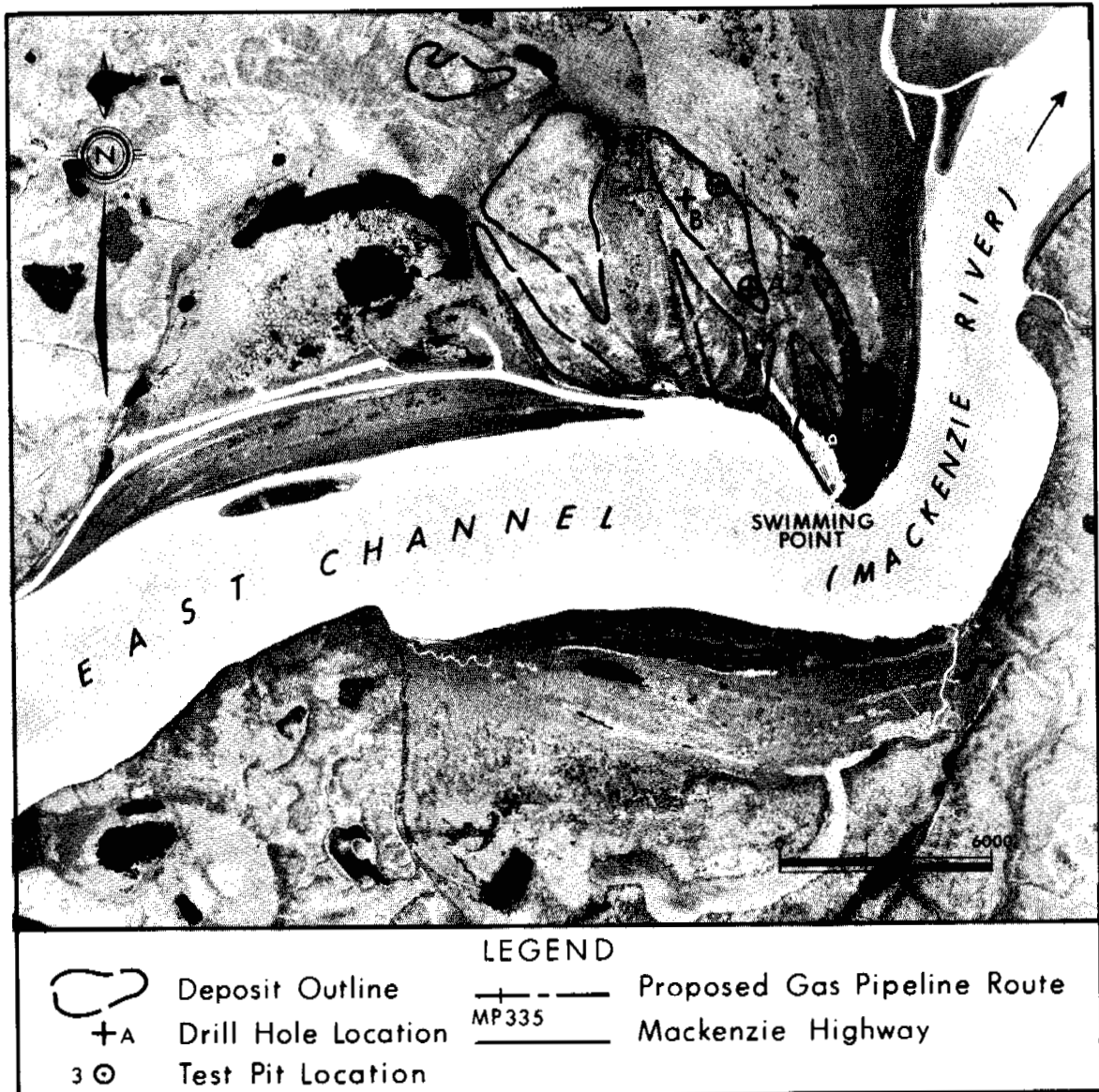
DEPOSIT 107C-B1

Physical Setting: Deposit 107C-B1 consists of large bars on a fluvial terrace located just west of Swimming Point and 8 miles east of milepost 25 on the right of way.

Material: SAND - well to poorly graded with occasional beds of gravel.

Volume: 14,000,000 cubic yards.

Assessment: Deposit 107C-B1 is a source of fair quality granular material suitable for general fill and backfill.



Airphoto No. A23476-128

Approximate Scale: 1" = 5100'

Latitude: 69° 07'

Longitude: 134° 25'

DEPOSIT 107C-B1

PHYSICAL SETTING

Deposit 107C-B1 is located just west of Swimming Point on East Channel of the Mackenzie River, and is 8 miles due east of milepost 25 of the proposed pipeline route. The deposit corresponds to source number 222 in Ripley, Klohn, Leonoff DIAND Granular Materials Inventory Zone II (1972) report. A detailed investigation of this deposit has also been made by EBA in: "Geotechnical Evaluation of Granular Material, Mackenzie Delta Area", 1976.

This deposit consists of large bars on a fluvial terrace that stands 20 to 50 feet above the level of the Mackenzie River floodplain. The surface of the bars are flat except for gently sloping slip-off slopes. Old abandoned channels are 10 to 30 feet below the general level of the bars. Occasionally steep scarps define the edges of the bars.

Peat and silt may range up to 4 feet thick on the bars and drainage is good to imperfect. In the abandoned channels and on some lower parts of the terrace, peat and icy silt varies between 5 to 10 feet and drainage is imperfect to poor.

The surrounding terrain, which consists of floodplain and low terraces along the East Channel, contains standing water, indicating very poor drainage.

In mid-August the active layer is from 1 to 6 feet deep, below that the deposit is frozen with very little excess ice. EBA drill holes encountered visible ice in silt and fine sand layers of the deposit.

BIOLOGICAL SETTING

The vegetation at this site consists of dwarf birch, grass and lichen with sedges and scattered alder in wetter areas. Arctic ground squirrel

dens were observed at the site. The habitat is suitable for fox, wolf, and grizzly bear. A reindeer antler was found on the site. The area provides habitat for upland and passerine bird species. Waterfowl are present in the area throughout the summer season and stage during the mid-August to late September period. No suitable fish habitat is found in the immediate vicinity of the site.

MATERIAL

On the basis of our preliminary investigation and the detailed investigation by EBA the material in this deposit is of fair quality and consists mainly of coarse, well graded to poorly graded sand and gravel with occasional silty beds. Lenses composed mainly of gravel ranging up to 6 feet in thickness were scattered throughout the deposit.

VOLUME

Based on an area of 930 acres and a conservative depth estimate of 9 feet, the total volume of material available is approximately 14,000,000 cubic yards.

As a result of the detailed investigation of this deposit recently done by EBA in which 44 test holes were advanced it should be noted that the recoverable volume would be about 6,000,000 cubic yards. Water level of the adjacent lakes is the limiting factor for this lower volume.

DEVELOPMENT AND REHABILITATION

Deposit 107C-B1 is a source of fair quality granular materials and could be used for general fill and backfill in pipeline construction. Since a detailed investigation has been carried out at this deposit, further test holes and pits may be needed only in areas where proposed development will take place.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit may be achieved by barge to Swimming Point and overland from there to the deposit, a distance of approximately 1 mile. Material would be loaded on trucks and hauled over ice on the Mackenzie River to the pipeline right of way at Tununuk junction. Alternatively, access to the pipeline right of way from the deposit may consist of an access road of about 8 miles. Overland access during the winter season would consist of snow roads.

Initially the peat cover and overburden would be stripped from the area to be excavated, and stockpiled around the edge of the site.

Development of this deposit would involve excavating borrow material in stages from raised gravel bar areas down to a grade so that good drainage would be established over the deposit. Depths of overburden varies and must be determined before specific sections are exploited. To prevent slumping of ice rich material along slopes, borrow material close to the river banks or steep slopes should not be excavated. An adequate buffer zone should be left to prevent this situation from occurring. Development of this borrow site could be accomplished by using blasting or conventional earthmoving techniques depending on site drainage and the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Siltation controls should be used to prevent thaw water run-off from stockpiles draining into adjacent water courses.

Equipment required for development would be dozers, rippers, end dump trucks and front end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
					40	60	80	100	120	140 ▲									
					0	20	40	60	80	100 ○									
1.0	Pt		PEAT - fine fibrous, dark brown, wet, spongy	1.0	UF												19:30		
2.0					F												19:36		
2.0	SP		SAND - fine, uniform, grey, (trace silt)		35														
4.5																			
4.5	ML		SILT - trace fine sand, dark brown		60														
6.0																			
6.0	SP		SAND - medium to fine, trace coarse, trace fine gravel, orange, yellow and black grains		10												19:38	some gringing and gravel chips	
11.0																			
11.0	GP		GRAVEL - fine to coarse, little coarse sand, trace fine sand																
14.0																			
14.0			increasing fine sand																

TEST HOLE No. N75-107C-B1-A

- 63 -

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No. N75-107C-B1-A
CHKD: D.O.	LAT. & LONG: 89°06'50"N, 134°24'26"W	ELEVATION:		
DRWN BY: J.W.B.	AIRPHOTO No.: A 23476-127	PIPE MILEAGE:	NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	SHEET 1 OF 2
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 4°C		
METHOD: AIR				
START: D 08 M 08 Y 75 TIME: 19:30	FINISH: D 08 M 08 Y 75 TIME: 20:00	CANADIAN ARCTIC GAS STUDY LIMITED		


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	-----		Liquid limit									
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
18	GP		(GRAVEL) cont'd		F												18	
18	SP		SAND - fine, uniform, platy cuttings easily broken		10												18.0	19:47 19:51
28			28.0 End of hole														28	19:57

- 49 -

TEST HOLE No. N75-107C-B1-A

LOGGED BY: J. J. S.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 69°06'50"N, 134°24'28"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-127	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 08 M 08 Y 75 TIME: 10:30	FINISH: D 08 M 08 Y 75 TIME: 20:00	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107C-B1-A</p> <p>SHEET 2 OF 2</p>
--	---	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.2			Peat - fine fibrous, dark brown, moist		UF												21:20	
2	SW		SAND - fine to coarse, some gravel, light brown, fine fibres to 2.5' depth, pebbles to 3"															
2.5			occasional cobble, 4", moist from depth 5.0'															
6.5					F													
11.0			increasing gravel															
13.5																		
14			SAND - fine, uniform														21:45 hole sloughing	
28.0	SP		End of hole														22:05	

TEST HOLE No. N75-107C-B1-B

- 65 -

LOGGED BY: J. J. S.	FACILITY:	PROJECT: 13011
CHKD: D. O.	LAT. & LONG: 69°07'21"N, 134°25'13"W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: A 23476-127	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 08 M 08 Y 75 TIME: 21:20	FINISH: D 08 M 08 Y 75 TIME: 22:05	

1975 BORROW INVESTIGATION  NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-107C-B1-B SHEET 1 OF 1
--	---


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt	9 9 9	PEAT - dark brown, fibrous, moist		UF												Using shovels	
0.5																		
1	SW		SAND - well-graded, some fine to coarse gravel, pebbles rounded to sub-rounded, rusty brown, moist, stratified, loose									MA combined samples 1-2 G = 31% S = 67% F = 2%	B1	X			1 Fine gravel and coarse sand layer at depth 1.3' - 1.5'	
2													B2	X			2 Fine gravel and coarse sand layer at depth 2.3' - 2.5'	
3													B3	X				
3	SP		SAND - medium to fine (little coarse), some fine to coarse gravel, grey, damp, stratified, dense (skip-graded)									MA combined samples 3 - 6 G = 26% S = 69% F = 5% Cu = 8 Cc = 0.4 (SP)	B4	X				
4													B5	X				
5				5.0	Nb								B6	X			5 Using jack-hammer	
6																		
7			7.1 Bottom of pit															

TEST HOLE No. N75-107C-B1-1

LOGGED BY: J. G. R.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG. 89°08'50"N, 134°24'26"W	ELEVATION:
DRWN BY: N. L.	AIRPHOTO No.: A 12854-343	PIPE MILEAGE:
CHKD: D. O.	RIG:	AIR TEMP: 13°C
	METHOD: TEST PIT	
START: D 08 M 08 Y 75 TIME: 19:30	FINISH: D 08 M 08 Y 75 TIME: 22:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107C-B1-1
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt		PEAT - dark brown, fibrous, moist		UF												Using shovels	
0.6																		
1	SW		SAND - coarse to fine, some gravel, fine, subrounded, rusty brown, dry, stratified, dense															
2.0																		
2	SM		SAND - medium to fine, little gravel, fine, subrounded, greyish brown, damp, stratified															
3			3.1 sand layer, black															
3.2																		
3											MA, sample 1						Black sand layer at 3.1' - 3.2'	
4											3.2G = 17%							
4											S = 60%							
4											F = 23%							
4											(SM)							
4																	Using jack hammer and shovels	
5			4.8 no gravel, no coarse sand		Nbe													
5																		
5																		
6			6.2 isolated coal specks, black															
6																		
6																		
6.7			Bottom of pit															
6.7																		

TEST HOLE No. N75-107C-B1-2

- 67 -

LOGGED BY: J. S. R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 69°07'21"N, 134°25'00"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 12854-343	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 13°C
	METHOD: TEST PIT	
START: D 08 M 08 Y 75 TIME: 19:30	FINISH: D 08 M 08 Y 75 TIME: 21:30	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

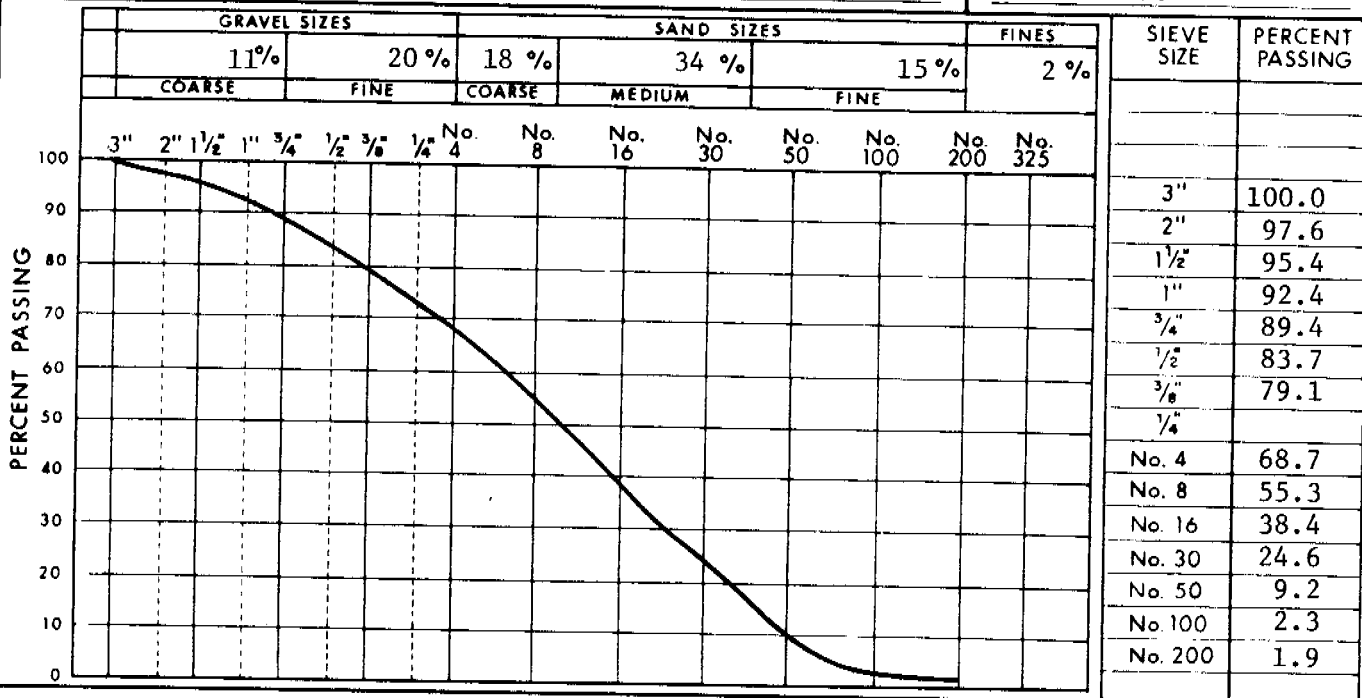
CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107C-B1-2

SHEET 1 OF 1

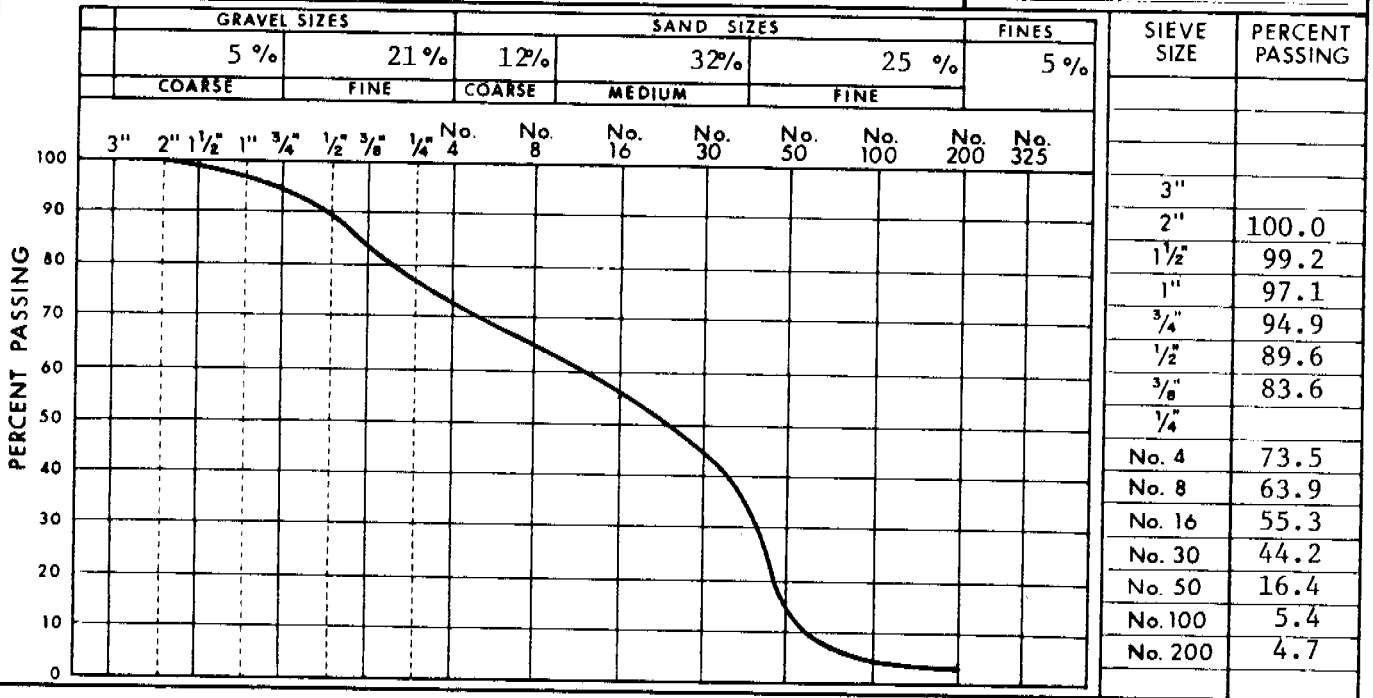
SIEVE ANALYSIS REPORT

SAMPLE N75-107C-B1-1 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 8, 1975 SAMPLED BY NESCL 70



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-107C-B1-1 DEPTH 3.0-7.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 8, 1975 SAMPLED BY NESCL 71



COMMENTS OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

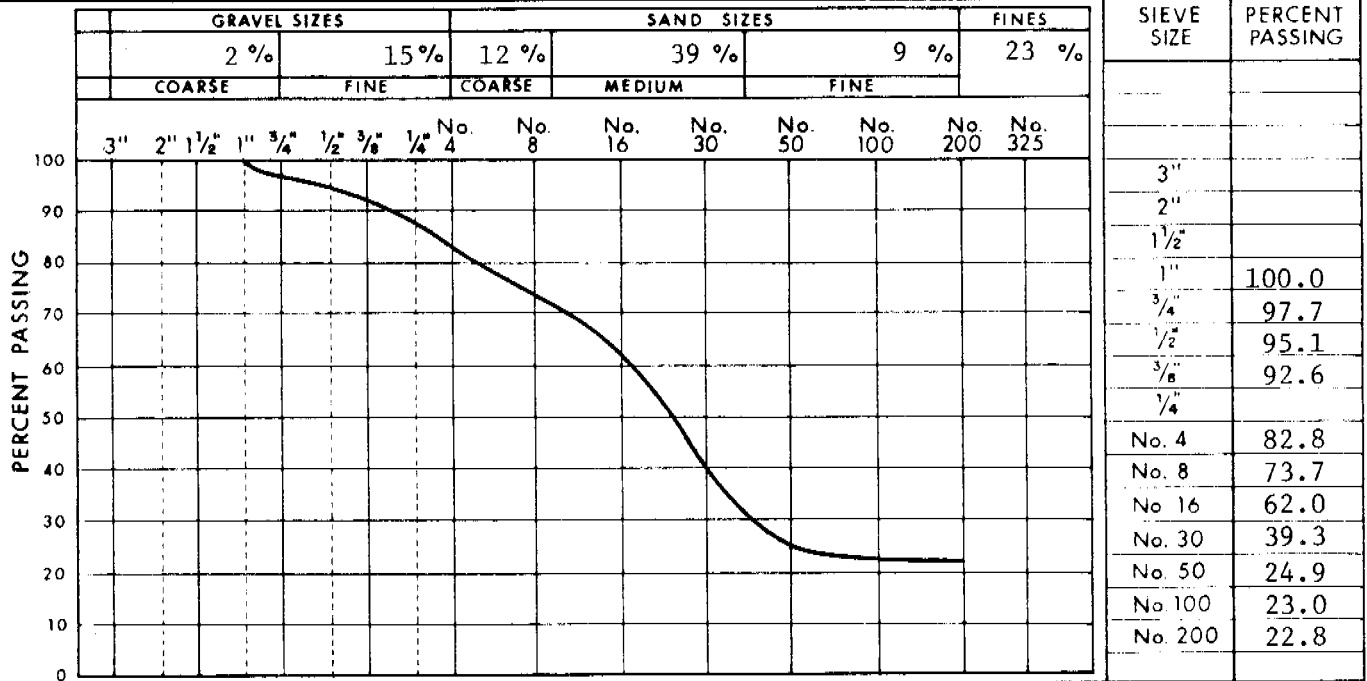


DEPOSIT No.
 N75-107C-B1

PAGE
 68

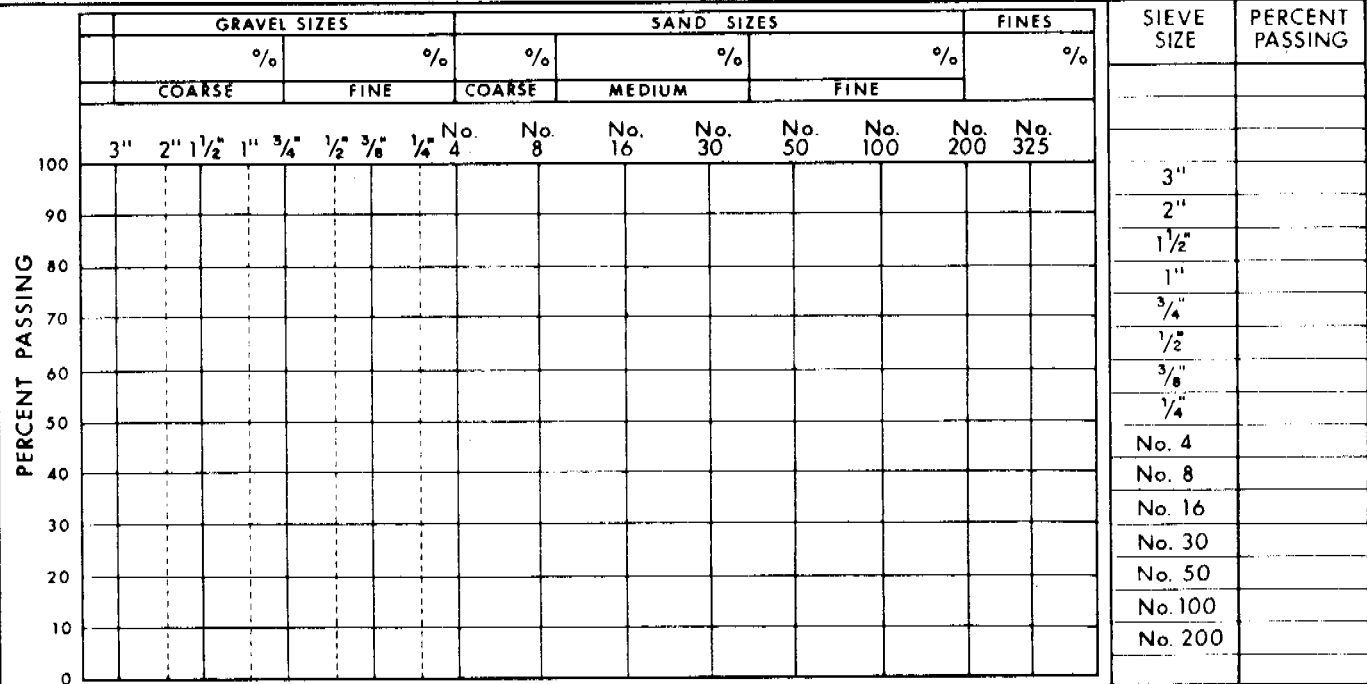
SIEVE ANALYSIS REPORT

SAMPLE N75-107C-B1-2 DEPTH 3.0-4.0 R.M.HARDY REPORT NUMBER 59
 DATE SAMPLED August 8, 1975 SAMPLED BY NESCL



COMMENTS Moisture content of 3.2% OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = _____ %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
N75-107C-B1

PAGE
 69

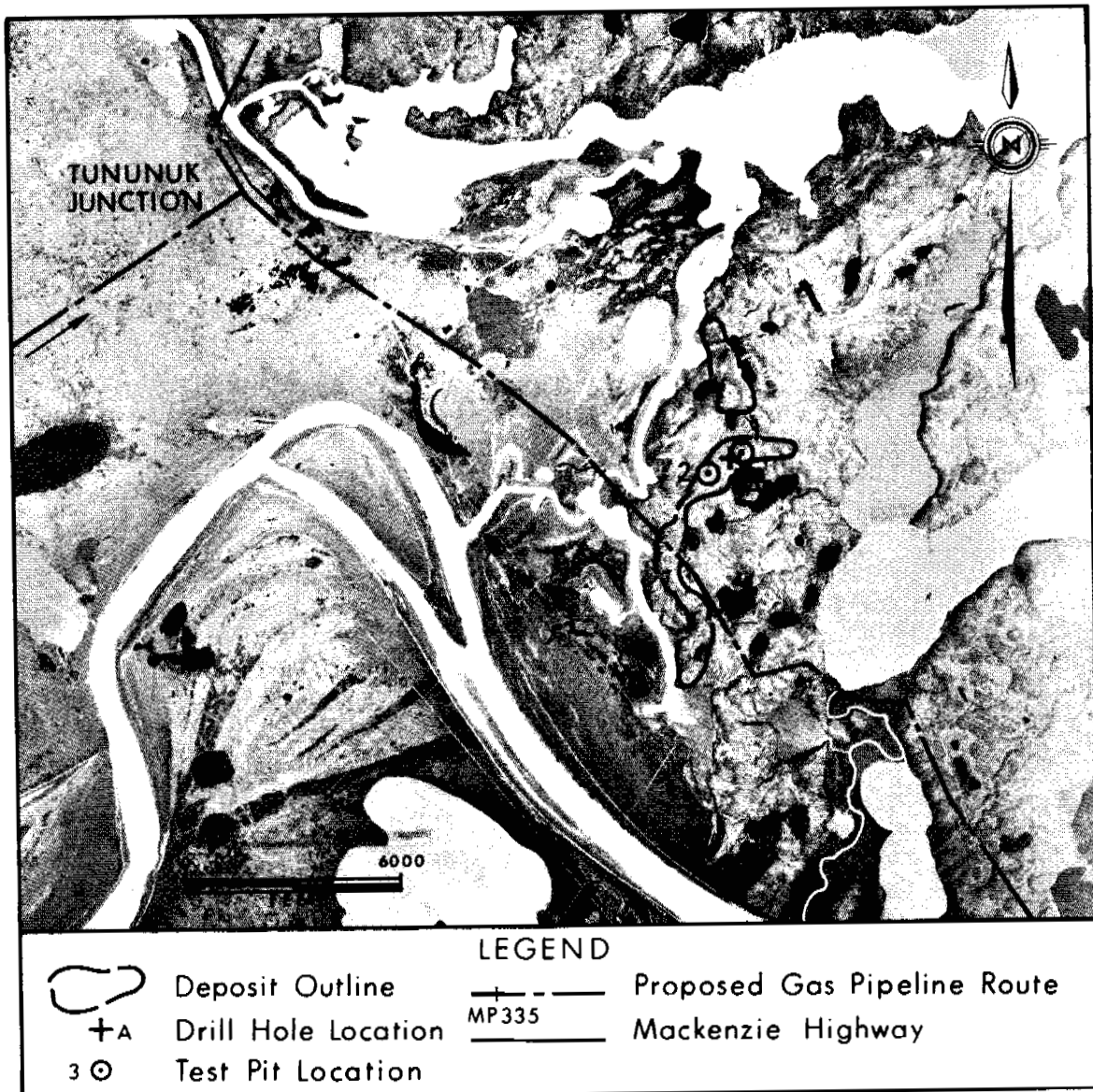
DEPOSIT 107C-B2

Physical Setting: Deposit 107C-B2 is part of an esker complex located 5 to 6 miles northwest of Tununuk Point and crossed by the right of way at milepost 23.

Material: SAND and GRAVEL - stratified, uniform to well graded sand and poorly graded gravel.

Volume: 1,000,000 cubic yards.

Assessment: Deposit 107C-B2 is a source of good quality material suitable for general fill, backfill, and building pads. Haul distances would be short as the deposit is crossed by the right of way.



Airphoto No. A23476-131
Approximate Scale: 1" = 5000'

Latitude: 69° 05'
Longitude: 134° 47'

DEPOSIT 107C-B2

PHYSICAL SETTING

The deposit is situated 5 to 6 miles northwest of Tununuk Point. The proposed Cross Delta Route crosses the southern end of deposit at milepost 23. The deposit corresponds to source number 226 in Ripley, Klohn, Leonoff DIAND Granular Materials Inventory Zone II (1972) report.

The deposit consists of the western end of an esker complex that continues five miles to the east past the southern end of Ya-Ya Lake where gravel is currently being extracted. The esker is superimposed on fluvial sands which contain thick layers of massive ice.

The surface of the deposit is rolling with local relief to 30 feet and moderate slopes. Subsurface ice wedges have locally created mounds 20 to 30 feet across, separated by trenches 2 to 5 feet deep. Thermokarst has formed relief of about 100 feet in the sand on which the esker is superimposed, and as a result, steep slopes are present in the surrounding area.

Overburden is less than 1 foot over most of the deposit and drainage is good except in a few flat imperfectly drained depressions. The active layer varies between 2 and 7 feet and the deposit material is low to medium in ice content.

The Mackenzie Delta lies northwest of the deposit. A major inlet to Ya-Ya Lake is immediately west of the esker. To the southeast, hummocky ice-cored topography is present except in a marshy abandoned channel.

BIOLOGICAL SETTING

The surface of the esker is partly covered by patches of dwarf birch and willow. In low areas, the ground cover is mainly sedges with scattered alder. The general area provides year-round habitat for fox,

wolf, grizzly bear and caribou. Arctic ground squirrel dens are abundant at the site. Nearby lakes provide low productivity habitat for muskrat. The site provides habitat for ptarmigan and passerines. Waterfowl are present in the area throughout the summer season and stage during the mid-August to late September period.

MATERIAL

Test pits 107C-B2-1 and 2, drill hole 107C-B2-A and DIAND Granular Materials Inventory Zone II reports indicate that the deposit is composed of stratified, uniform to well graded sand and subrounded to rounded, poorly graded gravel. The test hole and test pit logs indicate a wide variation in material quality.

VOLUME

Based on a depth of 10 feet and an area of 100 acres the total estimated volume is approximately 1,000,000 cubic yards. It can be expected that at least half the material will be gravel.

DEVELOPMENT AND REHABILITATION

Deposit 107C-B2 is a source of good quality granular material, and could be used for general fill, backfill in pipeline construction, and building pads. The material cannot be recommended at this time for use in concrete aggregate as more extensive testing is required to define amounts of deleterious material. Tests from DIAND Granular Materials Inventory Zone II report and this report indicate that the chert in the aggregate may make it unsuitable for use in concrete production.

Equipment could be staged to the area by barging the equipment from Tununuk Point via river channels to the granular deposit. Haul of borrow material would be short as the pipeline right of way crosses the deposit at milepost 23. Access would involve building a winter snow

road from the deposit to the pipeline right of way. Care would have to be taken to avoid exposing slopes of their vegetative cover in order to insure that bimodal flows are not initiated.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Initially the peat cover and overburden, although minimal, would be stripped from the area to be excavated, and stockpiled around the edge of the site.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be established over the deposit. As massive ice layers are present within this deposit, care should be taken to leave sufficient cover over the ice to prevent thermal degradation. This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material would have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end dump trucks, front end loaders, as well as screening and crushing plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at

the abandonment of the site. This may include procedures such as:
selective grading and shaping; selective stripping and replacing of top
soil and overburden; installation of physical erosion control structures
and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.2	SP		PEAT - coarse fibrous, dark brown, damp		UF												10:15	
			SAND - fine to coarse, little fine gravel, (trace silt)															4 1/4" Walmac
3.0					F													
5.0			medium sand (approx. 70%), trace fine gravel, to 3/4"		35													
7.0					40													
8.0	ICE + SP		ICE with lenses of poorly graded sand (approx. 75% ice)		ICE +													To 3 7/8" Walmac at 9.0
13.0	ICE		ICE (traces of fine sand)		ICE													19.0' at 10:46
29.0			End of hole															10:52

TEST HOLE No. N75-107C-B2-A

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 69°05'07"N, 134°47'48"W	ELEVATION:
DRWN. BY: J.W.B.	AIRPHOTO No.: A 23476-130	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 7°C
	METHOD: AIR	
START: D 09 M 08 Y 75 TIME: 10:40	FINISH: D 09 M 08 Y 75 TIME: 10:52	


<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>TEST HOLE No.</p> <p>N75-107C-B2-A</p> <p>SHEET 1 OF 1</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS		
						▲ Dry density (pcf)			○ Water content %											
						40	60	80	100	120	140 ▲									
						0	20	40	60	80	100 ○									
	Pt		PEAT - dark brown, fibrous, moist.		UF															
0.5																				
1	SW		SAND - coarse to fine; and gravel, mainly fine, subrounded to rounded; rusty brown, damp, stratified, loose.										MA, combined 1 & 2 G = 62% S = 35% F = 3%	B1				1	Using shovels	
1.3																				
2	GW		GRAVEL - mainly fine, subrounded; and sand, coarse to fine; rusty brown, wet, stratified, isolated cobbles to 5" loose.																	
2.5																				
3			some coarse to medium sand																	
4			light rusty brown																	
4.0			Bottom of pit. ▼																Water level at 3.8	

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 69°05'07" N, 134°47'12" W	ELEVATION:
DRWN. BY: D.J.M.	AIRPHOTO No.: A 23478-130	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 15.5°C
	METHOD: TEST PIT	
START: D 08 M 08 Y 75 TIME: 22:20	FINISH: D 08 M 08 Y 75 TIME: 23:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107C-B2-1
SHEET 1 OF 1

- 78 -

TEST HOLE No. N75-107C-B2-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt		PEAT - dark brown, fibrous, moist		UF												Using shovels	
1	GW		GRAVEL - mainly fine, subrounded to rounded, and sand, coarse to medium, light brown, damp, stratified, isolated cobbles to 5", loose									MA, combined, samples 1 & 2 G = 82% S = 37% F = 1% (GW)	B1				Some fibres to depth 2.8'	
3.2	SP		SAND - mainly medium to fine, greyish brown, damp, dense									MA, combined samples 3 & 4 G = 53% S = 42% F = 5% (GW)	B3					
4.2	GW		GRAVEL - fine to coarse, and cmf sand, subrounded, light brown, damp, isolated cobbles to 6", dense										B4					
5.0	CI		CLAY - silty, medium plastic, grey, damp, stiff															
5.2	GW		GRAVEL - fine to coarse, and cmf sand, light brown, wet, stratified, dense									MA, combined samples 5 - 7 G = 53% S = 45% F = 2%	B5					
7.2	Nb												B6				Using jack-hammer	
8.0			Bottom of pit										B7					

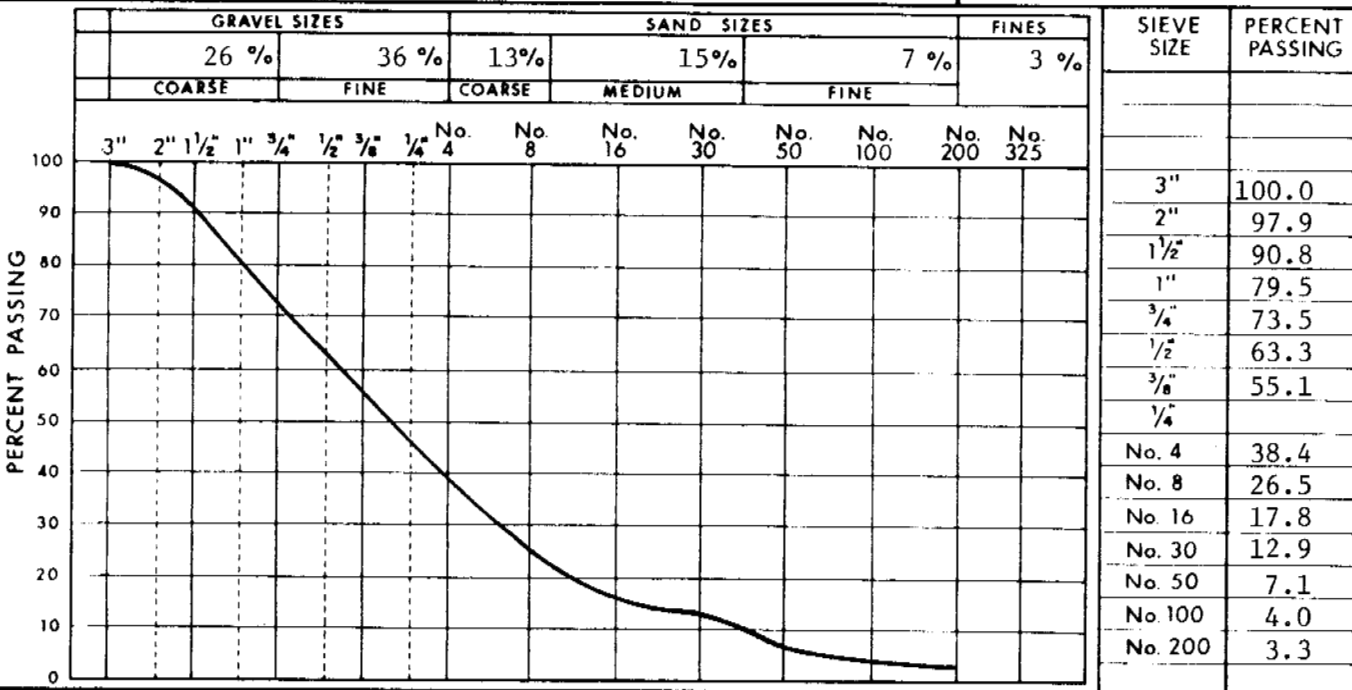
- 79 -

TEST HOLE No. N75-107C-B2-2

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R.H.	LAT. & LONG: 69°05'02"N, 134°47'19"W	ELEVATION:		N75-107C-B2-2
DRWN. BY: F.B.	AIRPHOTO No.: A 23476-130	PIPE MILEAGE:		
CHKD: D.O.	RIG:	AIR TEMP: 15.5°C		
	METHOD: TEST PIT			
START: D 08 M 08 Y 75 TIME: 22:50	FINISH: D 09 M 08 Y 75 TIME: 11:25			SHEET 1 OF 1

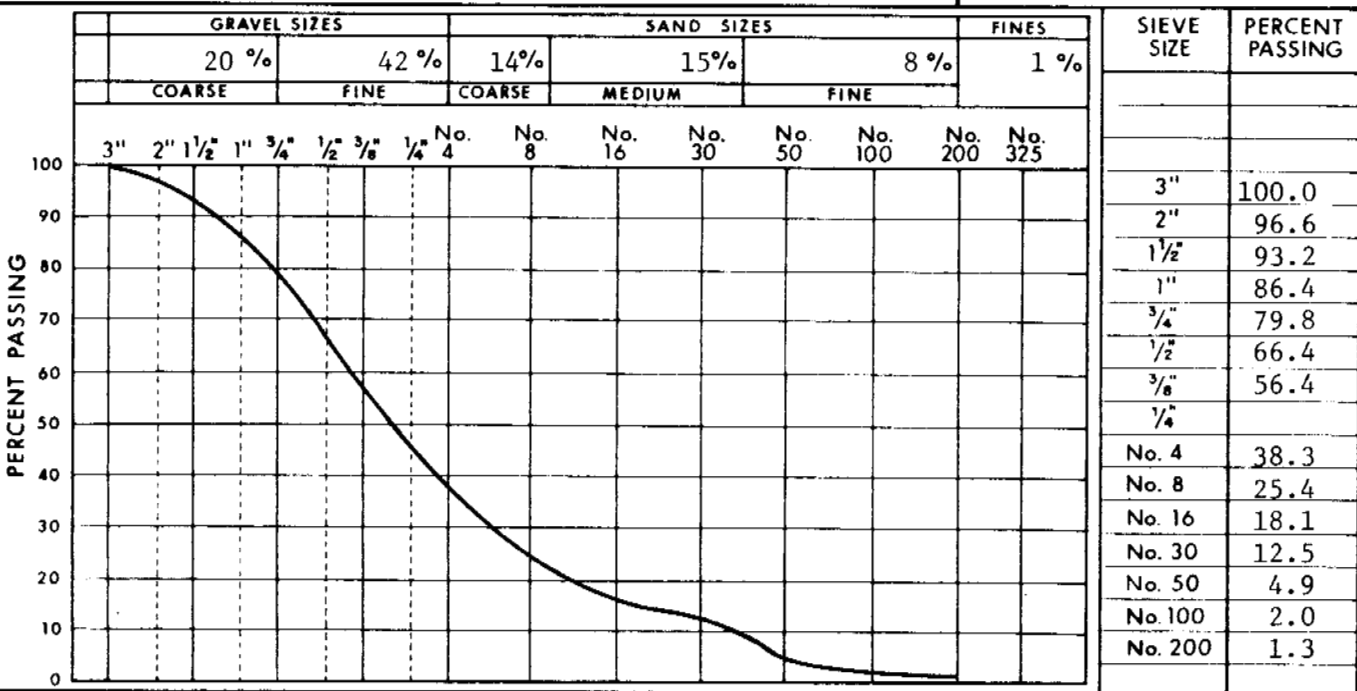
SIEVE ANALYSIS REPORT

SAMPLE N75-107C-B2-1 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 8, 1975 SAMPLED BY NESCL 139



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-107C-B2-2 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 8, 1975 SAMPLED BY NESCL 62



COMMENTS OVERSIZE (>3") = 0.0 %
 Moisture contents range from 1.6% to 2.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

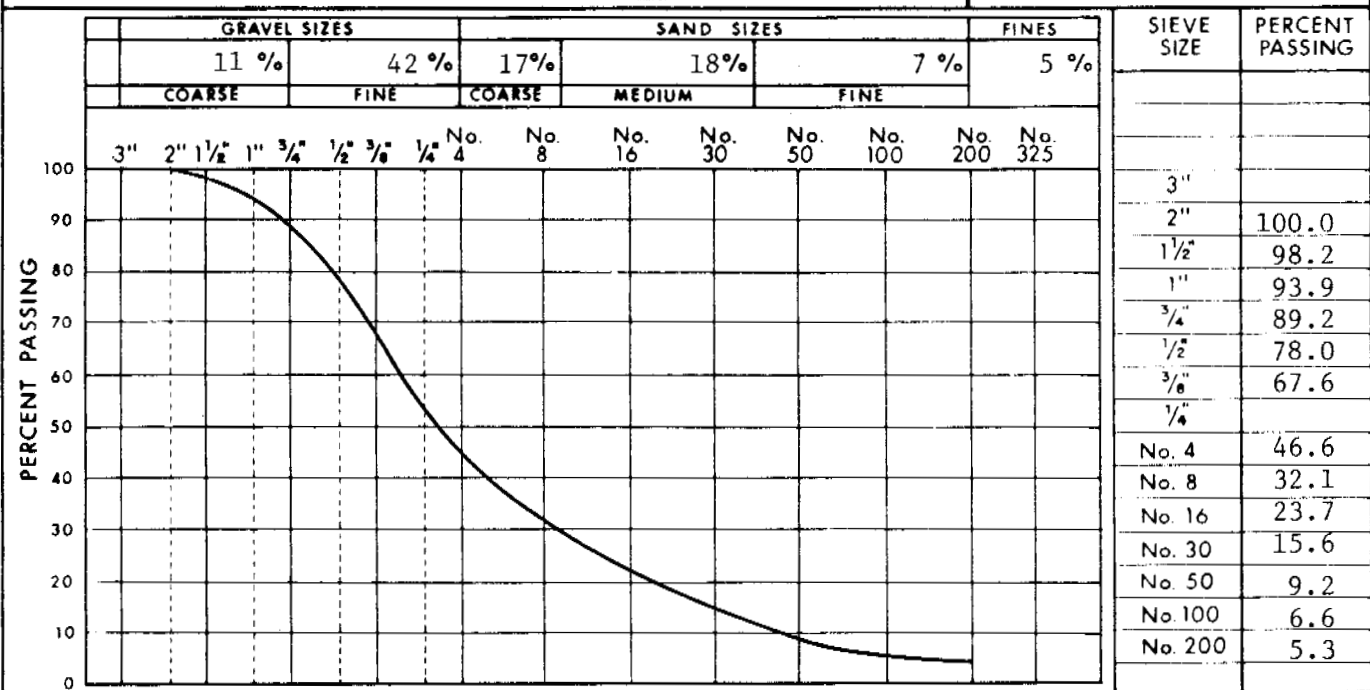


DEPOSIT No.
 N75-107C-B2

PAGE
 80

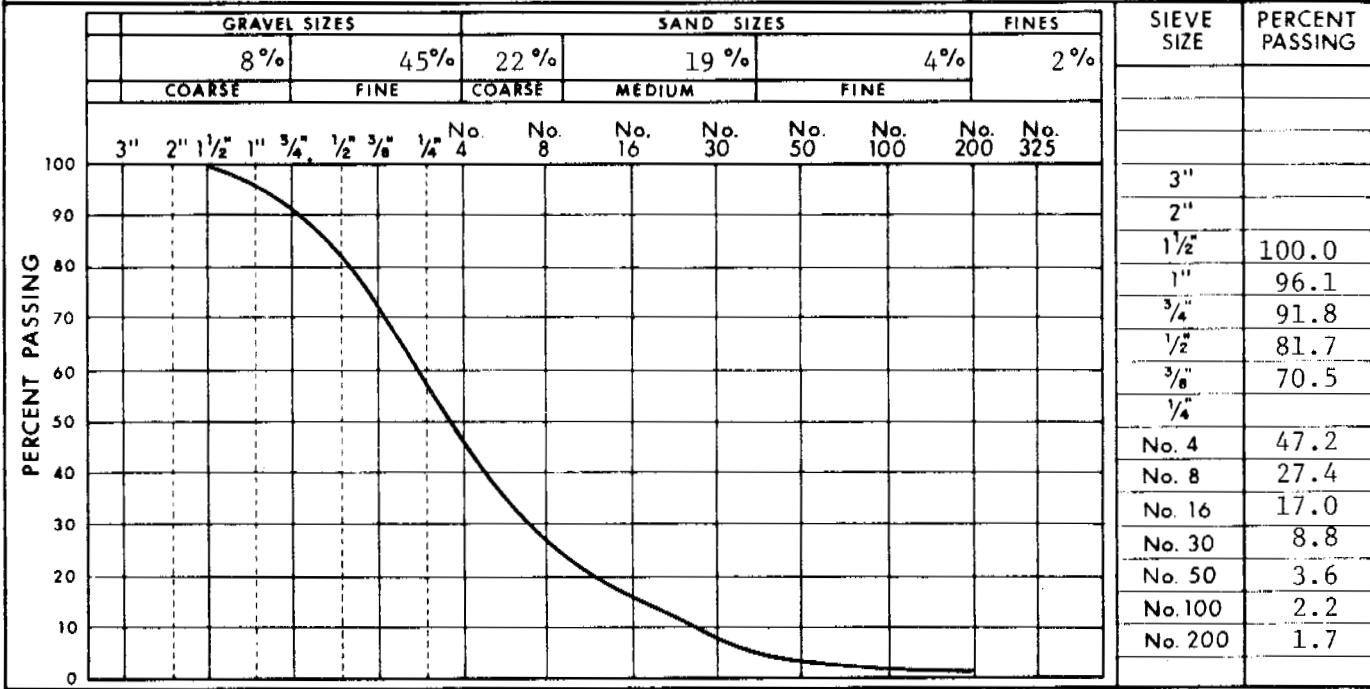
SIEVE ANALYSIS REPORT

SAMPLE N75-107C-B2-2 DEPTH 3.0-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 8, 1975 SAMPLED BY NESCL 63



COMMENTS Moisture content from 2.9% to 5.5% OVERSIZE (>3") = 0.0%

SAMPLE N75-107C-B2-2 DEPTH 5.0-8.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 8, 1975 SAMPLED BY NESCL 64



COMMENTS Moisture content from 3.3% to 4.3% OVERSIZE (>3") = 4.9%

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-107C-B2 <hr/> PAGE 81
---	--	---	--

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-107C-B2-2 DATE SAMPLED : August 8, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 1-3 DATE TESTED : February, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 3.96 %
 FINE AGGREGATE : LOSS = 7.67 %

ORGANIC IMPURITIES TEST

NUMBER : 4+
 COAL REMOVED : 4+
 COAL & ROOTLETS
 REMOVED : 4+
 COAL CONTENT : 0.01%
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 18.7 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Strong to very strong, Good	44.7
Granite		0.05
Sandstone	Strong, Good	8.6
Siltstone		2.0
Chert	Potentially Reactive, Fair	3.1
Flint		2.75
Friable Sandstone	Soft, Weak, Poor	0.15
Ironstone	Very soft, Deleterious	0.35
PN = 125	INTERPRETATION : Fair quality aggregate	61.7

COMMENTS : Strength tests required. Cherty component constitutes approx. 10% of coarse component, further examination of alkaline reactivity and absorption by prolonged boiling are recommended.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.

N75-107C-B2

PAGE 82

**SUMMARY OF LABORATORY TEST DATA
FOR
SUITABILITY OF AGGREGATES IN CONCRETE**

SAMPLE No. N75-107C-B2-2 DATE SAMPLED : August 8, 1975 SAMPLED BY : NESCL
DEPTH (FT.) : 3-5 DATE TESTED : February, 1976 TESTED BY : RMHA

**SOUNDNESS OF AGGREGATE
SULPHATE TEST**

COARSE AGGREGATE : LOSS = 4.96 %
FINE AGGREGATE : LOSS = 6.78 %

**ORGANIC IMPURITIES
TEST**

NUMBER : 5
COAL REMOVED : 5
COAL & ROOTLETS
REMOVED : 5
COAL CONTENT : 0.01%
SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 19.7 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	32.1
Granite		0.32
Sandstone	Strong, Good	8.9
Siltstone		3.7
Limestone		0.17
Flint		3.65
Chert	Potentially reactive, Fair	3.4
Soft Sandstone	Friable, Weak, Poor	0.08
Clay	Soft, Deleterious	0.17
Ironstone		0.91
PN = 145	INTERPRETATION : Poor quality	53.4

COMMENTS : Chert stability should be tested plus treatment for organic contamination. Caution: failed to meet strength requirements of CSA A23.1-5.3.2.2(b) (92%)



R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

DEPOSIT No.
N75-107C-B2

PAGE 83

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-107C-B2-2 DATE SAMPLED : August 8, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 5-8 DATE TESTED : February, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 4.96 %
 FINE AGGREGATE : LOSS = 6.78 %

ORGANIC IMPURITIES TEST

NUMBER : 5
 COAL REMOVED : 5
 COAL & ROOTLETS
 REMOVED : 4+
 COAL CONTENT : 0.01%
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 18.7 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	37.0
Granite		0.1
Sandstone	Medium strong to strong, Good	10.0
Siltstone		3.15
Limestone		0.1
Chert	Potentially reactive	2.75
Flint		1.85
Ironstone	Weak, Friable, Deleterious	0.15
PN # 126	INTERPRETATION : Fair quality aggregate	55.1

COMMENTS : Chert is the unfavourable rock type found amongst minor and subordinate components of the sample. Strength tests required. See also page 85.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.

N75-107C-B2

PAGE 84

**SUMMARY OF LABORATORY TEST DATA
FOR
SUITABILITY OF AGGREGATES IN CONCRETE**

SAMPLE No. N75-107C-B2-2 DATE SAMPLED : August 8, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 5-8 DATE TESTED : February, 1976 TESTED BY : RMHA

**SOUNDNESS OF AGGREGATE
SULPHATE TEST**

COARSE AGGREGATE : LOSS = 4.96 %
 FINE AGGREGATE : LOSS = 6.78 %

LOS ANGELES ABRASION TEST

PERCENT LOSS = 18.7 %

**ORGANIC IMPURITIES
TEST**

NUMBER : 5
 COAL REMOVED : 5
 COAL & ROOTLETS
 REMOVED : 4+
 COAL CONTENT : 0.01%
 SIGNIFICANCE :

SUMMARY OF ROCK TYPES, FINE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite, Quartz	Very strong, Good	33.78
Sandstone	Strong, Good	1.87
Siltstone		2.00
Chert	Potentially reactive, Fair	3.78
Flint		3.34
Ironstone	Soft, Weak, Deleterious	0.125
PN = 126	INTERPRETATION : Fair quality aggregate	44.9

COMMENTS : See page 84.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.

N75-107C-B2

PAGE 85

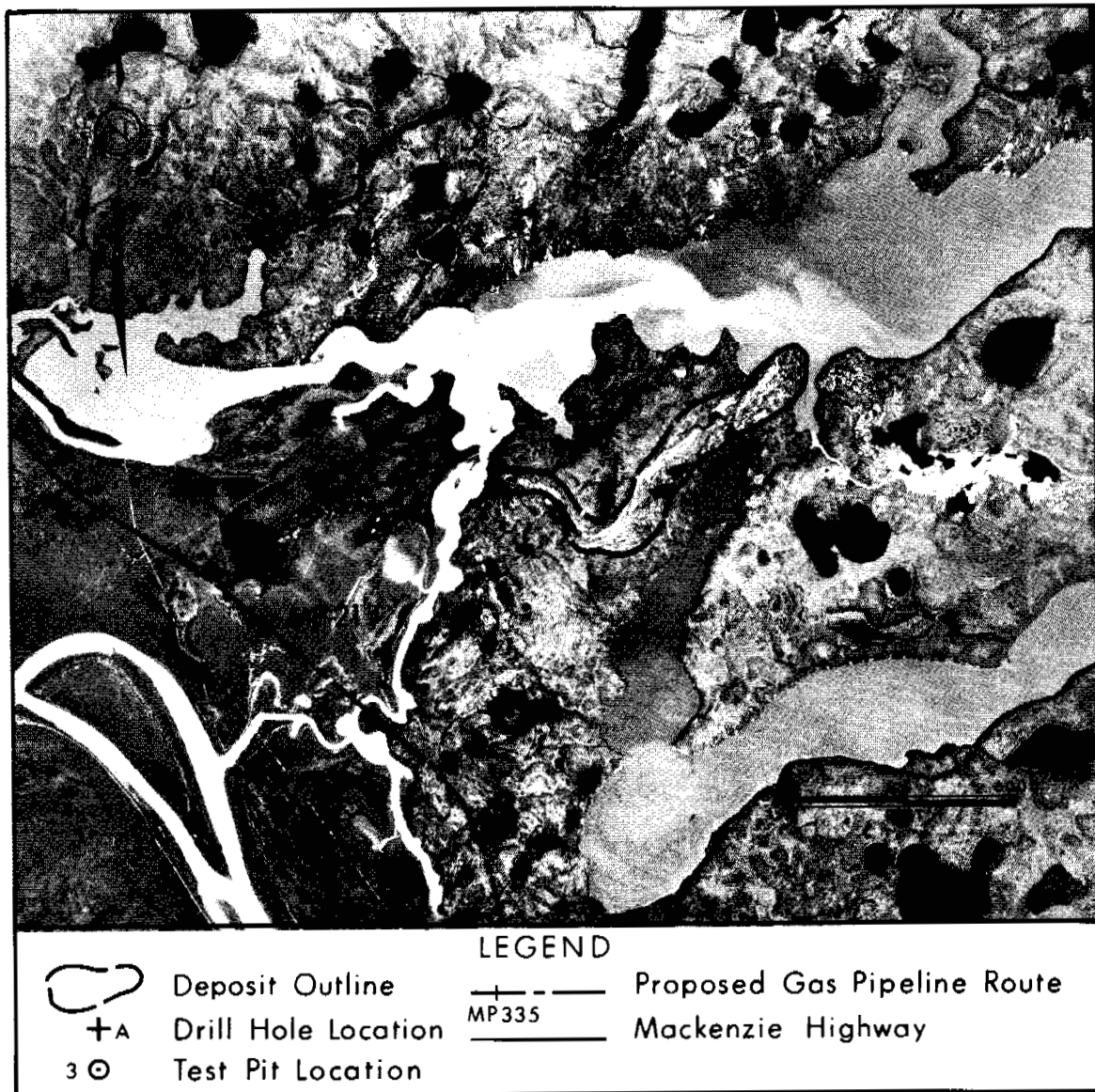
DEPOSIT 107C-B3(R)

Physical Setting: Deposit 107C-B3(R) which is part of the western end of the Ya-Ya esker is located about 2 miles northeast of milepost 22.5 of the proposed pipeline right of way.

Material: SAND and GRAVEL - well graded.

Volume: 7,900,000 cubic yards.

Assessment: Deposit 107C-B3(R) is a source of good quality granular material with access being relatively short via Ya-Ya Lake. Granular material from this deposit may be used for general fill, backfill, building pads, and possible concrete aggregate.



Airphoto No. A23476-130
Approximate Scale: 1" = 4800'

Latitude: 69° 06'
Longitude: 134° 46'

DEPOSIT 107C-B3(R)

PHYSICAL SETTING

This deposit is part of the western end of the Ya-Ya esker. It is located close to the south shore of Ya-Ya Lake about 2 miles northeast of milepost 22.5 of the proposed pipeline right of way. The deposit corresponds to source number 225 in the Ripley, Klohn, Leonoff DIAND Granular Materials Inventory Zone II (1972) report, and Area "A" of EBA Engineering Consultants Limited Ya-Ya Granular Resources Study Volume I (1975) report.

The esker stands about 50 feet above the surrounding terrain which is hummocky and underlain by icy sand. The esker ridge has a rolling crest with steep flanks, thus the surface is well drained. Overburden is nonexistent except in depressions that contain 5 to 10 feet of peat and silt. Ice contents appear to vary from low in the sand beds to high in the silt. Massive ice is expected within the deposit.

BIOLOGICAL SETTING

Vegetation on this esker is found only in poorly drained depressions, where dwarf birch, alder and sedge predominate. The area provides year-round habitat for fox, wolf, and grizzly bear. Arctic ground squirrel dens and nesting passerines were observed at the site. The site lies within potential grizzly bear denning habitat. Waterfowl are present in the area throughout the summer season and stage during the mid-August to late September period. Nearby Ya-Ya Lake supports several fish species including pike, suckers, and whitefish.

MATERIAL

EBA Engineering Consultants Limited Ya-Ya Granular Resources Study Volume I report indicates that much of the material in this source is well graded sand and gravel. Sporadic lenses of fine sand and silt occur throughout the deposit.

VOLUME

Results of the Ya-Ya Granular Resources Study indicate a total volume of 7,900,000 cubic yards. Massive ice, water levels of surrounding ponds, and overburden may limit the actual recoverable volume.

DEVELOPMENT AND REHABILITATION

Deposit 107C-B3(R) is a source of good quality granular material. This deposit was only investigated on a reconnaissance basis, but others have done more detailed investigations on it. Location of areas to possibly be exploited will be dictated by material requirements, the presence and position of massive ice, and insitu material quality. More drilling and test pitting will be required to delineate areas of better quality material, depth of overburden, and areas of massive ice. Haul distances to the pipeline right of way are in excess of 2 miles over gently rolling terrain. However, lake and channel surfaces are available for winter haulage across flat ice surfaces. Granular material from this deposit may be used for general fill, backfill in pipeline construction, and building pads. Suitable aggregate for concrete production may be produced from this deposit.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit with equipment may be achieved by barge to Ya-Ya Lakes camp and overland from there to the deposit, a distance of one mile. Alternatively, the equipment may be staged via the pipeline right of way to the deposit. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way.

Overburden varies in thickness from 0 to 10 feet and some stripping would be required at this site.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be maintained over the deposit. Excavations would be kept away from Ya-Ya Lake to protect the lake from siltation. This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. Some massive ice may have to be wasted during development. The excavated material may have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, screens and concrete plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

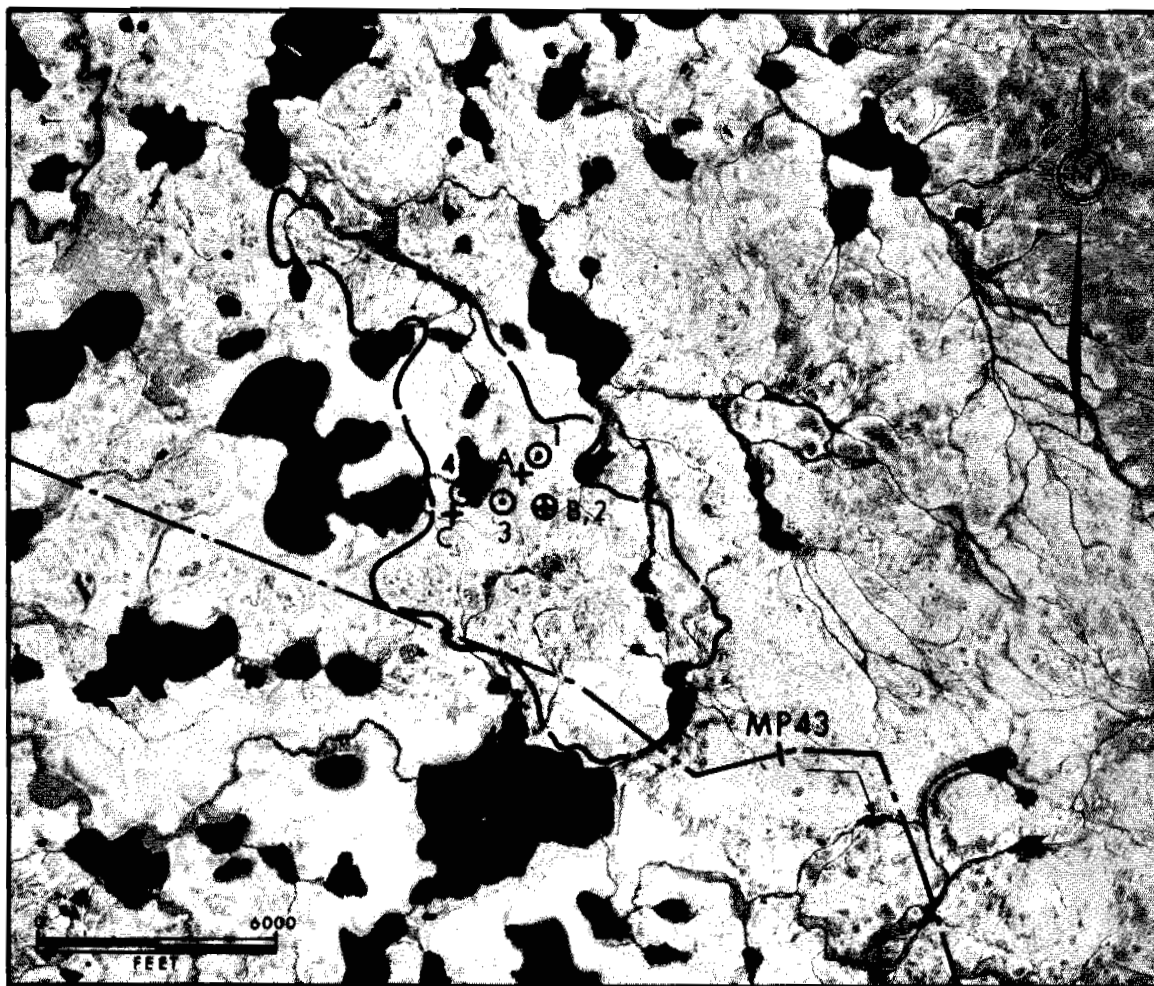
DEPOSIT 107B-B1

Physical Setting: Deposit 107B-B1 is an outwash plain modified by thermo-karst. It is located 2 miles north of Wolverine Lakes and at pipeline milepost 42. The pipeline right of way crosses the southern portion of the deposit.

Material: SAND and GRAVEL - stratified with little silt.

Volume: 3,000,000 cubic yards.

Assessment: Deposit 107B-B1 is a source of fair to good quality material suitable for general fill and backfill. Further testing would be required to delineate favourable areas for development.



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A23476-100
Approximate Scale: 1" = 4900'

Latitude: 68° 57'
Longitude: 134° 08'

DEPOSIT 107B-B1

PHYSICAL SETTING

Deposit 107B-B1 is an outwash plain modified by thermokarst. It is located about 2 miles north of the Wolverine Lakes, and the proposed pipeline right of way at milepost 42 passes through the southern portion. The deposit corresponds to source number 320 in Ripley, Klohn, and Leonoff DIAND Granular Materials Inventory Zone III (1972) report.

The outwash plain is hummocky to gently rolling with thermokarst lakes and depressions inset 100 feet below the general surface. The plain is also spotted with 20 to 30 foot knobs and ridges. Most slopes are gentle to moderate, but locally 40 to 100 foot scarps with slopes to 20 degrees are present.

Drainage is good over most of the deposit and there is negligible cover of peat and silt except in local swales. The active layer varies from 3 to 6 feet. Ice content in the sand and gravel is low but massive ice may be encountered anywhere from 7 to 27 feet below the ground surface.

BIOLOGICAL SETTING

Typical tundra vegetation covers the area with dwarf birch, willow, alder and lichen predominating. The area provides year-round habitat for Arctic ground squirrel, fox, wolf, and grizzly bear. Reindeer are common in the area and moose are occasionally present during the summer months. Ptarmigan, long-tailed jaegers and ground squirrel dens were observed at the site. A wide range of waterfowl, upland and passerine species occur during the summer months throughout the area. There is no suitable fish habitat in the vicinity of the site.

MATERIAL

Drill hole and test pit data as well as DIAND Granular Materials Inventory Zone II report show the deposit to be stratified gravel and sand, frequently

silty. Uniform and well graded gravels were found in beds ranging from 1 to 25 feet thick. Sands are uniform to well graded, often with varying amounts of gravel. Since quality of the material varies greatly, further drilling will be required to define areas of higher quality material.

VOLUME

Although the DIAND report indicates a probable maximum volume of 1,500,000 cubic yards, investigations to date indicate that an estimated volume of 3,000,000 cubic yards, based on an average depth of 6 feet and the possibility that only $\frac{1}{4}$ of the deposit area of 1,280 acres consists of good quality granular material, is conservative.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B1 is a source of fair to good quality granular material. Material requirements and insitu material quality will determine the amount of development that takes place on this deposit. Areas with thick overburden would be avoided. The deposit would be further investigated by drilling and test pitting to delineate areas of good quality material with the least amount of overburden. Granular material from this deposit is suitable for general fill and backfill in pipeline construction.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit may be achieved by barge to Tununuk Point and overland from there via pipeline right of way to the deposit, a distance

of 14 miles. In order to minimize environmental damage, snow roads would be built to transport the borrow material the short distance to haul points on the right of way. Care would have to be taken not to start bimodal flows along the valley walls in this area.

Initially the peat cover and overburden would be stripped from the area to be excavated, and stockpiled around the edge of the site.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained knobs and ridges so that good drainage would be maintained over the area. Excavations would be kept away from any of the nearby lakes and streams to avoid siltation. Excavations close to massive ice also would be avoided. Development of this source would be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Natural mixing during excavation would be adequate to obtain gradations for the purposes intended.

Equipment required for development would be dozers, rippers, end-dump trucks, and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA					OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit							
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○							
0.2			PEAT - fibrous, dark brown, damp.														
2.0	OL		SILT (organic) little fine sand, occasional fine gravel to 3/4", organic fibres, occas. cobble to 8"		UF												18:10
4.0	SW		SAND - coarse to fine, little fine gravel														
8.0					F 15												
9.0			SAND - medium, uniform, trace fine gravel, trace coarse sand.														
12.5	SP				15												18:20 to 3 7/8" Walnac
14.0																	
18.0	ICE		ICE - cloudy (slight fine sand, silt)		ICE												18:28
28' - 38'			28' - 38', slight gravel to approx. 1 1/2" inferred from drill action														18:0' at 18:32
38.0			38.0 FWD of hole														

TEST HOLE No. N75-107B-B1-A

- 86 -

LOGGED BY: J.J.S	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°57'04"N, 134°08'22"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 23478-99, 100	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 7°C
	METHOD: AIR	
START: D 09 M 08 Y 75 TIME: 18:10	FINISH: D 09 M 08 Y 75 TIME: 18:40	

1975 BORROW INVESTIGATION  NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-107B-B1-A SHEET 1 OF 1
--	---


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2			PEAT - dark brown, damp.		UF												19:20	
1.5	ML		SILT - little fine sand, light brown oxidization															
2.0	SW		SAND - fine to coarse.															
3.0	SM																	
4.0	ML		SILT - trace fine sand, low plastic, medium brown		F												excavated by shovel to determine depth of active layer	
7.0																		
8.0	GP		GRAVEL - coarse to fine, some fine sand, pebbles to 2", occas. 3"		10													
14.0			Poorly graded, gravel to approx. 1 1/2" some coarse to fine sand															

TEST HOLE No. N75-107B-B1-B

LOGGED BY: J.J.S	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°56'56"N, 134°08'04"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-89, 100	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 09 M 08 Y 75 TIME: 19:20	FINISH: D 09 M 08 Y 75 TIME: 20:45	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B1-B

SHEET 1 OF 2


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL	ICE %	▲ Dry density (pcf)	○ Water content %							
16	GP		(GRAVEL) (cont'd)		40	60	80	100	120	140 ▲							
18					0	20	40	60	80	100 ○							19:35 19:42
24																	
25.0			Cobble, approx. 4"														
28			(coarse gravel, +3")														
27.0			cobble, approx. 6"														
28																	19:50 Now 3 7/8"
28.0			End of hole														20:45 Walmac Seizing at 25' swivel jumping from skids. Reamed hole; abandoned.

TEST HOLE No. N75-107B-B1-B

LOGGED BY:	J.J.S.	FACILITY:		PROJECT:	13811
CHKD:	B.O.	LAT. & LONG:	88°56'58" N, 134°08'04" W	ELEVATION:	
DRWN. BY:	J.M.B.	AIRPHOTO No.:	A 23478-89, 100	PIPE MILEAGE:	
CHKD:	D.O.	RIG:	HELI-DRILL	AIR TEMP:	▲ B C
		METHOD:	AIR		
START:	D 09 M 08 Y 75	TIME:	19:20	FINISH:	D 09 M 08 Y 75 TIME: 20:45

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.	
	N75-107B-B1-B
SHEET 2	OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0-3	Pt		PEAT - fine fibrous, dark brown, moist		UF												10:30	
3-4			SAND - medium to coarse, silty, some gravel to 1½"														3''	pebbles at 0.3' below surface
4.0			little coarse sand, fine gravel		F												4½''	Walmac
13.0			SAND - fine grained, silty, medium grey.		10													
13.0					25													
13.0	ICE		ICE		ICE												10:38	To 3 7/8''
18																	10:42	Walmac

TEST HOLE No. N75-107B-B1-C

- 101 -

LOGGED BY: J.J.S	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°58'58"N, 134°09'12"W	ELEVATION:
DRWN. BY: S.M.B.	AIRPHOTO No.: A 23476-89	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 0°C
	METHOD: AIR	
START: D 10 M 08 Y 75 TIME: 10:30	FINISH: D 10 M 08 Y 75 TIME: 11:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B1-C

SHEET 1 OF 3

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL	ICE %	▲ Dry density (pcf)	○ Water content %							
18	ICE		(ICE) cont'd	ICE													
20			20.0														
22	GW		GRAVEL - fine, little well graded sand. Pebbles occ. to 1 1/2"	F													
24	ICE+		ICE with approx. 30% fine sand	ICE+													
28	GW		GRAVEL - fine, little well graded sand, pebbles occ. to 1 1/2"	F													
30			31.0														
32	SP		SAND														

TEST HOLE No. N75-107B-B1-C

- 102 -

LOGGED BY: J. J.S.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 88°56'56"N, 134°09'12"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-BRILL	AIR TEMP: 9°C
	METHOD: AIR	
START: D 10 M 08 Y 75	TIME: 10:30	FINISH: D 10 M 08 Y 75
		TIME: 11:00

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B1-C

SHEET 2 OF 3


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
32			(cont'd)		F													
			SAND - uniform, medium (fine coarse)															
34	SP				35													
					45													
38																		
30			30.0 End of hole															
			Circulation failing. Ice noticed on bit. Teeth on bit badly chipped.															11:00

TEST HOLE No. N75-107B-B1-C

LOGGED BY: J.J.S	FACILITY:	PROJECT: 1001
CHKD: D.B.	LAT. & LONG: 66°58'58"N, 134°08'12"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 23478-89	PIPE MILEAGE:
CHKD: D.O.	RIG: MELI-DRILL	AIR TEMP: 0°C
	METHOD: MR	
START: D 10 M 08 Y 75 TIME: 10:00	FINISH: D 18 M 08 Y 75 TIME: 11:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY, ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B1-C
SHEET 3 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit			Liquid limit								
					40 0	60	80	100	120	140 ▲									
1	SP		SAND - coarse to medium, little gravel, mainly fine, subrounded, light brown, damp, stratified, loose 1.0 - - - - and gravel, dense		UF													Trace organics and fibres to depth 0.3' Using shovels	
2																			
3	SW		SAND - coarse to fine, (trace silt), greyish brown 2.0 - - - -															+ 3" = 5.8% of total test samples	
4			(no silt), and fine gravel, isolated cobbles to 6" 3.0 - - - - GWL 4.5															Water level at 4.5'	
5			5.5 Bottom of pit																

MA, combined samples 1 & 2
G = 38%
S = 82%
F = 2%
(SW)

B1	X
B2	X

- 104 -

TEST HOLE No. N75-107B-B1-1

LOGGED BY: J.B.R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°57'06"N, 134°08'30"W	ELEVATION:
DRWN. BY: F.B.	AIRPHOTO No.: A-23478-89	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 13°C
	METHOD: TEST PIT	
START: D 09 M 08 Y 75 TIME: 11:30	FINISH: D 09 M 08 Y 75 TIME: 14:30	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B1-1
SHEET 1 OF 1


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.7	GP		GRAVEL - mainly fine, subrounded to rounded, and sand, coarse to fine, rusty brown, moist, loose.		UF												Using shovels	
1.5	SW		SAND - coarse to fine; trace gravel, fine, subrounded; light brown, moist, stratified, loose.															
5.0	GW		GRAVEL - mainly fine, subrounded; and sand, coarse to medium; light brown, damp, stratified, isolated cobbles to 5", loose and sand.									MA, combined samples 1-3 G = 52% S = 46% F = 2%	B1	<input checked="" type="checkbox"/>				
7.5			Bottom of pit Frozen at 7.5'										B2	<input checked="" type="checkbox"/>			Excessive sloughing.	
													B3	<input checked="" type="checkbox"/>			Permafrost at 7.6'	

TEST HOLE No. N75-107B-B1-2

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.W.	LAT. & LONG: 68°56'56"N, 134°08'04"W	ELEVATION:
DRWN. BY: A.W.	AIRPHOTO No.: A 23478-99	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 13°C
	METHOD: TEST PIT	
START: D 09 M 08 Y 75 TIME: 14:45	FINISH: D 08 M 08 Y 75 TIME: 16:30	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B1-2
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	SM		SAND - coarse to fine, and fine to coarse gravel, subrounded, little silt, rusty brown, moist, stratified, isolated cobbles to 5", dense		UF							MA, combined samples 1 - 3 G = 38% S = 47% F = 15%	B1	X			1' of PEAT cover, dark brown, fibrous, dry Using shovels	
2														B2	X			
3														B3	X			
4	GM		GRAVEL - coarse to fine, subrounded, some sand, coarse to fine, little silt, greyish brown, damp, stratified, isolated cobbles to 5", very dense															4 Using jack-hammer and shovels
5																		
8					Vx													
			Bottom of pit															

- 106 -

TEST HOLE No. N75-107B-B1-3

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.W.	LAT. & LONG: 88°58'56"N, 134°08'38"W	ELEVATION:
DRWN BY: D.J.M.	AIRPHOTO No.: A 23478-99	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 18°C
	METHOD: TEST PIT	
START: D 09 M 08 Y 75	TIME: 14:30	FINISH: D 09 M 08 Y 75
		TIME: 18:30

 <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p>	<p>TEST HOLE No. N75-107B-B1-3</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>		<p>SHEET 1 OF 1</p>

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2	Pt		PEAT - black, fibrous, moist		UF													Using shovels
1.3	SW		SAND - coarse to fine, some gravel, mainly fine, subangular, little silt, rusty brown, moist, dense															
1.9			and gravel, color changes to light grey															
1.9			isolated cobbles to 4", little gravel, dark grey, damp, very dense															few fibres to depth 2.4'
5.5			no silt, wet, dense															
6.2					Nd													
7.4			Bottom of pit															

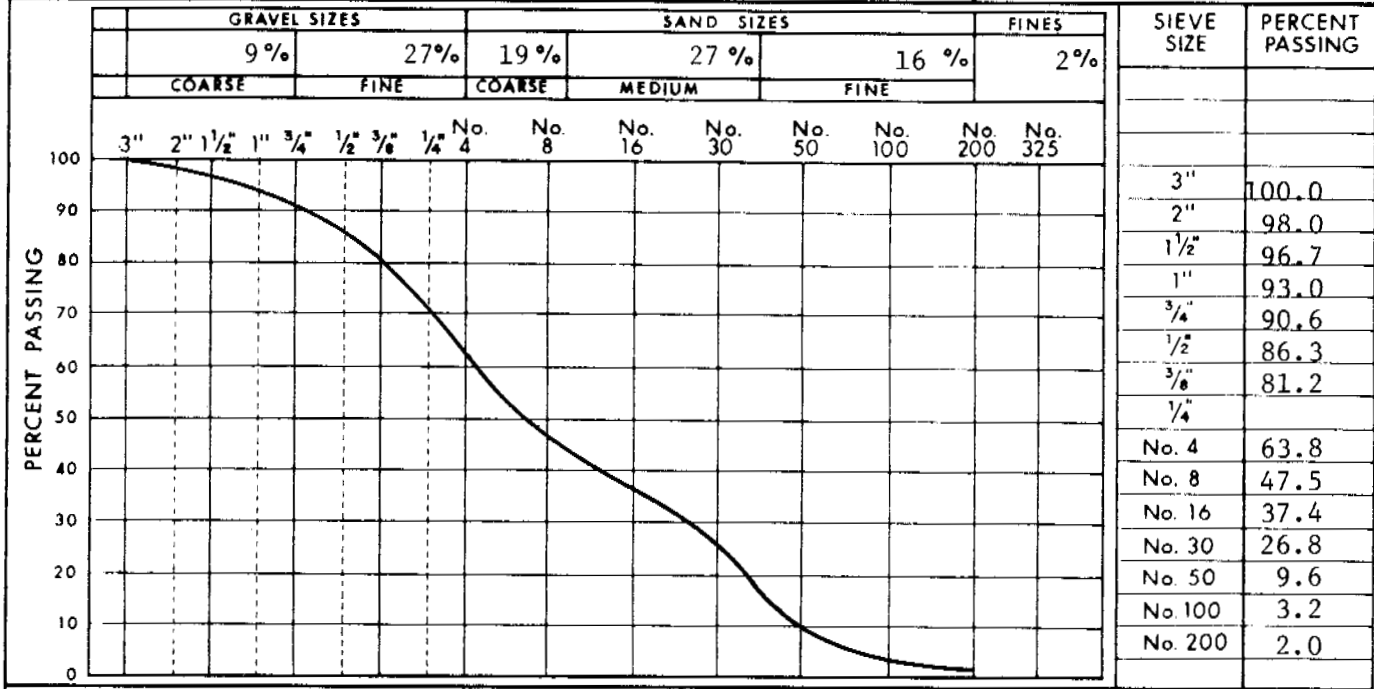
LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011	 1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R.H.	LAT. & LONG: 68°56'56"N, 134°09'12"W	ELEVATION:		N75-107B-B1-4
DRWN. BY: D.J.M.	AIRPHOTO No.: A 23476-89	PIPE MILEAGE:		
CHKD: D.O.	RIG:	AIR TEMP: 16°C		
METHOD: TEST PIT				
START: D 09 M 08 Y 75 TIME: 16:45	FINISH: D 09 M 08 Y 75 TIME: 19:45			SHEET 1 OF 1

- 107 -

TEST HOLE No. N75-107B-B1-4

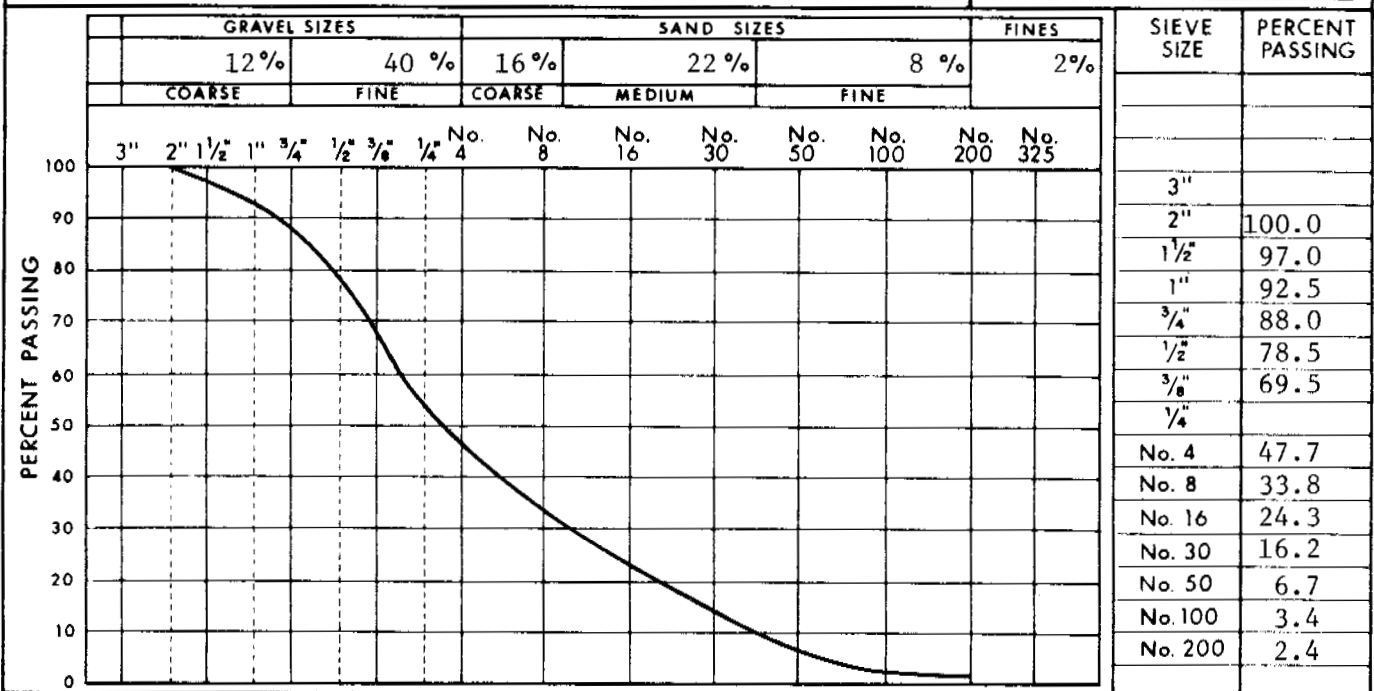
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B1-1 DEPTH 2.5-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 9, 1975 SAMPLED BY NESCL 42



COMMENTS OVERSIZE (>3") = 5.8 %

SAMPLE N75-107B-B1-2 DEPTH 2.0-5.6 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 9, 1975 SAMPLED BY NESCL 146

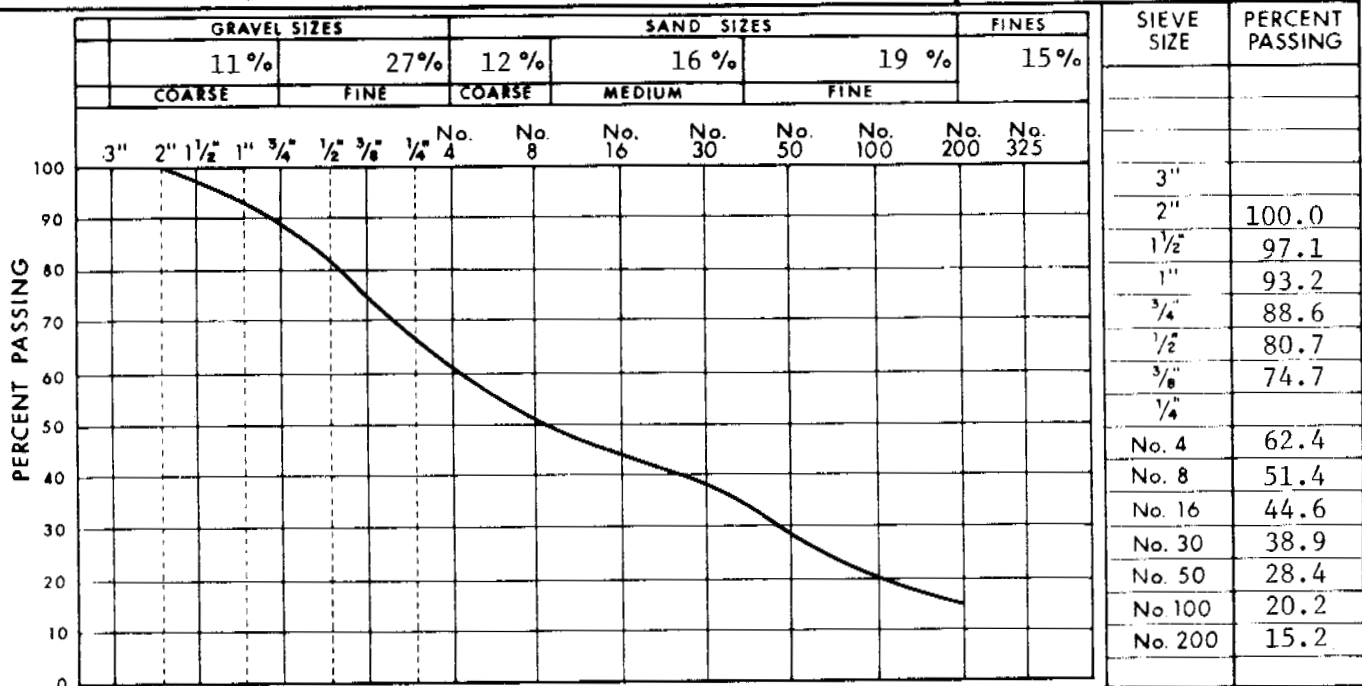


COMMENTS OVERSIZE (>3") = 0.0 %

 <p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	 <p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-107B-B1
		PAGE 108

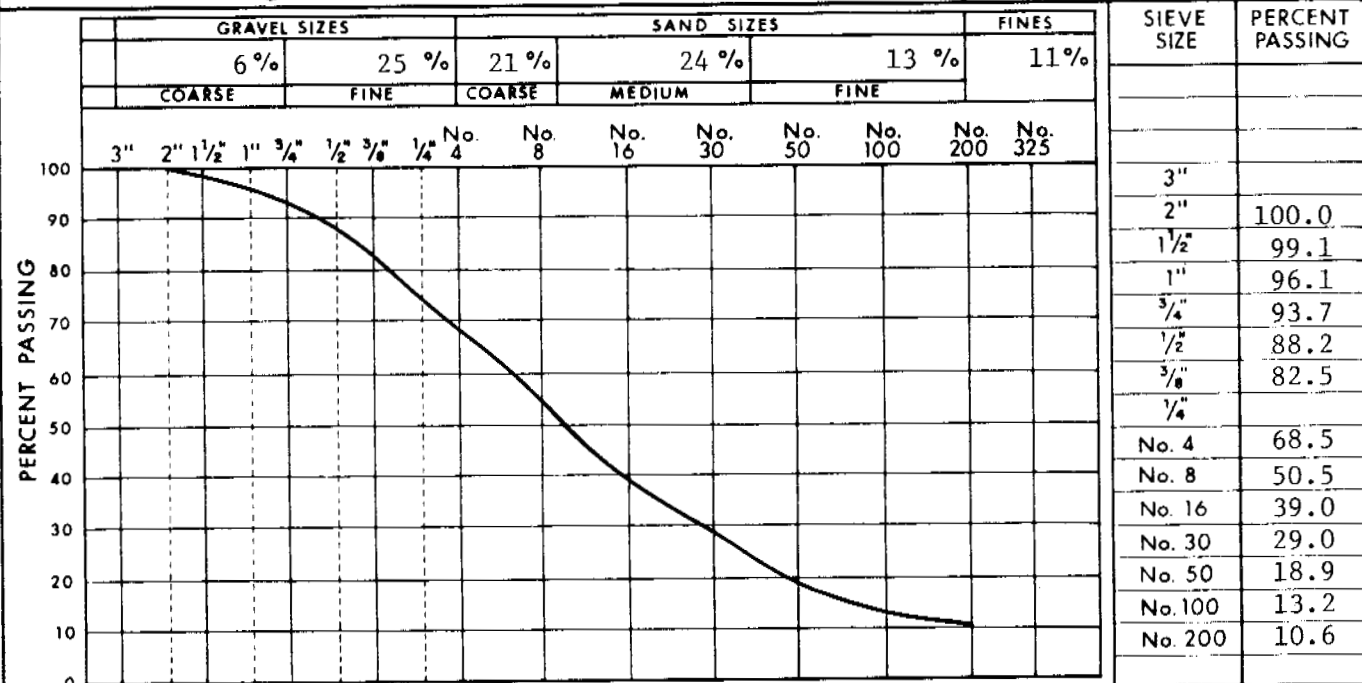
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B1-3 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 9, 1975 SAMPLED BY NESCL 85



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-107B-B1-4 DEPTH 2.0-7.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 9, 1975 SAMPLED BY NESCL 89



COMMENTS OVERSIZE (>3") = 0.0%
 Moisture contents range from 2.2% to 6.2%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B1

PAGE
 109

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-107B-B1-3 DATE SAMPLED : August 9, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 0-3 DATE TESTED : February, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 3.36 %
 FINE AGGREGATE : LOSS = 3.02 %

ORGANIC IMPURITIES TEST

NUMBER : 5
 COAL REMOVED : 4
 COAL & ROOTLETS
 REMOVED : 3+
 COAL CONTENT : Trace
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 19.8 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	26.8
Sandstone	Strong, Good	5.7
Siltstone		1.05
Chert	Potentially reactive, Fair	1.25
Flint		2.35
Ironstone	Soft, Poor	0.45
PN = 130	INTERPRETATION : Fair quality coarse aggregate, recommend further examination of alkaline reactivity and absorption.	37.6

COMMENTS : Further tests recommended. Chert components for sample close to 10%; recommend further examinations. Strength test required.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.

N75-107B-B1

PAGE 110

DEPOSIT 107B-B2


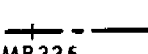

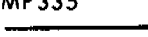

Physical Setting: Deposit 107B-B2 consists of two parts: the northern portion is an outwash plain modified by thermokarst, the southern portion is a series of gravel benches along an escarpment.

Material: SAND and GRAVEL - interbedded, well graded, with occasional beds of silt and clay.

Volume: 5,400,000 cubic yards.

Assessment: Deposit 107B-B2 is a source of fair to good quality granular material. Areas exploited will be dictated by the thickness of overburden. Haul distance to the pipeline right of way is in excess of ½ mile across a small valley. Material is suitable for general fill, backfill, building pads and possible concrete aggregate.



LEGEND			
	Deposit Outline		Proposed Gas Pipeline Route
	Drill Hole Location		Mackenzie Highway
	Test Pit Location		

Airphoto No. A23476-100 Latitude: 68° 54'

Approximate Scale: 1" = 4900' Longitude: 134° 06'

DEPOSIT 107B-B2

PHYSICAL SETTING

Deposit 107B-B2 is located at the northern end of the Wolverine Lakes, approximately 40 miles north-northwest of Inuvik. The proposed pipeline right of way passes about 2 miles to the north and east of the deposit. This deposit corresponds to source number 319 in the Ripley, Klohn, Leonoff DIAND Granular Materials Inventory Zone III (1972) report.

This deposit consists of two separate parts. The southern tip of the deposit is a series of gravel benches along the edge of a 200 foot escarpment, which flanks a meltwater channel. These benches are composed of erosional Tertiary remnants, kame terraces or slump blocks. The benches have flat to gently sloping surfaces separated by steep slopes. The flat upper surfaces are dotted with 10-foot gravel knobs. Except for local patches of silt, this area has a negligible amount of overburden and the drainage is generally good.

The northern portion of the deposit is an outwash plain modified by thermokarst. Relief is gently rolling with lakes inset 20 to 60 feet below the general surface level. The area is moderately well to imperfectly drained, with variable cover of up to 10 feet of silt and peat. It would be safe to assume that about half of the plain has less than 3 feet of overburden. Depending on the ground cover, the active layer varies from 2 to 7 feet.

BIOLOGICAL SETTING

The surface of the deposit, except for bare gravelly patches along the southern escarpment, is mainly covered by dwarf birch, willow and lichen with sedges in poorly drained areas. Reindeer occur in the area throughout the year and moose are occasionally present during the summer season. Numerous Arctic ground squirrel dens were observed at

the site. Grizzly bears used the area, as was indicated by diggings at ground squirrel dens. The area provides year-round habitat for foxes and wolves. The lower slopes of the site provide good passerine nesting habitat. Adjacent lakes provide water-fowl habitat during the open-water season. Wolverine Lake supports several species of fish including lake trout, whitefish, pike and burbot.

MATERIAL

NESCL drill holes and test pits, plus the DIAND Granular Materials Inventory Zone III report, show the deposit to consist of interbedded sand and gravel with occasional beds of silt and clay. Sand and gravel is well graded and usually subrounded. Ice is abundant in sands and gravel and massive ice was encountered in nearly all test holes. The quality of material varies greatly throughout the deposit. Petrographic analysis of gravel from one DIAND test hole showed sound material including quartzite (81%), a marginal sandstone (11%), with quartz (5%), chert and a trace of ironstone (8%).

VOLUME

In the southern portion (terraces), ice appears at depths of 5 to 20 feet. Total estimated volume, based on 30 acres and 10 feet of materials, is 400,000 cubic yards. In the approximately 340 acres of outwash modified by thermokarst, sand and gravel appears to be present to depths of more than 35 feet, and volume is estimated to be 5,000,000 cubic yards. Total volume is therefore 5,400,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B2 is a source of fair to good quality granular material. Areas to be exploited will be dictated by the amount of peat and overburden cover as well as insitu material quality and ice contents. Granular material from this deposit may be used for general fill, backfill in pipeline construction, building pads, and concrete aggregate production if the material is found to be suitable.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

The equipment may be staged via the pipeline right of way to the deposit. Haul distances from the deposit to the pipeline right of way are in excess of half a mile. A small valley between the deposit and the right of way would have to be crossed. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way.

Initially, the peat cover and overburden would be stripped from the area to be excavated, and stockpiled around the edge of the excavation.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained knobby areas so that good drainage would be established over the area. Excavations would be kept away from Wolverine Lake and any drainage channels so that siltation would not take place. This type of development could be established by using blasting or conventional earthmoving techniques, depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates. The effects of the borrow excavation on the thermal degradation of the insitu material will require careful consideration in view of the massive ice sheets at relatively shallow depths.

Equipment required for development would be dozers, rippers, end dump trucks, front end-loaders; as well as screening, drying, crushing and concrete plants, if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.3	PT		PEAT- fibrous, dk. brn, moist		UF												12:00	
1.2	ML		SILT- low plastic, light brown, moist		F													
2.0	GP		GRAVEL - fine, some sand		30													
3.0			ICE		ICE +													
4.2			ICE		+													
6.0	GP		GRAVEL - coarser to 1", some sand, (trace silt), pebbles to 2", little med. to fine sand, trace sand, med. to coarse		F													hard drilling
10.5			ICE		25													
11.5			ICE		ICE													
12.0	GP		GRAVEL- fine to coarse, trace medium sand, pebbles 1/2", occ. to 3"+		F													
15.0			ICE with med. to fine sand, cloudy ice		15-10													
16.0	ICE +				ICE +													

TEST HOLE No. N75-107B-B2-A

- 117 -

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 60°54'33" N, 134°08'47" W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-99	PIPE MILEAGE:
CHKD: D.O.	RIG: RELI-BRILL	AIR TEMP: 1°C
	METHOD: AIR	
START: D 10 M 8 Y 75 TIME: 12:00	FINISH: D 10 M 8 Y 75 TIME: 13:00	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B2-A
SHEET 1 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
16	ICE+		ICE+ (cont'd)		ICE											16		
18	SP		SAND - medium to fine high ice content, possibly ICE + SP		F											18	12:38 new Walmac bit	
20			(20.0) SAND - fine, uniform, (trace silt), possible ICE with soil incl.															
22	GP		GRAVEL - fine															
24	SP		SAND - medium to fine															
26	ICE+		ICE with traces of fine gravel and coarse sand		ICE+											26	12:48	
28																		
30																		
32																		

TEST HOLE No. N75-107B-B2-A

LOGGED BY: J. J. S.	FACILITY:	PROJECT: 13011
CHKD: D. O.	LAT. & LONG: 68°54'33"N, 134°06'47"W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 6°C
	METHOD: AIR	
START: D 10 M 8 Y 75 TIME: 12:00	FINISH: D 10 M 8 Y 75 TIME: 13:00	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B2-A

SHEET 2 OF 3


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
32	Cl	[Hatched Pattern]	CLAY-medium plastic, white (creamy)		F													
34																		
35.0																		
36	Sp	[Dotted Pattern]	SAND-medium, uniform		10											36	13:00	
			End of hole															

TEST HOLE No. N75-107B-B2-A

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13811
CHKD: D.O.	LAT. & LONG: 68°54'33"N, 134°06'47"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 1°C
	METHOD: AIR	
START: D 10 M 8 Y 75	TIME: 12:00	FINISH: D 10 M 8 Y 75
		TIME: 13:00

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B2-A
SHEET 3 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL	ICE %	▲ Dry density (pcf)	○ Water content %							
0.8	Pt		PEAT - fine fibrous, black, damp.	UF													
1.0	OL		SILT-(organic) trace fine sand, dark brown	F												15:25	
2.2																4 1/4" Walmac	
4.0	ML		SILT - trace coarse sand, trace fine sand. Medium brown, darker brown at approx. 5.0' depth	40													
6.0																	
8.0																	
9.0	GW		GRAVEL - fine, and sand, little coarse sand, (trace silt), pebbles to 1	30													
10.0			increasing coarse sand														
11.0			little medium sand														
13.0			trace fine sand, little coarse sand.														
15.0			some medium to coarse sand, trace fine														
16.0	SW		SAND - fine to coarse, little fine gravel	25													

- 120 -

TEST HOLE No. N75-107B-82-B

LOGGED BY: J.J.S	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°54'30"N, 134°06'31"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 10 M 08 Y 75 TIME: 15:25	FINISH: D 10 M 08 Y 75 TIME: 18:25	

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	1975 BORROW INVESTIGATION CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-107B-82-B SHEET 1 OF 2
--	--	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
16			cont'd		F													
18	SW		SAND - fine to coarse, little fine gravel		25												18:08 18:12	
20			20.0															
22	ICE +		ICE possibly approx. 5% fine to medium sand		ICE +													
24																		
26			26.0															
28	SP		SAND - fine to medium, some fine gravel		F 45												18:22	
30			30.0															
32			fine to coarse sand, oxidation (rust)															
34																		
36			36.0															
38			End of hole															

TEST HOLE No. N75-107B-82-B

LOGGED BY: J.J.S	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°54'30"N, 134°08'31"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 10 M 08 Y 75 TIME: 15:25	FINISH: D 10 M 08 Y 75 TIME: 18:25	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-82-B


SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.8	Pt		PEAT - fibrous, black, moist		UF												18:55		
1.3	OL		SILT - (organic), little fine gravel, trace fine sand, low plastic, dark brown		F												17:15	4 1/2' Walmac	
2.5					20														
4	GP		GRAVEL - fine to coarse, some medium to coarse sand, rusty (oxidized), pebbles to 1 1/2"		10														
7.0			no oxidization																
8	SP		SAND - medium to coarse																
10.0																			
10	GP		GRAVEL - fine (3/4"), little medium sand														17:19	chert and quartzite pebbles	
14																	17:22		
14	SW		SAND - fine, medium to coarse, (no gravel)		15														
16																			

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13011
CHKD: D.D.	LAT. & LONG: 68°54'28"N, 134°06'12"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-98	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-DRILL	AIR TEMP: 2°F
	METHOD: AIR	
START: D 10 M 8 Y 75 TIME: 17:15	FINISH: D 10 M 8 Y 75 TIME: 18:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B2-C

SHEET 1 OF 2

- 122 -

TEST HOLE No. N75-107B-B2-C

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
18	SW		SAND (cont'd)		F												18	17:24
18		18.3															18	17:27
20	GP		GRAVEL—fine, and medium to coarse sand, occasional pebbles to 1"															
22		21.0	increasing med. coarse sand															
24	SP		SAND—fine (uniform), slight medium														24	
32		32.0															32	
34			SAND—medium to fine, possible trace clay, (white-coloured)															
36		36.0	rusty yellow															
38		38.0	End of hole														38	End

TEST HOLE No. N75-107B-B2-C


- 123 -

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: D.O.	LAT. & LONG.: 68°54'29" N, 134°06'12" W	ELEVATION:		N75-107B-B2-C
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:		
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 2°C		
	METHOD: AIR			
START: D 10 M 8 Y 75 TIME: 17:15	FINISH: D 10 M 8 Y 75 TIME: 18:50			SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %	▲ Dry density (pcf)	○ Water content %	Plastic limit							
	Pt	7 7	0.2 PEAT - black, fibrous, damp														
1	ML		SILT - little gravel, coarse and fine, subangular, trace sand, medium to fine, trace clay, low plastic, grayish brown, wet, stratified, very dense		UF												Using jack-hammer and shovels
2																	
3																	
4																	
4	SW		4.2 SAND - coarse to fine, little gravel, mainly fine, subangular, rusty brown, stratified, very dense		Vs 30												
5																	
6			6.0 Bottom of pit														

LOGGED BY: J. G. R.	FACILITY:	PROJECT: 33011
CHKD: R. H.	LAT. & LONG: 68°54'48"N, 134°07'23"W	ELEVATION:
DRWN. BY: A. W.	AIRPHOTO No.: A 23478-89	PIPE MILEAGE:
CHKD: D. D.	RIG:	AIR TEMP: 4°C
METHOD: TEST PIT		
START: D 10 M 08 Y 75 TIME: 10:20	FINISH: D 10 M 08 Y 75 TIME: 12:00	

<p>1975 BORROW INVESTIGATION</p>  <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107B-B2-1</p> <p>SHEET 1 OF 1</p>
--	--

- 124 -

TEST HOLE NO. N75-107B-B2-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
1	SW		SAND - coarse to fine; some gravel, mainly fine, subangular, brown, moist, stratified, loose.		UF													Using shovels	
2	GP		GRAVEL - mainly fine, subrounded; and sand, coarse to fine; brown, damp, stratified, isolated cobbles to 4", dense.										B1						
5	SW		SAND - coarse to fine; and gravel, fine, subrounded; trace silt, greyish brown, damp, dense.																
6	SW		SAND - coarse to fine; little silt; trace fine gravel, low plastic, grey, wet, dense.																
7	SW		SAND - coarse to fine; little gravel, mainly fine, subrounded, greyish brown.																
			Bottom of pit										B3					Using jack-hammer and shovels	

TEST HOLE No. N75-107B-B2-2

- 125 -

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°54'33"N, 134°06'47"W	ELEVATION:
DRWN BY: A.J.B.	AIRPHOTO No.: A 23478-99	PIPE MILEAGE:
CHKD: D.D.	RIG:	AIR TEMP: 4°C
	METHOD: TEST PIT	
START: D 10 M 08 Y 75 TIME: 10:30	FINISH: D 10 M 08 Y 75 TIME: 13:00	

<p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>TEST HOLE No. N75-107B-B2-2</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>SHEET 1 OF 1</p>

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	GP		GRAVEL - fine, rounded; and sand, coarse to fine; rusty brown, moist, stratified, occasional cobbles to 8", loose.		UF													Using shovels
2																		trace organic to depth 0.8'
3	GW		GRAVEL - fine to coarse, subrounded; and coarse to fine sand, brown, damp, loose, unstratified light brown, stratified, loose															
4																		
5																		Excess sloughing
6																		Water level at 5.8'

MA, combined samples 1 & 2
 G = 82.7%
 S = 38.0%
 F = 1.3%

B1

B2

GWL 5.8

Bottom of pit

- 126 -

TEST HOLE No. N75-107B-B2-3

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°54'30"N, 134°08'31"W	ELEVATION:
DRWN BY: A.J.B.	AIRPHOTO No.: A 23478-89	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 4°C
METHOD: TEST PIT		
START: D 10 M 08 Y 75 TIME: 14:05	FINISH: D 10 M 08 Y 75 TIME: 15:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.

N75-107B-B2-3

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.7	SW		SAND - coarse to fine, and gravel, fine, trace silt, rusty brown, damp, isolated cobbles to 7", loose		UF													Using shovels
1	GM		GRAVEL - coarse and fine, subrounded, and sand, coarse to fine, light brown, damp, occasional cobbles to 7"										B1				1	
2													B2				2	Sand layer (SP), medium at 2.0' - 2.3'
3													B3				3	
3.7													B4				4	
4	SW		SAND - coarse to fine, and gravel, fine, subrounded, greyish brown, damp, loose										B5				5	
5													B6				6	
6													B7				8	
6.5			Bottom of pit														8.5	

MA, sample 4,
G = 58.2%
S = 40.8%
F = 1.2%

- 127 -

TEST HOLE No. N75-107B-B2-4

LOGGED BY: J. B. R.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 68°54'31" N, 134°06'12" W	ELEVATION:
DRWN. BY: A. J. B.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:
CHKD: D. D.	RIG:	AIR TEMP: Approx. 4°C
	METHOD: TEST PIT	
START: D 10 M 08 Y 75 TIME:	FINISH: D 10 M 08 Y 75 TIME:	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B2-4

SHEET 1 OF 1


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt	99	PEAT - black, fibrous, moist		UF													
0.5																		
	SW	79	SAND - coarse to fine, little gravel, fine, subrounded, trace silt, grayish brown, damp, dense															Using jack-hammer
1.3																		
	ML		SILT - little gravel, fine, subrounded, little sand, coarse to fine, low plastic, grey, wet, stratified, very dense															
2.4																		
					Ys													
					35													
			3.3 -- some sand															
			4.5 Bottom of pit															

- 128 -

TEST HOLE No. N75-107B-B2-5

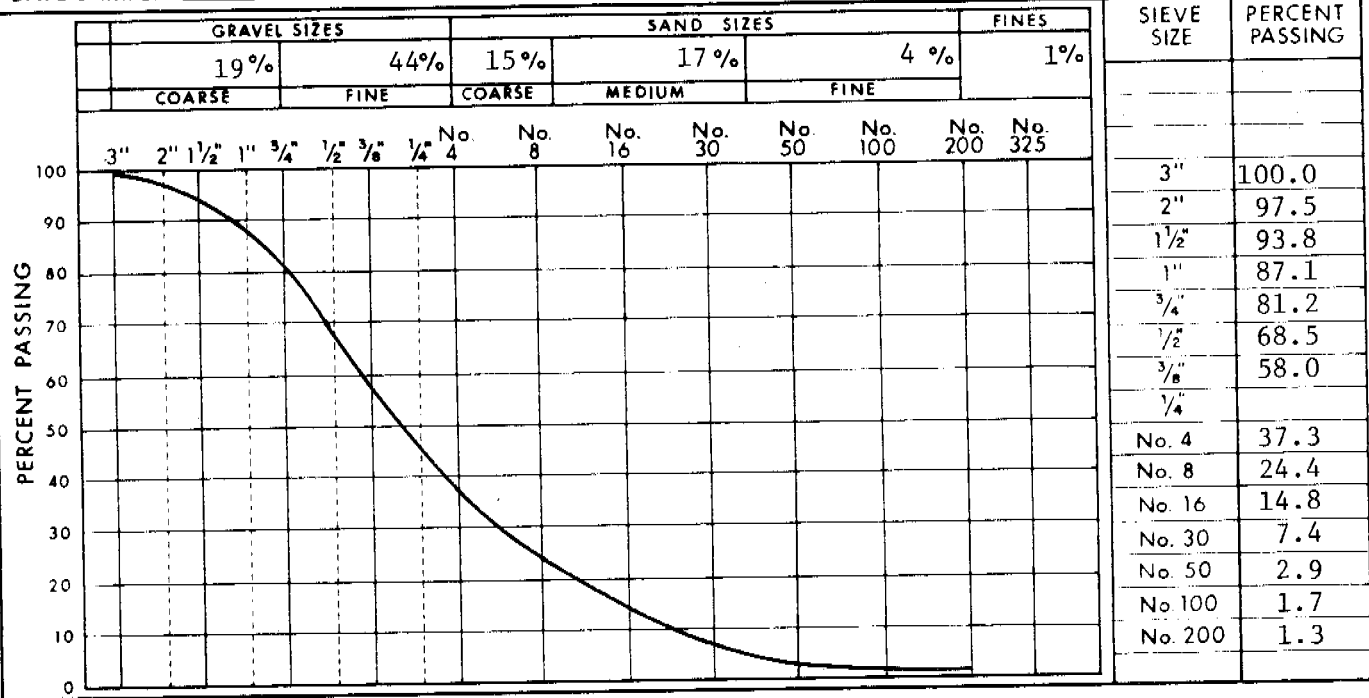
LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°54'41"N, 134°06'11"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 23476-99	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 4°C
	METHOD: TEST PIT	
START: D 10 M 08 Y 75 TIME: 16:00	FINISH: D 10 M 08 Y 75 TIME:	

1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-107B-B2-5
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B2-3 DEPTH 3.0-3.5 & 5.5-6.0
 DATE SAMPLED August 10, 1975 SAMPLED BY NESCL

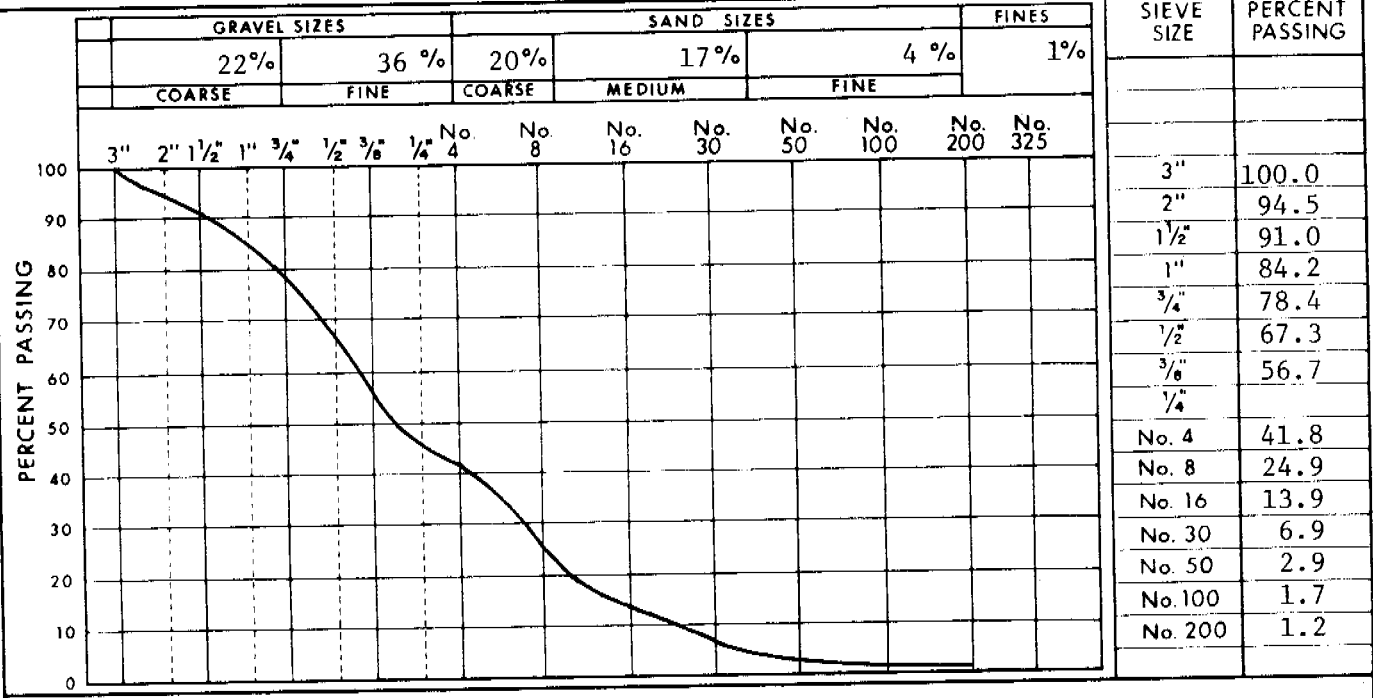
R.M.HARDY REPORT NUMBER
205



COMMENTS OVERSIZE (>3") = 5.0 %

SAMPLE N75-107B-B2-4 DEPTH 4.0-4.5
 DATE SAMPLED August 10, 1975 SAMPLED BY NESCL

R.M.HARDY REPORT NUMBER
210



COMMENTS OVERSIZE (>3") = 0.0 %



R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING



DEPOSIT No.
N75-107B-B2

PAGE
129

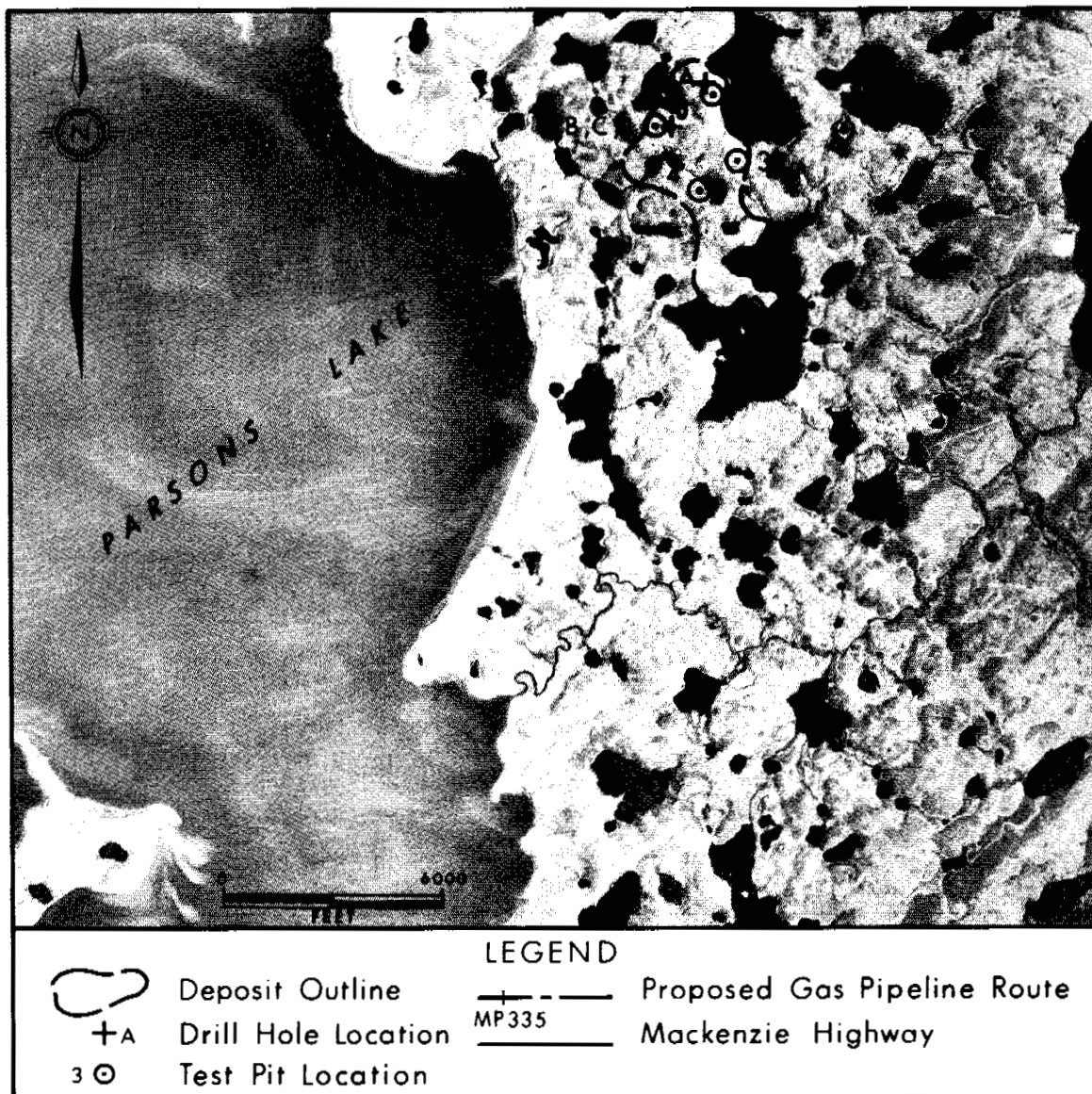
DEPOSIT 107B-B3

Physical Setting: Deposit 107B-B3 is an outwash plain modified by thermokarst located 1.5 miles east of the northeast corner of Parsons Lake. Local relief within this deposit is 120 feet.

Material: GRAVEL - well graded and sand with minor amounts of silt and isolated cobbles.

Volume: 6,000,000 cubic yards.

Assessment: Deposit 107B-B3 is a source of an excellent quality granular material. Access from the deposit to the right of way is 6 miles in length across hilly ice cored terrain, or across Parsons Lake. Granular material from this deposit may be used for general fill, backfill, building pads and possible concrete and asphalt aggregate.



Airphoto No. A23476-104
Approximate Scale: 1" = 5000'

Latitude: 69° 59'
Longitude: 133° 30'

DEPOSIT 107B-B3

PHYSICAL SETTING

This deposit is an outwash plain modified by thermokarst. It is located 1.5 miles east of the northeast corner of Parsons Lake and is 6 miles north of the Parsons Lake lateral. The Ripley, Klohn, Leonoff DIAND Granular Materials Inventory Zone III (1972) report refers to this deposit as Source 309.

The outwash plain may have been a kame and kettle complex originally, but the topography has been modified by thermokarst and its original geomorphic form is difficult to determine.

Local relief within this deposit is 120 feet. Although most depressions have steep slopes, the deposit is generally characterized by a gently rolling surface with isolated superimposed ridges and knobs standing 15 to 50 feet above the general level of the deposit.

Overburden varies from negligible on knobs, ridges, steep slopes and some gently sloping areas, to 3 to 8 feet in most depressions and on level areas. Drainage is generally good over most of the deposit but locally, it may be moderately good to imperfect. The active layer ranges from 1 to 6 feet and the ice content in the glaciofluvial material is low.

The terrain between the deposit and the proposed pipeline right of way is hummocky with ice cored hills.

BIOLOGICAL SETTING

This site is covered by dwarf birch, willow, alder, sedge, moss, and lichen. The site is located in a reindeer calving area. Arctic ground squirrel dens were observed on the site together with grizzly bear

diggings. Caribou and occasional moose also use the area. A lake to the west of the site supports a small Arctic tern colony. Twelve birds were observed during the 1975 survey. Ptarmigan, passerines, and waterfowl occur throughout the area. Immediately adjacent bodies of water do not appear to support fish populations.

MATERIAL

The materials in this deposit are well graded gravel and sand with minor amounts of silt and isolated cobbles. The gravel appears to be concentrated in the knobs and ridges, but is not confined to them. The glaciofluvial material at the site is probably underlain by preglacial sand, gravel, and silt containing abundant ground ice. The DIAND report and drill holes 107-B3-A and C show massive ice at 8 to 30 feet below the surface.

VOLUME

The total estimated volume of sand and gravel based on 200 acres and 20 foot thickness is 6,000,000 cubic yards. This volume would be decreased if only the knobs and ridges of granular material are considered.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B3 is a source of an excellent quality granular material. Areas to be exploited will be dictated mainly by length of haul, environmental restrictions, local ground ice conditions and overburden. Granular material from this deposit may be used for general fill, backfill in pipeline construction, building pads, and concrete and asphalt aggregate production. The gravel will require further testing prior to use in concrete production. More drilling and test pitting would be required to delineate the areas of best quality material.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socioeconomic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

A 6 mile access snow road would have to be constructed from the pipeline right of way to the deposit. This road would cross hilly, ice cored terrain, or the ice on Parsons Lake. If crossing the hilly terrain, care should be taken not to initiate bimodal flows on slopes.

Initially the peat cover and overburden would be stripped from the area to be excavated, and stockpiled around the edge of the site. Borrow material would then be excavated evenly from the knobs and ridges to a grade such that good drainage would be maintained over the area. Excavations would be kept away from the lakes and creeks in the area to prevent siltation. This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Natural mixing during excavation will provide adequate good gradations. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end dump trucks, front-end loaders, as well as screening, drying, crushing, concrete and asphalt plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as:

selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC ICE TYPE VISUAL ICE %	▲ Dry density (pcf)		○ Water content %		Plastic limit							
					40	60	80	100	120	140 ▲							
					0	20	40	60	80	100 ○							
0.0	Pt		PEAT - moss cover, black.		UF											4 1/2" Walmac bit	
0.8	CL		CLAY - silty, low plastic, light brown.		Vx											19:10	
7.0	GW		GRAVEL - some coarse sand, pebbles rounded to 3/8"													3 7/8" Walmac bit	
8.0	ICE		ICE clear		ICE												
38.0			End of hole. dirty													19:26	

TEST HOLE No. N/5-107B-B3-A

- 137 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 69°59'29"N, 133°30'48"W	ELEVATION:
DRWN BY: J.W.B.	AIRPHOTO No.: A 23476-105	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 20°C
	METHOD: AIR	
START: D 11 M 08 Y 75 TIME: 19:10	FINISH: D 11 M 08 Y 75 TIME: 19:26	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B3-A

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.1	Pt		PEAT - mossy		UF													
2	BW		GRAVEL - fine to coarse, little cwf. sand, pebbles to 1 1/2, rounded, clean, rusty brown, moist, occasional cobbles to 6															
4.0			End of hole															
			Refusal due to unfrozen gravel caving into hole.															20:28

LOGGED BY: J.K.W	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 80°59'18"N, 133°31'11"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-105	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 2°C
	METHOD: AIR	
START: D 11 M 08 Y 75 TIME: 20:00	FINISH: D 11 M 08 Y 75 TIME: 20:28	

<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p style="text-align: center;">N75-107B-B3-B</p> <p>SHEET 1 OF 1</p>
--	---

- 138 -

TEST HOLE No. N75-107B-B3-B


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt		PEAT - non-woody, roots, brown-black, clear ice at 1.0'		UF													4 1/2" Walmac bit. 10:14
	ICE		ICE		ICE													
2	Pt		PEAT		Vx													
			3.0															
4	GM		GRAVEL - fine grained, silty, pebbles to 3/4", rounded, occasional cobbles, rounded to 6" at 5.0		F													
			5.0															
8			8.0 cobble to 6"															3 7/8" Walmac bit 10:17
10			increasing in size															
12			12.0															
14	GP		GRAVEL - fine to coarse, poorly graded, little fine sand, trace silt, occasional cobbles, pebbles rounded to 1.0															
			16.0 boulder to 12"															3 7/8" tricone bit 10:30

TEST HOLE No. N75-107B-B3-C

LOGGED BY: J.K.W	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 69°59'11"N, 133°30'26"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-105	PIPE MILEAGE:
CHKD: R.H.	RIG: HELI-DRILL	AIR TEMP: 2°C
	METHOD: AIR	
START: D 12 M 8 Y 75	TIME: 10:10	FINISH: D 12 M 8 Y 75 TIME: 11:25

1975 BORROW INVESTIGATION




NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B3-C

SHEET 1 OF 2

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
18	SP		17.0 GRAVEL (cont'd) 17.0' - 19.0' numerous cobbles		F												10:42	
22			21.0 2" pebble inferred by action of drill.														no cutting return	
28			on borderline of coarse to fine gravel with occasional large cobbles. (inferred by drill action).															
29.0			29.0 End of hole														11:25	

- 140 -

TEST HOLE No. N75-107B-B3-C

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: D. O.	LAT. & LONG: 69°59'11"N, 135°30'28"W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: A 23478-105	PIPE MILEAGE:
CHKD: R. H.	RIG: HELI-DRILL	AIR TEMP: 2°C
	METHOD: AIR	
START: D 12 M 08 Y 75 TIME: 10:10	FINISH: D 12 M 08 Y 75 TIME: 11:25	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B3-C

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt	9/9 9/9	PEAT - black, fibrous, damp		UF													Using jack-hammer No samples taken
1	ML	0.5	SILT - some fine sand, little gravel, fine, subangular, low plastic, light brown, wet, stratified, firm															
2		1.5	occasional ice lenses to 1/2"		Ys													
2		2.2	little sand, to grey		50													
3		3.0	Bottom of pit															

TEST HOLE No. N75-107B-B3-1

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13911
CHKD: R.H.	LAT. & LONG: 89°59'29"N, 133°30'48"W	ELEVATION:
DRWN BY: A.J.B.	AIRPHOTO No.: A 12918-266	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 7°C
METHOD: TEST PIT		
START: D 11 M 08 Y 75 TIME: 12:00	FINISH: D 11 M 08 Y 75 TIME: 14:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.

N75-107B-B3-1

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS		
						▲ Dry density (pcf)			○ Water content %											
						40	60	80	100	120	140 ▲									
						0	20	40	60	80	100 ○									
0.3	Pt		PEAT - black, fibrous, dry		UF															
1	GW		GRAVEL - fine to coarse, subrounded, some fine to coarse sand, light brown, dry, loose, isolated cobbles to 7", numerous fibres									MA, combined samples 1 - 3 oversize = 3.6% G = 71% S = 27% F = 2%	B1				1	Using shovels		
2													B2						2	
3																				3
4	BP		GRAVEL - mostly coarse (½" - 3") rounded, little sand, light brown, dry, loose											B3						4
5.0			Bottom of pit																	5

- 142 -

TEST HOLE No. N75-107B-B3-2

LOGGED BY: J. B. R.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 69°59'18" N, 133°31'31" W	ELEVATION:
DRWN. BY: D. J. M.	AIRPHOTO No.: A 23478-105	PIPE MILEAGE:
CHKD: D. O.	RIG:	AIR TEMP: Approx. 7°C
	METHOD: TEST PIT	
START: D 11 M 08 Y 75 TIME: 12:00	FINISH: D 11 M 08 Y 75 TIME: 14:15	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B3-2

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	SW		SAND - medium to coarse, some gravel, pebbles to 2½'', rounded, very small ice crystals visible only in sunlight		Nbc (occ. Vx)							%						
1.5																		
2	GW		GRAVEL - some coarse sand, pebbles to approximately 1½'', rounded, low moisture, occasional cobble to 4'									1.6	MA, combined samples 1 - 6	B1				
												1.8	G = 74%	B2				
													S = 24%					
													F = 2%					
													Oversize = 5.3%					
4			Boulder, round, 12''									1.2		B3				
4	GP		GRAVEL - approximately ½'' to maximum 2½''									2.1		B4				
5			--- cementation on gravel															
6												1.9		B5				
6	GW		GRAVEL - fine to coarse, and coarse sand, rounded pebbles, numerous cobbles									3.5		B6				
7			Bottom of pit															

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT & LONG: 69°59'11"N, 133°30'26"W	ELEVATION:
DRWN BY: D.J.M.	AIRPHOTO No.: A 23476-105	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 2°C
	METHOD: TEST PIT	
START: D 11 M 08 Y 75 TIME:	FINISH: D 11 M 08 Y 75 TIME:	

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED <small>CALGARY ALBERTA</small> <small>ENGINEERS FOR</small>	1975 BORROW INVESTIGATION TEST HOLE No. N75-107B-B3-3
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

- 143 -

TEST HOLE No. N75-107B-B3-3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.3	Pt		PEAT - reindeer lichen		UF												10:00	
0.3 - 2.0	GW		GRAVEL - fine to coarse, some cml sand,									MA, combined samples 1 - 5 G = 88% S = 31% F = 1%	B1				10:15	
2.0 - 4.1			rust brown, moist to dry, occasional cobble to 8'', rounded, quartzite										B2				10:25	
4.1 - 6.0			cementation, rusty, occasional boulder 8 1/2''										B3				10:40	
													B4				10:55	
													B5					
6.0			Bottom of pit															

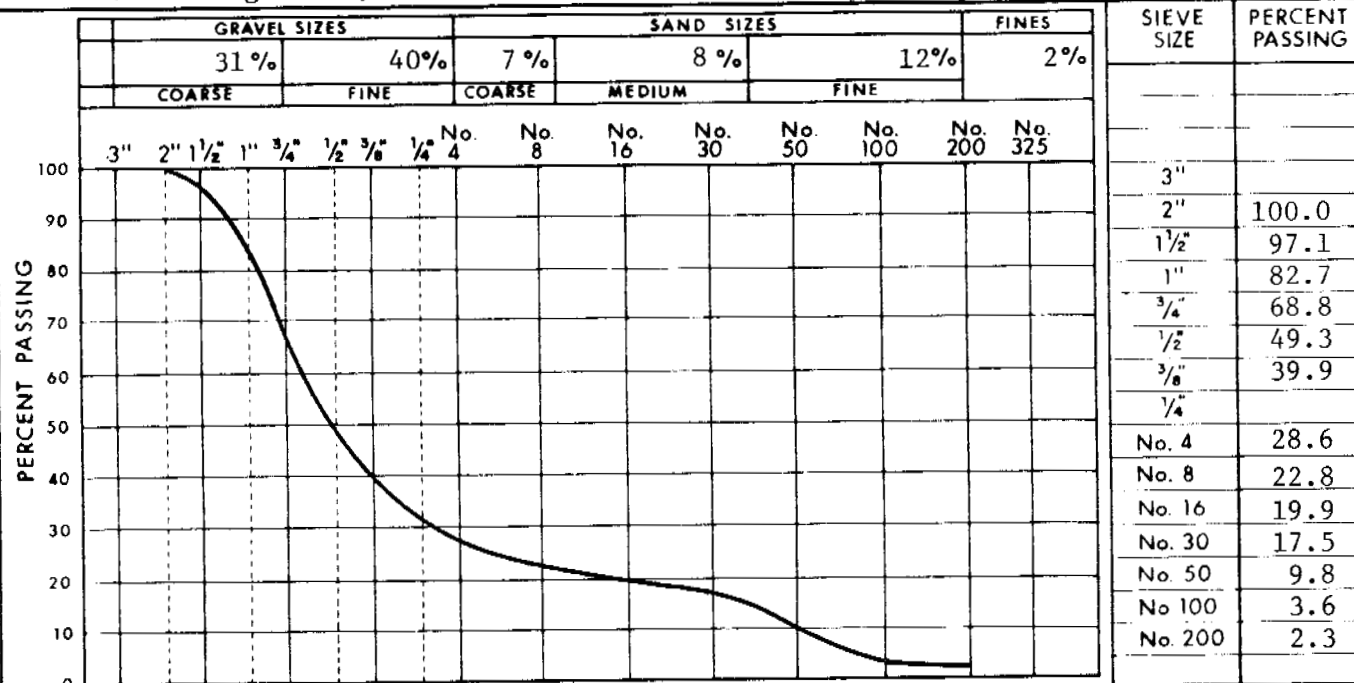
TEST HOLE No. N75-107B-B3-4

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 89°58'59"N, 133°30'54"W	ELEVATION:
DRWN BY: D.J.M.	AIRPHOTO No.: A 23476-105	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 13°C
	METHOD: TEST PIT	
START: D 12 M 08 Y 75 TIME: 09:50	FINISH: D 12 M 08 Y 75 TIME: 10:55	

1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-107B-B3-4 SHEET 1 OF 1
---	--

SIEVE ANALYSIS REPORT

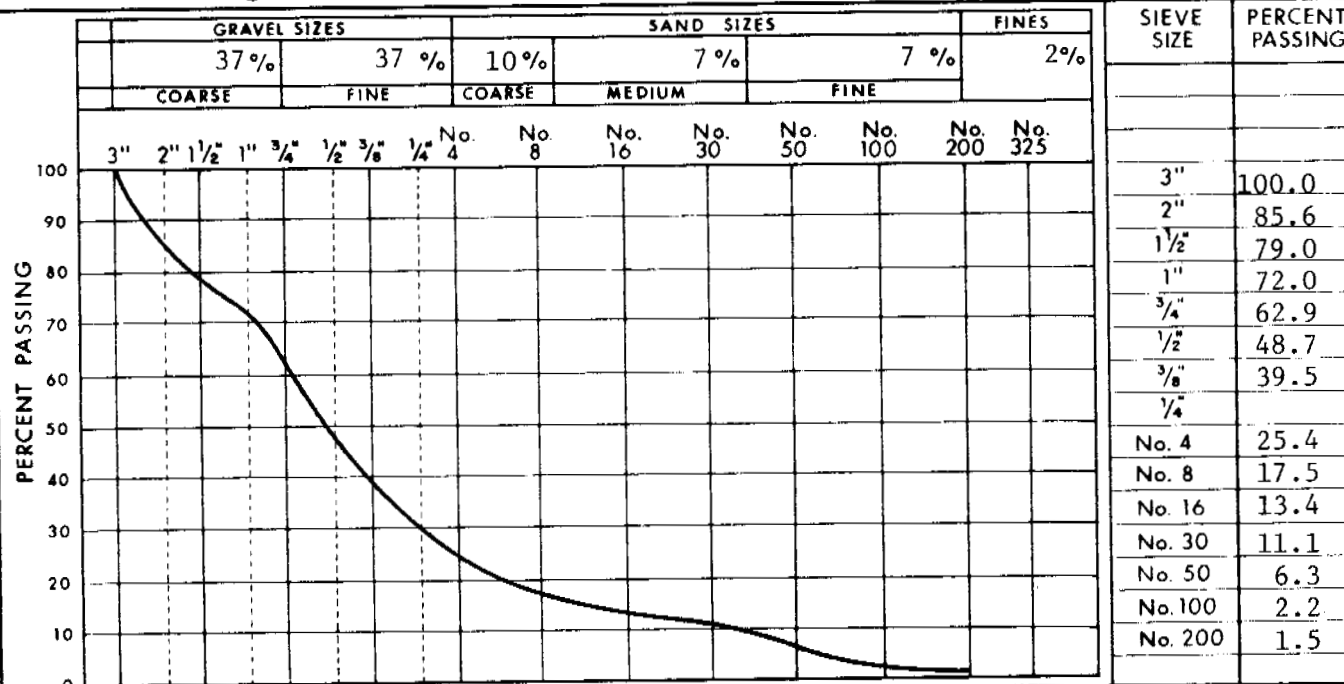
SAMPLE N75-107B-B3-2 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 11, 1975 SAMPLED BY NESCL 68



COMMENTS

OVERSIZE (>3") = 3.6%

SAMPLE N75-107B-B3-3 DEPTH 1.0-7.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 11, 1975 SAMPLED BY NESCL 78



COMMENTS

OVERSIZE (>3") = 5.3%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

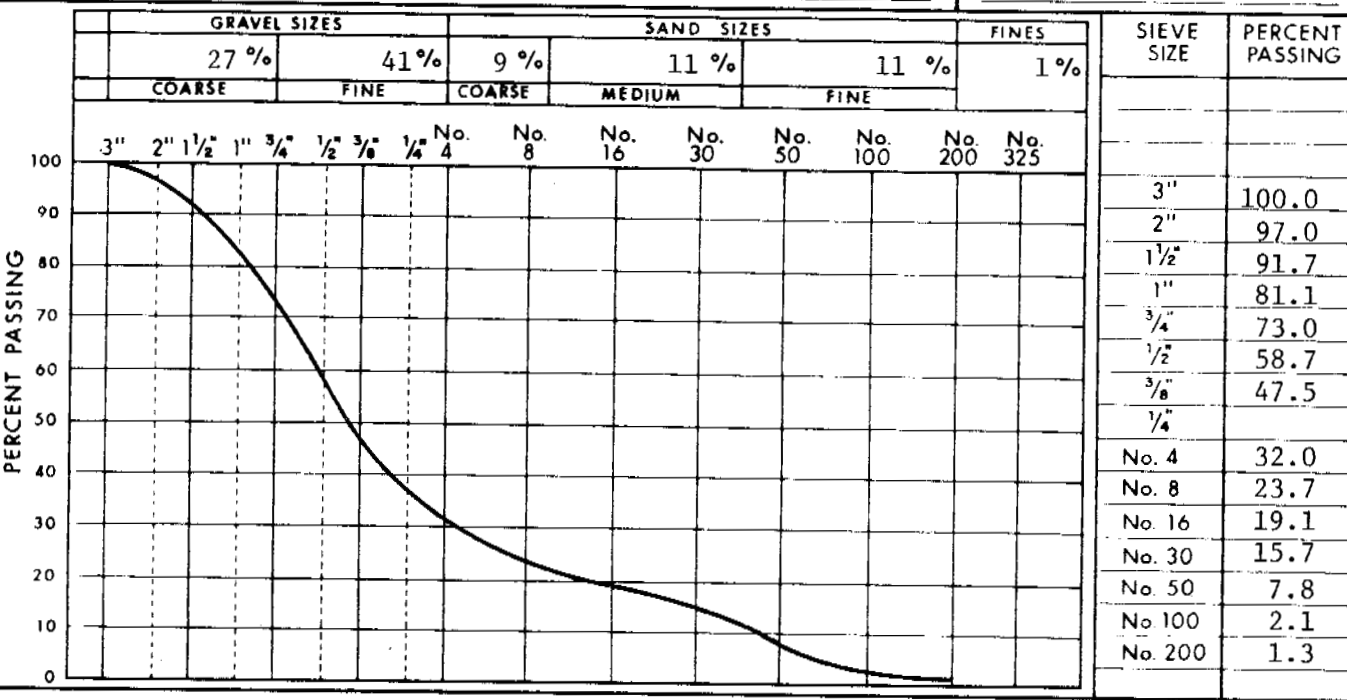


DEPOSIT No.
 N75-107B-B3

PAGE
 145

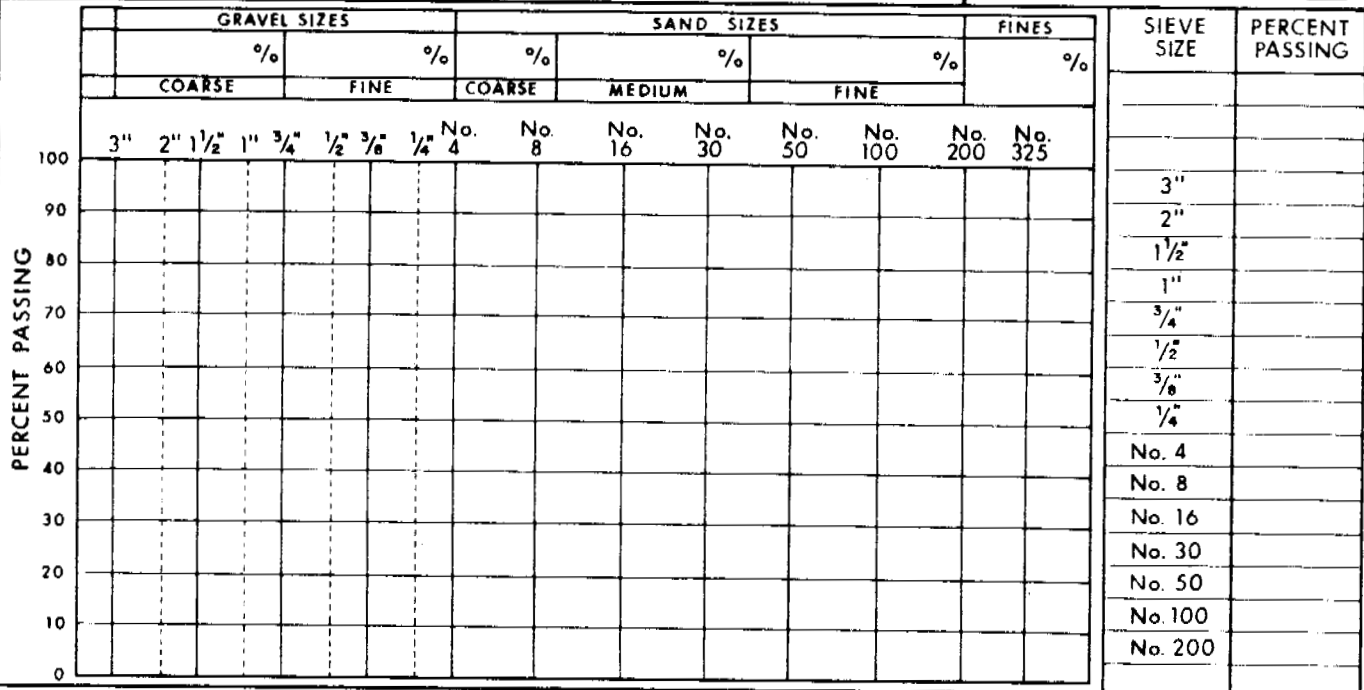
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B3-4 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER 83
 DATE SAMPLED August 11, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS OVERSIZE (>3") = %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B3
 PAGE
 146

**SUMMARY OF LABORATORY TEST DATA
FOR
SUITABILITY OF AGGREGATES IN CONCRETE**

SAMPLE No. N75-107B-B3-4 DATE SAMPLED : August 12, 1975 SAMPLED BY : NESCL
DEPTH (FT.) : 1-6 DATE TESTED : March, 1976 TESTED BY : RMHA

**SOUNDNESS OF AGGREGATE
SULPHATE TEST**

COARSE AGGREGATE : LOSS = 0.5 %
FINE AGGREGATE : LOSS = 4.9 %

**ORGANIC IMPURITIES
TEST**

NUMBER : 4
COAL REMOVED : 3
COAL & ROOTLETS
REMOVED : 3
COAL CONTENT : Trace
SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 13.8 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	37.39
Sandstone	Strong, Hard, Good	16.91
Siltstone		8.31
Limestone	Strong, Good	0.28
Altered Siltstone		1.85
Chert	Potentially reactive, Fair	1.89
Flint		1.30
Ironstone	Soft, Friable, Deleterious	0.07
PN = 115	INTERPRETATION : Good aggregate	68.00

COMMENTS : Satisfactory, See also page 148.



R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

DEPOSIT No.

N75-107B-B3

PAGE 147

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-107B-B3-4 DATE SAMPLED : August 12, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 1-6 DATE TESTED : March, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 0.5 %
 FINE AGGREGATE : LOSS = 4.9 %

ORGANIC IMPURITIES TEST

NUMBER : 4
 COAL REMOVED : 3
 COAL & ROOTLETS
 REMOVED : 3
 COAL CONTENT : Trace
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 13.8 %

SUMMARY OF ROCK TYPES, FINE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	20.72
Sandstone	Strong, Hard, Good	2.60
Siltstone		3.67
Limestone		0.15
Altered Siltstone	Strong, Soft, Good	0.15
Chert	Potentially reactive, Fair	2.05
Flint		2.59
Calcareous coating	Soft, Weak, Poor	0.06
Ironstone	Friable, Soft, Deleterious	0.01
PN = 115	INTERPRETATION : Good	32.00

COMMENTS : Satisfactory. See also page 147.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-107B-B3

PAGE 148

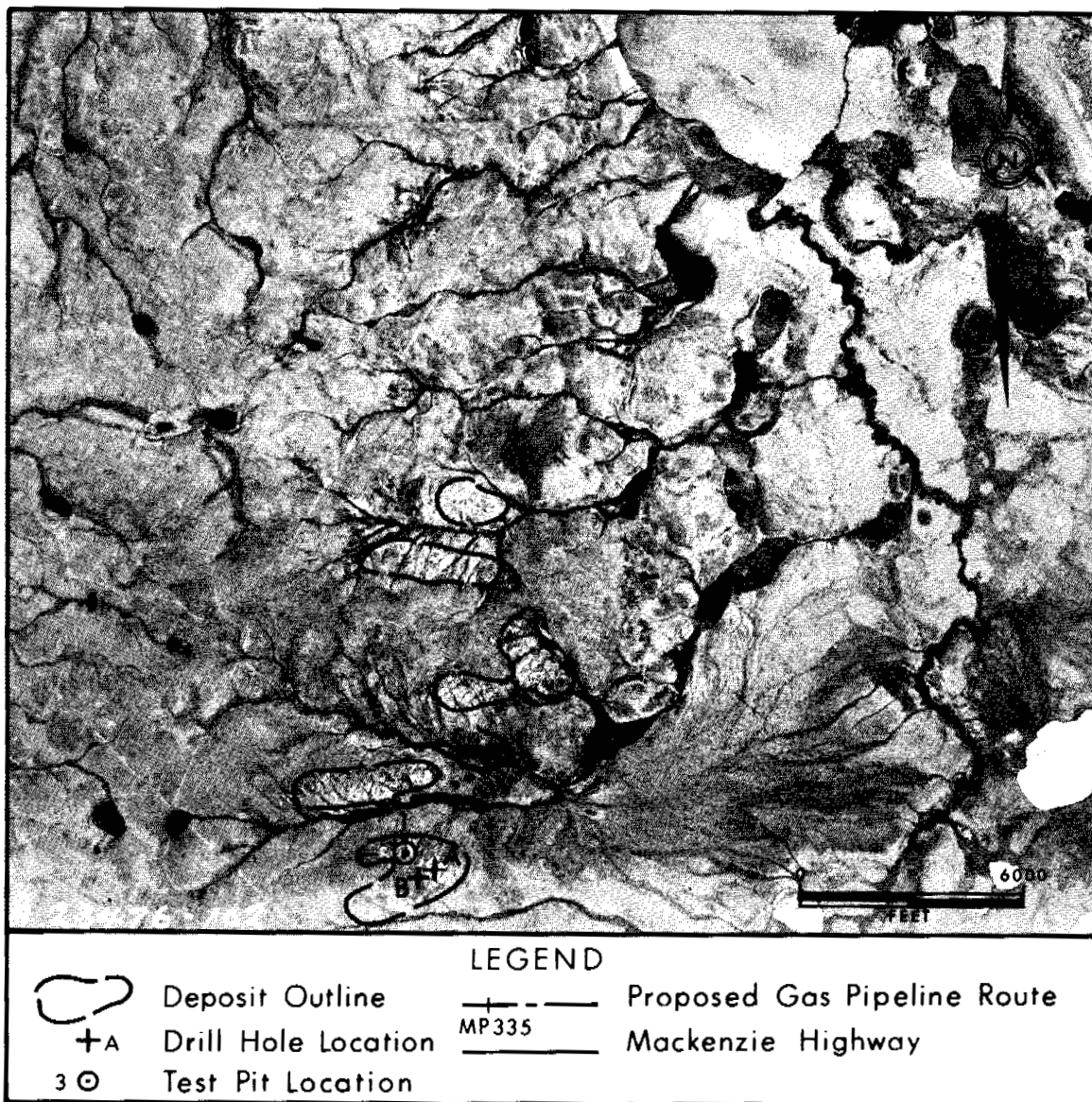
DEPOSIT 107B-B4

Physical Setting: Deposit 107B-B4 consists of exposed Tertiary strata located 6 miles east of Wolverine Lakes, about 40 miles north of Inuvik and about 2 miles east of milepost 48 of the proposed pipeline route.

Material: SAND - generally well graded, interbedded with gravel and some silt.

Volume: 10,000,000 cubic yards.

Assessment: Deposit 107B-B4 is a source of good to excellent quality granular material suitable for general fill, backfill, building pads and possible concrete aggregate. Haul distance from the deposit is about 2 miles.



Airphoto No. A23476-102
Approximate Scale: 1" = 4900'

Latitude: 68° 52'
Longitude: 133° 53'

DEPOSIT 107B-B4

PHYSICAL SETTING

Deposit 107B-B4 is 6 miles east of Wolverine Lakes and about 40 miles north of Inuvik. The deposit is approximately 2 miles east of the proposed pipeline milepost 48. The Ripley, Klohn, Leonoff DIAND Granular Materials Inventory Zone III (1972) report refers to this deposit as Source 315.

This deposit consists of exposed benches of Tertiary gravel and sand on the eastern flank of the North Storm Hills. These benches, which are between 150 and 250 feet above the lowland to the east, slope gently eastward and are broken by 10 to 20 foot scarps.

The benches are well drained and free of overburden except for their western edges where some icy silt may overlie the gravel and sand. The active layer in mid-August is more than 6 feet under bare gravel, but shallower where vegetative cover is present.

The terrain near the deposit consists of gently rolling moraine with fens along drainage ways; and imperfectly to poorly drained gently sloping alluvial fans; and poorly drained lacustrine areas.

BIOLOGICAL SETTING

The benches are sparsely covered with patches of dwarf birch, willow and lichen. The site is low quality, large mammal habitat. A small number of Arctic ground squirrel dens were observed at the site. The site may be an important raptor perching, nesting or feeding area, as eagle feathers and owl pellets were found at the site. Plover, long-tailed jaeger and ptarmigan were also observed in the area. There is no nearby suitable fish habitat.

MATERIAL

The deposit is primarily interbedded sand and gravel with some silt. NESCL drill holes and test pits plus the DIAND information shows that the well graded sand and generally fine gravel both have low ice contents. Local ice bodies were encountered within 15 feet of the surface.

VOLUME

Fifteen to 20 feet of gravel and sand is the minimum amount of granular material available over most of this deposit, approximately half of the area has granular material in excess of 30 feet in thickness.

The estimated total volume, based on 460 acres and 15 feet thickness, is 10,000,000 cubic yards. One quarter of this volume (2,500,000 cubic yards) is considered to be gravel.

Although the volume could be increased by extending the deposit to the west, deeper overburden would have to be removed to expose the deposit in that direction.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B4 is a source of good to excellent quality granular material and is suitable for general fill, backfill in pipeline construction, building pads, and concrete and asphalt aggregate. However, the gravel will require further testing before use in concrete production. The DIAND report indicates that the high proportion of sandstone particles will make the material unsuitable for high quality concrete.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads,

camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit would probably be along the pipeline right of way. A 2 mile snow road would have to be built to transport material to haul points on the right of way across gently rolling morainic hills. Initially, the peat cover and overburden, although minimal, would be stripped from the area to be excavated and stockpiled around the edges.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas to a grade such that good drainage would be established over the area. Terracing would make it possible to excavate the steeper slopes of this deposit. This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce construction aggregates. The long term effects of thermal degradation will have to be considered because of the presence of local, massive ice bodies.

Equipment required for development would be dozers, rippers, end dump trucks front-end loaders, as well as screening, drying crushing, concrete and asphalt plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.3	Pt		PEAT - coarse fibrous, black, moist		UF												18:25 hole sloughing poor air cutting return	
2	SM		SAND - medium to coarse, and silt, some fine gravel, mottled medium brown, pebbles to 1½", occasional cobble to 6", very silty from 0.3'															
8.0			8.0 whitish silt with medium coarse sand. 8.0		F												excavated by shovel to determine depth of frozen ground	
10.0			10.0		35												19:30	
12	GM		GRAVEL - fine, and silt, trace coarse to medium sand															
15.0			15.0														14 19:37	
18	ICE +		ICE with trace of fines		ICE +												18	

TEST HOLE No. N75-107B-B4-A

- 154 -

LOGGED BY: J.J.S.	FACILITY: J	PROJECT: 13011
CHKD: D.D.	LAT. & LONG: 68°52'41"N, 133°53'27"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-100	PIPE MILEAGE:
CHKD: R.H.	RIG: HELI-BRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 10 M 08 Y 75 TIME: 18:45	FINISH: D 10 M 08 Y 75 TIME: 20:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B4-A

SHEET 1 OF 2

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						Plastic limit	Liquid limit												
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
18	ICE +		ICE (cont'd) ICE+ - with trace of fines, (silt)		ICE +												18	18:50	
18																			
20																			
22																			
24																			
26																			
28																			
28			28.0 End of hole														28	20:00	

TEST HOLE No. N75-107B-B4-A

- 155 -

LOGGED BY: J.J.S	FACILITY:	PROJECT: 13011
CHKD: D.D.	LAT. & LONG: 68°52'41"N, 133°53'27"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 2347B-100	PIPE MILEAGE:
CHKD: R.W.	RIG: HELI-DRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 10 M 08 Y 75 TIME: 18:45	FINISH: D 10 M 08 Y 75 TIME: 20:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B4-A

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt	5.2	0.4 PEAT - fibrous, black															
2	ML		SILT - trace fine to med. sand, low plastic. stiff.		UF													4 3/4" Waimac
2.5																		
4	SM	4.0	SAND - medium, fine, coarse, little fine gravel, little silt. Pebbles to 1"		F													
4					25													
8			GRAVEL - fine, little medium to coarse sand, (trace silt), occasional cobble to 5", oxidation															
8	GP		occ. pebbles to 2"															
10																		
12																		
12	SW	12.0	SAND - fine to coarse, some fine gravel															
14																		
16					10													
16		16.0																

- 156 -

TEST HOLE No. N75-107B-B4-B

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°52'39"N, 133°53'38"W	ELEVATION:
DRWN. BY: J.W.B.	AIRPHOTO No.: A 23476-101	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 2°C
	METHOD: AIR	
START: D 11 M 08 Y 75	TIME: 11:20	FINISH: D 11 M 08 Y 75
		TIME: 13:50

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B4-B
SHEET 1 OF 3

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
16	SP		16.0 SAND - med., coarse, fine, some fine gravel.		F													
18			18.0 coarser (to 2") with depth		10													11:45
20			20.0 gravel to 3/4"															11:48
22			whitish fines															
24			24.0 little gravel to 1 1/2" medium, coarse sand. Pebbles to 1 1/2"															
26			26.5 some fine gravel															
28	GP		27.0 GRAVEL - coarse, to 1 1/2"															11:58 New 3 7/8"
30	GW		29.0 GRAVEL - fine, little med sand, pebbles to 1 1/2"															12:22 Waimac. Ream hole. Difficult to run stem down hole.
32			rust coloured															

TEST HOLE No. N75-107B-B4-B

- 157 -

LOGGED BY: J.J.S	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°52'39"N, 133°53'36"W	ELEVATION:
DRWN. BY: J.W.B.	AIRPHOTO No.: A 23478-101	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 2°C
	METHOD: AIR	
START: D 11 M 08 Y 75 TIME: 11:20	FINISH: D 11 M 08 Y 75 TIME: 13:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B4-B

SHEET 2 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
32	GW		GRAVEL (cont'd)		F													
34			(34.0)															
34	SP		SAND - coarse to fine, little fine gravel, (trace silt, creamy white)															occasional white "rubbery" cuttings. Ash?
38																		
38																		12:32 12:43 difficulty in running stem in hole
40			40.0 End of hole															

- 158 -

TEST HOLE No. N75-107B-B4-B

LOGGED BY: J.J.S.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°52'39"N, 133°53'36"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-101	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 2°C
	METHOD: AIR	
START: D 11 M 08 Y 75	TIME: 11:20	FINISH: D 11 M 08 Y 75
		TIME: 12:50

1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-107B-B4-B SHEET 3 OF 3
CANADIAN ARCTIC GAS STUDY LIMITED	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
					40	60	80	100	120	140 ▲									
					0	20	40	60	80	100 ○									
1	GW-GM		GRAVEL - fine to coarse, subangular, and mfc sand, brown, moist, stratified, loose		UF								MA, sample 1 G = 48% S = 44% F = 8% (GW-GM)	B1				1	Using shovels borderline gravel/sand
2			2.0 --- some sand.											B2				2	
3														B3				3	
4														B4				4	
5														B5				5	
6														B6				6	
6.2														B6					
6.2	SW		SAND - coarse to fine; and gravel, fine, subangular; light brown, damp, dense.											B7				6.2	
7			Bottom of pit															7	Permafrost at 7.2'
7.2																		7.2	

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 65°52'41"N, 133°53'27"W	ELEVATION:
DRWN BY: A.J.B.	AIRPHOTO No. A 23476-101	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 4°C
	METHOD: TEST PIT	
START: D 10 M 08 Y 75 TIME: 18:00	FINISH: D 10 M 08 Y 75 TIME: 22:10	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1078-B4-1

SHEET 1 OF 1

- 159 -

TEST HOLE No. N75-1078-B4-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
							▲ Dry density (pcf)			○ Water content %										Plastic limit
							40	60	80	100	120	140 ▲								
							0	20	40	60	80	100 ○								
1	GP		GRAVEL - mainly fine, subrounded; and sand, coarse to fine, light grey, moist, stratified, loose.		UF								MA, combined samples 1 - 7 G = 53.2% S = 42.5% F = 4.3%	B1				1	Using shovels	
2														B2				2		
2.2																				
3	SP		SAND - mainly medium to fine; little gravel, fine, subrounded; light grey, moist, stratified, loose.												B3					3
3.8																				
4	GP		GRAVEL - fine, subrounded; little sand, coarse and medium; light grey, damp, loose.												B4					4
5															B5					5
6														B6				6		
6.4			Bottom of pit											B7						

LOGGED BY: J.G.R.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 88°52'45''N, 133°53'43''W	ELEVATION:
DRWN BY: A.J.B.	AIRPHOTO No.: A 23478-101	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 4°C
	METHOD: TEST PIT	
START: D 10 M 08 Y 75	TIME: 18:00	FINISH: D 10 M 08 Y 75
		TIME: 20:20

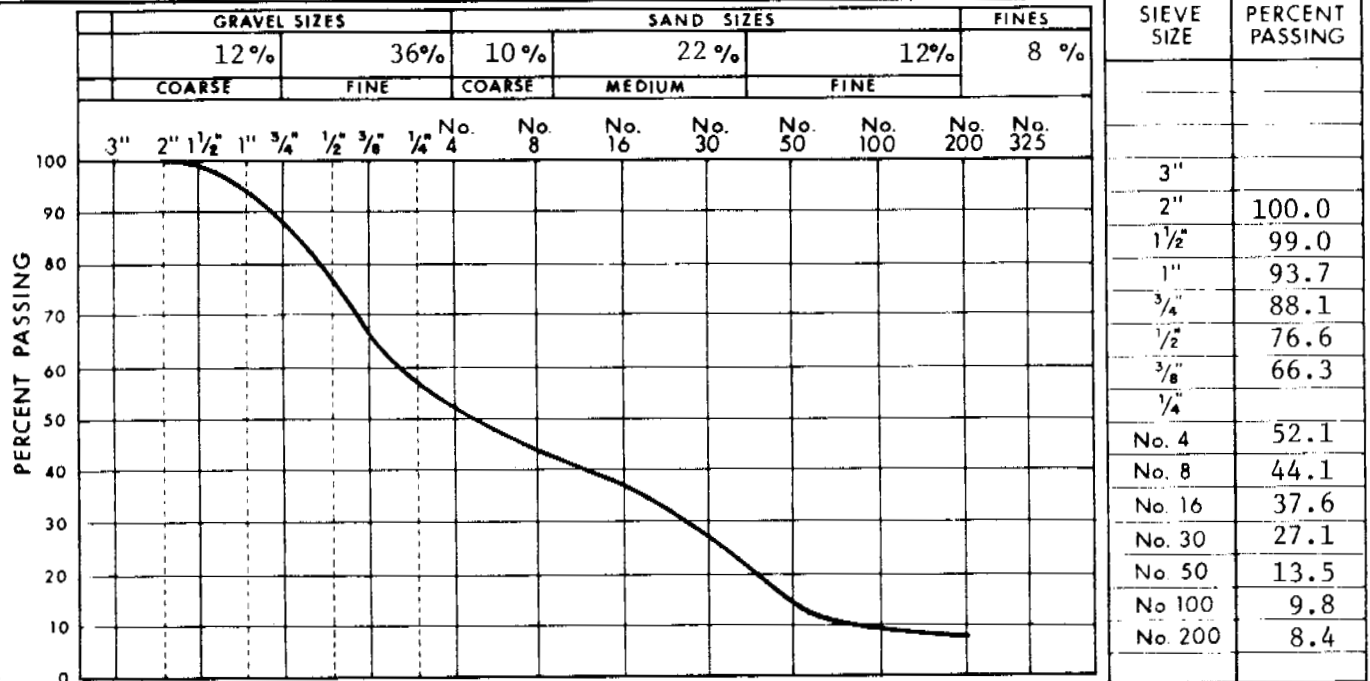
1975 BORROW INVESTIGATION		 NORTHEN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No.
 CANADIAN ARCTIC GAS STUDY LIMITED			N75-107B-B4-2
			SHEET 1 OF 1

- 160 -

TEST HOLE No. N75-107B-B4-2

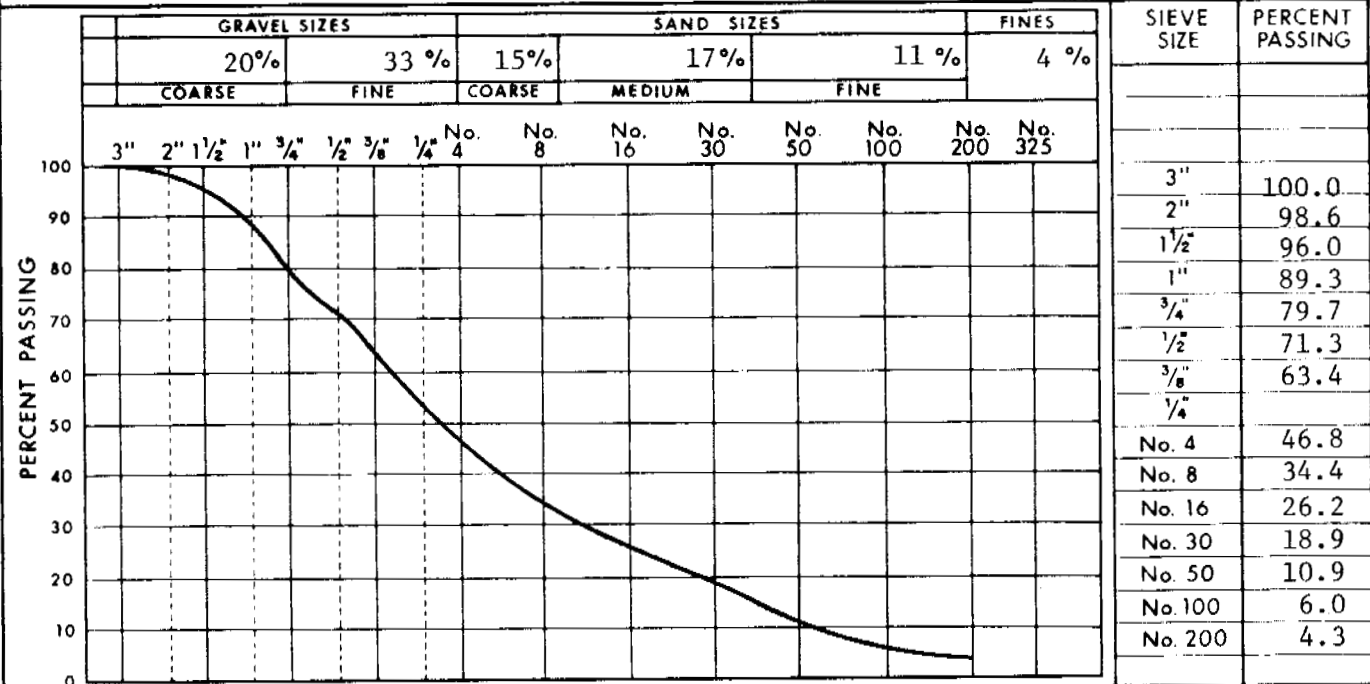
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B4-1 DEPTH 1.0-2.0 R.M.HARDY REPORT NUMBER 209
 DATE SAMPLED August 10, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-107B-B4-2 DEPTH 0.0-6.5 R.M.HARDY REPORT NUMBER 206
 DATE SAMPLED August 10, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0%

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-107B-B4
			PAGE 161

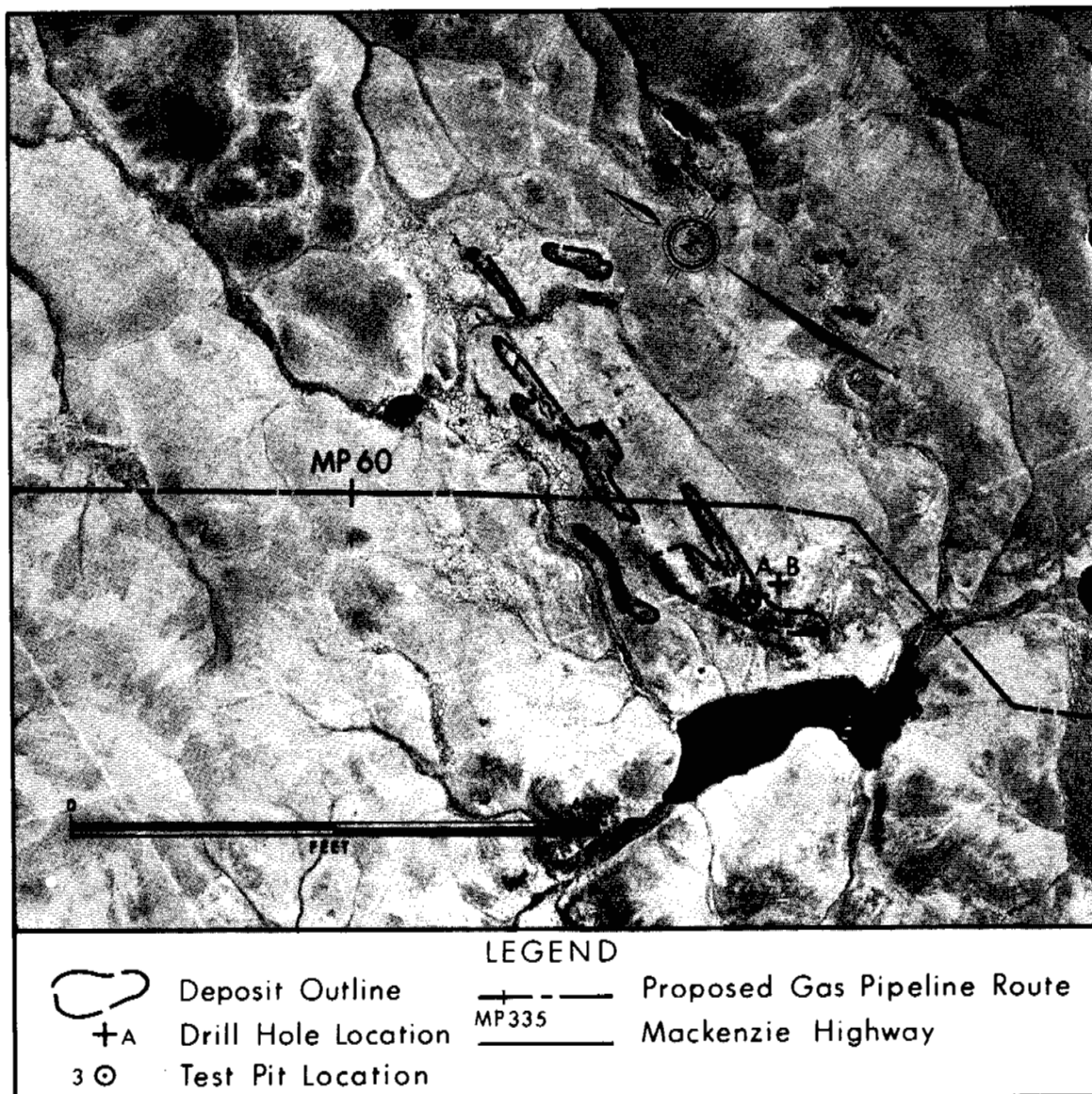
DEPOSIT 107B-B5

Physical Setting: Deposit 107B-B5 consists of kame terraces located 11.5 miles NNW of Noell Lake, 9 miles east of Reindeer Depot and crossed by the right of way at milepost 60.

Material: SAND - interbedded with silt and clay, and with some gravel.

Volume: 300,000 cubic yards.

Assessment: Deposit 107B-B5 is generally a source of poor quality granular material suitable only for general fill and backfill. It is crossed by the right of way and thus local use is expected.



Airphoto No. BR74404-97

Approximate Scale: 1" = 2050'

Latitude: 68° 42'

Longitude: 133° 45'

DEPOSIT 107B-B5

PHYSICAL SETTING

Deposit 107B-B5 is 11.5 miles north-northwest of Noell Lake and 9 miles east of Reindeer Depot. The pipeline right of way crosses the deposit near milepost 60.

The deposit consists of narrow flat-topped kame terraces which border the western edge of a north-south trending meltwater channel. The western edges of the terraces are generally formed by short scarps. The kame terraces are free of significant cover and are well drained. The active layer under bare gravel surfaces is approximately 5 feet thick.

BIOLOGICAL SETTING

Scattered clumps of vegetation on the terraces consist of dwarf birch and lichen with cottongrass in poorly drained areas. The site provides low quality, large mammal habitat. Reindeer, grizzly and black bear, Arctic ground squirrel, fox and wolf are found in the area. The area provides generally poor quality habitat for both waterfowl and terrestrial birds. Arctic loons were observed nesting on the small lake northwest of the site in 1975. Nearby lakes and streams do not appear to support fish populations.

MATERIAL

Test pit 107B-B5-1 showed good well graded gravel and coarse sand to a depth of 5 feet. Drill hole logs show interbedded sand, silt and clay. The test pit was located on one of the knobs indicating gravel is concentrated in these areas. Over the entire deposit the quality of the material is poor, but pockets of good quality gravel are present.

VOLUME

An average depth of 5 feet of good quality material for the area outlined on the airphoto is probably an optimistic figure. The total estimated volume, based on 40 acres and 5 feet depth is 300,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B5 is, for the most part, a source of poor quality granular material and is only suitable for general fill and backfill in pipeline construction. Despite the varied quality and small quantity of aggregate at this site, development for local use is expected as the pipeline right of way crosses the western end of the deposit and overburden and vegetative cover are minimal.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Since this is a small intermediate deposit, development would not be extensive and could be carried out by equipment available along the pipeline right of way. In order to minimize environmental damage, snow roads would be built the short distances to the pipeline.

Development at this deposit would first involve locating all the small areas of good quality gravel by extensive drilling and test pitting. Initially the sparse vegetation would be removed and harvested according to land use regulations. Since this deposit is essentially free of overburden, stripping of the excavation area would be minimal. Excavation of the best areas would follow by removing borrow material

evenly from these isolated pockets to a level whereby good drainage is maintained throughout the area.

Conventional earthmoving techniques would probably be all that is required for development; however, blasting techniques could be used if areas of high ice cementation are encountered.

The excavated material may have to be stockpiled, thawed and drained before it is used.

Equipment required for development would be dozers, rippers, end-dump trucks, and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt		PEAT - non-woody, sandy, brown															
1.5	SM		SAND - fine, silty, light red brown, sensitive, saturated		UF													4 1/2" Walmac bit 20:35
5.0					Yr													
7.0					Vx													
8.0	CL		CLAY - sandy-fine, low plastic, brown.															
																		3 7/8" Walmac bit 20:40
																		(9.3) possibly a layer of MH in this interval
																		(11.0)
15.0					Nb n													
16.0	SP		SAND - fine, grey, damp when thawed															

TEST HOLE No. N75-107B-B5-A

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 68°42'34"N, 133°45'53"W	ELEVATION:
DRWN. BY: J. N. B.	AIRPHOTO No.: BR 74404-87	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 4°C
	METHOD: AIR	
START: D 12 M 08 Y 75	TIME: 20:30	FINISH: D 12 M 08 Y 75
		TIME: 20:45

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B5-A


SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %		Plastic limit									
					40	60	80	100	120	140	▲							
					0	20	40	60	80	100	○							
	SP		SAND - (cont'd)															
18	CL		CLAY - some medium sand, low plastic, chocolate brown.														20:45	
			End of hole															

TEST HOLE No. N75-107B-B5-A

- 169 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No. N75-107B-B5-A
CHKD: R.H.	LAT. & LONG: 88°42'34"N, 133°45'53"W	ELEVATION:		
DRWN. BY: J.M.B.	AIRPHOTO No.: BR 74404-07	PIPE MILEAGE:	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	SHEET 2 OF 2
CHKD: G.O.	RIG: HELI-BRILL	AIR TEMP: 4°C		
METHOD: AIR			CANADIAN ARCTIC GAS STUDY LIMITED	
START: D 12 M 08 Y 75	TIME: 20:30	FINISH: D 12 M 08 Y 75	TIME: 20:45	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.1	PI		PEAT - gravelly, sandy, rootlets, brown, weathered															
1.5	CI		CLAY - medium plastic, grey		UF													
3.5					Nb													
4.5	ICE		ICE		ICE													
6.5	CI		CLAY - medium plastic, grey		Vr													
8.5	SP		SAND - medium, grey-brown		Vx													
9.0					Nb													
10.0	ML		SILT - occasional concretions, low plastic, grey with orange mottled streaks		ICE													
10.2					Nbn													
					Trace													
					Vx													
					5													

- 170 -

TEST HOLE No. N75-107B-B5-B

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.D.	LAT. & LONG: 88°42'33" N, 133°45'50" W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: BR 74404-97	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-DRILL	AIR TEMP: 10°C
	METHOD: AIR	
START: D 13 M 8 Y 75	TIME: 12:12	FINISH: D 13 M 8 Y 75
		TIME: 13:22

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>TEST HOLE No. N75-107B-B5-B</p> <p>SHEET 1 OF 2</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL	ICE %	▲ Dry density (pcf)	○ Water content %							
18	ML		SILT (cont'd)	Mbn trace												12:23	
19.8	CH		CLAY - high plastic, orange-tan, brown	Vx 5													
20.0	SP		SAND - medium, clean, grey black with white quartz,	Vx 10												"salt and pepper" appearance	
23.5			quartzite pebble approx. 2" grey													3 7/8" tricone bit 12:30	
26.5	GW		GRAVEL - coarse, range coarse sand to coarse gravel														
27.0	ML		SILT - trace fine sand, low plastic, orange brown, damp, transition to Cl below	UF ?												3 7/8" Waimac bit 12:58	
31.0	Cl		CLAY - silty, medium plastic, damp, finely laminated alternating dark and orange brown													loss of circulation, bit plugged up 13:22	
			End of hole														

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: D. O.	LAT. & LONG: 68°42'33" N, 133°45'50" W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: BR 74404-97	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 10°C
	METHOD: AIR	
START: D 13 M 8 Y 75 TIME: 12:12	FINISH: D 13 M 8 Y 75 TIME: 13:22	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY, ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B5-B

SHEET 2 OF 2

- 171 -

TEST HOLE No. N75-107B-B5-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	GM		Spate surface cover GRAVEL - silty, brown, pebbles mainly 1/2", some coarse, rounded		UF													
2	GW		GRAVEL - fine, well graded to 3/8", damp at 1.4', fine, occasional silty clay pocket to approximately 2", stratified										NA, combined samples 1 - 4 G = 45% S = 53% F = 2% (GW-SW)	B1				
3	SP		GRAVEL and SAND, some coal *										B2					* possibly organic silt
4	GW		SAND - coarse, approximately 1/2", uniform, damp										B3					two samples from depth 3.0' to 4.0'
5			GRAVEL - fine, some coarse sand, well-graded, fairly clean, damp										B4					probably good borrow source if profile mixed.
5.0			Bottom of pit															

- 172 -

TEST HOLE No. N75-107B-B5-1

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 88°42'35"N, 133°45'59"W	ELEVATION:
DRWN. BY: A.J.B.	AIRPHOTO No.: BR 74404-97	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 13°C
	METHOD: TEST PIT	
START: D 12 M 08 Y 75 TIME: 09:30	FINISH: D 12 M 08 Y 75 TIME: 10:45	

1975 BORROW INVESTIGATION

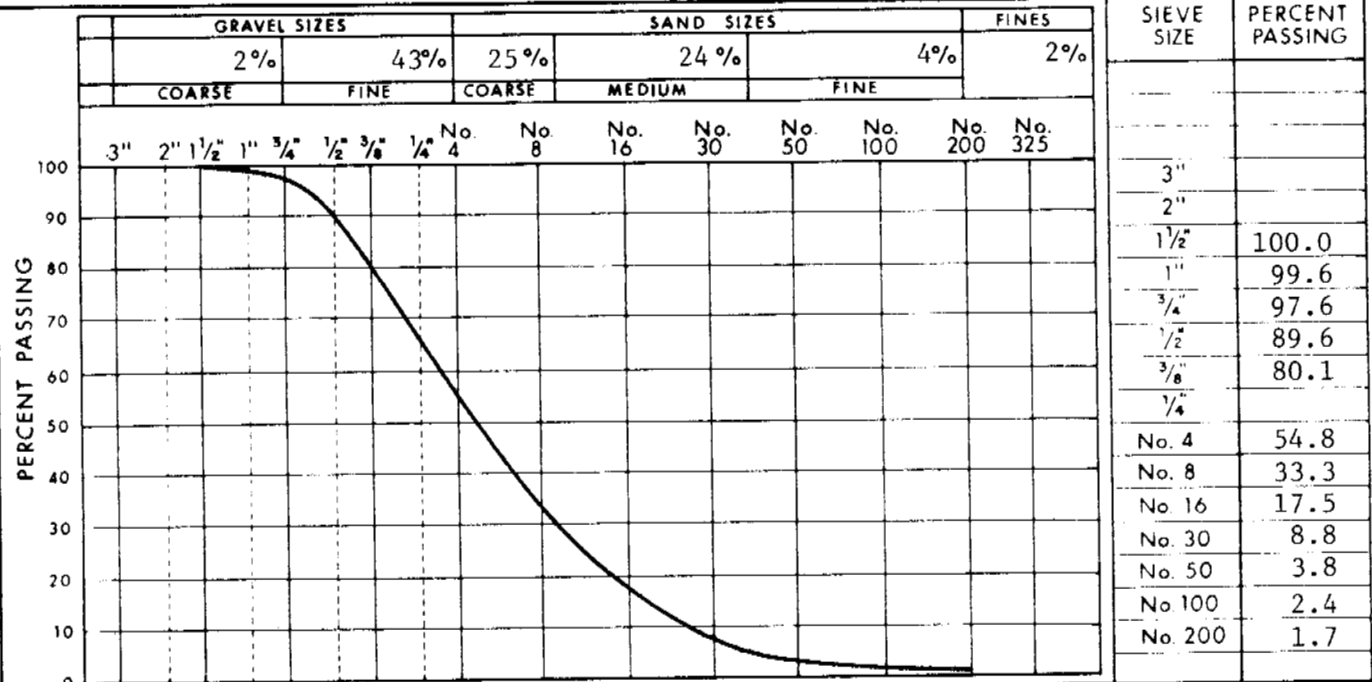
NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No. N75-107B-B5-1
SHEET 1 OF 1

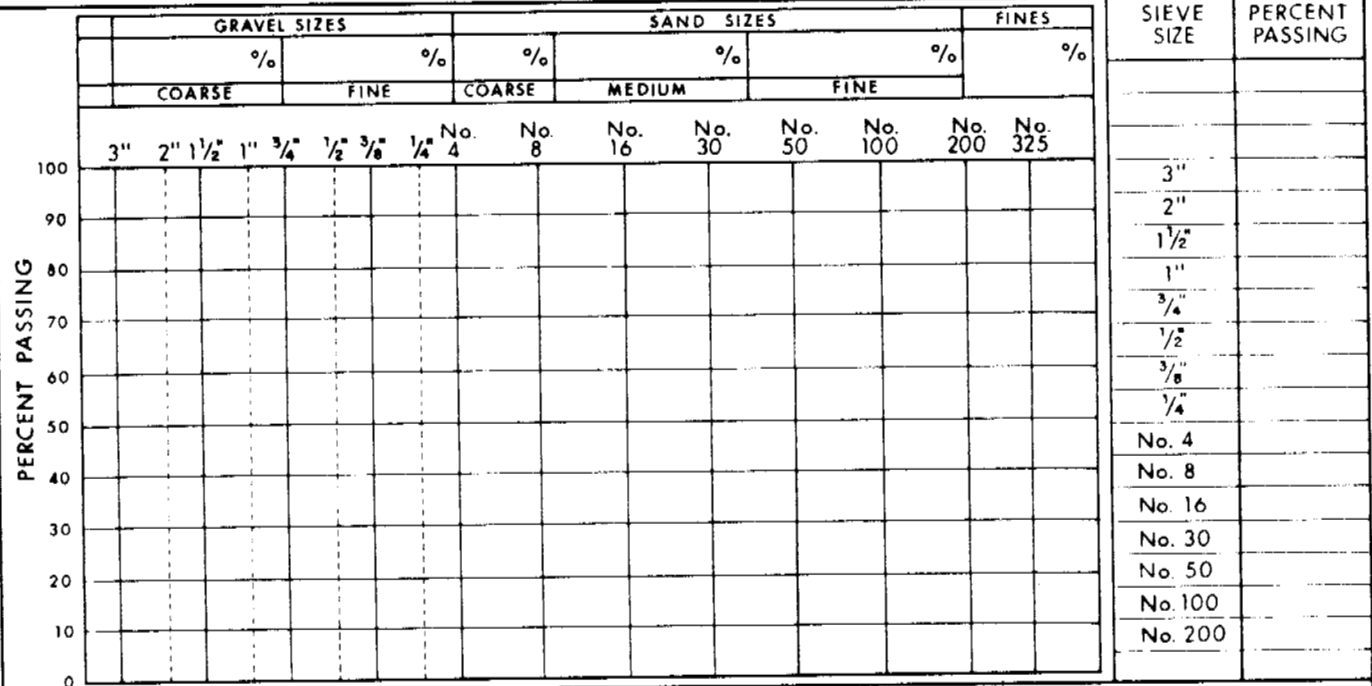
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B5-1 DEPTH 1.0-5.0 R.M.HARDY REPORT NUMBER 214
 DATE SAMPLED August 12, 1975 SAMPLED BY NESCL



COMMENTS _____ OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B5

PAGE
 173

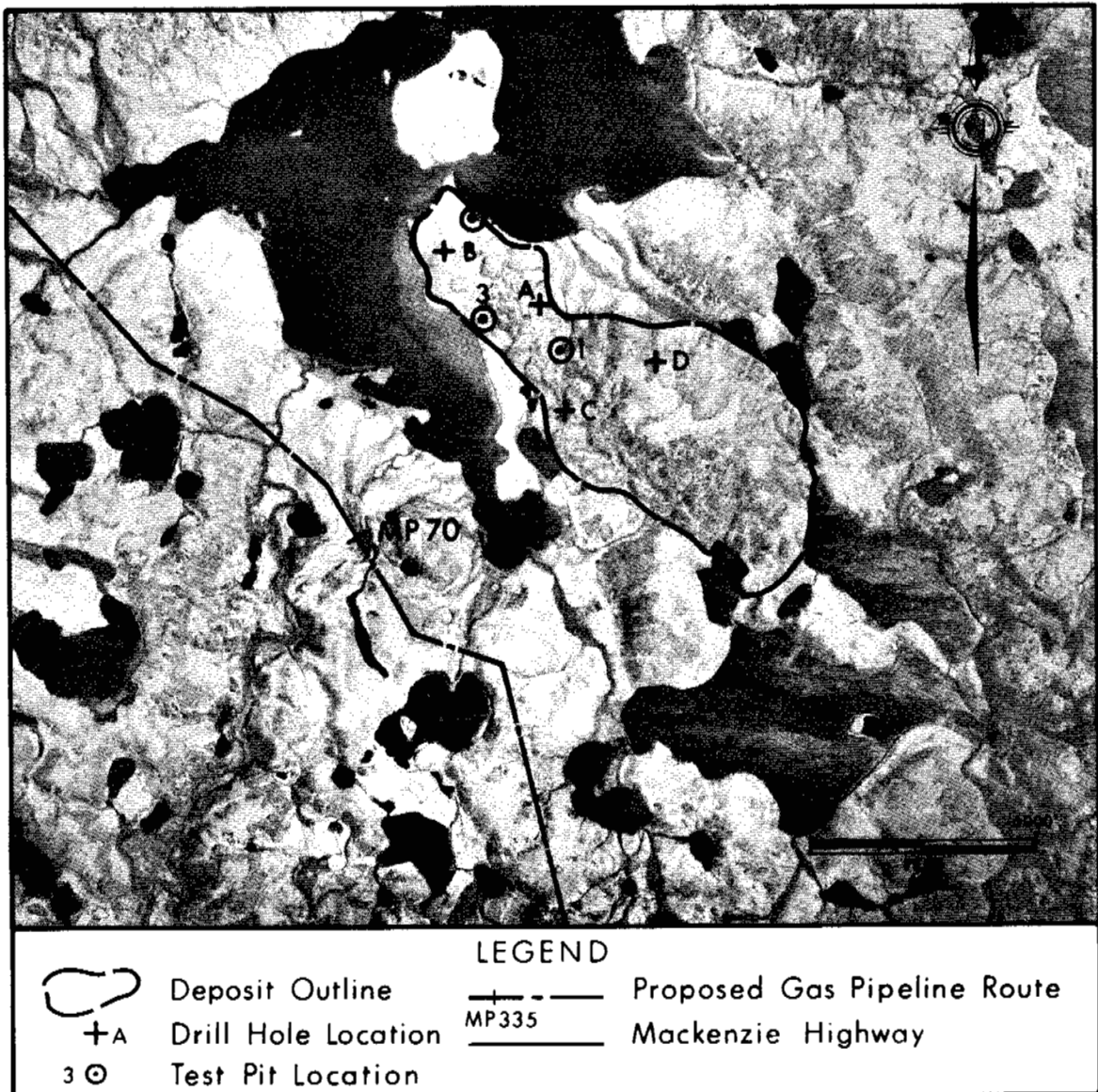
DEPOSIT 107B-B6

Physical Setting: Deposit 107B-B6 is a lacustrine plain located on the southern edge of Jimmy Lake just 4.5 miles NNE of Noell Lake and 2 miles northeast of the right of way.

Material: GRAVEL - poorly graded.

Volume: No volume calculated due to the thick overburden.

Assessment: Deposit 107B-B6 is not recommended for development due to its poor quality granular material and the thick overburden.



Airphoto No. A23476-34

Approximate Scale: 1" = 4800'

Latitude: 68° 37'

Longitude: 133° 30'

DEPOSIT 107B-B6

PHYSICAL SETTING

This deposit is a lacustrine plain at the southern edge of Jimmy Lake. It is 4.5 miles north-northeast of Noell Lake and 2 miles northeast of milepost 70 on the proposed pipeline right of way.

The plain is gently to moderately rolling and its edge is defined by 20 to 50 foot scarps formed by meltwater and thermokarst activity. The surface of the plain is moderately well to imperfectly drained. In mid-August the active layer was generally less than 1 foot in depth.

BIOLOGICAL SETTING

Vegetation typical of the forest-tundra transition occurs on this plain. Common species on the northern portion are bog birch, willow and alder with a ground cover of moss and lichen. The southern part has scattered black spruce up to 20 feet in height and sedges in wet depressions. The site is located in low quality, large mammal habitat. Occasional black bear may occur in the area. Jimmy Lake provides nesting and moulting habitat for waterfowl. A pair of swans were observed on the lake during the 1975 survey. Several species of passerines were observed nesting at the site. It is not known whether Jimmy Lake supports fish populations. There is no other potential fish habitat in the immediate vicinity.

MATERIAL

The deposit consists of 2 to 10 feet thick layers of poorly graded gravel. The material is of poor quality and is overlain by 10 to 20 feet of icy lacustrine sediments with zones of ground ice.

VOLUME

The volume of recoverable material can be considered nil due to the depth of icy clays, silts and massive ice overlying the gravel.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B6 is not recommended for development because the granular material in this deposit is of poor quality and is overlain by thick overburden.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.0	Pt		PEAT—fine fibrous, amorphous, woody inclusions, black		UF												4 1/2" Walmac bit 15:15	
0.8	OL		SILT—(organic) low to non plastic, black.		Vx													
4.0	CL		CLAY—silty, trace fine gravel, rust brown, in part mottled grey, pebbles subangular to 3/8", (till-like)															
7.0	ICE +		ICE + SILT		ICE +												3 7/8" Walmac bit. 15:20	
12.0			almost clear															
15.5	GP		pebbles, 2" - 3"		F													
16			GRAVEL															

- 179 -

TEST HOLE No. N75-107B-B6-A

LOGGED BY: J.K.W	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°37'36"N, 133°31'50"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 10°C
	METHOD: AIR	
START: D 13 M 08 Y 75	TIME: 15:15	FINISH: D 13 M 08 Y 75
		TIME: 18:08

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B6-A
SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
18	GP		(cont'd) GRAVEL - coarse grained, occasional cobbles, granite, sandstone, siltstone.		F													
22	ML		21.5 SILT - and very fine sand, pebble at 22.5															
24	GP		24.0 GRAVEL - coarse grained															
24	ML		24.5 SILT - clayey, some fine sand. Ice rich.															
26	ICE		ICE grey cloudy cobble - hard		ICE													
			27.0 End of Hole														27.0	16:00

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 60°37'36"N, 133°31'50"W	ELEVATION:
DRWN. BY: J. K. W.	AIRPHOTO No.: A 2347 B-34	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 10°C
	METHOD: AIR	
START: D 13 M 08 Y 75	TIME: 15:15	FINISH: D 13 M 08 Y 75
		TIME: 18:08

1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-107B-B6-A
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 2 OF 2

- 180 -

TEST HOLE No. N75-107B-B6-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○								
0.0	Pt		PEAT - fine fibrous, amorphous, black		UF												4 1/2" Walmac bit 18:32	
1.5			SILT - organic, black															
3.0	OL		Ice rich	++++														
3.0			CLAY - silty, gravel rounded to 3/8"	++++	Yx													
4.0	CL		rust brown, TILL	++++														
6.0			gravelly layer approx. 1.0' thick	++++														
7.0			trace coarse sand, ice rich	++++														
8.0			mottled rust brown and grey	++++													3 7/8 Walmac bit 18:38	
10.0				++++														
10.0			greyer	++++	Nbe													
14.0	SM		SAND - fine, little silt, grey														

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No.
CHKD: D.O.	LAT. & LONG: 88°37'24"N, 133°30'34"W	ELEVATION:		 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-34	PIPE MILEAGE:	SHEET 1 OF 2	
CHKD: D.O.	RIG: HELI-BRILL	AIR TEMP: 29°C		
	METHOD: AIR			
START: D 13 M 08 Y 75 TIME: 18:32	FINISH: D 13 M 08 Y 75 TIME: 16:52			

- 181 -

TEST HOLE No. N75-107B-B6-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○								
18	SM		SAND (cont'd)															
21.0	GP		GRAVEL - fine, occasional to 1.5", rounded															18:43
22	ICE		ICE - clear															
25.5			trace fine gravel															
28	ICE + ML		ICE + SILT															
28.0			End of hole															18:52

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°37'24"N, 133°30'34"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-34	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 20°C
	METHOD: AIR	
START: D 13 M 08 Y 75 TIME: 18:32	FINISH: D 13 M 08 Y 75 TIME: 18:52	

<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107B-B6-B</p> <p>SHEET 2 OF 2</p>
---	---

- 182 -

TEST HOLE No. N75-107B-B6-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					▲ Dry density (pcf)			○ Water content %									
					NRC ICE TYPE	Plastic limit		Liquid limit									
					VISUAL ICE %	40	60	80	100	120	140 ▲						
						0	20	40	60	80	100 ○						
0 - 1.0	Pt		PEAT - fine fibrous, amorphous, dark brown, becoming lighter														
1.0 - 2.0	ML		SILT - trace fine sand, low plastic, light grey brown		UF												
2.0 - 5.0																	
5.0 - 12.0	CI		CLAY - silty, trace fine sand, occasional fine gravel to coarse sand, medium plastic, light grey brown grey														
12.0			End of hole														4 1/2 Walmac bit 17:30 bit plugged up 3 7/8" Walmac bit 17:45 Loss of circulation 17:58

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°37'10"N, 133°29'15"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 20°C
	METHOD: AIR	
START: D 13 M 08 Y 75 TIME: 17:30	FINISH: D 13 M 08 Y 75 TIME: 17:58	

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	1975 BORROW INVESTIGATION TEST HOLE No. N75-107B-B6-C SHEET 1 OF 1
CANADIAN ARCTIC GAS STUDY LIMITED	

- 183 -

TEST HOLE No. N75-107B-B6-C

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	ML		SILT - trace fine gravel, pebbles to 3/8", sub angular, light brown, dry, fibrous roots at surface		UF													4 1/2" Walmac bit 18:43
2					No e													
4																		
6																		
7.0	CL		CLAY - silty, gravel to 1", low plastic, grey															
7.5																		
8	ICE		ICE clear		ICE													3 7/8" Walmac bit 18:47
9.0																		
9.0			CLAY - silty, low plastic, grey															
10	CL				F													
10.7																		
11.2	ICE		ICE dirty		ICE													
12	CL		CLAY - gravel fragmented to 3/8", low plastic, grey															
12.0																		
12	GM		GRAVEL - coarse, silty		No e													
14																		
14	ICE		ICE dirty		ICE													
16																		

TEST HOLE No. N75-107B-B6-D

- 184 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 68°36'55"N, 133°30'03"W	ELEVATION:
DRWN. BY: J.N.B.	AIRPHOTO No.: A 23478-34	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 20°C
	METHOD: AIR	
START: D 13 M 8 Y 75 TIME: 18:43	FINISH: D 13 M 8 Y 75 TIME: 19:07	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B6-D
SHEET 1 OF 2

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
					40	60	80	100	120	140	▲							
					0	20	40	60	80	100	○							
17.0	ICE		ICE (cont'd)		ICE													
18.0	ML		SILT		F													inferred by drilling action 18:55
19.0																		
20.0	ICE		ICE clear		ICE													
26.0																		
26.5	ML		SILT		F													
28.0	ICE		ICE clear		ICE													
28.0			End of hole															19:07

- 185 -

TEST HOLE No. N75-107B-B6-D

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: D. O.	LAT. & LONG: 68°36'55"N, 133°30'03"W	ELEVATION:
DRWN BY: J. M. B.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 20°C
	METHOD: AIR	
START: D 13 M 8 Y 75 TIME: 18:43	FINISH: D 13 M 8 Y 75 TIME: 19:07	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B6-D

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.25	Pt		PEAT - amorphous, fine fibrous, black, woody inclusions		UF													No samples taken
1.0	OL		SILT (organic)-non-plastic, black ice rich		Yx													columnar crystals spectrum colours
1.25	ICE+		ICE-with SILT (organic)		ICE+													
	ICE		ICE-clear, columnar		ICE													
2.0			Bottom of pit															2.0
Abandoned																		
Note: Refer also to test hole N75-107B-88-A																		

LOGGED BY: R. H.	FACILITY:	PROJECT: 1301
CHKD: R. H.	LAT. & LONG: 68°37'45" N, 133°31'17" W	ELEVATION:
DRWN. BY: A. W.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:
CHKD: D. G.	RIG:	AIR TEMP: Approx. 18°C
METHOD: TEST PIT		
START: D 13 M 08 Y 75 TIME: 15:00	FINISH: D 13 M 08 Y 75 TIME: 16:30	

1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-107B-B6-1
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

- 186 -

TEST HOLE No. N75-107B-86-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
1	Pt		PEAT - amorphous, fine fibrous, black, woody inclusions		UF												No samples taken	
	OL		SILT (organic), non-plastic, black		Yx 50													
	ICE +		ICE with SILT (organic)		ICE +													
	OL		Bottom of pit															
			Abandoned															

TEST HOLE No. N75-107B-B6-2

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R.H.	LAT. & LONG: 68°37'22"N, 133°31'22"W	ELEVATION:		N75-107B-B6-2
DRWN. BY: A.M.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:		
CHKD: D.O.	RIG:	AIR TEMP: approx. 21°C		
	METHOD: TEST PIT			
START: D 13 M 08 Y 75	TIME: 17:00	FINISH: D 13 M 08 Y 75	TIME: 17:30	SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
	Pt		PEAT - fine fibrous, black, woody inclusions		UF													
0.7			ICE - clear with SILT, (organic), black, approximately 75% ice		ICE +													
1.8	ICE + DL		ICE with SAND, clayey, some gravel, pebbles rounded to 2", quartzite, brown, (fill-like)		ICE +													
2.5	ICE + SC		ICE with SAND, clayey, some gravel, pebbles rounded to 2", quartzite, brown, (fill-like) Bottom of pit		ICE +							MA. G = 20% S = 43% F = 37%	*			2.5	• Disturbed sample from bottom of excavation. Not kept frozen	

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 88°37'18"W, 133°30'33"W	ELEVATION:
DRWN. BY: F.B.	AIRPHOTO No.: A-23478-34	PIPE MILEAGE:
CHKD: D.O.	RIG: *	AIR TEMP.: Approx. 21°C
METHOD: TEST PIT		

1975 BORROW INVESTIGATION	
	NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED	

TEST HOLE No.
N75-107B-B6-3
SHEET 1 OF 1

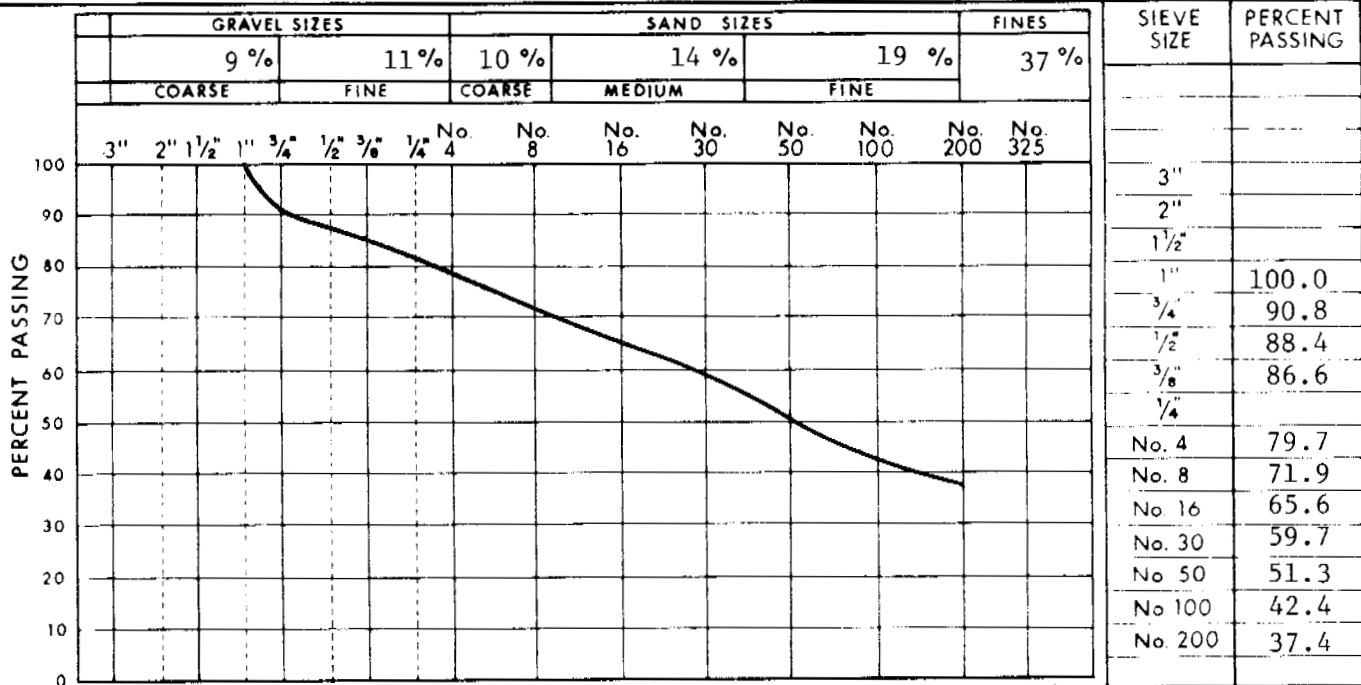
START: D 13 M 08 Y 75	TIME: 17:15	FINISH: D 13 M 08 Y 75	TIME: 18:15
-----------------------	-------------	------------------------	-------------

- 188 -

TEST HOLE No. N75-107B-B6-3

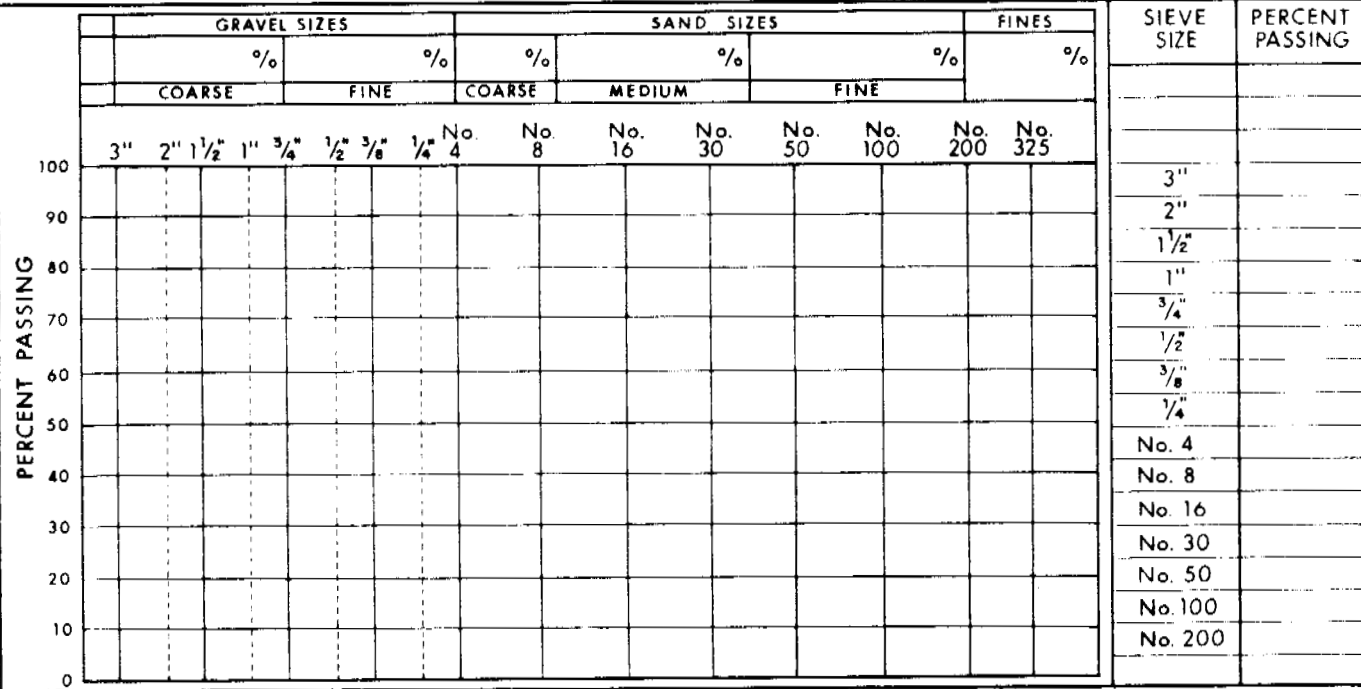
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B6-3 DEPTH 2.5 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 13, 1975 SAMPLED BY NESCL 49



COMMENTS _____ OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = %

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-107B-B6 <hr/> PAGE 189
---	--	---	---

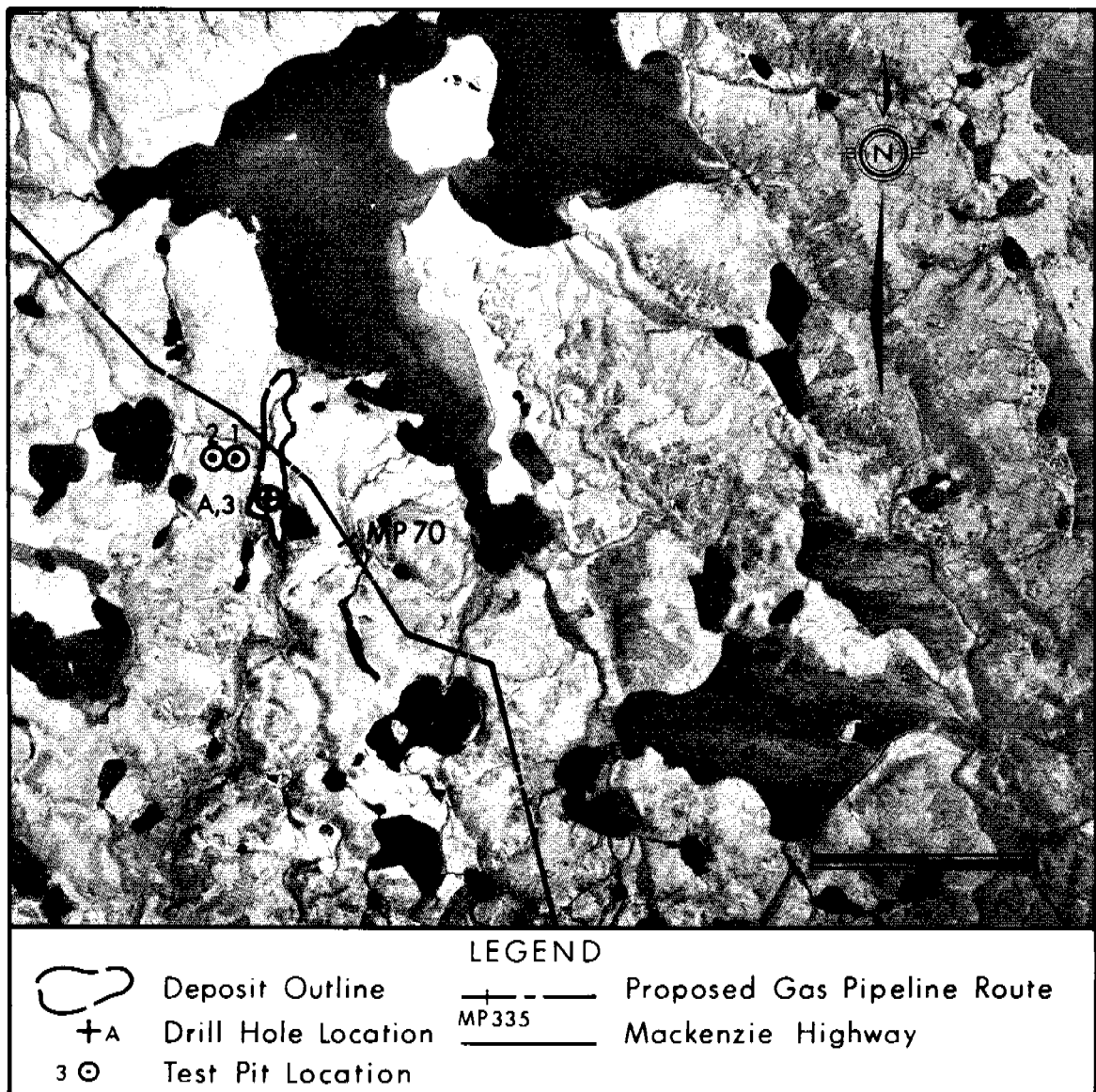
DEPOSIT 107B-B7

Physical Setting: Deposit 107B-B7 consists of small fluvial terraces located 3 miles north of Noell Lake and just north of milepost 70 on the right of way.

Material: SAND - silty, overlain by thick peat and silt.

Volume: No volume calculated, non-granular material.

Assessment: Deposit 107B-B7 is not recommended for development because of its lack of acceptable granular material.



Airphoto No. A23476-34
Approximate Scale: 1" = 4800'

Latitude: 68° 36'
Longitude: 133° 34'

DEPOSIT 107B-B7

PHYSICAL SETTING

This deposit consists of small fluvial terraces located 3 miles north of Noell Lake and just north of milepost 70 on the proposed pipeline right of way.

The terraces are 5 to 15 feet above the low, marshy floodplain of a small creek which flows from Noell Lake to Jimmy Lake. This creek dissects the southern end of the deposit. The site is moderately well to imperfectly drained. The active layer appears to be less than 1 foot over most of the area.

BIOLOGICAL SETTING

The common shrubs on the terraces are willow and alder with a lichen and moss ground cover. The flood plain is dominated by sedges and bog birch. The site is located in generally poor quality wildlife habitat. Several ptarmigan including two broods were seen at the site. Occasional fox, wolf, grizzly and black bear may occur in the area. The creek which dissects the site does not appear to support fish populations.

MATERIAL

Drill hole 107B-B7-A shows 7 feet of peat and icy organic silt over 11 feet of silty sand.

VOLUME

Material of acceptable granular quality was not encountered.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B7 is not recommended for development.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE	TYPE	VISUAL	ICE	%							
					40	60	80	100	120	140	▲						
					0	20	40	60	80	100	○						
0.8	Pt		PEAT - fine fibrous, amorphous, woody inclusions, dark brown to black 0.8		UF												4 1/2" Walmac bit
3.0	ML		SILT - trace fine sand becoming organic		Yx												14:38
7.0	DL		SILT - (organic), non-plastic, black sandy, turning grey, High Ice		25												
8.0	SM		SAND - medium to fine, silty, brown High Ice		Nbe												3 7/8" Walmac bit
18.0			End of hole														14:48

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°38'33"N, 133°33'49"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 10°C
	METHOD: AIR	
START: D 13 M Y 75 TIME: 14:38	FINISH: D 13 M Y 75 TIME: 14:48	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107B-B7-A</p> <p>SHEET 1 OF 1</p>
--	---	--

- 194 -

TEST HOLE No. N75-107B-B7-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	Pt		PEAT - fine fibrous, dark brown, spongy		UF													No samples taken
	OL		SILT (organic), trace sand, very fine, black, ice pockets to 6", cloudy, dark brown, well-bonded		Vx 30													
	ICE + OL		ICE with SILT (organic)		ICE +													
2			Bottom of pit															

TEST HOLE No. N75-107B-B7-1

- 195 -


LOGGED BY: R.H.	FACILITY:	PROJECT: 13011	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	1975 BORROW INVESTIGATION	TEST HOLE No.
CHKD: R.H.	LAT. & LONG: 88°36'33"W, 133°33'49"W	ELEVATION:			N75-107B-B7-1
DRWN. BY: A.M.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:			
CHKD: D.O.	RIG:	AIR TEMP: Approx. 18°C			
	METHOD: TEST PIT				
START: D 13 M 08 Y 75 TIME: 12:10	FINISH: D 13 M 08 Y 75 TIME: 12:55		SHEET 1 OF 1		

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○									
	Pt		PEAT - moss cover, amorphous, fine fibrous with woody inclusions, dark brown, spongy		UF														No samples taken
	OL		1.0 SILT-(organic), black		+ + W x 25													1.0	
			Bottom of excavation at 1.0'																
			Note: Adjacent area tested by geophysics - results negative, therefore excavation abandoned																

LOGGED BY: R. H.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 68°36'42"N, 133°34'12"W	ELEVATION:
DRWN. BY: A. N.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:
CHKD: D. D.	RIG:	AIR TEMP: Approx. 18°C
	METHOD: TEST PIT	
START: D 13 M 08 Y 75 TIME: 13:00	FINISH: D 13 M 08 Y 75 TIME: 13:30	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B7-2

SHEET 1 OF 1

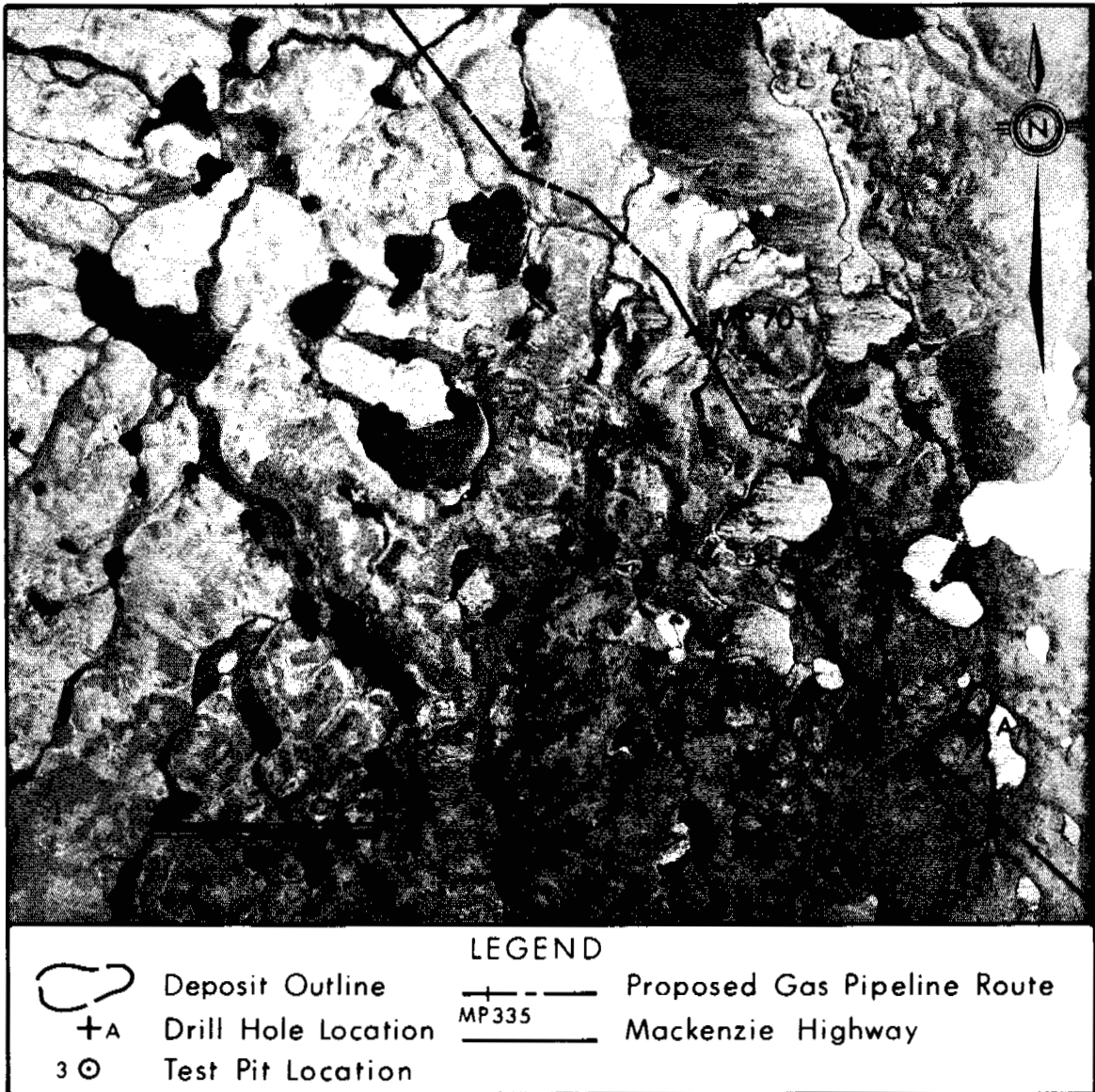
DEPOSIT 107B-B8

Physical Setting: Deposit 107B-B8 is a lacustrine veneered outwash plain located 2 miles northeast of Noell Lake and adjacent to the right of way between milepost 72 and 73.

Material: GRAVEL - silty, fine, and sand.

Volume: 1,000,000 cubic yards.

Assessment: Deposit 107B-B8 is a source of fair to poor quality granular material suitable for general fill and backfill. It is not recommended for development due to thick overburden and massive ground ice.



Airphoto No. A23476-35
Approximate Scale: 1" = 4800'

Latitude: 68° 34'
Longitude: 133° 29'

DEPOSIT 107B-B8

PHYSICAL SETTING

Deposit 107B-B8 is a lacustrine veneered outwash plain deposit located two miles northeast of Noell Lake and adjacent to the pipeline right of way between mileposts 72 and 73.

The plain is a remnant of a more extensive lacustrine plain that has been greatly modified by thermokarst. At this site, the lacustrine sediments overlies outwash. Most of the surface of this deposit is gently rolling, but moderate to steep slopes are found at its edges. Overburden on the average is 5 feet thick and drainage is moderately good. The active layer is generally less than 1 foot. The sand and gravel have low ice contents, but massive ice is present in underlying sediments.

BIOLOGICAL SETTING

This plain is located in the forest-tundra transition zone. Vegetation is made up of scattered black spruce with bog birch, willow, alder and lichen. Reindeer and moose are present. The area is also moderately productive habitat for fox, wolf, grizzly and black bear. The site provides habitat for passerines and ptarmigan. Waterfowl are present in the area throughout the open-water season. The immediately adjacent small ponds and streams appear to be unsuitable fish habitat. Noell Lake supports a native domestic fishery.

MATERIAL

The drill hole and test pit at this location show up to 5 feet of peat, clay and silt over 8 feet of fine gravel and sand. Both gravel and sand are silty with occasional small amounts of clay.

VOLUME

Total estimated volume of gravel and sand based on 90 acres and a thickness of 8 feet is 1,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B8 is a source of fair to poor quality granular material, suitable for general fill or backfill in pipeline construction. Even though this deposit is close to the pipeline right of way, development is not recommended due to the thick overburden and the existing massive ground ice beneath the thin layer of silty sand and gravel. Poor quality and low volume also reduce its feasibility as a possible source of borrow material.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt		PEAT - fine fibrous, amorphous, black, woody inclusions		UF													
2	CL		CLAY - some fine sand, low plastic, wet when thawed		Nbe													
5.0	GW		GRAVEL - fine, silty, and coarse sand, pebbles to 3/8", sub angular.		Nbn													
7.5	SM		SAND - medium to fine, silty, some fine gravel, dark grey brown.		Nbe occ Yx													
13.0	ICE		ICE clear		ICE													

- 201 -

TEST HOLE No. N75-107B-B8-A

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°34'41"N, 133°29'26"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 23478-34	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 18°C
	METHOD: AIR	
START: D 13 M 08 Y 75 TIME: 19:43	FINISH: D 13 M 08 Y 75 TIME: 19:57	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED


TEST HOLE No.
N75-107B-B8-A
SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
					40	60	80	100	120	140	▲							
					0	20	40	60	80	100	○							
18	ICE		ICE - clear (cont'd)		ICE												18:50	
24																		
24																		
28	CI		CLAY - medium plastic, grey, occasional pebbles. dirtier high ice		F												27.0	18:57
			End of hole															

TEST HOLE No. N75-107B-B8-A

- 202 -

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION  NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R. H.	LAT. & LONG: 68°34'41"N, 133°29'28"W	ELEVATION:		N75-107B-B8-A
DRWN. BY: A. M. B.	AIRPHOTO No.: A 23476-34	PIPE MILEAGE:		
CHKD: D. G.	RIG: HELI-DRILL	AIR TEMP: 18°C		
	METHOD: AIR			
START: D 13 M 08 Y 75 TIME: 18:43	FINISH: D 13 M 08 Y 75 TIME: 18:57			SHEET 2 OF 2


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)			○ Water content %									
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
	Pt	??	0.2 PEAT - moss cover, amorphous, fine fibrous, woody inclusions		UF														No samples taken
	CL	//	CLAY - some sand, fine to medium grain, rust brown, wet, soft, occ. peaty layer																
1			1.0																
	ML		SILT - clayey, pebbles rounded to 3/8" ice to 3" pockets	+		Vx													
2			2.0 Bottom of pit	+															

TEST HOLE No. N75-107B-B8-1

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°34'41"N, 133°29'28"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 23478-34	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: approx. 21°C
	METHOD: TEST PIT	
START: D 13 M 08 Y 75 TIME: 19:00	FINISH: D 13 M 08 Y 75 TIME: 20:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B8-1

SHEET 1 OF 1

DEPOSIT 107B-B9






Physical Setting: Deposit 107B-B9 is a kame terrace complex located 2.5 miles south of Sitidgi Lake and 6 miles northeast of milepost 96 on the right of way.

Material: SAND and GRAVEL - interbedded fine sand and gravel with a little silt.

Volume: 5,800,000 cubic yards.

Assessment: Deposit 107B-B9 is a source of fair quality granular material suitable for general fill, backfill and building pad subgrade.



LEGEND			
	Deposit Outline		Proposed Gas Pipeline Route
	Drill Hole Location		Mackenzie Highway
	Test Pit Location		

Airphoto No. A12918-30
Approximate Scale: 1" = 3250'

Latitude: 68° 22'
Longitude: 132° 44'

DEPOSIT 107B-B9

PHYSICAL SETTING

Deposit 107B-B9 is a kame terrace complex about 2.5 miles south of Sitidgi Lake. The deposit is 6 miles northeast of milepost 96 on the proposed pipeline right of way. This deposit corresponds to source number 452 in Ripley, Klohn, and Leonoff DIAND Granular Materials Inventory Zone IV (1972) report.

The terrace complex consists of ridges and hills located along the eastern edge of a lowland occupied by Sitidgi Lake. The topography in the area is gently to moderately rolling with local relief of about 50 feet and occasional slopes to 20 degrees.

Overburden is normally thin, but peat and silt may vary between 1 and 3 feet in low areas. Drainage on hills, ridges and most slopes ranges from moderately good to good, but depressions are poorly drained. The active layer is from 1 to 5 feet thick. Below the active layer the deposit is frozen with varied but generally low ice content.

Terrain between the deposit and the pipeline right of way is a drum-linized morainic plain with a few peat-filled marshy drainageways.

BIOLOGICAL SETTING

Most of the site is covered by white spruce up to 40 feet high and a thick understory of dwarf birch, willow, crowberry and lichen. Low, wet areas are covered with sedges. The site provides low quality habitat for fox, wolf, and moose but good habitat for reindeer and caribou. A pair of swans was observed nesting on the adjacent lake in 1975. The nearby lake does not appear to support fish populations.

MATERIAL

Drill hole and test pit logs and the DIAND report indicate this deposit is mainly interbedded fine sand and gravel with a small amount of silt.

In test pit 107B-B9-1 ablation till was encountered at 4.2 feet. Massive ice appeared at a depth of 10 feet in drill hole 107B-B9-B and therefore, may occur elsewhere in the deposit.

VOLUME

Total estimated volume, based on 270 acres and a maximum depth of 30 feet under ridges is 5,800,000 cubic yards. The DIAND report giving a lower volume calculation of 1,500,000 cubic yards is based on a smaller area and shallower depth.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B9 is a source of fair quality granular materials in an area where good granular deposits are scarce. More drilling is needed to outline the best portions of the deposit. This deposit could be used for general fill and backfill in pipeline construction and building pad subgrade material.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit would probably be accomplished via the pipeline right of way. A 5 mile snow road from the pipeline right of way would be necessary to reach the deposit.

Tree and shrub cover would have to be removed from areas to be excavated and disposed of in accordance with land use regulations. The peat cover and overburden would then be stripped from the area and stockpiled around the edge of the excavation.

Development of this deposit would involve excavating borrow material in stages from the higher, well drained areas so that good drainage would be maintained.

This development could be accomplished by blasting techniques or conventional earthmoving techniques depending on the degree of ice cementation. Care would have to be taken to leave sufficient material over areas with massive ice in order to prevent thermal degradation. The excavated material may have to be stockpiled, thawed, and drained before it is used.

Equipment required for development would be dozers, rippers, end-dump trucks, and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %	▲ Dry density (pcf)	○ Water content %	Plastic limit	Liquid limit							
	Pt GM	0.2 0.8	PEAT - fine fibrous, amorphous, woody inclusions, black		40	60	80	100	120	140 ▲								
2	ML	1.0	GRAVEL - fine, silty, pebbles to ½", orange brown.		0	20	40	60	80	100 ○							4 ½" Walmac bit 15:41	
4			SILT - and fine sand, low plastic, grey brown	high ice														
10	SM	10.0	SAND - fine, silty, occasional medium to coarse zones	Ncb														
22	SP	22.0	SAND - very fine, trace silt	Nbr														
28		28.0	End of hole														3 7/8" Walmac bit 15:44	
																	15:54	

TEST HOLE No. N75-107B-B9-A

- 210 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°22'11"N, 132°44'59"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 12918-30	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 15°C
	METHOD: AIR	
START: D 14 M 8 Y 75	TIME: 15:41	FINISH: D 14 M 8 Y 75
		TIME: 15:54

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107B-B9-A</p> <p>SHEET 1 OF 1</p>
--	---	--

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1.0	Pt		PEAT - fine fibrous, amorphous, woody inclusions, roots, dark brown		UF													4 1/4" Walmac bit 18:58
1.5	SM		SAND - fine, silty															
2.0	ICE		ICE		ICE													
4.0	SM		SAND - fine, silty															
4.0	GP		GRAVEL - fine, trace fines, pebbles to 3/4", sub rounded, ovate		Mbe occ. Vx													
9.0	SP		SAND - medium, grey black		Ice rich													
10.0	ICE		ICE		clear													
28.0			End of hole		clear													3 7/8" Walmac bit 17:00
28.0			End of hole		clear													17:00

TEST HOLE No. N75-107B-89-B

- 211 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°22'16"N, 132°44'37"W	ELEVATION:
DRWN. BY: J.W.B.	AIRPHOTO No.: A 12918-30	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 22°C
	METHOD: AIR	
START: D 14 M 8 Y 75	TIME: 16:58	FINISH: D 14 M 8 Y 75
		TIME: 17:09

1975 BORROW INVESTIGATION




NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-89-B
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %		Plastic limit								
					40	60	80	100	120	140	▲						
					0	20	40	60	80	100	○						
2	SM		SAND - fine, silty, trace gravel, pebbles to 3/8", orange, damp	UF												4 1/4" Walmac bit 17:45	
3	ML		SILT - trace fine sand, low plastic														
4	GM		GRAVEL - fine, silty, poorly sorted	Nbb													
6	SM		SAND - fine to medium, silty, grey with orange band from 5' - 7'														
10			pebble to 1.5"														
14			less silty (possibly SP)														
16																	
LOGGED BY: J.K.W.			FACILITY:			PROJECT: 13011			1975 BORROW INVESTIGATION				TEST HOLE No. N75-107B-B9-C				
CHKD: R.H.			LAT. & LONG: 68°22'33"N, 132°43'31"W			ELEVATION:											
DRWN BY: J.M.B.			AIRPHOTO No.: A 12918-30			PIPE MILEAGE:			 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR								
CHKD: D.O.			RIG: HELI-DRILL			AIR TEMP: 22°C											
			METHOD: AIR						CANADIAN ARCTIC GAS STUDY LIMITED				SHEET 1 OF 2				
START: D 14 M 8 Y 75 TIME: 17:45			FINISH: D 14 M 8 Y 75 TIME: 18:14														

TEST HOLE No. N75-107B-B9-C

- 212 -

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %		Plastic limit								
					40	60	80	100	120	140 ▲							
					0	20	40	60	80	100 ○							
18	SM		SAND (cont'd)														
19.0																	
20	GW		GRAVEL - fine, low fines, pebbles to 5/8", sub-angular to sub-rounded														
26.5			coarse from 26.5' to 28.0'														
31	SM		SAND - fine to medium, silty, grey														
31.0			very sandy														
38			End of hole														
38.0																	

- 213 -

TEST HOLE No. N75-107B-B9-C

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG.: 66°22'33" N, 132°43'31" W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: A 12918-30	PIPE MILEAGE:
CHKD: D. D.	RIG: HELI-DRILL	AIR TEMP.: 22°C
	METHOD: AIR	
START: D 14 M 8 Y 75 TIME: 17:45	FINISH: D 14 M 8 Y 75 TIME: 18:14	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B9-C

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt		PEAT - amorphous, fine fibrous, spongy, dark brown		UF												13:15		
1	SC		0.8 1.2 SAND - some silty clay, rust brown, dirty, saturated medium to fine grained, and fine to coarse gravel, little silty clay		Nbe												1	13:45	
2			pebbles subrounded to 2", shale, platy to 5"		occ Vx												2	14:10	dirty gravel thawing and quicking
3			some sand, medium grain, little silty clay, well bonded by ice		Vc												3		
4			shaley, platy, av. 2 1/2" water entering the excavation		Yc												4		
	CI-CH		4.2 4.4 TILL CLAY - trace gravel, medium to high plastic, pebbles to 3/8" rounded and angular stratified ice to 1/16"		Ys												4.4		
			Bottom of pit 4.4'																
			Note: Drillhole N75-1078-B9-1 104' from North and 80' from test pit, rough measure 1.0' decrease in elevation. Different materials encountered.																
LOGGED BY: R.H.		FACILITY:		PROJECT: 13011		1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED						TEST HOLE No.							
CHKD: R.H.		LAT. & LONG: 68°22'11"N, 132°44'59"W		ELEVATION:								N75-1078-B9-1							
DRWN BY: F.F.B.		AIRPHOTO No.: A 12918-30		PIPE MILEAGE:															
CHKD: D.O.		RIG:		AIR TEMP: Approx. 19°C															
		METHOD: TEST PIT																	
START: D 14 M 08 Y 75 TIME: 13:15				FINISH: D 14 M 08 Y 75 TIME: 18:15								SHEET 1 OF 1							

- 214 -


TEST HOLE No. N75-1078-B9-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.2	Pt		PEAT - fine fibrous, brown, woody inclusions		UF							MA, combined samples 1 & 2					0.2	17:20
1	GM		GRAVEL - coarse to fine, little fine to medium sand, little silt, gravel platy to 5", rust brown, dry, "gap-graded"									Oversize 3.0%	B1				1	17:55
1.5			occasional quartzite cobble, rounded to 8"									G = 66%					2	18:50
2			damp									S = 17%	B2				3	19:05
3												F = 17%						
3.4	SM		SAND - fine-grained, some silt, brown, damp									MA, sample 3					3	
4			Bottom of pit									G = 12%	B3				4	19:45
												S = 65%						
												F = 23%						

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°22'33"N, 132°43'31"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 12918-30	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 21°C
	METHOD: TEST PIT	
START: D 14 M 08 Y 75	TIME: 17:20	FINISH: D 14 M 08 Y 75
		TIME: 19:45

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-89-2

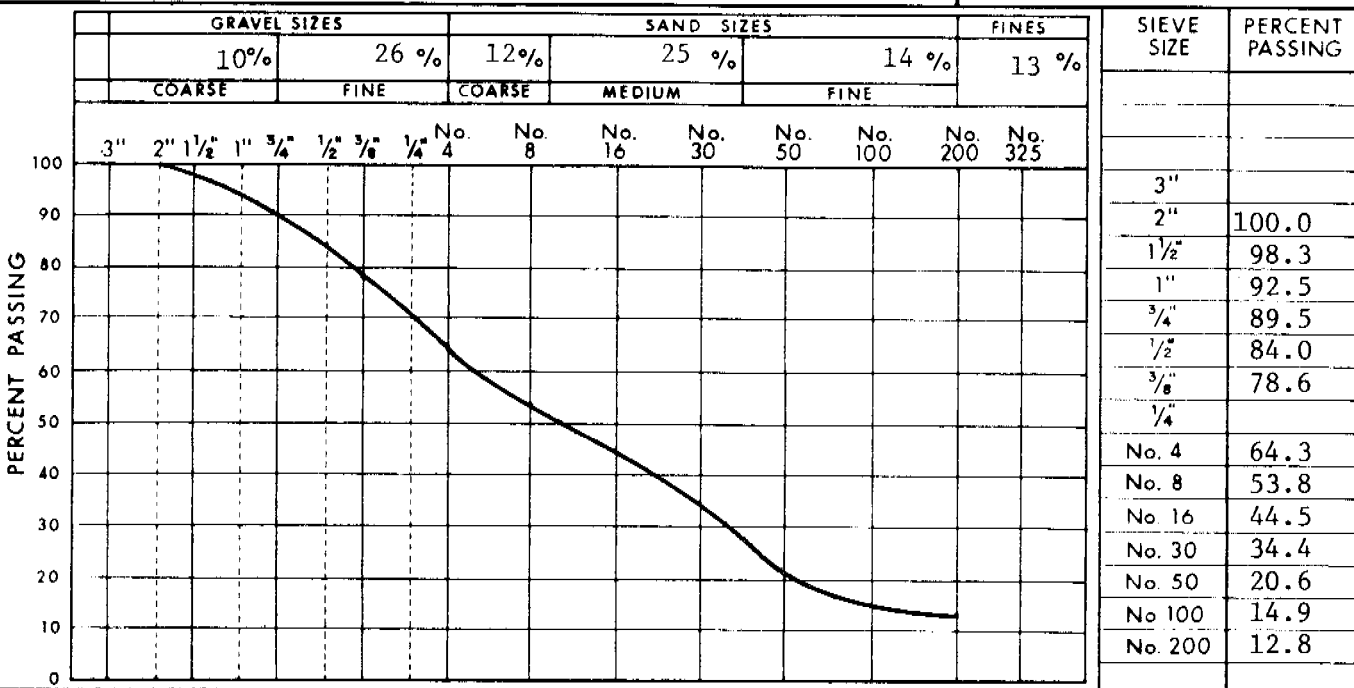
SHEET 1 OF 1

- 215 -

TEST HOLE No. N75-107B-89-2

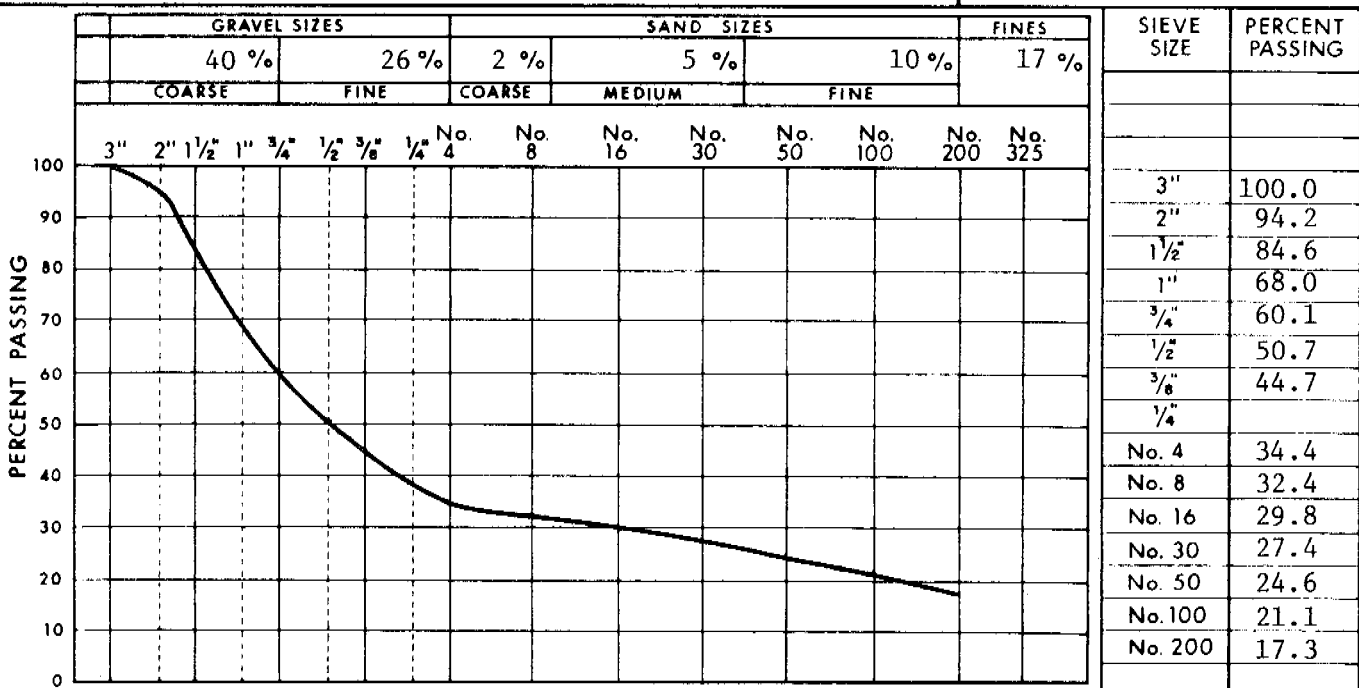
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B9-1 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 14, 1975 SAMPLED BY NESCL 136



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-107B-B9-2 DEPTH 0.2-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 14, 1975 SAMPLED BY NESCL 142



COMMENTS OVERSIZE (>3") = 3.0 %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

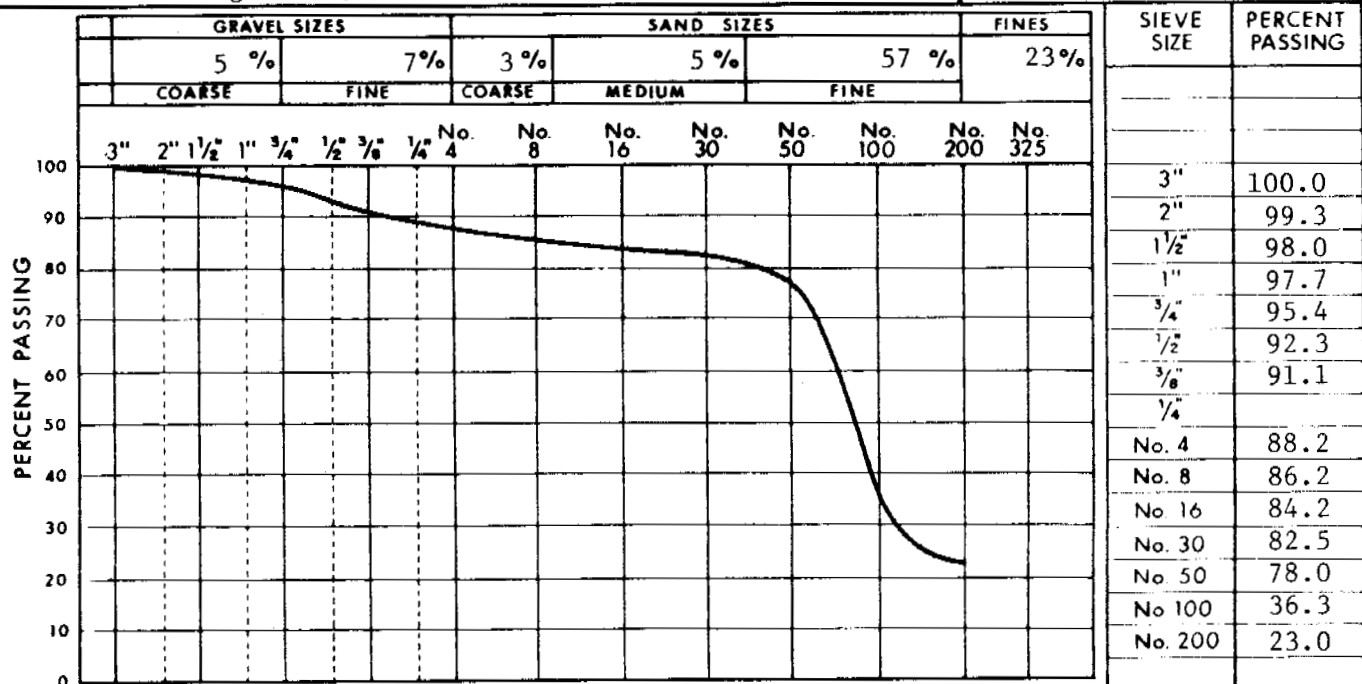


DEPOSIT No.
 N75-107B-B9

PAGE
 216

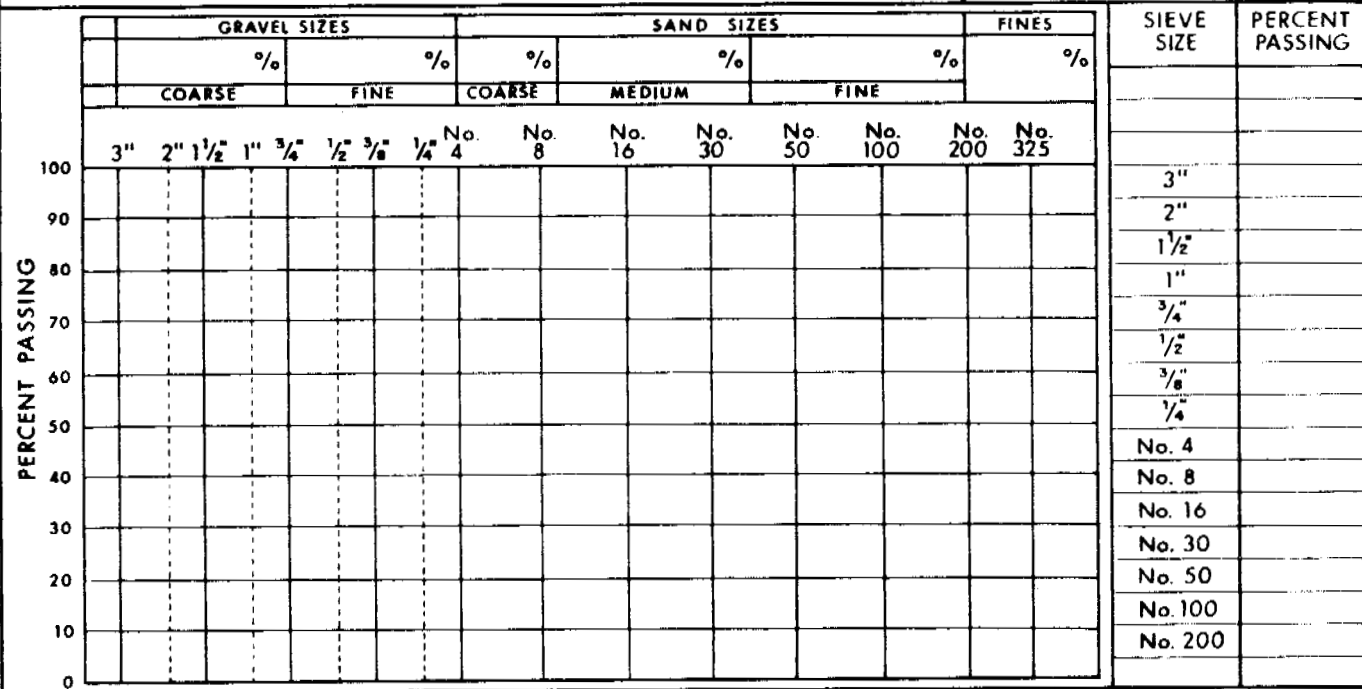
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B9-2 DEPTH 3.0-4.0 R.M.HARDY REPORT NUMBER 143
 DATE SAMPLED August 14, 1975 SAMPLED BY NESCL



COMMENTS _____ OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = %

 <p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	 <p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-107B-B9
		PAGE 217

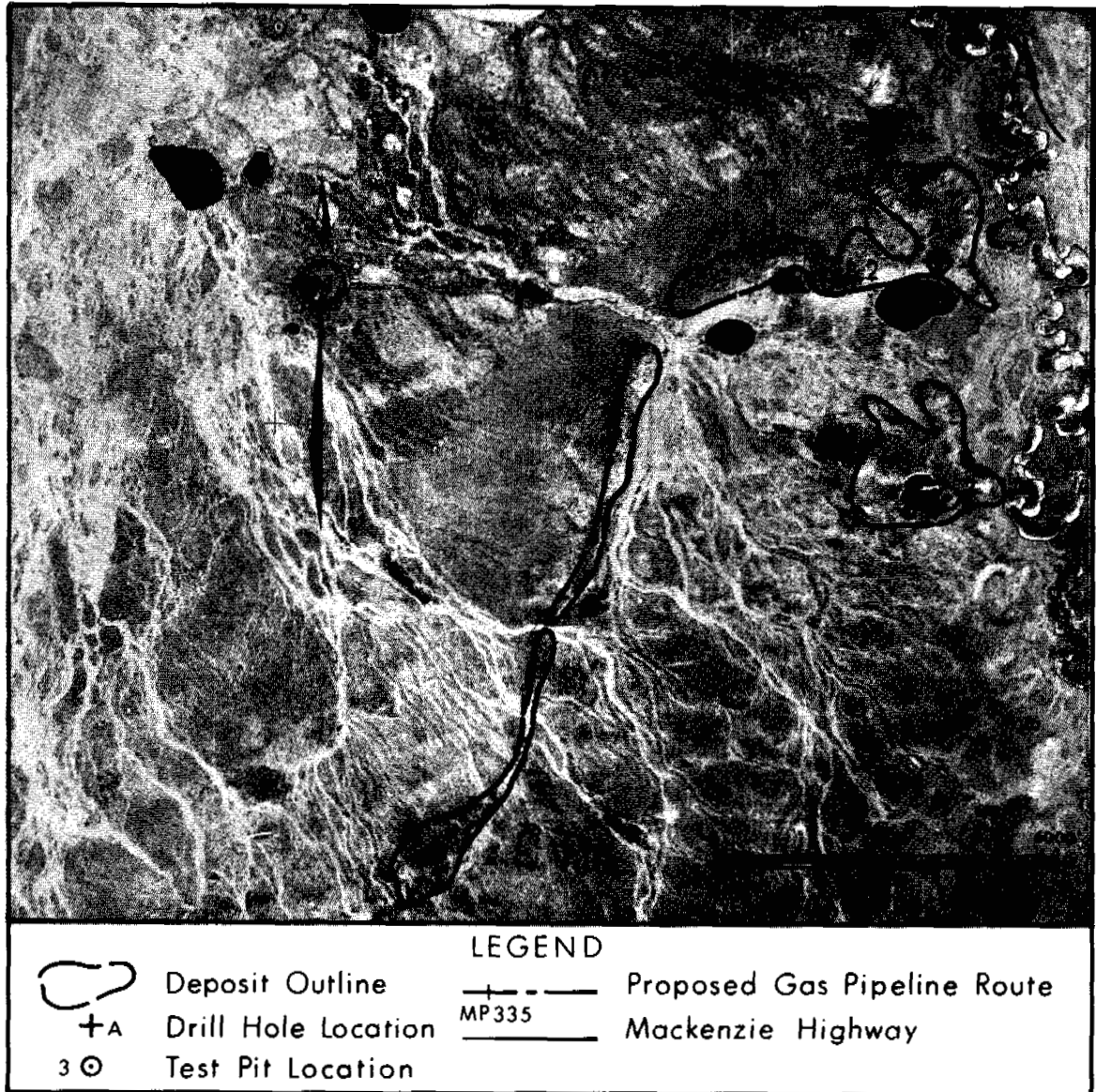
DEPOSIT 107B-B10

Physical Setting: Deposit 107B-B10 is an esker with a kame delta at its eastern end. It is located 4 miles east of Campbell Lake and 3.5 miles west of milepost 94 on the right of way.

Material: SAND - fine to medium with variable silt content.

Volume: 9,400,000 cubic yards.

Assessment: Deposit 107B-B10 is a source of fair quality granular material suitable for general fill and backfill. Access to the deposit is fair over poorly drained moraine and lacustrine plain.



Airphoto No. A12918-58
Approximate Scale: 1" = 3150'

Latitude: 68° 18'
Longitude: 133° 02'

DEPOSIT 107B-B10

PHYSICAL SETTING

This deposit begins approximately 4 miles east of Campbell Lake and runs in a northeasterly direction for about 4 miles. The northeast end of the deposit is 3.5 miles west of milepost 94 on the proposed pipeline right of way.

The deposit consists of a broad esker with a probable kame delta at its eastern end. The crests of the esker and kame delta stand 40 to 80 feet above the surrounding lowlands with side slopes of 15°. Fresh scarps around the lake within the kame delta indicate active thermokarst is occurring.

Overburden is generally less than 1 foot and drainage varies from moderately good to good. The active layer is about 3 feet deep, below this the deposit is frozen with low to moderate ice content. Scattered ground ice can be expected throughout the kame delta.

The terrain west of the deposit is a poorly drained flat to gently sloping moraine and lacustrine plain. Poorly drained fluvial terraces and a small creek border the eastern end of the deposit and a poorly drained moraine plain lies between the stream and the pipeline right of way.

BIOLOGICAL SETTING

The crests and south-facing slopes of the esker and delta support mixed black spruce and white birch up to 30 feet in height, with pure black spruce on north-facing slopes. The understory on both slopes is fairly uniform and consists of dwarf birch, willow, labrador tea, and lichen. The area provides low productivity habitat for fox, wolf and snowshoe hare. The site lies within the winter range of the Mackenzie Reindeer Herd. Good moose habitat occurs around the small lake adjacent to the

site and along the nearby tributary of Norris Creek, but moose populations in the area are low. No evidence of beaver was seen in the adjacent stream or lakes. The area is important waterfowl habitat although no waterfowl were observed on the nearby lakes. The fish potential of the adjacent creek is not known.

MATERIAL

The drill hole and test pit logs from this deposit indicate the material is mainly fine to medium sand with varying silt content. Six feet of silty gravel is present at site 107B-B10-3 in the kame delta. Further drilling will be required to define areas of better quality material.

VOLUME

An estimate of total volume based on an area of 390 acres and 30 foot depth is 9,400,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B10 is a source of fair quality granular material which could be used for general fill and backfill in pipeline construction.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit could be obtained via the pipeline right of way. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way, a distance in excess of 4 miles. Access would be over

poorly drained moraine and lacustrine plain and care would have to be taken not to disturb the drainage and initiate thermokarst subsidence. Tree cover would have to be removed, both from areas to be excavated and the haul road right of way, and disposed of or harvested in accordance with current land use regulations. The peat cover and overburden would then be stripped from the area to be excavated, and stockpiled around the edge of the excavation area.


Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be maintained. This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. A buffer zone would have to be maintained, between the nearby creek and the excavation, to ensure that thermokarst subsidence and siltation of the stream is prevented.

Equipment required for development would be dozers, rippers, end-dump trucks, and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
2	SP		SAND - medium fine, grey		UF												4 1/2 Walmac bit 10:54	
			2.0															
			coarse sand to fine gravel															
4	ML		SILT - some sand, low to non-plastic, grey		Nbe													
			3.0															
6	SP-ML		SAND - very fine, very silty, occasional coarse sand		Nbn													
			6.0															
10	SP		SAND - (trace silt)		Nbe												3 7/8 Walmac bit 10:57	
			(10.0)															
18.5			small cobble or coarse pebble at 18.5'															
28			End of hole														28.0 11:08	

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No. N75-107B-B10-A
CHKD: R. H.	LAT. & LONG: 68° 18' 39" N, 133° 03' 18" W	ELEVATION:		
DRWN. BY: J. M. B.	AIRPHOTO No.: A 12918-58	PIPE MILEAGE:	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS TOR	SHEET 1 OF 1
CHKD: D. D.	RIG: HELI-DRI LL	AIR TEMP:		
METHOD: AIR				
START: D 15 M 06 Y 75	TIME: 10:54	FINISH: D 15 M 08 Y 75	TIME: 11:08	CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No. N75-107B-B10-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
1.0			SAND - fine, silty, rusty brown														4 1/2" Walvac bit 11:37	
2.0	SP		SAND - very fine grained, wet, soft to 3.0', brown															
3.0																		
4.0			slight trace silt															
6.0			brown to grey															
11.0			(11.0) --- grey														3 1/8" Walvac bit 11:42	

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION  NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R.W.	LAT. & LONG: 88° 18' 37" N, 133° 02' 30" W	ELEVATION:		N75-107B-B10-B
DRWN. BY: J.M.B.	AIRPHOTO No.: A 12918-58	PIPE MILEAGE:		
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 20°C		
	METHOD: AIR			
START: D 15 M 08 Y 75 TIME: 11:37	FINISH: D 15 M 08 Y 75 TIME: 12:23		SHEET 1 OF 2	

- 225 -

TEST HOLE No. N75-107B-B10-B

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
18	SP		SAND (cont'd)		Nbn													11:47
20			finer															
26	CI		CLAY - trace fine gravel to coarse sand, medium plastic		Yx													11:54
28	SP		SAND - very fine, trace silt, gray		Nbo													
36	SM		SAND - silty															
38			End of hole															loss of circulation 12:23

TEST HOLE No. N75-107B-B10-B

- 226 -

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 68°18'37"N, 133°02'30"W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: A 12918-58	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-BRILL	AIR TEMP: 20°C
	METHOD: AIR	
START: D 15 M 08 Y 75 TIME: 11:37	FINISH: D 15 M 08 Y 75 TIME: 12:23	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B10-B


SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
	Pt	0.3	PEAT - amorphous, fine fibrous, occasional woody inclusions, dark brown to black		UF	40	60	80	100	120	140 ▲						10:45	No samples taken
1	CL	1.3	CLAY - silty, little sand, medium to fine, rust brown Bottom of pit (ICE) Abandoned Frozen at bottom of pit		(F)	0	20	40	60	80	100 ○					1.3	11:00	
			Note: Refer also to drillhole N75-107B-B10-A															

TEST HOLE No. N75-107B-B10-1

LOGGED BY: R.H.	FACILITY	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°18'39"N, 133°03'16"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 12918-58	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 18°C
METHOD: TEST PIT		
START: D 15 M 08 Y 75	TIME: 10:45	FINISH: D 15 M 08 Y 75
TIME: 10:45		TIME: 11:00

1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-107B-B10-1
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2	Pt		PEAT - fine fibrous		UF													11:30
1	SC		SAND - fine-grained, clayey, rust brown									MA, combined samples 1 - 3 G = 5% S = 82% F = 33%	B1	<input checked="" type="checkbox"/>			1	
2			2.0 - clayey, trace organic, dark brown										B2	<input checked="" type="checkbox"/>			2	11:50
3	SP-SM		2.5 - SAND - fine-grained, grey, wet, soft										B3	<input checked="" type="checkbox"/>			3	Refer also to drillhole N75-107B-B10-B
4			4.0 Bottom of pit		F													

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 88°18'37"N, 133°02'30"W	ELEVATION:
DRWN. BY: F.F.B.	AIRPHOTO No.: A 12918-58	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 29°C
	METHOD: TEST PIT	
START: D 15 M 08 Y 75 TIME: 11:30	FINISH: D 15 M 08 Y 75 TIME: 12:10	

1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-107B-B10-2 SHEET 1 OF 1
---	--

- 228 -

TEST HOLE No. N75-107B-B10-2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.4	Pt		PEAT - amorphous, fine fibrous, woody		UF													
0.9	GM		GRAVEL and silt, pebbles, angular to 3", roots, brown															
2.1	GP-SP		GRAVEL and coarse grained sand, stratified layer approximately 0.4'															
2.1	SW-SC		SAND - coarse, medium, fine, and fine to coarse gravel, trace fines (clayey), possibly cemented, pebbles sub-rounded to 2 1/2", platy to approx. 1 1/2" x 1/2"									MA, combined samples 1 & 2 G = 41% S = 50% F = 9%	B1					
			occasional oversize to 7"										B2					
7.0			Face exposed to 7.0'															
			below top of lake bank															

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°17'59"N, 133°02'16"W	ELEVATION:
DRWN BY: D.J.M.	AIRPHOTO No.: A 12918-58	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 27°C
	METHOD: TEST PIT	
START: D 15 M 08 Y 75 TIME: 15:00	FINISH: D 15 M 08 Y 75 TIME: 16:00	

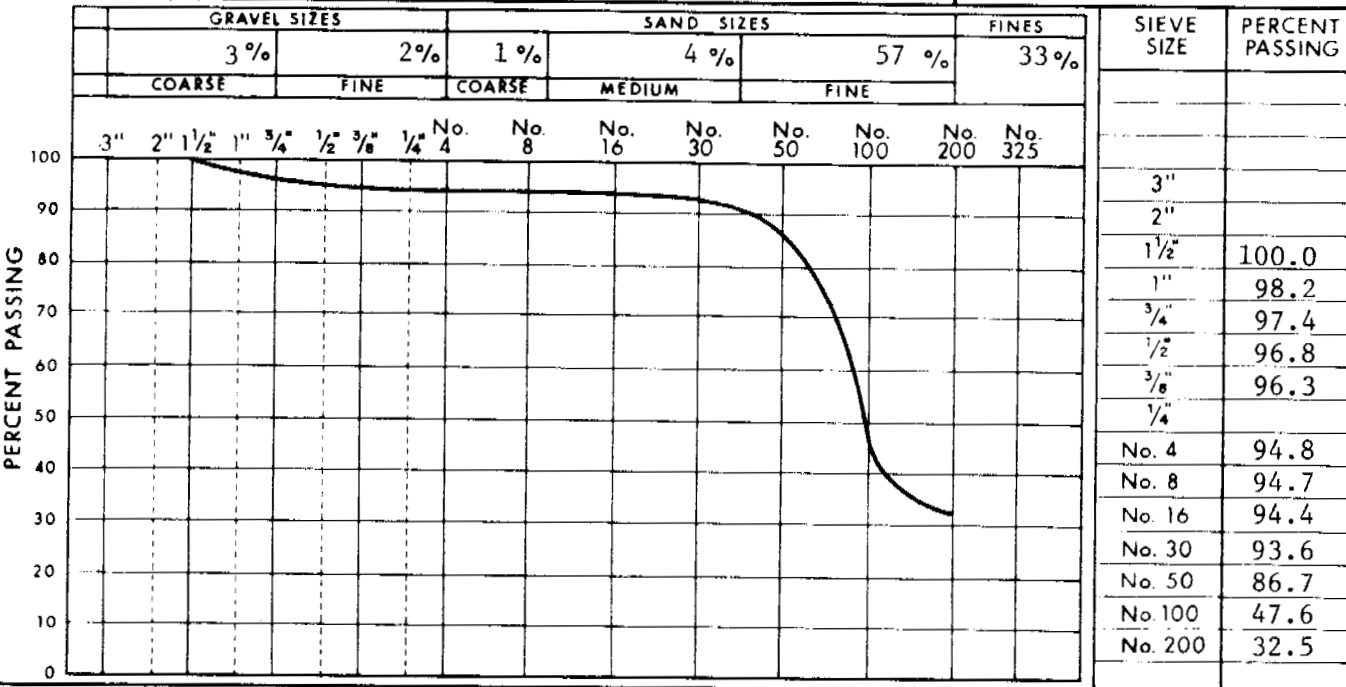
1975 BORROW INVESTIGATION
NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B10-3
SHEET 1 OF 1

TEST HOLE No. N75-107B-B10-3

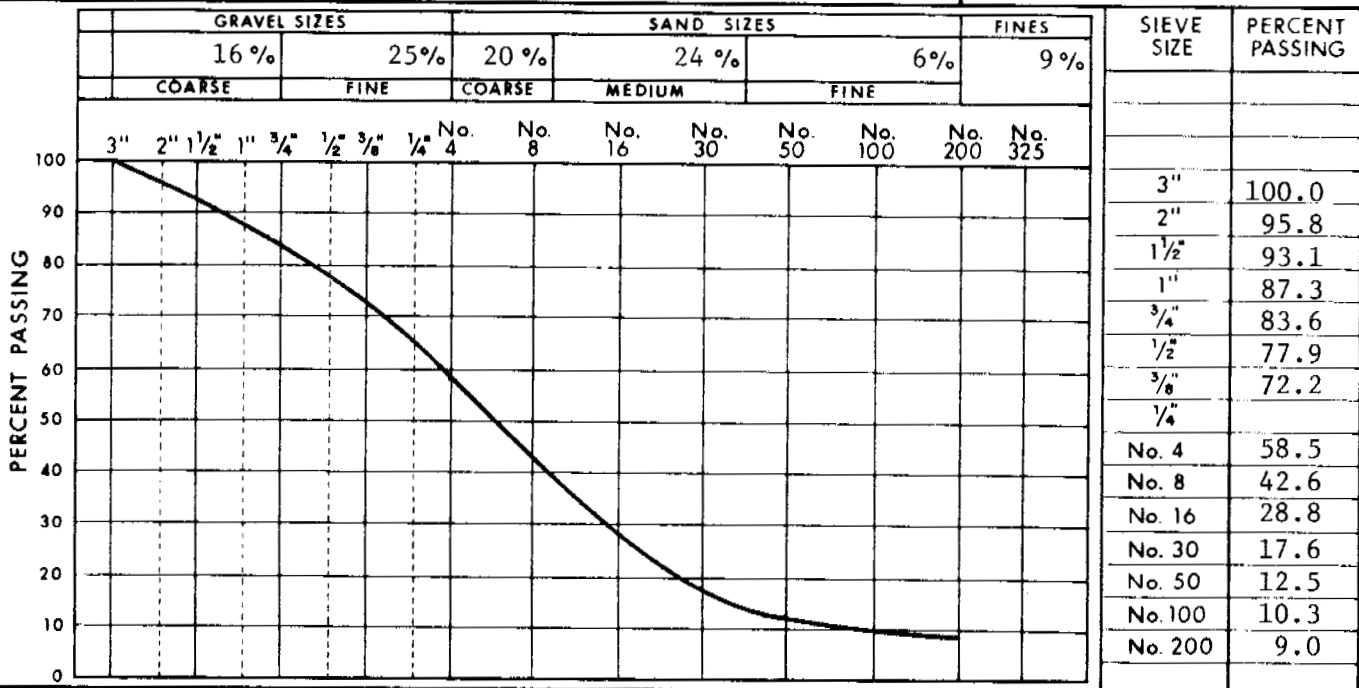
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B10-2 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 15, 1975 SAMPLED BY NESCL 81



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-107B-B10-3 DEPTH 2.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 15, 1975 SAMPLED BY NESCL 79



COMMENTS OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B10

PAGE
 230

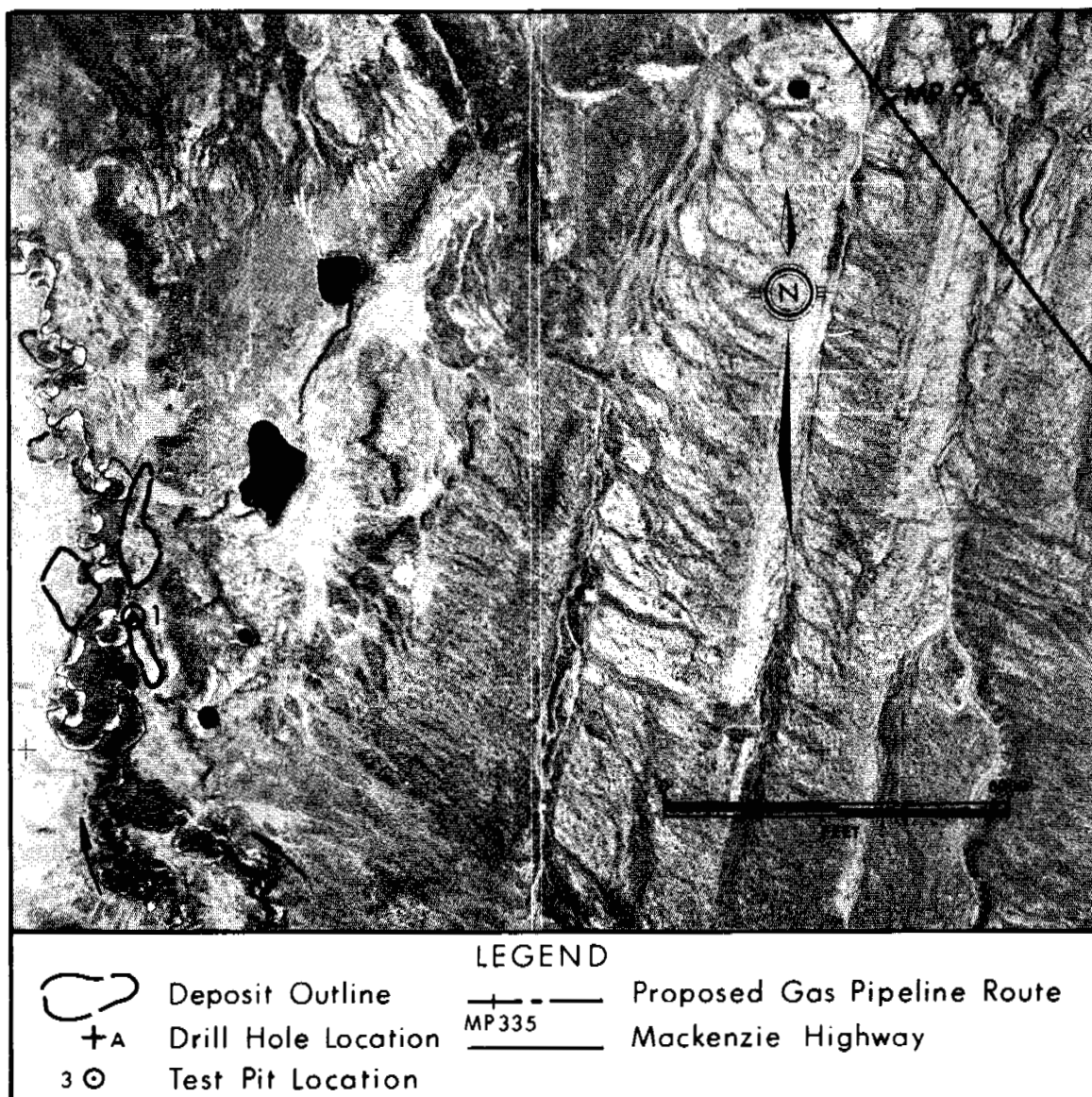
DEPOSIT 107B-B11

Physical Setting: Deposit 107B-B11 is a fluvial terrace located 6.5 miles east of Campbell Lake and 3.5 miles west of milepost 94 on the right of way.

Material: GRAVEL - interbedded with sand, scattered boulders.

Volume: 800,000 cubic yards.

Assessment: Deposit 107B-B11 is a source of good quality granular material suitable for general fill, backfill, building pads and possible concrete aggregate.



Airphoto No. A12861-277

Approximate Scale: 1" = 3150'

Latitude: 68° 18'

Longitude: 133° 01'

DEPOSIT 107B-B11

PHYSICAL SETTING

This deposit is a fluvial terrace located 6.5 miles east of Campbell Lake and approximately 3.5 miles west of milepost 94 of the proposed pipeline right of way.

The terrace stands about 12 feet above the floodplain of a stream which bissects the deposit. Overburden varies between 1 and 5 feet and drainage is imperfect. The active layer is probably between 1 and 3 feet thick, increasing where overburden is thin.

Terrain between the deposit and the pipeline right of way is a poorly drained, gently rolling morainic plain.

BIOLOGICAL SETTING

The vegetation at the site is stunted black spruce. The understory consists of dwarf birch, willow, labrador tea, and lichen, with sedges in depressional areas. The area provides low productivity habitat for fox, wolf and snowshoe hare. No evidence of beaver was seen in the stream or lakes. The site lies within the winter range of the Mackenzie Reindeer Herd. Good moose habitat occurs around the small lake adjacent to the site and along the tributary of Norris Creek. Moose populations in the area are low. The area is important waterfowl habitat although no waterfowl were observed on the nearby lakes. The fish potential of the creek is not known.

MATERIAL

The test pit log shows 10 feet of interbedded gravel and sand with scattered boulders up to 8 inches in diameter. The platy nature of the gravel indicates high shale contents.

VOLUME

Total estimated volume based on 60 acres and a 10 foot depth is 800,000 cubic yards. The volume of this deposit could be greatly increased by including adjacent poorly drained terraces that appear to be covered by a moderate thickness of overburden.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B11 is a source of good quality granular material based on the results of one test pit excavated at the deposit. More drilling and test pitting would be required to determine overburden thickness, the extent, and quality of the material in this deposit. Granular material from this deposit could be used for general fill, backfill in pipeline construction, building pads, and possibly concrete aggregate.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit from the pipeline right of way would have to cross poorly drained terraces and a stream, but could follow an esker ridge for a portion of the way. Care would have to be taken not to initiate thermokarst subsidence in the poorly drained area between the deposit and the pipeline alignment.

In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to the right of way, a distance in excess of 3 miles.

Tree cover would have to be removed, both from areas to be excavated and along the haul road right of way, and disposed of in accordance with

current land use regulations. The peat cover and overburden would then be stripped from the area to be excavated and stockpiled around the edge of the excavation.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be established over the area. Care would have to be taken to avoid siltation of nearby streams. This could be accomplished by a buffer zone between the stream and the borrow pit. This source could be developed by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing and concrete plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
0.5	Pt		PEAT - fine fibrous, spongy			UF													
1.0	M		SAND - medium, silty, nonplastic, brown, slightly stratified																
2.2	GP		GRAVEL - some sand, medium grain, platy to 8'' - probably fine-grained sandstone																
3.0	GP		GRAVEL - poorly graded --- platy to 2½''																
4.8			sandy, rounded to approximately 4'' platy to approximately 8''																
5.5			some sand, coarse to medium																
8.0	GW		GRAVEL - little sand, medium, light brown																
LOGGED BY: R.H. FACILITY: PROJECT: 13011 CHKD: R.H. LAT. & LONG: 66°18'19''N, 133°01'03''W ELEVATION: DRWN. BY: B.J.M. AIRPHOTO No.: A 120 B1-277 PIPE MILEAGE: CHKD: D.G. RIG: AIR TEMP: Approx. 27°C METHOD: TEST PIT				1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED				TEST HOLE No. N75-107B-B11-1 SHEET 1 OF 2											
START: D 15 M 08 Y 75 TIME: 12:15				FINISH: D 15 M 08 Y 75 TIME: 13:50															

* MA combined samples 1 - 4
oversize = 21.6%
- 3'' material:
B = 72%
S = 22%
F = 8%
(GW-GM)

* Combined samples from depth 3.0' to 10.5'-
GRAVEL - coarse to fine, some cm' sand, trace fines

- 236 -

TEST HOLE No. N75-107B-B11-1

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
							▲ Dry density (pcf)			○ Water content %										Plastic limit
							40	60	80	100	120	140 ▲								
							0	20	40	60	80	100 ○								
8	SM		B.2 SAND - medium, silty, rust brown and grey			UF							MA 1 - 4 cont'd	B3				8		
9	SP		SAND, medium grain, poorly graded																9	
10	GB		B.2 GRAVEL - some sand, medium, oversize platy 8" x 1 1/2"												B4					
			Discontinued at approximately 4' above stream level Stream bed, cobbles & platy gravel																	

TEST HOLE No. N75-107B-B11-1

- 237 -

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°18'19"N, 133°01'03"W	ELEVATION:
DRWN. BY: D.J.W.	AIRPHOTO No.: A 12881-277	PIPE MILEAGE:
CHKD: D.G.	RIG:	AIR TEMP: Approx. 27°C
	METHOD: TEST PIT	
START: D 15 M 08 Y 75 TIME: 12:15	FINISH: D 15 M 08 Y 75 TIME: 13:50	

1975 BORROW INVESTIGATION



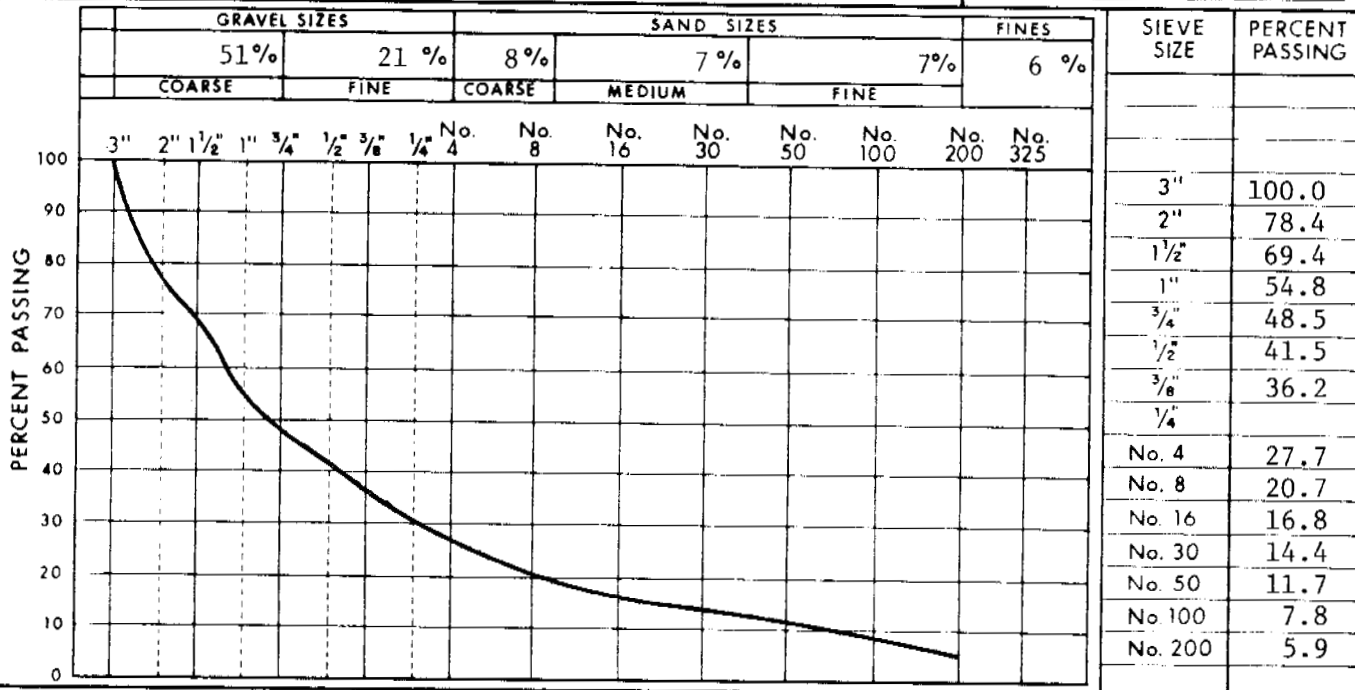
NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No. N75-107B-B11-1
SHEET 2 OF 2

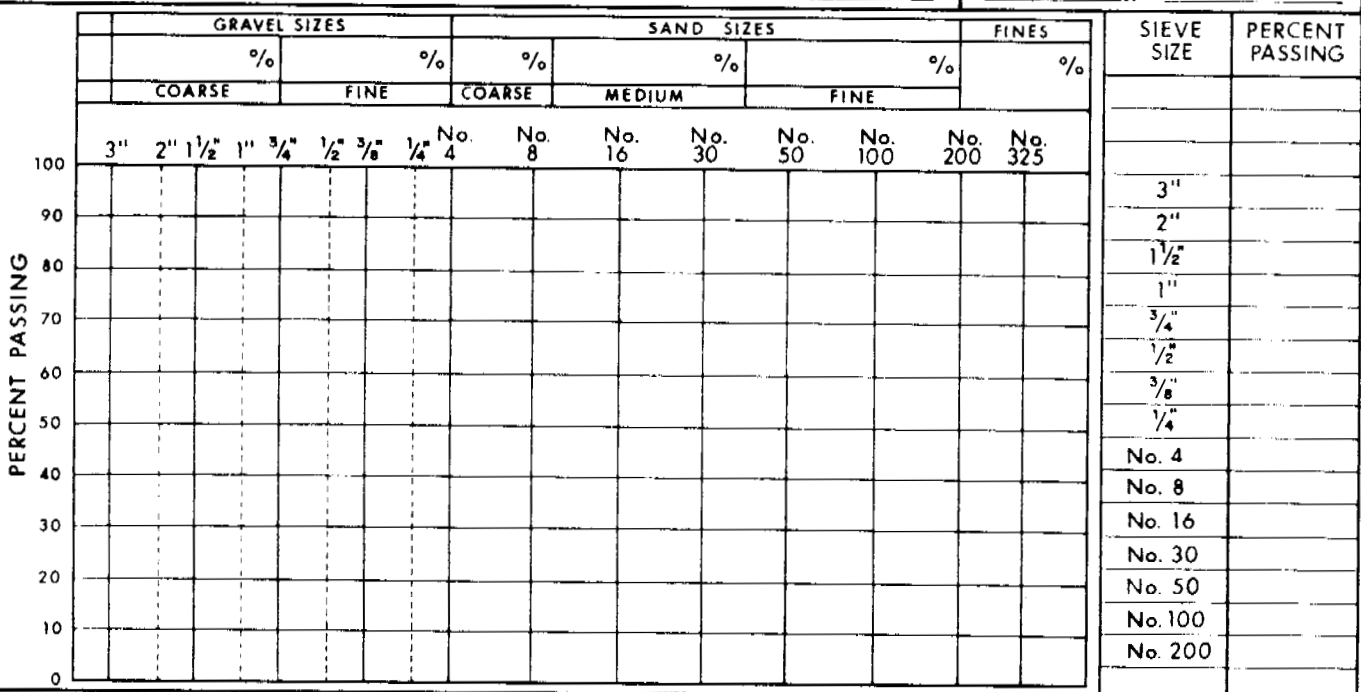
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B11-1 DEPTH 3.0-10.5 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 15, 1975 SAMPLED BY NESCL 98



COMMENTS OVERSIZE (>3") = 21.6%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS OVERSIZE (>3") = %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B11
 PAGE
 238

DEPOSIT 107B-B12

UTM Zones 8

601000 E, 7561000 N

Physical Setting: Deposit 107B-B12 is a kame located 1 mile northwest of Lost Reindeer Lake and 2 miles southwest of the right of way at milepost 111.

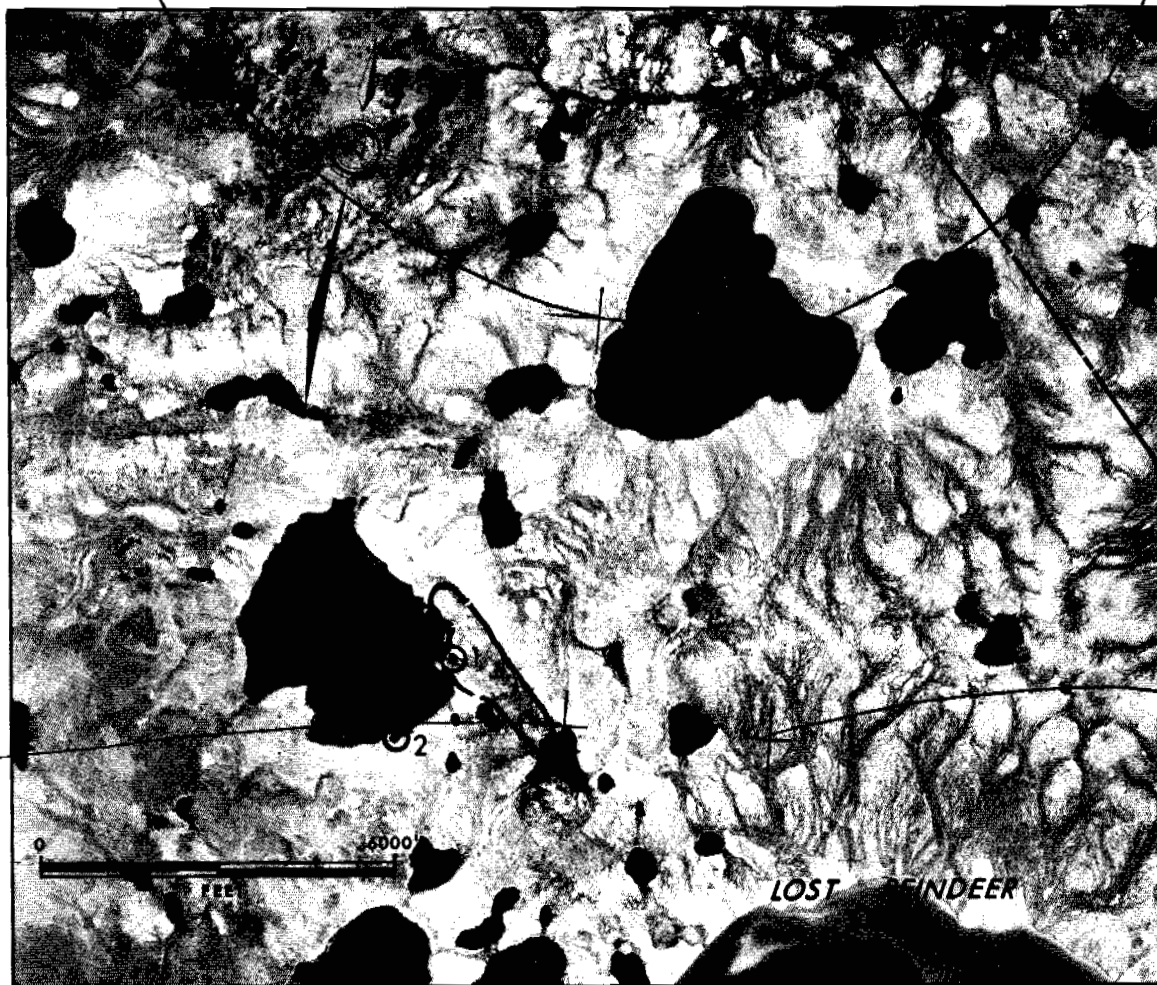
Material: GRAVEL - well graded, and fine to medium sand.

Volume: 500,000 cubic yards.

Assessment: Deposit 107B-B12 is a source of good quality granular material suitable for general fill, backfill, building pads and possible concrete aggregate.

600000 E
7561000 N

601000 E
7561000 N



600000 E
7559000 N

601000 E
7559000 N

LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A12902-10

Approximate Scale: 1" = 3250'

Latitude: 68° 07'

Longitude: 132° 36'

DEPOSIT 107B-B12

PHYSICAL SETTING

This deposit is a kame located 1 mile northwest of the western Lost Reindeer Lake and 2 miles southwest of milepost 111 on the proposed pipeline right of way.

The complex consists of a low ridge with gentle to moderate slopes. A slump, that has developed on the edge which borders a small lake, suggests this deposit is ice cored. The depth of overburden was not determined but probably ranges between 1 to 3 feet over most of the deposit. Drainage is moderately good to imperfect.

The terrain between the pipeline right of way and the deposit is gently undulating to rolling, poorly drained moraine with peat in swales and depressions.

BIOLOGICAL SETTING

The vegetation at this site consists of scattered black spruce with an understory of willow, alder and bog birch and a ground cover of lichen and moss. The area provides good reindeer and caribou habitat but is only moderately productive habitat for lynx, fox, marten and wolf. Grizzly and black bear occur infrequently in the area. The western Lost Reindeer Lake is used by a wide range of waterfowl during the open-water season. Arctic terns were observed nesting on the lake during the 1975 survey. Ptarmigan and passerines are common in the area. Lost Reindeer Lake is inhabited year-round by pike, burbot, and grayling.

MATERIAL

The 2 test pits on this site show the material to consist of well graded gravel and fine to medium sand. Near surface gravel is silty and at

depth it is composed of soft, incompetent rock fragments. Further drilling is required to determine a more accurate estimate of quality and thickness of the deposit.

VOLUME

Total estimated volume based on an area of 60 acres and a 6 foot depth is 500,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B12 is a source of good quality granular materials. Areas to be exploited will be dictated by overburden thickness, insitu material quality and material requirements in the area. Further drilling and test pitting are required to determine overburden thickness, to define the quantity and quality of material within this deposit and delineate any massive ice that may be present before development commences.

Initial indications are that the granular material from this deposit could be used for general fill, backfill in pipeline construction, building pads and concrete aggregate production with some processing.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Equipment could be staged to the deposit along the pipeline right of way and then to the deposit across 2 miles of gently undulating to rolling poorly drained moraine. When crossing this terrain care should be taken not to initiate thermokarst subsidence or disturb drainage. In order to prevent environmental damage snow roads would be built to transport the borrow material from the deposit to haul points on the right of way.

Tree cover would have to be removed from access roads and excavation areas and harvested in accordance with current land use regulations. The peat cover and overburden then would be stripped from the area to be excavated and stockpiled around the edge of the site.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be maintained over the area.

This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used.

Equipment required for development would be dozers, rippers, end-dump trucks and front-end loaders as well as screening, crushing and concrete plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2	Pt		PEAT - amorphous, fine fibrous, woody.		UF							MA, sample 1 G = 51% S = 41% F = 8%					0.2	
1	GM		GRAVEL - silty, and coarse to medium sand, light brown, pebbles to 3", rounded, dirty, rootlets, loose.															
2.1			oxidation layers and silt, (organic) dirty, dark brown, gravel rectangular to 2 1/2".															
2.8			contorted layers															
3.4																		
4	SM		SAND - fine to medium grain, and silt, trace fine gravel, moist, loose. Occasional pebble to 1".									MA, sample 2 G = 55% S = 58% F = 38%					3.5	
5			Bottom of exposed face															
5.0			LAKE BANK - numerous fracture slides, mud slide noted; refer also to W75-107B-812-2															Does not correspond with height of lake bank which continues for an estimated 28' below this.

- 244 -

TEST HOLE No. N75-107B-812-1

LOGGED BY: R.H.	FACILITY:	PROJECT: 13811
CHKD: R.H.	LAT. & LONG: 68°07'07"N, 132°38'27" W	ELEVATION:
DRWN. BY: D.J.M.	AIRPHOTO No.: A 12902-10	PIPE MILEAGE:
CHKD: D.D.	RIG:	AIR TEMP: Approx. 27°
	METHOD: TEST PIT	
START: D 16 M 88 Y 75 TIME: 12:00	FINISH: D 16 M 08 Y 75 TIME: 12:45	

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	1975 BORROW INVESTIGATION TEST HOLE No. N75:107B-812-1 SHEET 1 OF 1
CANADIAN ARCTIC GAS STUDY LIMITED	

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
5	GM		Approximately Top of bank 5' - GRAVEL - fine to coarse, and sand, oxidized.									MA, combined Samples 1 - 3 G 50% S 41% F 9%	B1	<input checked="" type="checkbox"/>			5	Bulk samples at 5', 10' & 23'.	
10			10' - as above										B2	<input checked="" type="checkbox"/>				10	soft rocky may abrade easily.
23			23' - approximately 5' from lake water level GRAVEL - "soft" rock, black											B3	<input checked="" type="checkbox"/>			23	distances estimated from top of bank.
28			28' - Bottom of excavation																
			* NOTE: not measured accurately due to insufficient time and difficult terrain. Possible better source of gravel (quantity) than N75-107B-B12-1																

TEST HOLE No. N75-107B-B12-2

- 245 -

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 86°07'04"N, 132°38'36"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 12802-10	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 30°C
	METHOD: TEST PIT	
START: D 18 M 08 Y 75 TIME: -	FINISH: D 16 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

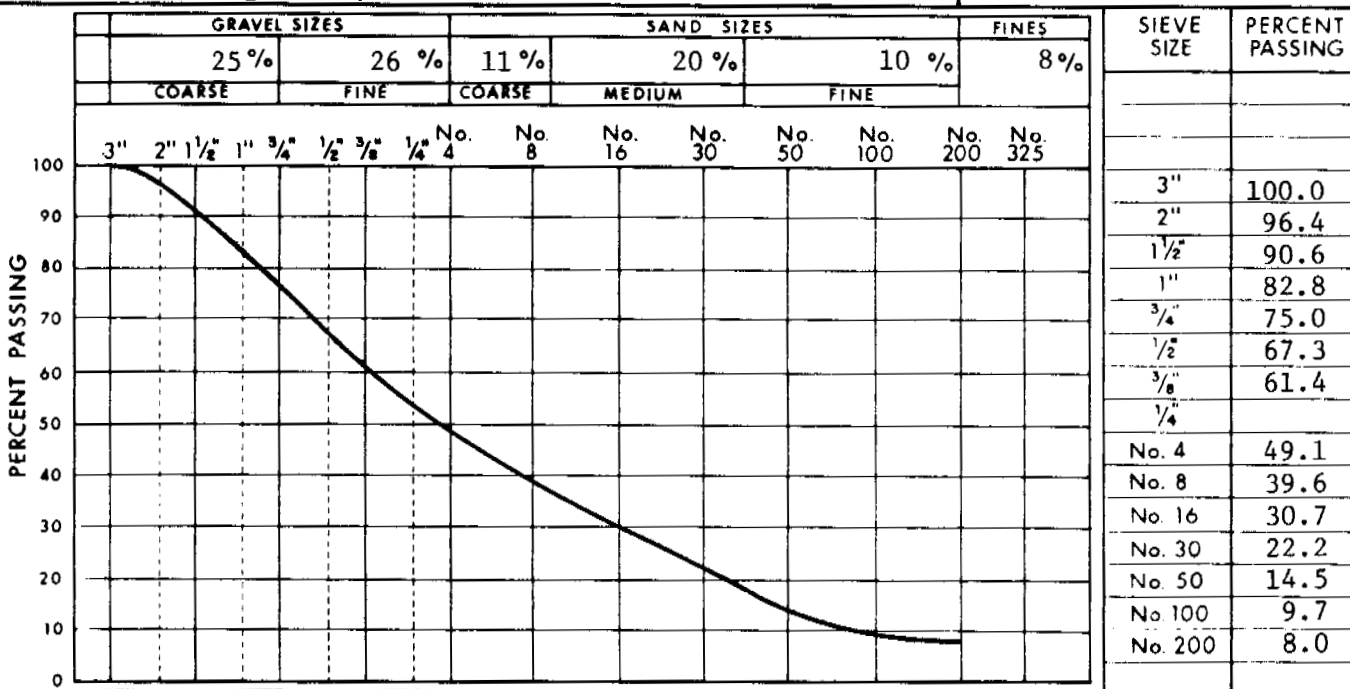
CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B12-2

SHEET 1 OF 1

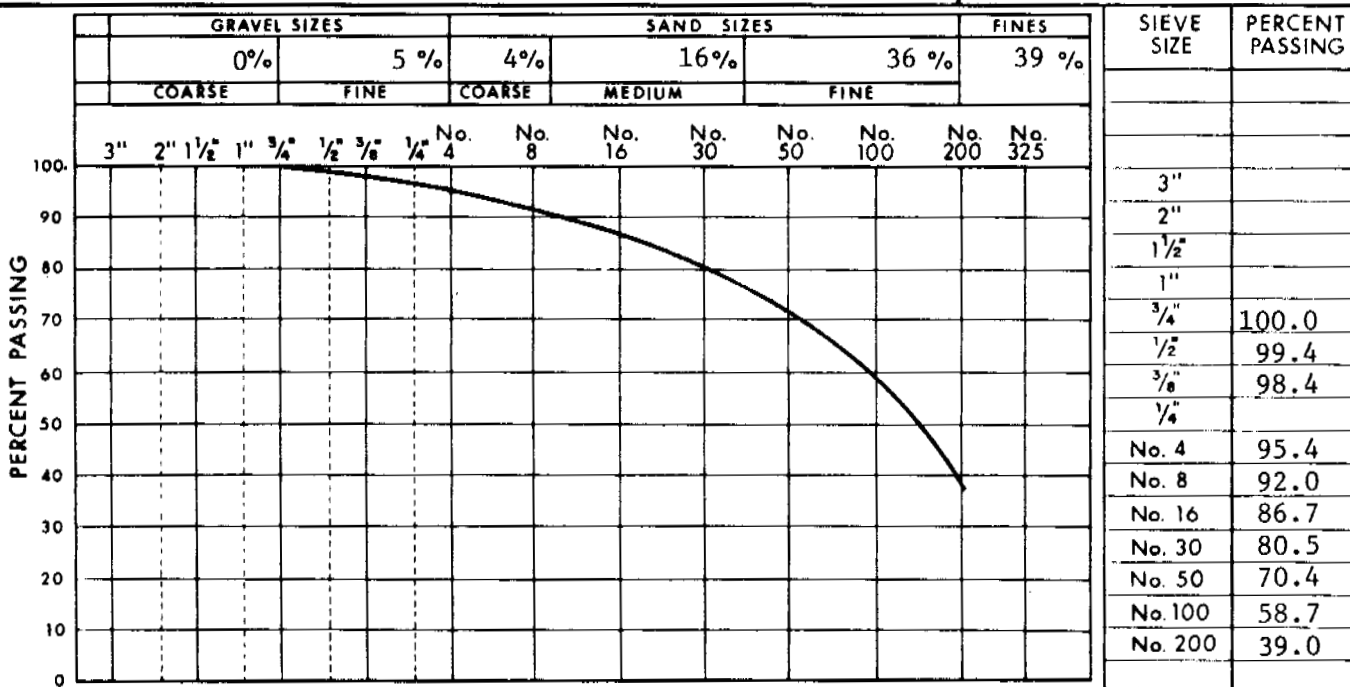
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B12-1 DEPTH 0.2-2.2 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 16, 1975 SAMPLED BY NESCL 140



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-107B-B12-1 DEPTH 3.5-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 16, 1975 SAMPLED BY NESCL 141

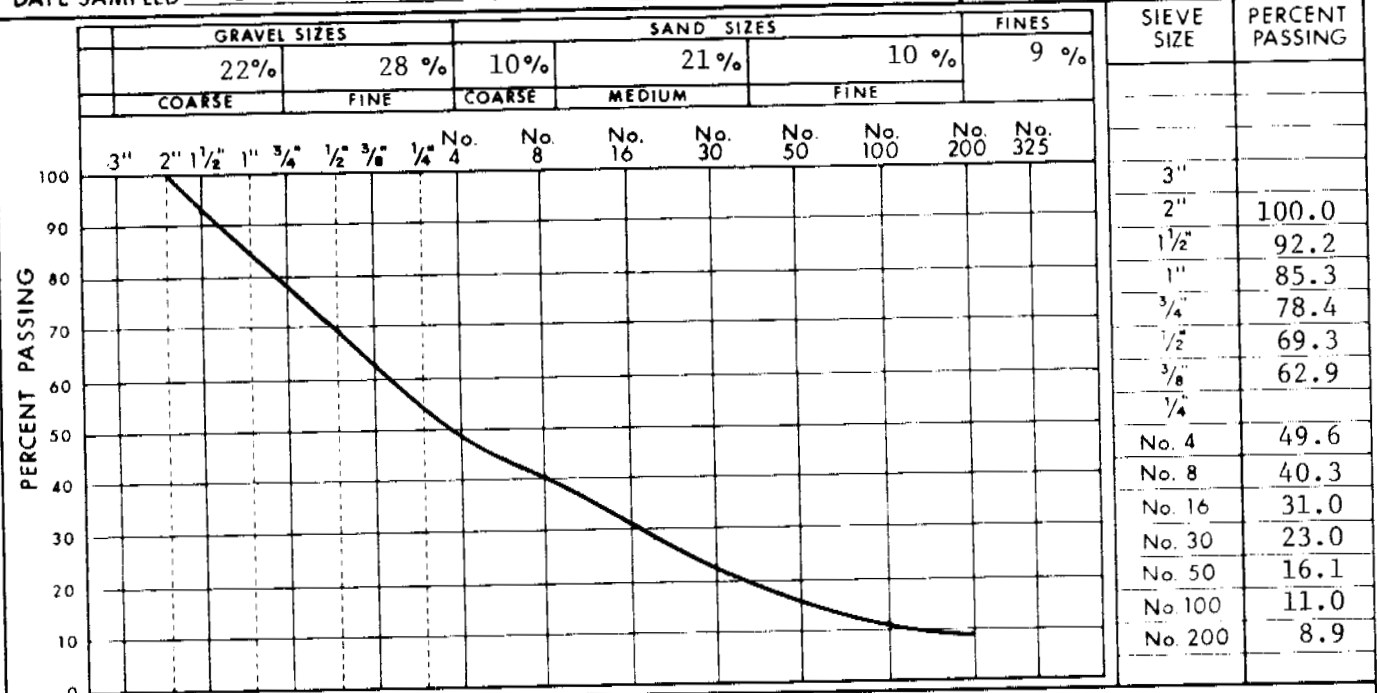


COMMENTS OVERSIZE (>3") = 0.0 %

 <p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	 <p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-107B-B12
		PAGE 246

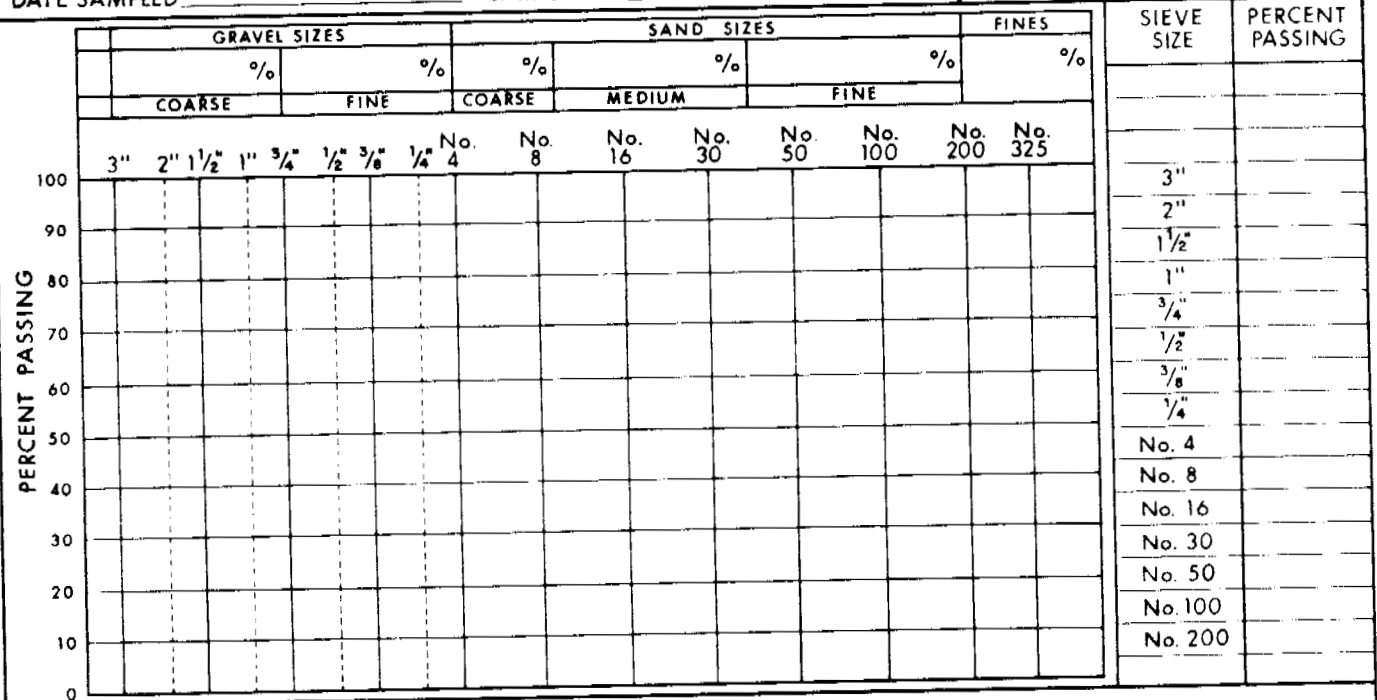
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B12-2 DEPTH 1.0-5.0, 10.0 & 15.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 16, 1975 SAMPLED BY NESCL 147



COMMENTS _____ OVERSIZE (>3") = 0.0 %

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B12

PAGE
 247

B 13 - A 599780E 7556630N

B 13 - B 600070E 7557080N

OUT OF STUDY AREA
UTM - Zone 8

DEPOSIT 107B-B13

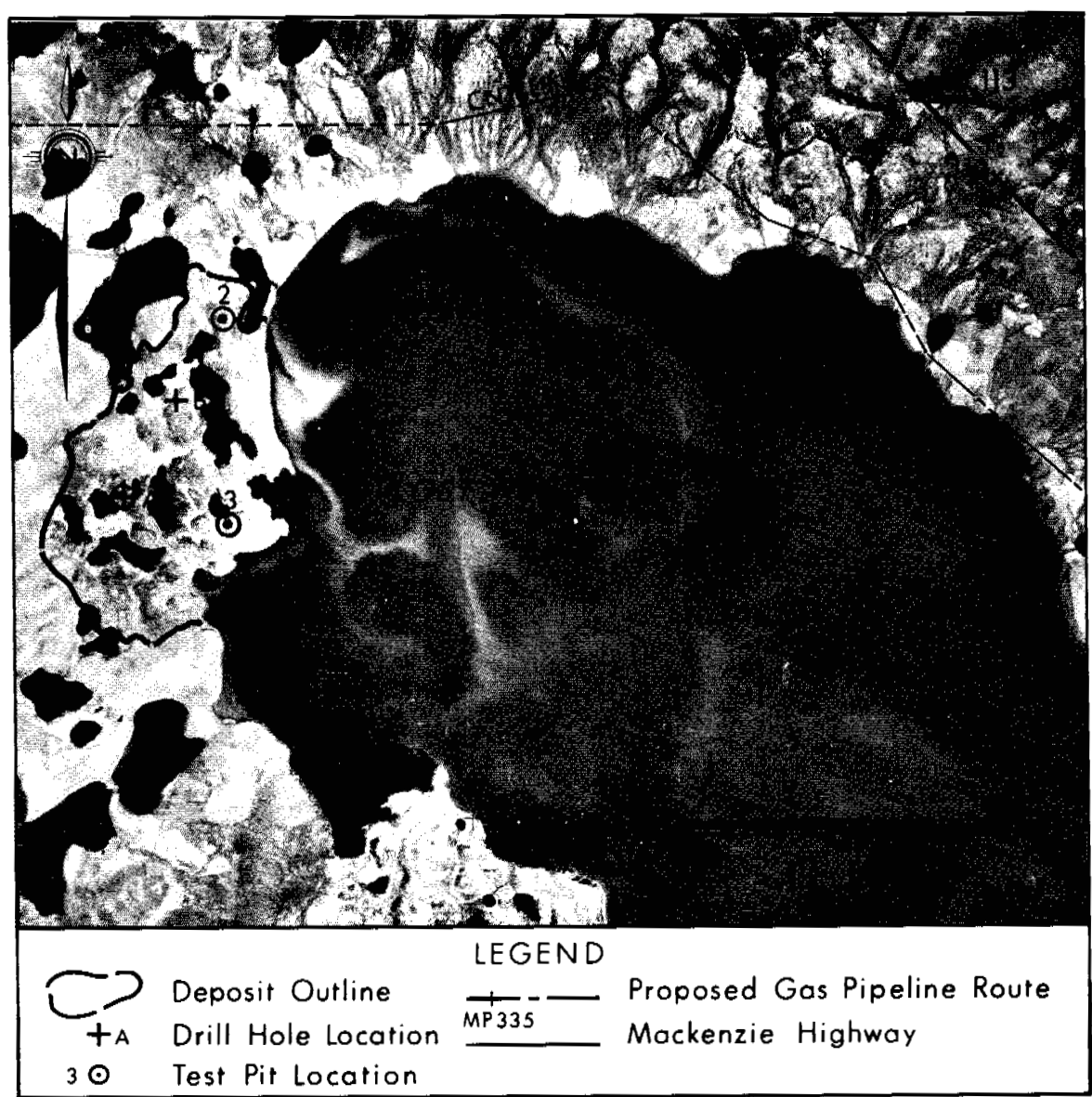
*see site # 1153-1

Physical Setting: Deposit 107B-B13 is a kame and kettle complex bordering the northwestern corner of Lost Reindeer Lake and is about 3 miles from milepost 112 on the right of way.

Material: GRAVEL - well graded, and sand.

Volume: 4,600,000 cubic yards.

Assessment: Deposit 107B-B13 is a source of good quality granular material suitable for general fill, backfill and building pads; although it is not considered suitable for concrete aggregate.



Airphoto No. A12902-9
Approximate Scale: 1" = 3250'

Latitude: 68° 06'
Longitude: 132° 35'

DEPOSIT 107B-B13

PHYSICAL SETTING

This deposit is a kame and kettle complex bordering the northwestern corner of the most western Lost Reindeer Lake. It is approximately 3 miles southwest of milepost 112 on the proposed pipeline right of way. This deposit corresponds to source number 1153a in the EBA DIAND Granular Materials Inventory (1974) report.

The kame and kettle complex consists of hills rising up to 100 feet above intervening depressions. Maximum slopes are about 20 degrees. Peat and silt on hills and ridges varies from 0 to 1 foot in thickness, however in the depressions they may be more than 10 feet thick.

The deposit is well drained except for marshy depressions, and small lakes scattered throughout the area. In August the active layer ranges from 2 to 6 feet. Below this active layer the deposit is frozen with low to moderate ice content.

Terrain between the deposit and the pipeline route is a flat to rolling moraine plain with occasional patches of peat. Drainage is moderate to imperfect and there is a possibility that massive ice is present in the rolling moraine.

BIOLOGICAL SETTING

Better drained portion of the site support black spruce up to 30 feet in height. The understory consists of willow, alder, and bog birch, with a ground cover of lichen and moss. Depressions have a thick moss cover and scattered stunted black spruce. The site provides marginal moose habitat but potentially good reindeer and caribou habitat. Reindeer and caribou populations in the area are low. Habitat is low to moderately productive for fox, lynx, marten, and wolf. Grizzly and black bear occur infrequently in the area. Arctic terns were observed nesting on the western Lost Reindeer Lake. The degree of waterfowl utilization of this

and nearby small lakes is not fully known. Lost Reindeer Lake is inhabited year-round by pike, burbot and grayling.

MATERIAL

Drill hole and test pit logs indicate the material at this deposit is well graded gravel and sand. Silt content varies throughout. Drill hole 107B-B13-A encountered a washed till with boulders 10 to 12 inches in diameter.

VOLUME

Only the hills and ridges on the area outlined on the airphoto are considered in the volume calculation. Total estimated volume based on 160 acres and a maximum depth of 40 feet is 4,600,000 cubic yards. Approximately 50 percent of the material can be assumed to be gravel.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B13 is a source of good quality granular material, but is not considered suitable for concrete aggregate. Areas to be exploited will be dictated by material requirements, insitu material quality, and overburden thicknesses. Granular material from this deposit may be used for general fill, backfill in pipeline construction and building pads. Extensive drilling and test pitting would be required to delineate the boundaries of the better quality granular material prior to development.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access could be gained from the pipeline right of way to the deposit by crossing the ice on Lost Reindeer Lake in the winter. This would make a haul distance of 4 miles from the deposit to the pipeline right of way.

Vegetative cover would be removed from pit areas in accordance with land use regulations. The peat cover and overburden would then be stripped from the area to be excavated and stockpiled around the perimeter of the site.

Development of this deposit would involve mining the borrow material in stages from the steep side slopes of the kames. A buffer zone should be established to avoid siltation of Lost Reindeer Lake and protect the shoreline environment from thermokarst subsidence. Some gentle to moderate slopes of the deposit will probably be developed by excavating material evenly so that good drainage is maintained. Sufficient cover would be left on massive ice layers to prevent thermal degradation. Either type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Natural mixing during excavation will be adequate to obtain good gradations.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, and crushing plants if required.


A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40 0	60 20	80 40	100 60	120 80	140 100	▲ ○							
0 to 2	CL to CI		CLAY - sandy, silty, trace, coarse and fine gravel low to medium plastic, pebbles to 1 1/2", rounded and angular, rusty orange brown turning grey brown, cobbles to 4"		UF												4 1/2" tricone bit switching to 4 1/2" Walmac bit 15:20	
2 to 4																		
4 to 5.0	SM		SAND - very fine to coarse, silty, pebbles to 2", occasional boulders at 5.0', 7.5' and 13.0'		Vx												3 7/8 tricone bit 16:30	
5.0 to 7.5																		
7.5 to 13.0																		
13.0 to 14			coarse sand to fine gravel, occasional cobbles														at approx. 11.0' moist sand returned, possibly thawed by drilling	
14 to 18			End of hole														hole sloughed in 16:45	

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 68°05'38"N, 132°36'02"W	ELEVATION:
DRWN BY: J. M. B.	AIRPHOTO No.: A 12902-9	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 20°C
	METHOD: AIR	
START: D 15 M 08 Y 75	TIME: 15:20	FINISH: D 15 M 08 Y 75
		TIME: 18:45

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1078-B13-A

SHEET 1 OF 1

- 254 -

TEST HOLE No. N75-1078-B13-A

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0 - 1.5	SW		SAND- cmf, trace fine gravel														4 1/2" Walmac bit 19:25	
1.5 - 4.5	GW		GRAVEL- fine, occasional coarse, well graded, pebbles subrounded to sub angular, pebbles to 3/4", occasional to 2", dark brown-grey		UF													
4.5 - 12.0					Nbe													
12.0 - 16			fine to 3/8", sand, coarse, angular, trace silt, occasional coarse gravel		occ. Yx												3 7/8" Walmac bit 19:27	

TEST HOLE No. N75-107B-B13-B

- 255 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°05'53"N, 132°35'35"W	ELEVATION:
DRWN. BY: J.W.B.	AIRPHOTO No.: A 12902-9	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP.: 23°C
	METHOD: AIR	
START: D 15 M 8 Y 75	TIME: 19:25	FINISH: D 15 M 8 Y 75
	TIME: 20:04	

1975 BORROW INVESTIGATION




NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B13-B
SHEET 1 OF 2

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC ICE TYPE	VISUAL ICE %	▲ Dry density (pcf)	○ Water content %	Plastic limit	Liquid limit							
18	GW			F	40	60	80	100	120	140 ▲							19:33
20					0	20	40	60	80	100 ○							
22																	
24																	
26			coarse gravel, sandy (inferred by drilling action)														
28			28.0 End of hole														3 7/8" tricone bit hole caved in @ 20:04

- 256 -

TEST HOLE No. N75-107B-B13-B

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°05'53" N, 132°35'35" W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 12802-9	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-BRILL	AIR TEMP: -23°C
	METHOD: AIR	
START: D 15 M 8 Y 75 TIME: 19:25	FINISH: D 15 M 8 Y 75 TIME: 20:04	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B13-B

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	SW		Thin PEAT cover, fine fibrous		UF												17:15	
0.5			SAND - medium to fine grain, trace gravel, rounded to ¼", little silt									MA, combined samples 1 - 3 G = 26% S = 60% F = 14%	B1					difficult to excavate
2.0			slightly more gravel										B2				17:40	
3.0			some gravel subrounded to 1", cobble noted to 7", slight oxidation										B3				17:50	
4.0			and gravel, subrounded to 1½"										B4				18:15	
5.0			GRAVEL and SAND, coarse to fine grained, trace silt, granitic gravel broken to 2½"										B5				4.5	
6.0	GW		Bottom of pit										B6				5.5	
6.0																	6.0	18:50

TEST HOLE No. N75-107B-B13-1

- 257 -


LOGGED BY: R.H.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS LTD.	TEST HOLE No.
CHKD: R.H.	LAT & LONG 88°05'38"N, 132°36'02"W	ELEVATION:		N75-107B-B13-1
DRWN BY: F.B.B.	AIRPHOTO No. A 12902-9	PIPE MILEAGE:	CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1
CHKD: D.O.	RIG:	AIR TEMP: Approx. 27°C		
METHOD: TEST PIT				
START: D 15 M 09 Y 75 TIME: 17:15	FINISH: D 15 M 08 Y 75 TIME: 18:50			

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS		
						▲ Dry density (pcf)			○ Water content %											
						40	60	80	100	120	140 ▲									
						0	20	40	60	80	100 ○									
0.1	Pt		PEAT - sedge, grass, brown.																	
1.0	GW GC		GRAVEL															19:30		
1.5	SM		SAND - medium to fine-grained, (trace coarse) and fine to coarse gravel, trace finns. at 1.5', occasional cobble with cementation. at 2.0' cementation on gravel.									MA, combined samples 1-4 G=40% S=44% F=16%	B1					1		
2.0																		B2		2
3.5																		B3		3
4.5	SG SB		GRAVEL - and medium grained sand, pebbles 1 1/2" to occasional 3", moist. Bottom of pit.																20:00 15.06.75 10:00 18.06.75 dirty material	
4.5																		4.5	11:40	

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°06'09"N 132°35'11"W	ELEVATION:
DRWN. BY: R.J.S.	AIRPHOTO No.: A 12902-10	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 27°C
	METHOD: TEST PIT	
START: D 15 M 08 Y 75 TIME: 19:30	FINISH: D 16 M 08 Y 75 TIME: 11:40	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-813-2

SHEET 1 OF 1

- 258 -


TEST HOLE No. N75-107B-813-2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.5	Pt		PEAT - brown, roots		UF							MA, combined samples 1 - 3 G = 42% S = 37% F = 21%					1		
1.0	DL		SILT - (organic), spongy, brown - black																
2.0	GM		GRAVEL - fine to coarse, and cmf sand, some silt, gravel to 3"										B1					2	dirty material
					Nbe								B2					3	
													B3					4	
4.0			boulder, 12", rounded																
4.5			Bottom of pit																

LOGGED BY: S.C.M.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°05'34"N, 132°35'11"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 12902-9	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 21°C
	METHOD: TEST PIT	
START: D 16 M 08 Y 75	TIME: 11:00	FINISH: D 18 M 08 Y 75
		TIME: 12:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B13-3

SHEET 1 OF 1

- 259 -

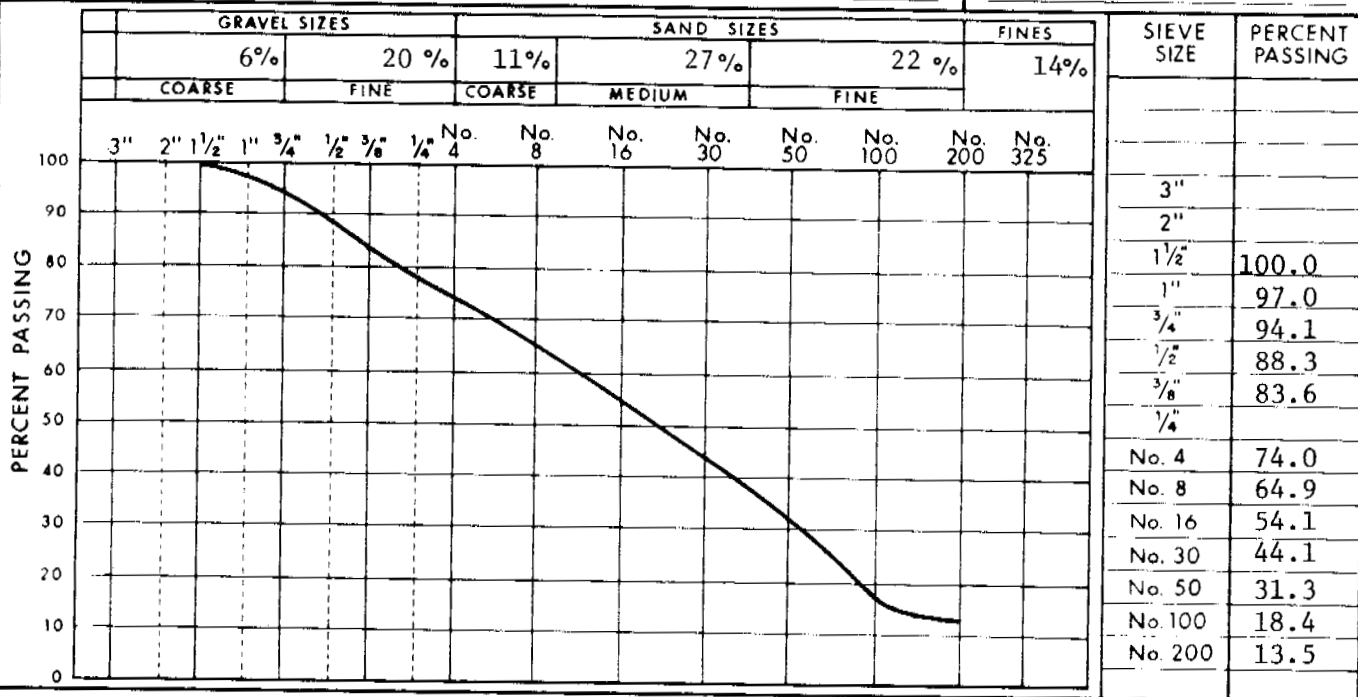
TEST HOLE No. N75-107B-B13-3

SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B13-1 DEPTH 1.0-4.0

R.M.HARDY REPORT NUMBER
155

DATE SAMPLED August 15, 1975 SAMPLED BY NESCL



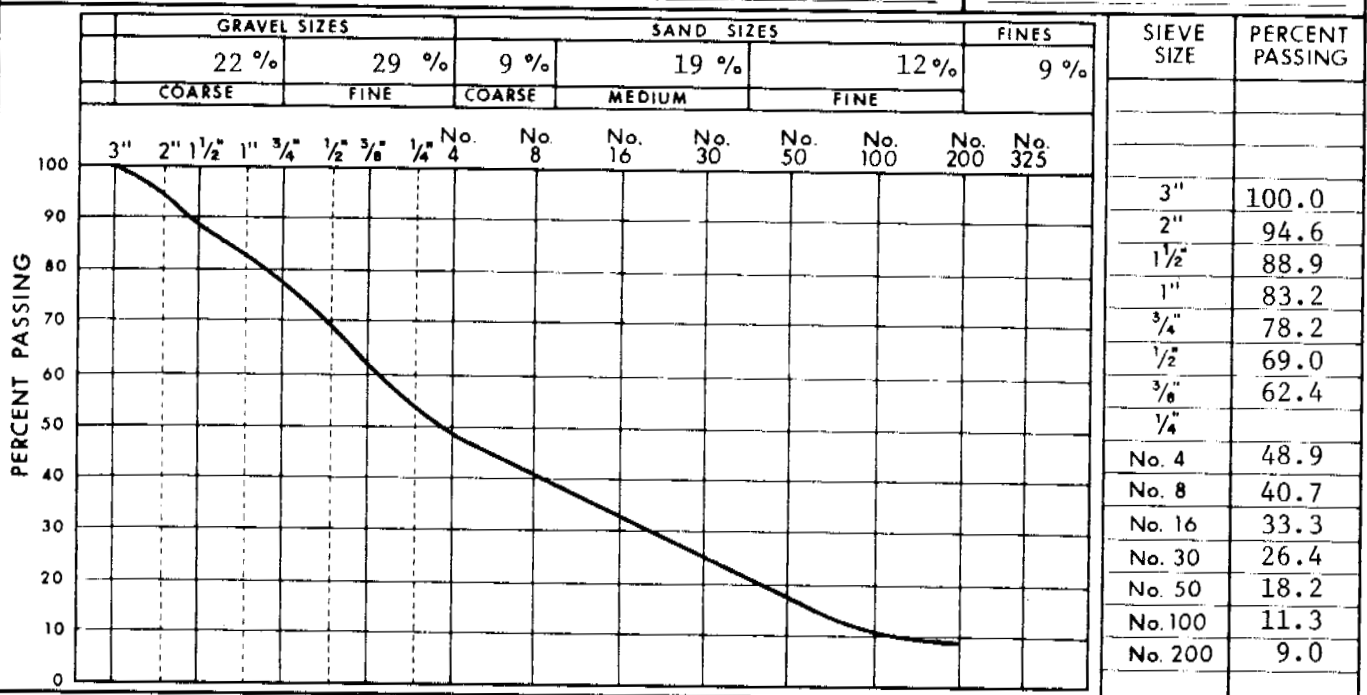
COMMENTS

OVERSIZE (>3") = 0.0%

SAMPLE N75-107B-B13-1 DEPTH 5.0-6.0

R.M.HARDY REPORT NUMBER
156

DATE SAMPLED August 15, 1975 SAMPLED BY NESCL



COMMENTS

OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

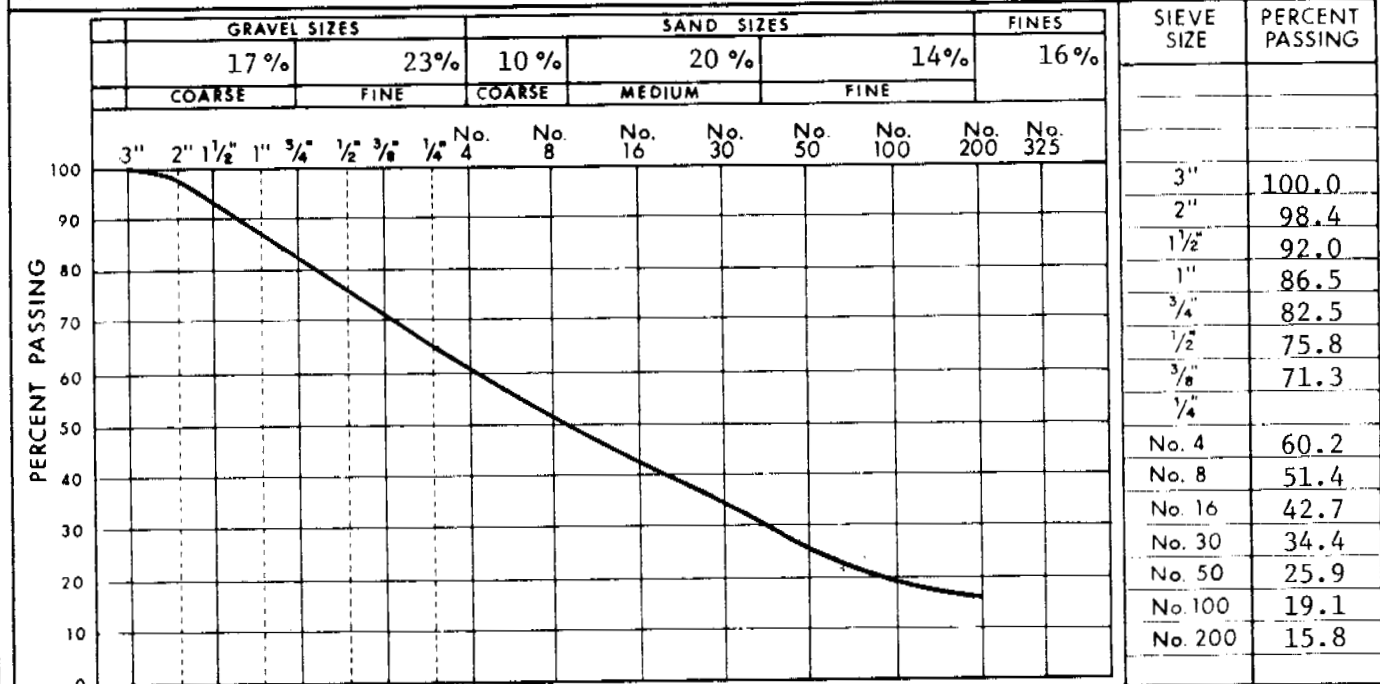


DEPOSIT No.
N75-107B-B13

PAGE
260

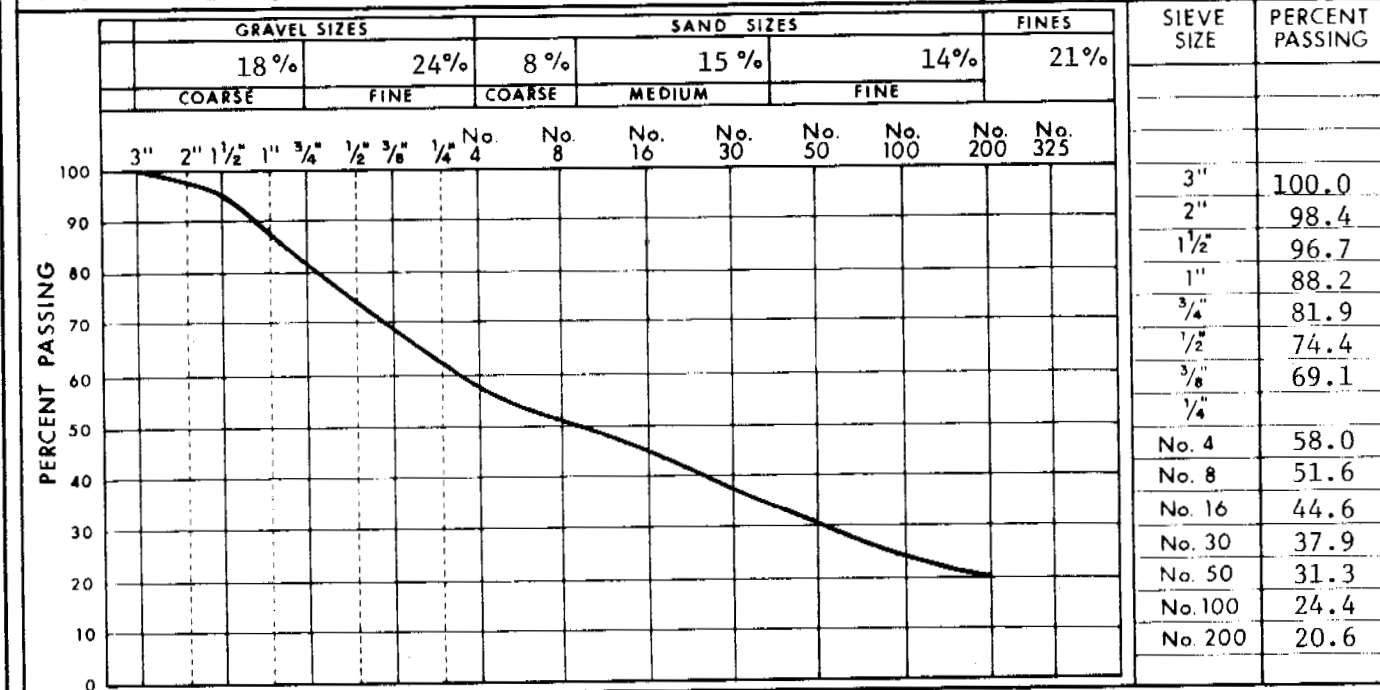
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B13-2 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 15, 1975 SAMPLED BY NESCL 130



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-107B-B13-3 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 16, 1975 SAMPLED BY NESCL 157



COMMENTS OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B13

PAGE
 261

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-107B-B13-3 DATE SAMPLED : August 16, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 1-4 DATE TESTED : January, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 28.97 %
 FINE AGGREGATE : LOSS = 24.33 %

ORGANIC IMPURITIES TEST

NUMBER : 2
 COAL REMOVED : Nil
 COAL & ROOTLETS
 REMOVED : Nil
 COAL CONTENT : Nil
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 21.5 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Strong to very strong, Good	10.3
Granite		3.35
Chert	Potentially reactive, Fair	0.2
Flint		0.5
Ironstone		3.55
Sandstone	Medium strong, Friable, Fair	12.05
Siltstone		8.4
Limestone		3.45
Friable Clay	Deleterious	0.2
PN = 238	INTERPRETATION : Not suitable for use in concrete	42.0

COMMENTS : Not suitable



R.M. HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-107B-B13

PAGE 262

B14 - A 605610 E 7549940N

B14 - B 604210 E 7550140N

UTM Zone 8
OUT OF STUDY AREA

DEPOSIT 107B-B14

Physical Setting: Deposit 107B-B14 is a hummocky moraine and kame complex located 2.5 miles south of Lost Reindeer Lake and 2.5 miles southwest of milepost 118 on the right of way.

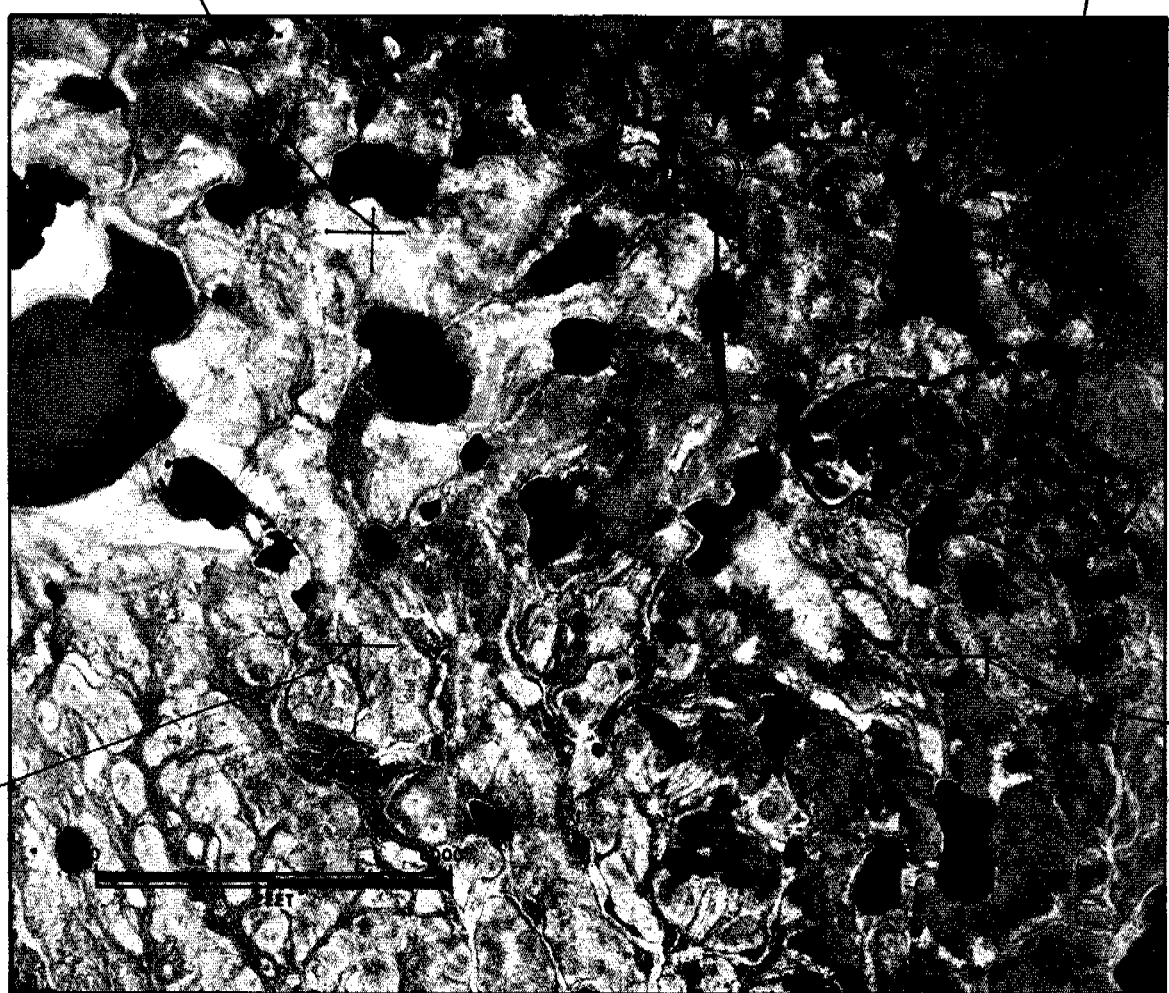
Material: TILL - primarily ablation till with some gravel and sand.

Volume: 1,200,000 cubic yards.

Assessment: Deposit 107B-B14 is a source of poor quality granular material suitable only for marginal fill. It is therefore not recommended for development.

602000E
7551000N

605000E
7551000N



602000E
7549000N

605000E
7549000N

LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A12902-7
Approximate Scale: 1" = 3250'

Latitude: 68° 03'
Longitude: 132° 31'

DEPOSIT 107B-B14

PHYSICAL SETTING

This deposit is a complex of hummocky moraine and kames located 2.5 miles south of the western Lost Reindeer Lake and 2.5 miles southwest of milepost 118 of the proposed pipeline right of way.

Relief over the deposit averages about 30 feet with gentle to moderate slopes. Locally steep sided hills stand 80 feet above bordering depressions. Overburden on most hills and slopes is negligible, whereas depressions may contain up to 10 feet of peat and icy organic silt. Drainage on most hills and south-facing slopes is good, on gentler north-facing slopes it is moderate to imperfect and in depressions poor. The active layer is normally less than 3 feet. Below the active layer the deposit is frozen with moderate ice contents.

Surrounding terrain consists of flat to gently rolling moraine with numerous boggy areas along poorly defined drainageways. High ground ice contents can be expected in the moraine.

BIOLOGICAL SETTING

Vegetation on hilltops and south-facing slopes at this site consist of white spruce up to 40 feet in height and a thick understory of willow, soapberry, rose, juniper, moss and grasses. North-facing slopes and low land are characterized by shrubs and black spruce. The area provides marginal moose and caribou habitat. Habitat is low to moderately productive for lynx, fox, marten, wolf, snowshoe hare, grizzly, and black bear. Little suitable habitat is available for beaver or muskrat. Owl pellets were found at the site. Ponds and lakes in the area do not appear to support fish populations.

MATERIAL

The material in this deposit is primarily a bouldery ablation till with some gravel and sand. Further drilling and test pitting are required to outline areas of adequate quality and volume.

VOLUME

The geomorphology of the deposit indicates maximum possible depths of 40 feet of granular material under some hills. Investigations to date reveal that no more than one quarter of the deposit may be fair to good quality granular material. Total estimated volume of granular material based on an area of 240 acres and 40 foot depth is 1,200,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B14 is a source of poor quality granular material and would be suitable only as marginal fill. Development of the deposit is not recommended unless extreme shortages of borrow exist in this area and extensive drilling and test pitting would be necessary to delineate the areas of better quality material before this deposit is developed.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit ———— Liquid limit		40	60							
2	ML		SILT- and fine gravel, little coarse gravel, sand, fine to medium, trace clay, low to non plastic, occasional small cobbles, sedimentary and metamorphic	1.0	UF	Vr/Vx												4 1/2" Walmac bit 11:50	
4																		3 7/8" Walmac bit 11:57	
6																			
8																			
10																			
12																			
14																			
16																			
18																			
20			boulder 12" - 14"															3 7/8" tricone bit 12:15	
22			End of hole															13:25	

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: D.O.	LAT. & LONG: 68°02'48" N, 132°31'49" W	ELEVATION:		N75-107B-B14-A
DRWN BY: J.K.W.	AIRPHOTO No.: A 12902-8	PIPE MILEAGE:	SHEET 1 OF 1	
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 21°C		
METHOD: AIR				
START: D 16 M 8 Y 75 TIME: 11:50	FINISH: D 16 M 8 Y 75 TIME: 13:25			

- 267 -


TEST HOLE No. N75-107B-B14-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
0					40	60	80	100	120	140 ▲								
0					0	20	40	60	80	100 ○								
2	ML		SILT - low plastic, sandy, rusty brown	1.0	UF												4 1/2" Walmac bit 14:31	
4	SM		SAND - coarse, silty, coarse gravel chips	+	Yx													
6	ML		SILT - and coarse to fine gravel, sand, cmf, low plastic, occasional cobbles,	+														
8			9.0 --- isolated boulder to 10"	+														
10				+														
12			12.0 --- finer gravel	+														
14				+														
16			18.0 End of hole	+													18.0 15:42	

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.G.	LAT. & LONG: 68°02'53"N, 132°30'00"W	ELEVATION:
DRWN. BY: J.K.W.	AIRPHOTO No.: A 12802-7	PIPE MILEAGE:
CHKD: R.H.	RIG: HELI-DRILL	AIR TEMP: 24°C
	METHOD: AIR	
START: D 18 M 8 Y 75 TIME: 14:31	FINISH: D 18 M 8 Y 75 TIME: 18:42	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B14-B

SHEET 1 OF 1

- 268 -

TEST HOLE No. N75-107B-B14-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.5	Pt	3 3 3	PEAT - amorphous, fine fibrous, woody inclusions		UF												15:40 No samples taken	
1.0	Cl	0.8 1.2 1.4 1.5	CLAY - trace gravel, medium plastic, pebbles to ½", clear ice to 2" pockets 1.2 - 1.2', little gravel, rectangular to 3" 1.4 - 1.4', boulder rounded to 11"	+ + + + + + + + + + + +	Vx 40												18:00	
1.5	GM	1.8	GRAVEL - very silty, some fine sand, pebbles to 1", subangular and platy, black, till?, well-bonded by ice Bottom of pit	+ + + +	None												1.8 Difficult to excavate	





LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°02'46"N, 132°31'48"W	ELEVATION:
DRWN. BY: A.J.B.	AIRPHOTO No.: A 12902-7	PIPE MILEAGE:
CHKD: D.D.	RIG:	AIR TEMP: Approx. 29°C
	METHOD: TEST PIT	
START: D 18 M 08 Y 75 TIME: 15:40	FINISH: D 18 M 08 Y 75 TIME: 18:40	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107B-B14-1</p> <p>SHEET 1 OF 1</p>
--	---	--

- 269 -


TEST HOLE No. N75-107B-B14-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.4	Pt		PEAT - coarse fibrous, roots		UF													
1.2	GP		GRAVEL - little coarse sand, angular pebbles to 8" x 1", cementation on gravel, grayish white boulder, rounded, 15"															
2.0	SM		SAND - medium grain, silty, brown									MA, 1.5' to 2.5' B = 35% S = 43% F = 22%	B1					
3.0			Bottom of pit															

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 66°02'37"N, 132°31'05"W	ELEVATION:
DRWN BY: F.F.B.	AIRPHOTO No.: A 12902-7	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: App to x. 27°C
	METHOD: TEST PIT	
START: D 18 M 08 Y 75 TIME: 15:30	FINISH: D 18 M 08 Y 75 TIME: 17:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B14-2

SHEET 1 OF 1

- 270 -

TEST HOLE No. N75-107B-B14-2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit ———— Liquid limit												
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2	Pt		PEAT - amorphous, fine fibrous, woody, inclusions, black		UF												14:45	
1.0	CL		CLAY, - silty, little fine sand, low to medium plastic, rust brown and mottled grey															No samples taken
1.5			peaty layers, black to dark brown															
2.0			soft, saturated															
2.5			Bottom of pit														2.5	15:00
	ICE		at depth 2.5'		ICE +													poorly drained

TEST HOLE No. N75-107B-B14-3

- 271 -

LOGGED BY: R. H.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 06° 02' 44" N, 132° 30' 23" W	ELEVATION:
DRWN. BY: A. M.	AIRPHOTO No.: A 12802-B	PIPE MILEAGE:
CHKD: B. D.	RIG:	AIR TEMP: Approx. 28°C
METHOD: TEST PIT		
START: D 18 M 08 Y 75 TIME: 14:45	FINISH: D 18 M 08 Y 75 TIME: 15:00	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

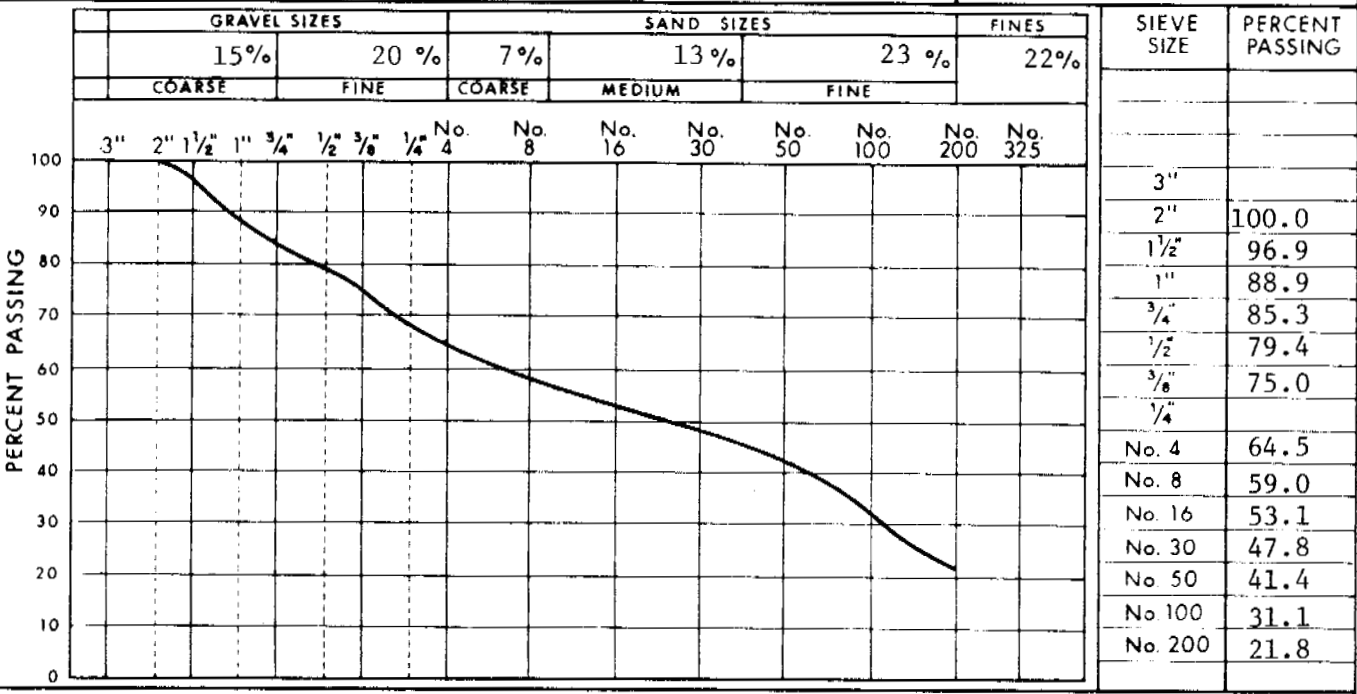
CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B14-3

SHEET 1 OF 1

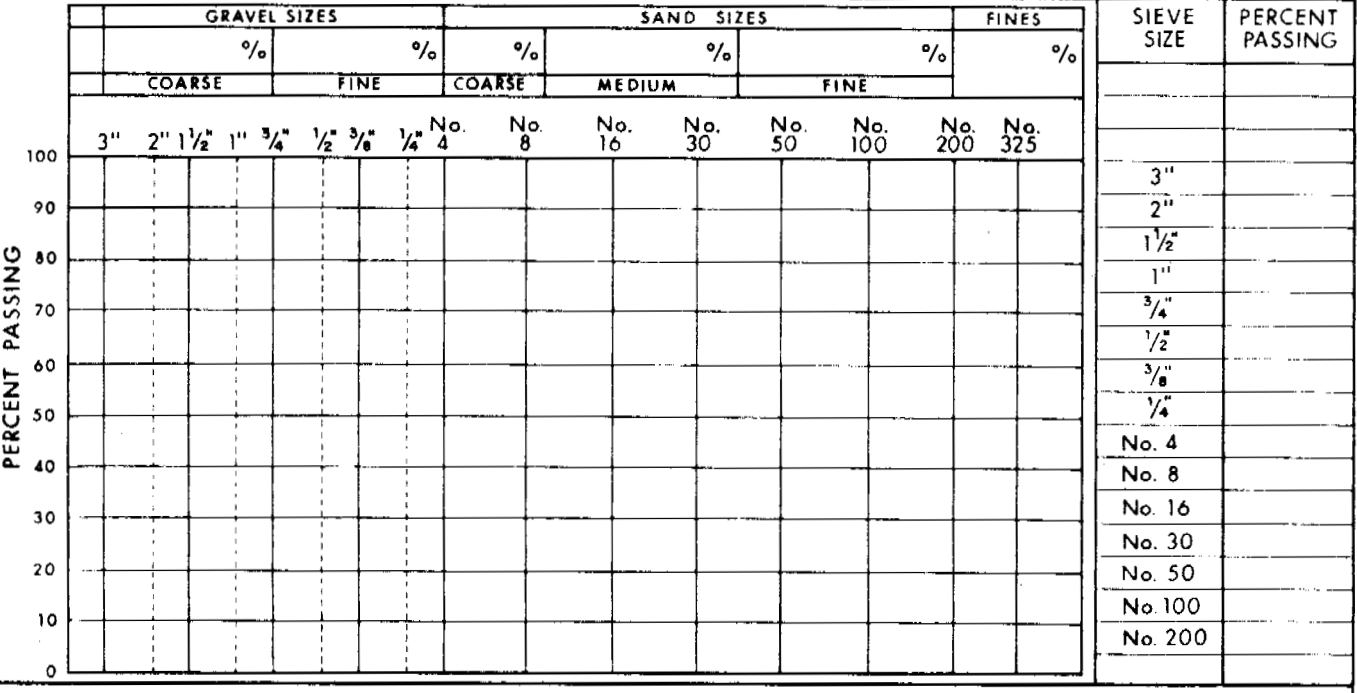
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B14-2 DEPTH 1.5-2.5 R.M.HARDY REPORT NUMBER 144
 DATE SAMPLED August 16, 1975 SAMPLED BY NESCL



COMMENTS _____ OVERSIZE (>3") = 0.0 %

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = _____ %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B14

PAGE
 272

B15-A 612810 E 7546540 N

B15-B 611870 E 7547400 N

A Project No. 13011
B Proj. Name: 1975 Pipeline Borrow Investigations
C Canadian Arctic Gas Study Ltd.
D EBA 1146 Tech ~~BD4-17~~
E Tech BD4-13

F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z

JKW
DD LPB

32'

7546540 N 612810 E
75 08 19 15:58
75 08 19 16:29

* see 1146-1

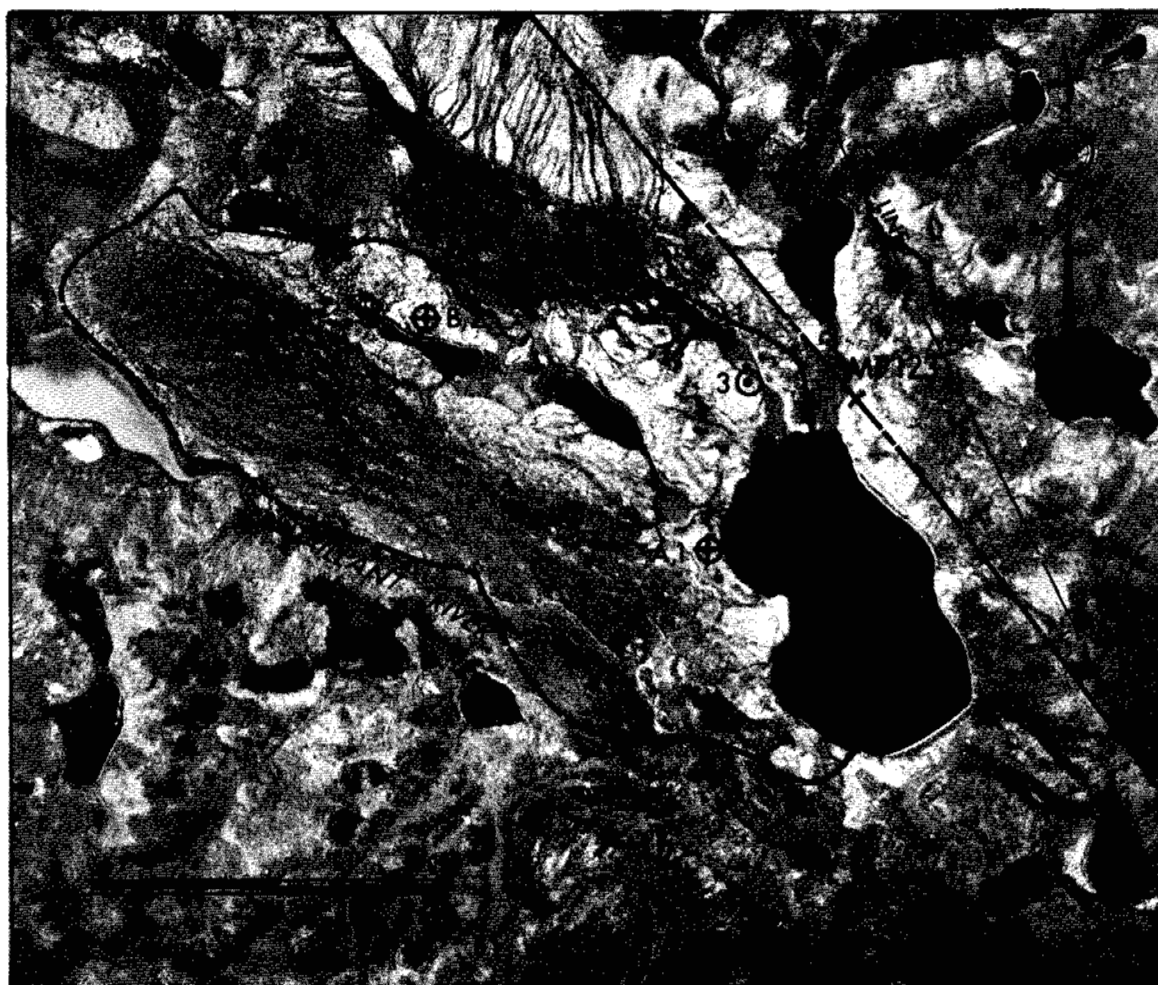
DEPOSIT 107B-B15

Physical Setting: Deposit 107B-B15 is an outwash plain located about 5.5 miles southeast of Lost Reindeer Lake and 1/2 mile west of the right of way at milepost 123.

Material: GRAVEL - fine, and sand, variable silt content.

Volume: 22,400,000 cubic yards.

Assessment: The eastern part of deposit 107B-B15 is a source of good quality granular material whereas the remainder is fair to poor quality. The material is suitable for general fill, backfill, building pads and possible concrete aggregate.



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A12760-182
Approximate Scale: 1" = 3250'

Latitude: 68° 00'
Longitude: 132° 18'

DEPOSIT 107B-B15

PHYSICAL SETTING

This deposit is an outwash plain approximately 5.5 miles southeast of the eastern most Lost Reindeer Lake and $\frac{1}{2}$ mile west of the pipeline right of way. This deposit corresponds to source number 1146 in EBA DIAND Granular Materials Inventory Volume IV (1974) report.

The outwash plain has a very gentle southern slope with a few channels and lakes inset 10 to 20 feet below its surface. Overburden of peat and icy organic silt varies between 1 and 10 feet and is thinnest in the southern section. Drainage varies from moderately good to imperfect on the outwash plain itself and is poor in the inset channels. The active layer is generally less than 2.5 feet and the frozen material below has low to moderate amounts of ice. The outwash material is underlain by clay with massive ice. Terrain between the deposit and pipeline right of way consists of an imperfectly drained, gently sloping till plain.

BIOLOGICAL SETTING

Vegetation on this plain consists of black spruce with an understory of willow and labrador tea and a ground cover of lichen. The site is located in good reindeer and caribou winter range. Ungulate sign was observed in the area, including a well-worn trail along the lakeshore. The area is good potential marten habitat although no furbearers were seen. Grizzly and black bear are found occasionally throughout the area. The adjacent lake is utilized by waterfowl throughout the open-water season. Ptarmigan winter in the area and a wide range of passerines occurs. The lake and associated Travailant River system support several fish species including humpback whitefish, ninespine stickleback, long-nose suckers, Arctic grayling and pike.

MATERIAL

Drill holes, test pits and the DIAND report show this deposit consists of 15 to 20 feet of gravel and sand. Gravels are generally fine, silty, sandy and poorly graded. The fine to medium grain sized sand has variable amounts of silt and gravel. Massive ice was encountered at shallow depths (1 to 2 feet) in test pits 107B-B15-2 and 107B-B15-4.

VOLUME

A total estimated volume based on 1390 acres and 20 foot thickness over half the area is 22,400,000 cubic yards. This volume would be reduced to 7,000,000 cubic yards if development is restricted to areas of shallow overburden.

DEVELOPMENT AND REHABILITATION

Portions of deposit 107B-B15 are a source of good quality granular material, the remainder of the deposit being fair to poor quality material. The eastern portion of the deposit appears to be the best part to develop, as drill hole and test pit data indicates thick overburden and massive ice exist in the western portion. Material from this deposit would be suitable for general fill, backfill in pipeline construction, building pads, and possibly concrete aggregate.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit would probably be achieved along the pipeline right of way. From the pipeline right of way to the deposit a 0.5 mile snow road over gentle to moderate slopes would probably be used.

The vegetation would be removed and disposed of in accordance with land use regulations. The peat cover and overburden would then be stripped from the area to be excavated, and stockpiled around the perimeter of the site.

Development of this deposit would involve extensive drilling and test pitting to locate areas of better quality material with the least amount of overburden. Excavations would then proceed over these areas and involve removing borrow material evenly from the better quality areas. Proper drainage would have to be maintained and sufficient cover left over areas with massive ice. This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing, and concrete plants if required.


A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						Dry density (pcf)			Water content %									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.2			PEAT- woody, fibrous, roots															
1.5			SILT- trace sand, low plastic, light brown.		WF													4 1/2" Walmac bit 15:58
2.5			SAND- medium coarse, silty, some fine to medium gravel		F													
8.5			GRAVEL- fine, silty, occasional coarse, pebbles subrounded to sub angular to 3", few platy pieces, few pebbles to 1.5".															3 7/8" Walmac bit 15:58

LOGGED BY: J.K.W	FACILITY:	PROJECT: 13811
CHKD: B.B.	LAT. & LONG: 69°00'13"N, 132°17'57"W	ELEVATION:
DRWN. BY: J.K.W	AIRPHOTO No.: A 12700-102	PIPE MILEAGE:
CHKD: B.B.	RIG: MELI-BRILL	AIR TEMP: 18°C
	METHOD: AIR	
START: D 18 M 08 Y 75 TIME:	FINISH: D 18 M 08 Y 75 TIME:	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B15-A
SHEET 1 OF 2

- 278 -
 TEST HOLE No. N75-107B-B15-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
16.0	SP		SAND - coarse,		Vx													
17.0																		
18.0	SM		SAND - very fine, silty, grey		Ndb												16:10	
23.0																		
24.0	ICE		ICE clear		ICE													
30.0	CI		CLAY - medium plastic, grey.		Vx Vr													
32.0			End of hole														loss of circulation 18:29	

- 279 -

TEST HOLE No. N75-107B-B15-A

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13013
CHKD: D.D.	LAT. & LONG: 88°00' 13"N, 132° 17' 57"W	ELEVATION:
DRWN BY: J.K.W.	AIRPHOTO No.: A 12700-182	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-DRILL	AIR TEMP: 10°C
	METHOD: AIR	
START: D 19 M 08 Y 75 TIME: 15:56	FINISH: D 19 M 08 Y 75 TIME: 16:29	

1975 BORROW INVESTIGATION

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B15-A

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.2	PL		PEAT - fibrous, woody inclusions, dark brown		UF													
0.5																		
2	ML		SILT - trace fine sand, occasional fine gravel, low plastic, pebbles to 1/2".		Vr in Nbr													4 1/2" Walmac bit 14:38
4.0	OL		SILT - (organic) black ice rich		Nbr occ. Vx													
9.0	GP to GM		GRAVEL - fine, sand, medium to coarse, occasional coarse gravel, pebbles sub angular to sub rounded to 3/4", increasing silt with depth.		F													3 7/8" Walmac bit 14:45

- 280 -

TEST HOLE No. N75-107B-B15-B

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 88°00'51"N, 132°19'47"W	ELEVATION:
DRWN. BY: A.N.	AIRPHOTO No.: A 12780-182	PIPE MILEAGE:
CHKD: R.N.	RIG: HELL-DRILL	AIR TEMP: 10°C
	METHOD: AIR	
START: D 19 M 08 Y 75 TIME: 14:38	FINISH: D 19 M 08 Y 75 TIME: 15:18	

<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107B-B15-B</p> <p>SHEET 1 OF 2</p>
--	---

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC ICE TYPE	VISUAL ICE %	Plastic limit		Liquid limit								
					40	60	80	100	120	140	▲						
					0	20	40	60	80	100	○						
18	GP to BM		GRAVEL - (cont'd) gets dirtier with depth		F											14:50	
21.0			appears finer														
26.0	CI		CLAY - medium plastic, grey													28.0	Loss of circulation 3 7/8" Walmac bit 15:00
28.0			End of hole													15:18	

- 281 -

D₂

TEST HOLE No. N75-107B-B15-B


LOGGED BY: J.K.W	FACILITY:	PROJECT: 13011	 1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: D.O.	LAT. & LONG: 88°00'51"N, 132°18'47"W	ELEVATION:		N75-107B-B15-B
DRWN. BY: J.K.W	AIRPHOTO No.: A 12700-102	PIPE MILEAGE:		
CHKD: R.H.	RIG: HELY-DRILL	AIR TEMP: 10°C		
	METHOD: AIR			
START: D 19 M 08 Y 75 TIME: 14:39	FINISH: D 19 M 08 Y 75 TIME: 15:18			SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt		PEAT - amorphous, fine fibrous, spongy, dark brown, silty (organic) black, wet		UF												15:15	
0.8																		
2.0	SM		SAND - medium grain, silty, some gravel, subangular to 1", brown, till-like (frequent ice pockets to 2") medium, coarse, fine, some fine to coarse gravel, little silt, pebbles rounded to 3/8"		Nbe Nbe occ. Vx 5							MA, sample 1 G = 28% S = 57% F = 15%	B1				1.5	
3.8			pebbles, angular to 1"									MA, combined samples 2 & 3 G = 28% S = 60% F = 14%	B2				2.5	
5.0			Bottom of pit										B3				3.5	
																	4.5	
																	5	
																	17:00	

LOGGED BY: R.H.	FACILITY:	PROJECT: 130 31
CHKD: R.H.	LAT. & LONG: 68°00'13"N, 132°17'57"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 12760-182	PIPE MILEAGE:
CHKD: D.D.	RIG:	AIR TEMP: Approx. 18°C
	METHOD: TEST PIT	
START: D 19 M 08 Y 75 TIME: 15:15	FINISH: D 19 M 08 Y 75 TIME: 17:00	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B15-1

SHEET 1 OF 1

- 282 -

TEST HOLE No. N75-107B-B15-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	Pt SM	1.2 1.2	PEAT - amorphous, fine fibrous, spongy, dark brown SAND - medium grain, silty, wet		UF												13:25 No samples taken	
2	ICE + DL		ICE with SILT (organic), nonplastic, black		ICE +													
3		3.0	Bottom of pit													3.0	15:00	

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°00'51"N, 132°19'47"W	ELEVATION:
DRWN BY: A.W.	AIRPHOTO No.: A 12760 - 182	PIPE MILEAGE:
CHKD: B.D.	RIG:	AIR TEMP: approx. 18°C
	METHOD: TEST PIT	
START: D 19 M 08 Y 75 TIME: 13:25	FINISH: D 19 M 08 Y 75 TIME: 15:00	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-107B-B15-2</p> <p>SHEET 1 OF 1</p>
--	---	---

- 283 -

TEST HOLE No. N75-107B-B15-2


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.3	Pt		PEAT - amorphous, fine fibrous, woody inclusions, dark brown		UF													
1.7	CI		CLAY - medium plastic, brown, soft															
1.7	SM		SAND - medium grain, silty, trace gravel, brown, pebbles rounded to 3/8"															
2.8																		
3.0			Bottom of pit		F													
3.0																		

No samples taken

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°00'38" N, 132°17'37" W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 12700-182	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 16°C
	METHOD: TEST PIT	
START: D 19 M 08 Y 75 TIME:	FINISH: D 19 M 08 Y 75 TIME:	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-107B-B15-3

SHEET 1 OF 1

- 284 -

TEST HOLE No. N75-107B-B15-3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.5	Pt		PEAT - amorphous, fine fibrous, woody inclusions, black, spongy		UF												13:25	
1.25	CL		CLAY - trace fine sand, brown, damp, soft, peaty layers, black															No samples taken
2.1	ICE + DL		ICE with SILT (organic), non-plastic, black, trace organic inclusions, clear ice about 75%. candled?		ICE +												14:10	
4.0			Bottom of pit														14:40	Poorly drained

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°01'19"N, 132°20'32"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 12760-182	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 16°C
METHOD: TEST PIT		
START: D 19 M 08 Y 75 TIME: 13:25	FINISH: D 19 M 08 Y 75 TIME: 14:40	

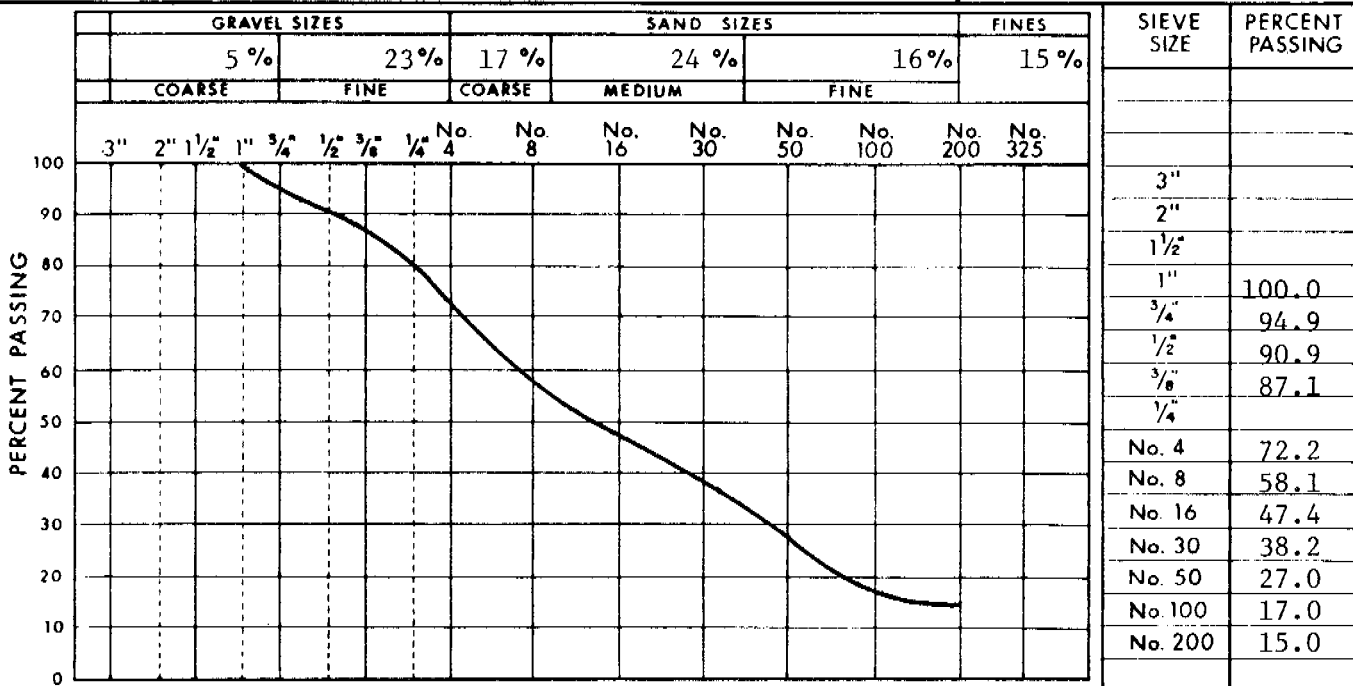
1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-107B-B15-4 SHEET 1 OF 1
---	--

- 285 -

TEST HOLE No. N75-107B-B15-4

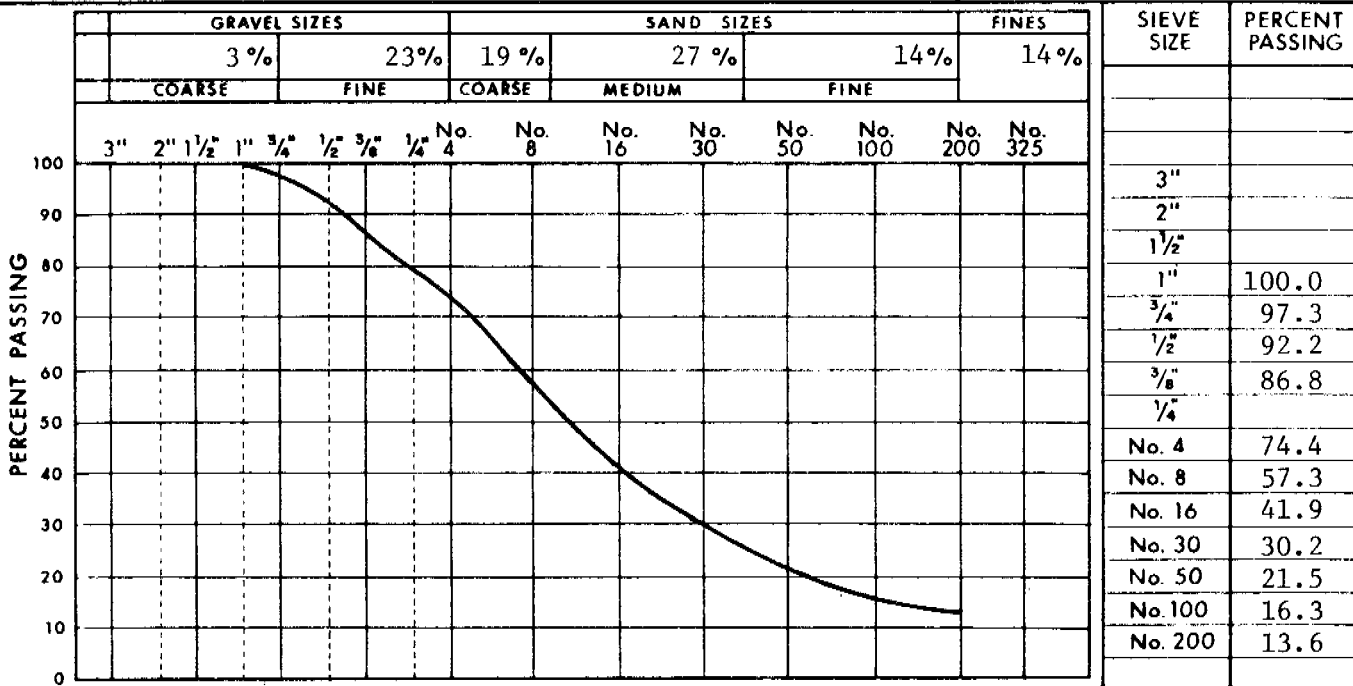
SIEVE ANALYSIS REPORT

SAMPLE N75-107B-B15-1 DEPTH 1.5-2.5 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 19, 1975 SAMPLED BY NESCL 151



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-107B-B15-1 DEPTH 2.6-4.5 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 19, 1975 SAMPLED BY NESCL 152



COMMENTS OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-107B-B15

DEPOSIT 107B-B16(R)

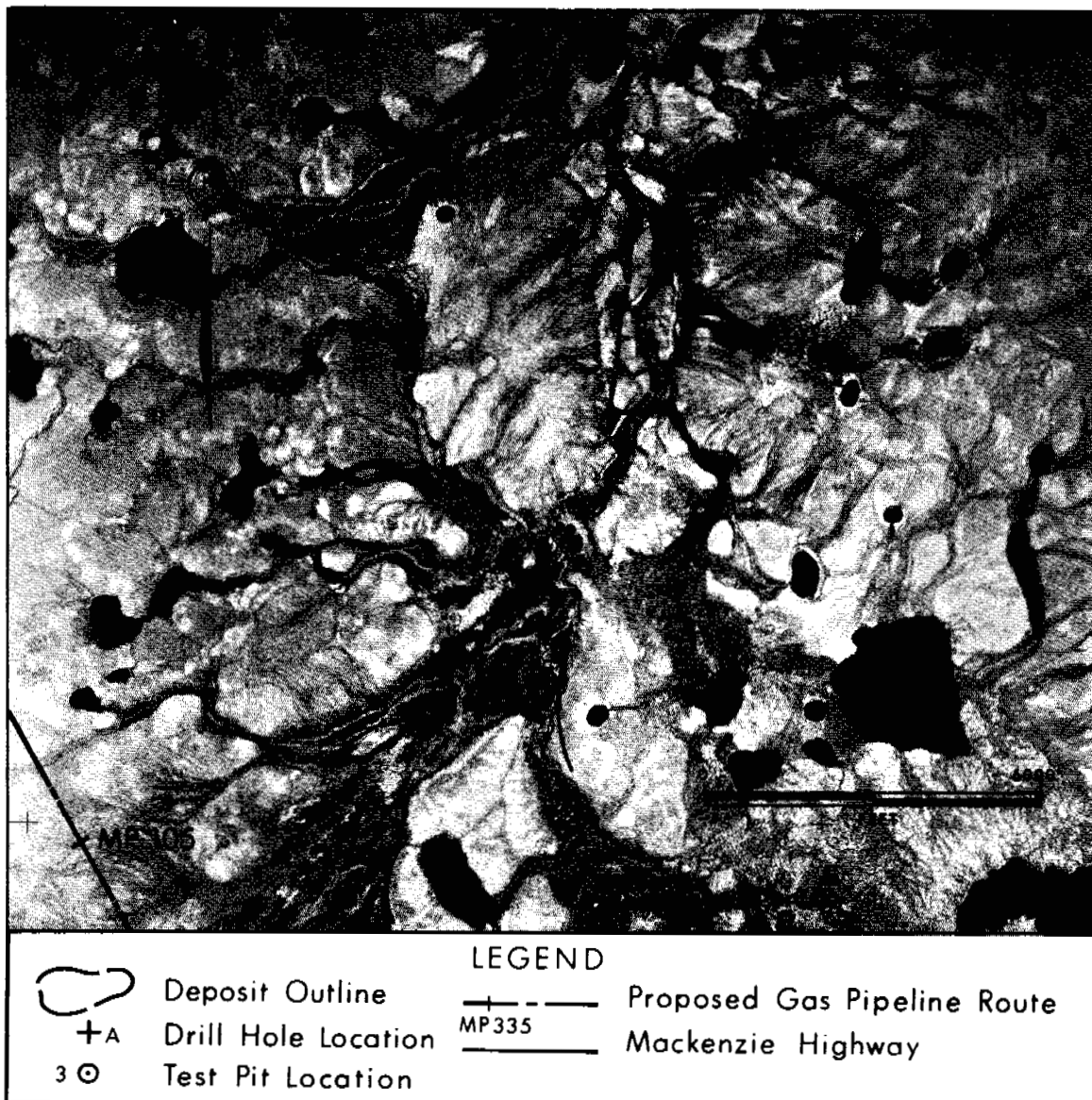
out of study
area

Physical Setting: Deposit 107B-B16(R) is a fluvial terrace located on the west side of Miner River and is approximately 2.5 miles east of milepost 104 of the proposed pipeline right of way.

Material: GRAVEL - silty, and rich in shale fragments.

Volume: 400,000 cubic yards.

Assessment: Deposit 107B-B16(R) is not recommended for development because it consists of poor quality material.



Airphoto No. A12902-13
Approximate Scale: 1" = 3250'

Latitude: 68° 36'
Longitude: 132° 15'

DEPOSIT 107B-B16(R)

PHYSICAL SETTING

This deposit is a fluvial terrace on the west side of Miner River. It is approximately 2.5 miles east of milepost 104 on the proposed pipeline right of way.

The terrace slopes gently to the north except for a couple of minor swales which drain east to the Miner River. The site is moderately well drained, has moderate to high ice content, and overburden may be up to 10 feet thick.

Terrain between the pipeline and the deposit is rolling to hummocky moraine which is moderately well drained except in depressions.

BIOLOGICAL SETTING

This terrace is covered by dwarf birch, ericaceous shrubs, sedges, and lichens. Upland areas provide good quality reindeer and caribou habitat. Riparian areas provide moderately productive habitat for fox, wolf, bear and moose. There is little suitable habitat for muskrat and beaver. Swans were observed nesting along the Miner River. No other suitable waterfowl habitat is present at the site. The Miner River is used by grayling for spawning, rearing, and possibly over-wintering. Lakes and the headwaters of the Miner River support grayling, pike, and whitefish populations.

MATERIAL

Gravel exposed in the river bank is very silty and rich in shale fragments. This composition suggests overall poor quality gravel for construction purposes.

VOLUME

Deposit 107B-B16(R) covers an area of about 50 acres and has a total estimated volume of 400,000 cubic yards based on a thickness of 10 feet.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B16(R) is a source of poor quality granular materials and the site is not recommended for development. Material is of poor quality and therefore of little use for construction materials. The possibility of thick overburden and moderate to high ice contents also make this deposit unfavourable for development. This deposit was only investigated on a field reconnaissance basis.

out of study area.

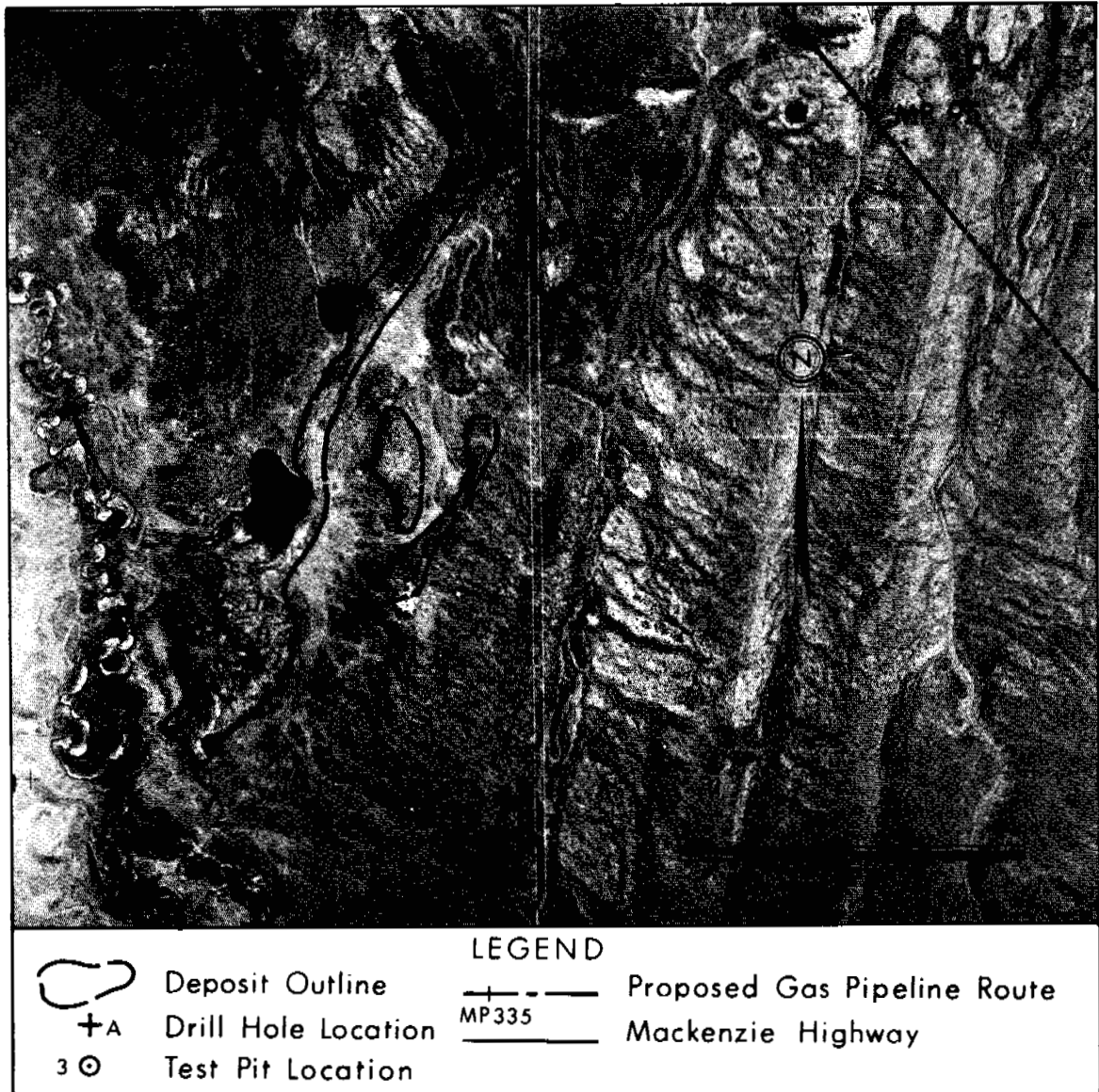
DEPOSIT 107B-B17(R)

Physical Setting: Deposit 107B-B17(R) is part of an esker complex located 7.5 miles east of Campbell Lake and 2 miles west of milepost 94 of the proposed pipeline right of way.

Material: SAND - fine.

Volume: 4,000,000 cubic yards.

Assessment: Deposit 107B-B17(R) is considered a source of poor quality granular material since it is composed of fine sand with a high ice content. It is therefore not recommended for development.



Airphoto No. A12861-277
Approximate Scale: 1" = 3150'

Latitude: 68° 19'
Longitude: 133° 00'

DEPOSIT 107B-B17(R)

PHYSICAL SETTING

This deposit is part of an esker complex located 7.5 miles east of Campbell Lake and 2 miles west of milepost 94 on the proposed pipeline right of way. Deposit 107B-B10 is also a part of this same complex. The Ripley, Klohn, Leonoff DIAND Granular Materials Inventory Zone IV-VI (1972) report identifies this source as number 450.

The crest of the esker complex is gently rolling and rises 30 to 100 feet above the surrounding terrain. Ridge crests are 200 feet or more across with steeply sloping sides. The site is moderately well drained and overburden is minimal, rarely exceeding 1 foot.

Terrain between the deposit and pipeline right of way is mainly imperfectly drained morainic plain with a thin cover of lacustrine sediments.

BIOLOGICAL SETTING

The majority of the esker complex is covered by mixed black spruce and birch up to 30 feet in height. Shrubs up to 4 feet in height are common in the understory with a ground cover of mosses and lichens. The area provides low productivity habitat for fox, wolf and snowshoe hare. The site lies within the winter range of the Mackenzie Reindeer Herd and also supports caribou. Streams, ponds, and lakes in the vicinity are used throughout the open-water season by a wide range of waterfowl and shore birds.

MATERIAL

The DIAND report indicates that this deposit is primarily fine sand with low to moderate ice content at the surface. Sands do contain a small amount of gravel, but in general this is poor quality material. Ice lenses are present at depth.

VOLUME

The total estimated volume, based on an area of 180 acres and an average depth of 30 feet, is 4,000,000 cubic yards over half the area. Only a portion of this volume may be readily accessible.

DEVELOPMENT AND REHABILITATION

Deposit 107B-B17(R) is a source of poor quality granular materials because it is primarily sand and has ice lenses immediately below the active layer. Therefore, it is not recommended for development because better material exists in deposits 107B-B10 and 107B-B11. This site could be developed for use as marginal fill if a shortage of granular material results in this area. This assessment is based only on a field reconnaissance of the deposit.

106N - B1-A 617100E 7540480N

X ref EBA 1141
Tech BD4-30

see site #1142

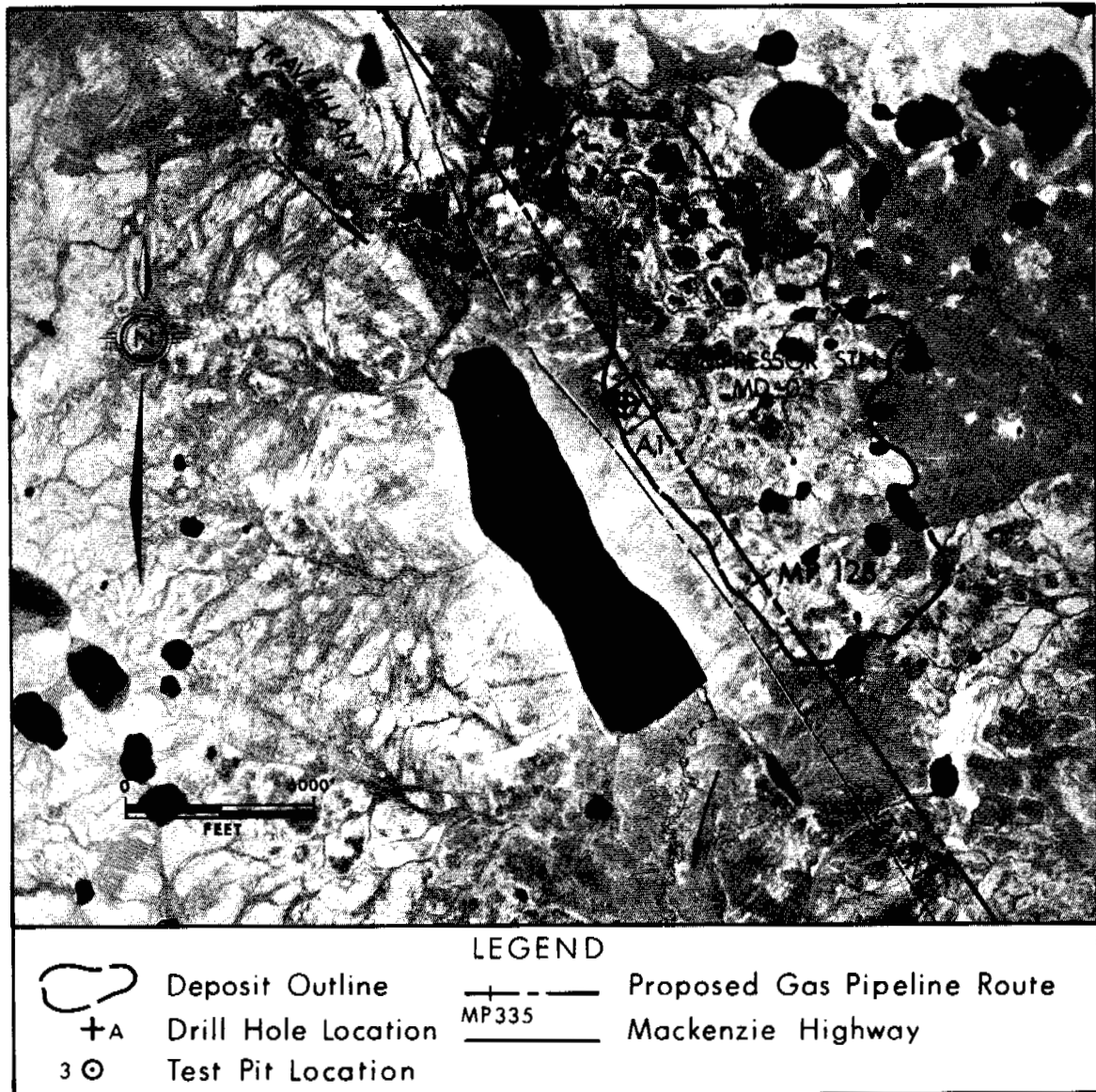
DEPOSIT 106N-B1

Physical Setting: Deposit 106N-B1 is a till covered area one half mile northeast of Fish Trap Lake at milepost 126 of the proposed gas pipeline right of way.

Material: TILL

Volume: No granular materials volume.

Assessment: Deposit 106N-B1 is not recommended for development either as a granular or a general fill borrow source because of poor material quality.



Airphoto No. A12583-30
Approximate Scale: 1" = 5700'

Latitude: 67° 57'
Longitude: 132° 12'

DEPOSIT 106N-B1

PHYSICAL SETTING

Deposit 106N-B1 is a till covered area one half mile northeast of Fish Trap Lake on or adjacent to the pipeline alignment near mile 126.

The slopes adjacent to Fish Trap Lake are moderately steep and lead up to a rolling morainic area. Drainage over the site is moderate, the overburden is thin, and ice content is high.

BIOLOGICAL SETTING

This site supports scattered black spruce with an understory of dwarf birch, willow and lichen. Moose use the area but the population is low. The area provides good marten habitat and marten sign was observed during the 1975 survey. Grizzly and black bear are occasionally present in the area. A limited number of waterfowl use Fish Trap Lake throughout the open-water season. There was no evidence of raptors in the area during the 1975 survey. Pike have been identified in Fish Trap Lake and it is likely that other species including humpback whitefish, grayling, burbot and lake trout, which are found in other lakes of the Travaillant Lake river system, are also present in the lake.

MATERIAL

Material in this deposit is till with a low pebble content.

VOLUME

There is no granular material available from this area. Unlimited poor quality fill would be available if this type of material was suitable for construction.

DEVELOPMENT AND REHABILITATION:

Deposit 106N-B1 consists of glacial till with high ice content and no granular material. It is not recommended for development either as a source of granular or general fill.


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	CI		CLAY - silty, occasional coarse sand, medium plastic, grey, soft		UF												2.0	4 1/2" insert bit 18:18
2																	2.8	
4																	5.0	
6																	6.5	
7.0	ML		SILT - gravelly, pieces shale, low plastic		Ys												11.9	18:21
13.0					?												12.3	
14	ICE + ML		ICE with silt inclusions		ICE +													
15.0																		
16	ICE + CI		ICE with clay inclusions															
17.0																		
18	CI - CH		CLAY - trace gravel (shale), medium to high plastic, saturated when thawed		Vx												17.8	
19.0			End of hole														18.5	18:55
																	19.0	

- 299 -

TEST HOLE No. N75-108N-B1-A

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT & LONG: 87°57'30"N, 132°12'19"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 12583-30	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 13°C
	METHOD: AIR	
START: D 19 M 08 Y 75 TIME: 18:19	FINISH: D 19 M 08 Y 75 TIME: 18:55	

 <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-108N-B1-A</p> <p>SHEET 1 OF 1</p>
---	---	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.5	Pt		PEAT - spongy, dark brown, woody inclusions		UF													No samples taken
1.0	Cl		CLAY - medium plastic, brown, trace gravel (< 5%)		Mbe													
2.5			Bottom of pit															
			Note: Granular material not encountered in adjacent drillhole															Poorly drained, flat

TEST HOLE No. N75-106N-B1-1

- 300 -

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°57'30"N, 132°12'19"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 12563-30	PIPE MILEAGE:
CHKD: D.D.	RIG:	AIR TEMP: Approx. 16°C
METHOD: TEST PIT		
START: D 19 M 08 Y 75 TIME: 18:30	FINISH: D 19 M 08 Y 75 TIME: 19:30	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106N-B1-1

SHEET 1 OF 1

106 N - B2 - A	623680 E	7533740 N
106 N - B2 - B	622800 E	7533900 N
106 N - B2 - C	623440 E	7534360 N

106 N

623 440 E

7534360 N

See site #1141

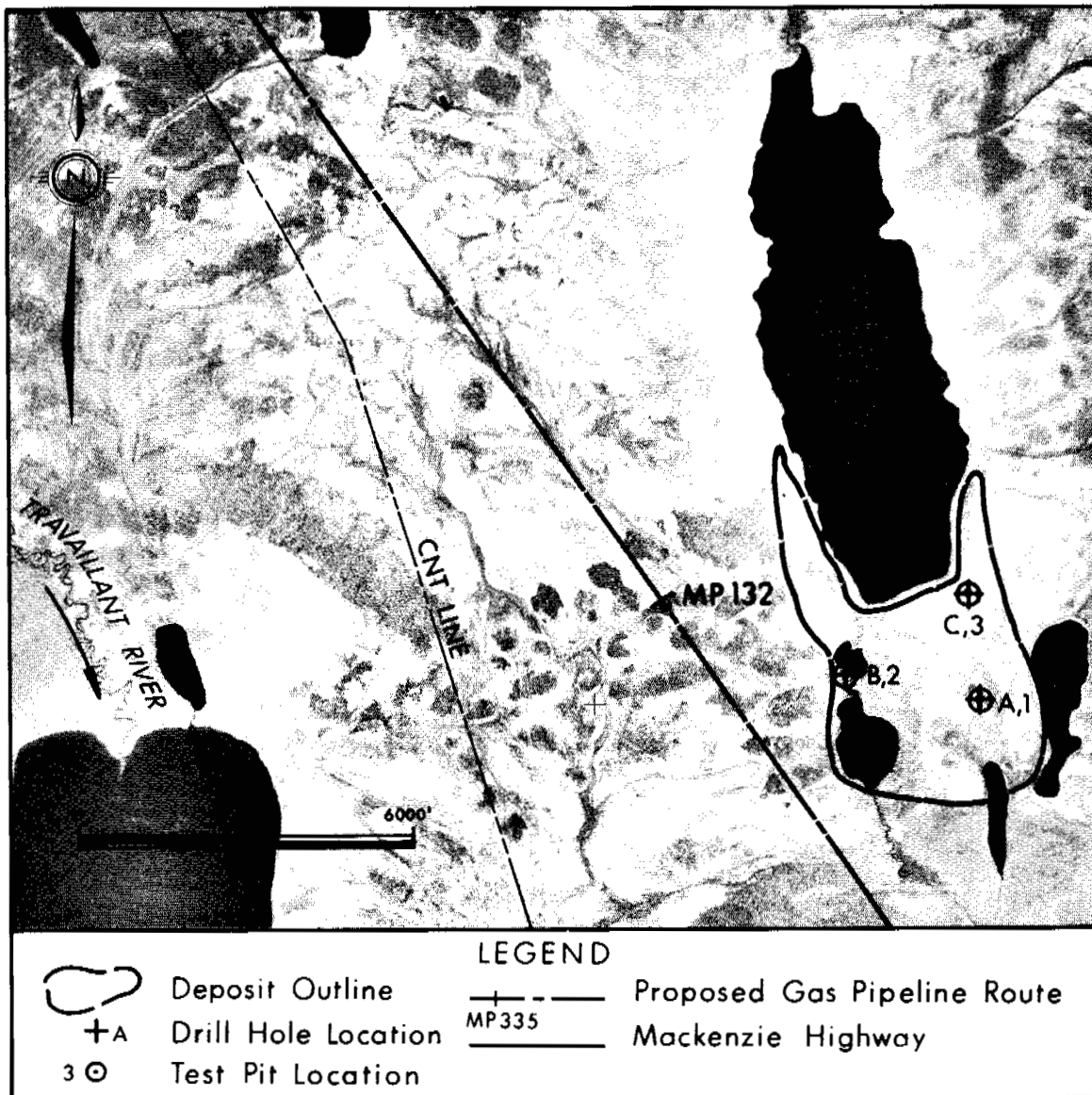
DEPOSIT 106N-B2

Physical Setting: Deposit 106N-B2 is a small outwash plain located 5 miles southeast of Fish Trap Lake and is close to the right of way.

Material: GRAVEL - well graded with some coarse sand.

Volume: 2,000,000 cubic yards.

Assessment: Deposit 106N-B2 is a source of fair to good quality granular material suitable for general fill, backfill and building pads. Access will involve crossing a small creek.



Airphoto No. A12697-6
Approximate Scale: 1" = 3250'

Latitude: 67° 53'
Longitude: 132° 04'

DEPOSIT 106N-B2

PHYSICAL SETTING

This deposit is a small outwash plain at the southern end of a small lake. It is about 5 miles southeast of Fish Trap Lake and the proposed pipeline right of way passes near the southwest corner of the deposit. This deposit corresponds to source number 1141 in the EBA DIAND Granular Materials Inventory Volume IV (1974) report.

The plain is about 3000 feet square with two narrow fingers extending part way along the sides of the lake. It has a gently undulating surface with local relief of 5 to 10 feet. A few small hills and scarps are moderately well drained, while the flatter areas and depressions are imperfectly to poorly drained. Overburden is generally less than 2 feet thick but may be thicker in low-lying areas. The depth of the active layer is about 1 foot in peat covered areas and more than 3 feet where cover is negligible. The deposit has a low ice content.

BIOLOGICAL SETTING

Vegetation on the small hills and slopes consists of black spruce up to 30 feet in height and ground cover of Labrador tea, cloudberry, blueberry and lichen. The poorly drained depressions and flat areas have a well developed peat layer covered with sedges and mosses. The site is located in good caribou habitat. An old beaver lodge was found in a small lake adjacent to the site. Evidence of trapping activity in the form of an old marten dead-fall trap was found. Grizzly and black bear are found occasionally throughout the area. The small ponds and lakes in the area provide suitable habitat for waterfowl. None of the adjacent water bodies appear to provide suitable fish habitat.

MATERIAL

Drill holes, test pits and the DIAND report show the outwash consists of well graded, rounded gravel from 2 to 10 feet thick. Some coarse sand,

a trace of silt and occasional cobbles and boulders are also present. One to 3 feet of peat, organic silt and ice cover the gravel which is underlain by lacustrine clay.

VOLUME

The total estimated volume, based on an area of 290 acres and average depth of 5 feet, is 2,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106N-B2 is a source of fair to good quality granular materials. Areas to be exploited would be dictated by insitu material quality and depth of overburden. Granular material from this deposit may be used for general fill, backfill in pipeline construction and building pads.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access from the deposit to the right of way is about 1500 feet across a creek and care should be taken not to disrupt drainage and cause siltation in this creek. A snow road would be built to transport the borrow material over this distance from the deposit to haul points on the right of way. Initially trees and other vegetation covering the area of excavation and access road would be harvested and/or disposed of in accordance with land use regulations. The peat cover and overburden then would be stripped from the area to be excavated, and stockpiled around the edge of the site.

Development of this deposit would involve excavating borrow material evenly from the higher, better drained areas to a grade such that

drainage is comparable to drainage before any excavation took place. The gravel is not deep and shallow excavations over large areas would take place. Care would be taken to avoid siltation of the lakes in the area. This type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation. The excavated material may have to be stockpiled, thawed, and drained before it is used. Natural mixing during excavation would be adequate to obtain good gradations.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, and crushing plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt		PEAT- fine fibrous, amorphous, woody inclusions, light brown becoming darker with depth		UF												4 1/2" Naimc bit 20:05	
2.5	GM		GRAVEL- fine, silty, sand, medium to coarse, pebbles angular and subangular to 3/4"		Yc												4 1/2" insert bit	
4.5	CI		CLAY- medium plastic, grey, moist when thawed		Yx												21:04	
13.0			End of hole		15												Loss of circulation 21:10	

A
 C
 D₂
 - 306 -
 TEST HOLE No. N75-106N-B2-A

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No. N75-106N-B2-A
CHKD: D.O.	LAT. & LONG: 87°53'43"N, 132°04'38"W	ELEVATION:		
DRWN BY: A.W.	AIRPHOTO No: A 12697-6	PIPE MILEAGE:	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	SHEET 1 OF 1
CHKD: D.O.	RIG: MELI-DRILL	AIR TEMP: 18°C		
METHOD: AIR				
START: D 19 M 08 Y 75	TIME: 20:55	FINISH: D 19 M 08 Y 75	TIME: 21:10	
CANADIAN ARCTIC GAS STUDY LIMITED				


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %	▲ Dry density (pcf)			○ Water content %							
					40	60	80	100	120	140 ▲	Plastic limit ————— Liquid limit							
					0	20	40	60	80	100 ○								
0.2	Pt		PEAT - fine fibrous, amorphous, black.	UF														4 1/2" Walmac bit 12:20
1.5	ML		SILT - some very fine sand trace cm sand. Low to non plastic, grey to slightly brown, transitional with below.	Ys														4 1/2" insert bit
6	CI		CLAY - silty, trace cmf sand, medium to low plastic, grey.															12:27
15.0			End of hole															Loss of circulation 12:58

- 307 -

TEST HOLE No. N75-106N-82-B

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°53'38"N, 132°03'28"W	ELEVATION:
DRWN. BY: K.W.	AIRPHOTO No.: A 32897-6	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 18°C
	METHOD: AIR	
START: D 20 M 08 Y 75 TIME: 12:20	FINISH: D 20 M 08 Y 75 TIME: 12:58	


 <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-106N-82-B</p> <p>SHEET 1 OF 1</p>
---	---	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt		PEAT - fine, amorphous, woody inclusions, black															
2.0	SM		SAND - medium grained, silty, very gravelly, occasional cobbles, sub rounded to 6", dark brown		UF												dug hole to 3.5' to facilitate drilling 19:55 4 1/2" Walmac bit	
3.5	GM		GRAVEL - fine, silty, sand, medium coarse, occasional coarse gravel, pebbles sub-angular to sub rounded to 2.0"		F													
10.0	CI-CH		CLAY - medium to high plastic, damp to moist when thawed, grey		Nbn													
11.0			End of hole														Loss of circulation 20:28	

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 130 11
CHKD: D.O.	LAT. & LONG: 87°53'58"N, 132°03'41"W	ELEVATION:
DRWN. BY: X.M.	AIRPHOTO No.: A 12887-B	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 16°C
	METHOD: AIR	
START: D 19 M 08 Y 75 TIME: 19:55	FINISH: D 19 M 08 Y 75 TIME: 20:28	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106N-B2-C

SHEET 1 OF 1

- 308 -

TEST HOLE No. N75-106N-B2-C

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt		Moss cover PEAT - dark brown, spongy		UF														
1	Pt + DL		PEAT and SILT (organic) black		Nbe														
2	ICE + Pt		ICE and PEAT, black		ICE +														
3			GRAVEL - fine to coarse, some sand, little fines, pebbles rounded to 3"		Nbn							NA, combined, samples 1 - 3 G = 89% S = 20% F = 11%					3.3		
4			4.5 --- occasional granitic pebble rounded to 2"															4	20:00
5			5.0 Bottom of pit															5	20:45

- 309 -

TEST HOLE No. N75-106N-B2-1

LOGGED BY: R.H.	FACILITY:	PROJECT: 130 11
CHKD: R.H.	LAT. & LONG: 67°53'43" N, 132°04'38" W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 12697-6	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 10°C
	METHOD: TEST PIT	
START: D 19 M 08 Y 75 TIME: 17:30	FINISH: D 19 M 08 Y 75 TIME: 20:45	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106N-B2-1
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt		PEAT - amorphous, fine fibrous, dark brown, spongy		UF												12:10	No samples taken
0.6																		
	ML		SILT - some very fine sand, non-plastic, brown ice to ¼" at approx. 1.2 1" spacing, clear, candled		VS 15												12:30	
1.5																		
			Abandoned															
			Note: Drillhole N75-106N-B2-B on this site, did not encounter gravel to the depth drilled															

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°53'38" N, 132°03'28" W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 12697-8	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 22° C
	METHOD: TEST PIT	
START: D 20 M 08 Y 75 TIME: 12:10	FINISH: D 20 M 08 Y 75 TIME: 12:30	

1975 BORROW INVESTIGATION	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No.
CANADIAN ARCTIC GAS STUDY LIMITED		N75-106N-B2-2
		SHEET 1 OF 1

- 310 -

TEST HOLE No. N75-106N-B2-2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt		PEAT - dark brown to black, spongy, roots		UF													
1.4	GM		GRAVEL - silty, brown, pebbles rounded to 3"															
2.8	GM		GRAVEL - coarse to fine, some coarse to fine sand, trace silt, brown, cobbles rounded to 7"															
3.0			--- boulder to 18" diameter															
4.0			Bottom of pit															
			Excavated into corner of test pit to obtain a sample from 3' - 4'															

NA, combined samples 1 - 3
G = 70%
S = 25%
F = 5%
oversize = 11.8%

B1
B2
B3

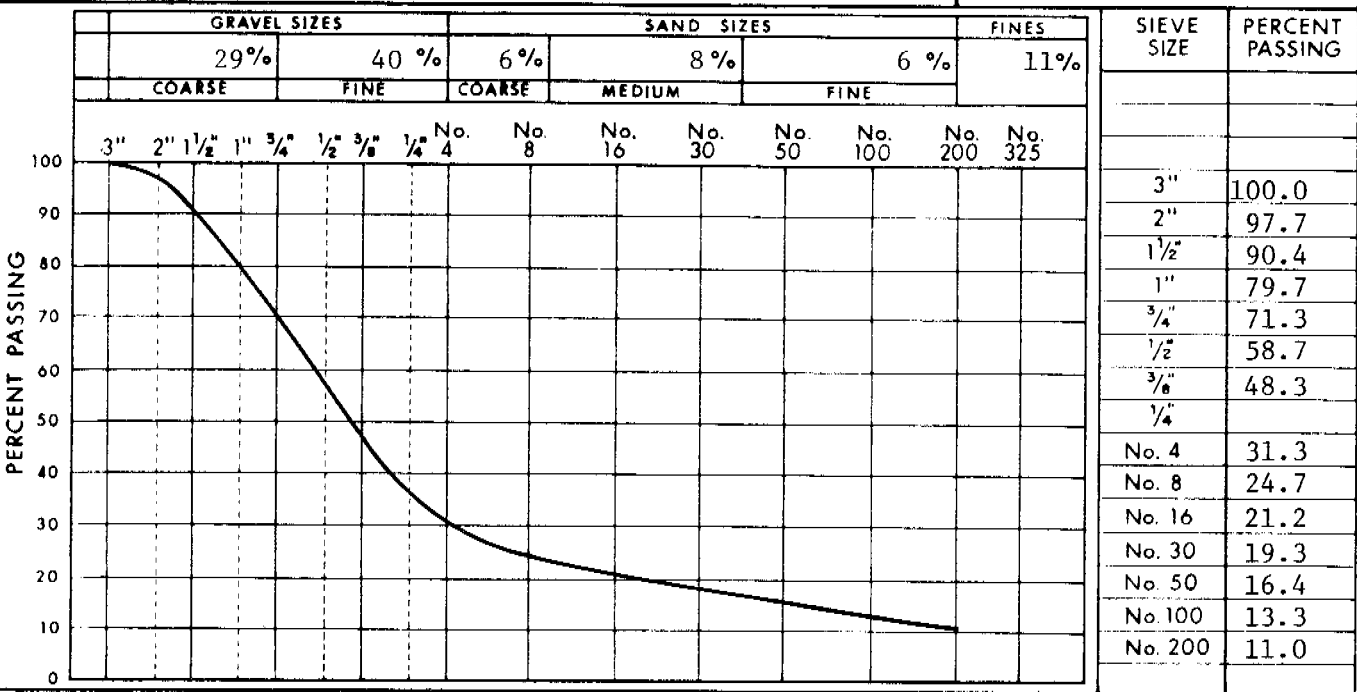
TEST HOLE No. N75-106N-B2-3

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°53'58"N, 132°03'41"W	ELEVATION:
DRWN BY: F.F.B.	AIRPHOTO No.: A 12887-6	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 18 M 08 Y 75 TIME: 20:00	FINISH: D 18 M 08 Y 75 TIME: 21:15	

1975 BORROW INVESTIGATION	TEST HOLE No.
NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-106N-B2-3
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

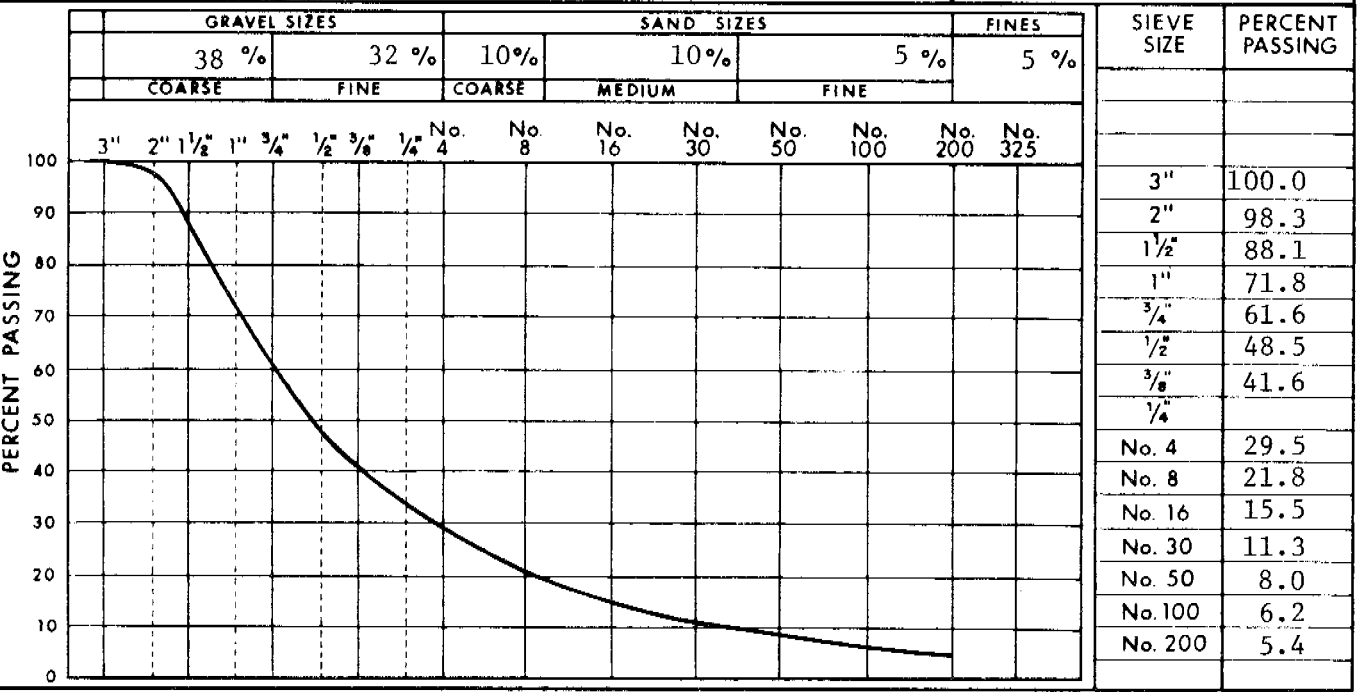
SIEVE ANALYSIS REPORT

SAMPLE N75-106N-B2-1 DEPTH 3.5-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 19, 1975 SAMPLED BY NESCL 153



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-106N-B2-3 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 19, 1975 SAMPLED BY NESCL 145



COMMENTS OVERSIZE (>3") = 11.6 %

 <p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	 <p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-106N-B2
		PAGE 312

106 N - B3 - A 625500E 7531420N

YR- 337 100
312 1100

see site # 1139

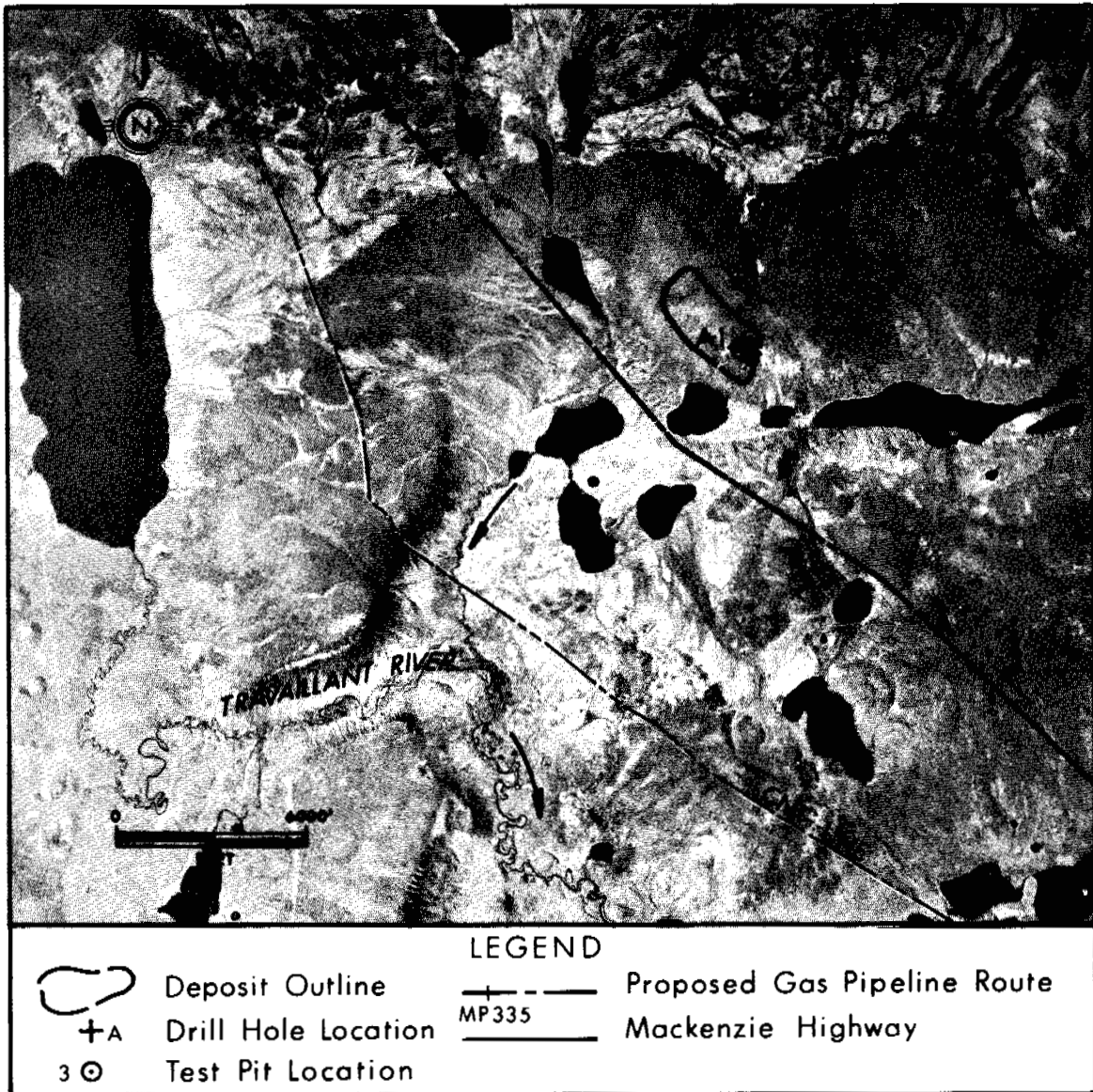
DEPOSIT 106N-B3

Physical Setting: Deposit 106N-B3 is a bedrock escarpment located 3 miles east of Wood Bridge Lake and less than 1 mile northeast of milepost 134 on the right of way.

Material: SHALE - poor quality.

Volume: Unlimited.

Assessment: Deposit 106N-B3 is a source of poor quality granular material and should probably not be considered for development.



Airphoto No. A21583-148
Approximate Scale: 1" = 5700'

Latitude: 67° 52'
Longitude: 132° 01'

DEPOSIT 106N-B3

PHYSICAL SETTING

This deposit is a bedrock escarpment 3 miles east of Wood Bridge Lake and less than 1 mile northeast of milepost 134 on the pipeline alignment. This deposit corresponds to source number 1139a in the EBA DIAND Granular Materials Inventory Volume IV (1974) report.

The 300 foot escarpment and the area adjacent to it are both considered part of this deposit. The escarpment slopes at about 30 degrees to the southwest, and the area behind the escarpment slopes very gently to the northeast. Drainage is good over the entire site and the active layer ranges from 3 to 5 feet in depth.

Terrain at the base of the escarpment is gently rolling and imperfectly drained.

BIOLOGICAL SETTING

The general area is part of an old burn which is now vegetated by black spruce and paper birch with an understory of willow, alder, cinquefoil, Labrador tea, and bilberry. Moose habitat at this site is marginal. Denning potential is considered good. Black and grizzly bear are found occasionally throughout the region. No evidence of beaver or other aquatic furbearers was observed in the adjacent lake. No raptor sign was observed in the vicinity of the escarpment. Waterfowl occur in the region throughout the open-water season. Small nearby ponds and lakes do not appear to support fish populations.

MATERIAL

About 20 feet of silty sand and gravel overlies shale along parts of the escarpment crest. In other areas 5 to 10 feet of till and colluvium

cover the shale. The shale contains occasional bentonitic beds and appears to be free of ice lenses. The sand and gravel, although not sampled, is probably also low in ice content (observed during geological field reconnaissance).

VOLUME

This escarpment and similar escarpments in the vicinity could provide an unlimited amount of poor quality borrow material.

DEVELOPMENT AND REHABILITATION

The shale found in deposit 106N-B3 is poor quality material for pipeline construction purposes and better borrow deposits exist closer to the pipeline right of way. This deposit should probably not be considered for development.

TEST HOLE LOG


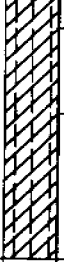
DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2	Pt		PEAT - fine fibrous, black.															
1.5	CL		CLAY - little medium to coarse sand, trace gravel to cobble sizes, low plastic, desiccated, blocky, light brown		UF													
1.5			from 1.5' black, silty, trace sand, trace gravel, pebbles rounded to 3"															
5.0																		
6.0	SHL		SHALE - platy chips, slightly fissile, light grey		Mbn													
6.0					F													
8					occ													
8					Vx													
10																		
10																		
24			Darker		incr													
24					Vx													
26																		
26																		
28			End of hole															
28																		

LOGGED BY: J.K.W	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R.H.	LAT. & LONG: 87°52'15"W, 132°01'02"W	ELEVATION:		N75-106N-B3-A
DRWN. BY: F.K.W	AIRPHOTO No.: A 21583-148	PIPE MILEAGE:		
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 25°C		
	METHOD: AIR			
START: D 20 M 08 Y 75 TIME: 14:10	FINISH: D 20 M 08 Y 75 TIME: 14:20			SHEET 1 OF 1

- 317 -


TEST HOLE No. N75-106N-B3-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL	ICE %	40	60	80							
	Pt		0.5 PEAT - fine fibrous, dark brown, roots		UF													
1	CL		0.8 CLAY - some fine sand, nuggetted, dry to desiccated, damp at 0.8', light brown														No samples taken	
2			1.8 silty, little fine sand, trace gravel, grey, moist															
3			3.0 pebbles rounded to 3", occasional cobble to 7" Bottom of pit															
			Refer also to drillhole #75-106N-B3-A															

LOGGED BY:	R. H.	FACILITY:	
CHKD:	R. H.	LAT. & LONG:	67°52'15"N, 132°01'02"W
DRWN. BY:	A. M.	AIRPHOTO No.:	A 21583-148
CHKD:	D. O.	RIG:	
		METHOD:	TEST PIT
START:	D 20 M 08 Y 75	TIME:	12:00
FINISH:	D 20 M 08 Y 75	TIME:	13:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106N-B3-1

SHEET 1 OF 1

- 318 -

TEST HOLE No. N75-106N-B3-1

106N - B4 - A	625450E	7530470N
106N - B4 - B	624730E	7530470N

410

5/2/1971

see site # 1138

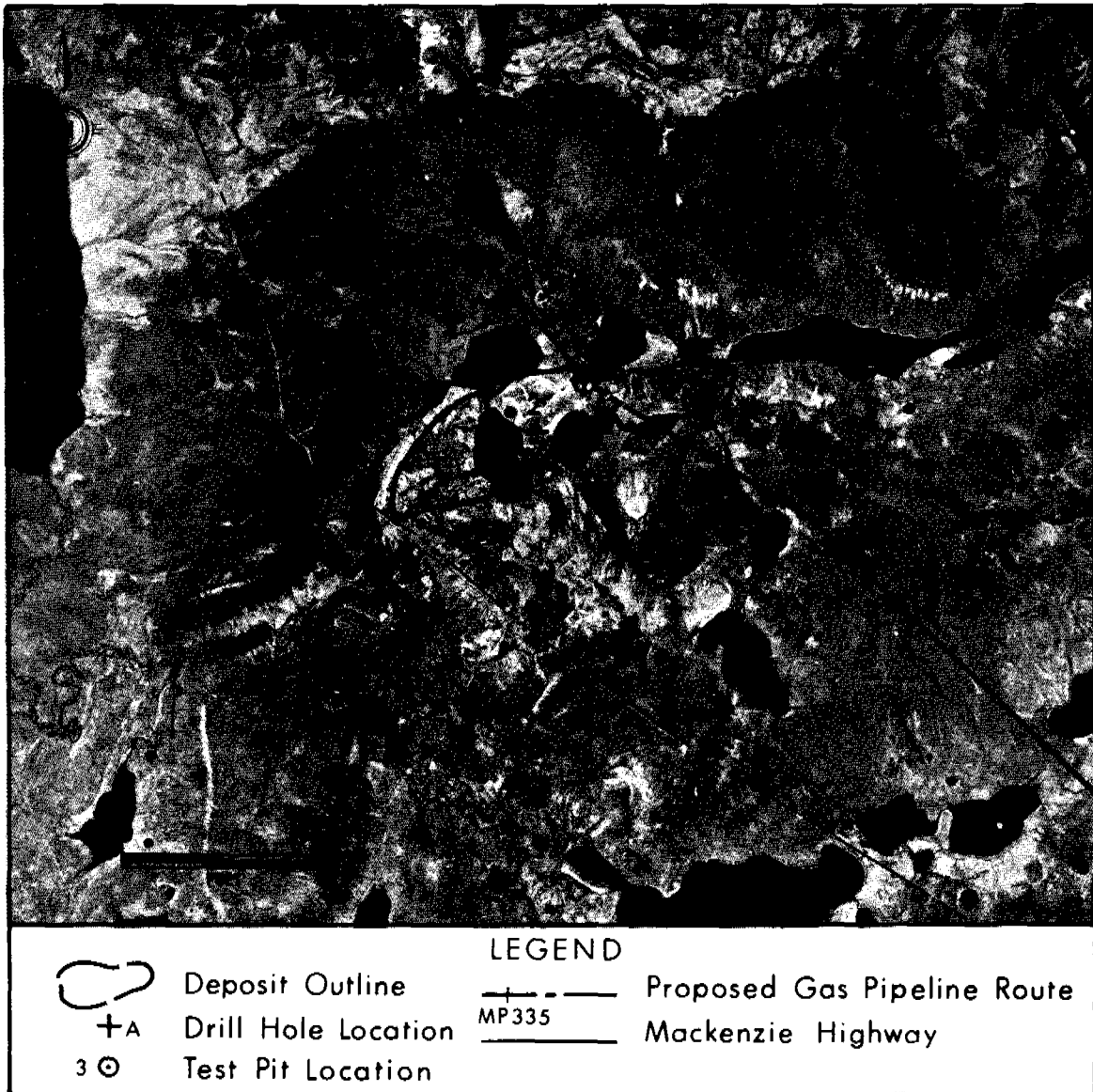
DEPOSIT 106N-B4

Physical Setting: Deposit 106N-B4 is an outwash terrace located 2 miles east of the south end of Wood Bridge Lake. The proposed pipeline alignment crosses the deposit near milepost 135.

Material: GRAVEL - well graded gravel to silty sand with variable silt content.

Volume: 17,000,000 cubic yards.

Assessment: Deposit 106N-B4 is a source of good quality granular material. Haul distance is short and granular material from this deposit may be used for general fill, backfill, in pipeline construction, building pads, and possible production of concrete aggregates.



Airphoto No. A21583-148
Approximate Scale: 1" = 5700'

Latitude: 67° 52'
Longitude: 132° 02'

DEPOSIT 106N-B4

PHYSICAL SETTING

This deposit is an outwash terrace located 2 miles east of the south end of Wood Bridge Lake. The proposed pipeline alignment crosses the deposit near milepost 135. This deposit has been previously documented as source 1138 in the EBA DIAND Granular Materials Inventory Volume IV (1974) report.

The terrace surface is flat to gently sloping, with maximum relief of 10 feet. Meltwater activity has formed a 20 foot scarp along its western and northern edges. Drainage near the scarp is moderate to good, but only fair to poor over the remainder of the site. Overburden near the scarp edge is negligible, but ranges from 3 to 10 feet over the rest of the deposit. Further drilling is required to determine the exact extent and thicknesses of overburden. The active layer varies between 1 and 8 feet. The deposit is overlain by icy peat and silt, but the gravel and sand has low ice content.

BIOLOGICAL SETTING

The site supports spruce up to 25 feet in height and a thick understory of willow, bog birch, and ericaceous shrubs. Ground cover consists of sedges and mosses. The area provides only marginal habitat for furbearers and large mammals. Grizzly and black bear are found occasionally throughout the region. No sign of beaver or other aquatic furbearers was evident in the adjacent lakes. Waterfowl occur in the region throughout the open-water season. Adjacent lakes do not appear to support fish populations.

MATERIAL

Material at this deposit is of good quality and ranges from well graded gravel to silty sand. Gravel is mainly rounded and exhibits variable silt content.

VOLUME

Total estimated volume, based on an area of 400 acres and a conservative depth of 30 feet of sand and gravel, is 17,000,000 cubic yards. Approximately half of this volume is estimated to be gravel.

DEVELOPMENT AND REHABILITATION

Deposit 106N-B4 is a source of good quality granular material. Areas to be exploited will be dictated by insitu material quality, overburden thicknesses, ice content and material requirements. Additional drilling and test pitting is required to define the areas with the least overburden and the best quality material. Granular material from this deposit may be used for general fill, backfill and pipeline construction, building pads, and possible production of concrete aggregates. Further testing would be necessary to determine material suitability for concrete.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit would probably be achieved from the pipeline right of way as it is more than 40 miles inland from the Mackenzie River. The pipeline right of way crosses the deposit, making snow haul roads conveniently short.

In order to prevent environmental damage, development would be kept away from shorelines and streams near the deposit.

Vegetation would have to be harvested and disposed of in accordance with existing land use regulations. The peat cover and overburden then would be stripped from the area to be excavated, and stockpiled around the edge of the excavation.


Development of this deposit could involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be maintained over the area. Pit development by mining vertical faces could also be considered along the valleytrain. This would involve excavating material from the face of the scarp. Either type of development could be accomplished by using blasting or conventional earthmoving techniques depending on the degree of ice cementation which appears to be low. The excavated material may have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, drying, crushing, and concrete production plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
2	SM		SAND - medium, silty, trace coarse sand, trace pebbles to ½", occasional pebbles to 2", rusty brown, weathered, dry to desiccated		UF												4 ½" Walmac bit 15:53	
7			7.0 End of hole														7.0 Hole caving 18:00	

LOGGED BY: J.K.W	FACILITY:	PROJECT: 13011	 <p style="font-size: small; margin: 0;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p style="margin: 0;">1975 BORROW INVESTIGATION</p>	<p style="margin: 0;">TEST HOLE No. N75-106N-B4-A</p>
CHKD: R.H.	LAT. & LONG: 67°51'50"N, 132°00'52"W	ELEVATION:			
DRWN. BY: J.K.W	AIRPHOTO No.: A 21583-148	PIPE MILEAGE:			
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 27°C			
	METHOD: AIR				
START: D 20 M 08 Y 75 TIME: 15:53	FINISH: D 20 M 08 Y 75 TIME: 18:00	CANADIAN ARCTIC GAS STUDY LIMITED		SHEET 1 OF 1	

- 324 -

TEST HOLE No. N75-106N-B4-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.5	Pt		PEAT - fine fibrous, amorphous, woody inclusions, black		UF													
3.0	SM		SAND - medium, silty, trace fine gravel, trace coarse sand, pebbles rounded to 1/4", light brown		Mbe occ. Vx													
6.0	GM		GRAVEL - fine, silty, and coarse sand, occasional cobbles, isolated boulder to 10" at 7.0', coarser intervals, pebbles rounded to 1/2", metamorphics		F													
38.0			End of hole															

4 1/2" Walmac bit 18:50

4 1/2" Tricone bit 17:01

at 18' - stem plugged
3 7/8" Walmac 17:51


18:50

TEST HOLE No. N75-106N-B4-B

- 325 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°51'51"N, 132°01'55"W	ELEVATION:
DRWN. BY: F.F.D.	AIRPHOTO No.: A 21583-148	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-DRILL	AIR TEMP: 27°C
	METHOD: AIR	
START: D 20 M 08 Y 75	TIME: 18:50	FINISH: D 20 M 08 Y 75
		TIME: 18:50

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106N-B4-B

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	Pt		PEAT - moss cover, spongy, brown 1.4		UF													
2	SM		SAND - medium to fine grain, (trace coarse), little silt, trace fine gravel, pebbles rounded to 3/8", wet when thawed 3.0		Me							NA, sample 1 G = 8% S = 78% F = 15%	B1				2.5	
3			Bottom of pit															
			Refer also to drillhole N75-106N-B4-B														Probable old burn	

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG.: 87°51'38"N, 132°02'50"W	ELEVATION:
DRWN. BY: F.F.B.	AIRPHOTO No.: A 21583-148	PIPE MILEAGE:
CHKD: D.D.	RIG:	AIR TEMP.: Approx. 27°C
METHOD: TEST PIT		
START: D 20 M 08 Y 75 TIME: 13:45	FINISH: D 20 M 08 Y 75 TIME: 15:45	

<p style="text-align: center;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p style="text-align: center;">CANADIAN ARCTIC GAS STUDY LIMITED</p>	TEST HOLE No.
		N75-106N-B4-1
SHEET 1 OF 1		

- 326 -

TEST HOLE No. N75-106N-B4-1

PC-9SK373

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
1	Pt		0.5 PEAT - amorphous, fine fibrous, dark brown to black		IF												No samples taken	
	Pt		1.0 PEAT with SILT (organic), black															
	ICE + DL		ICE to approximately 2'' with SILT (organic), black															
			2.6			2.6												
3	ICE + ML		ICE with SILT, some fine gravel, some coarse sand, rounded, occasional subrounded pebbles to 2'' Bottom of pit		ICE +												3.5	
																	18:10	

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°51'51''N, 132°01'55''W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 21583-148	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 27°C
	METHOD: TEST PIT	
START: D 20 M 08 Y 75 TIME: 16:00	FINISH: D 20 M 08 Y 75 TIME: 18:10	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106N-B4-2

SHEET 1 OF 1

- 327 -

TEST HOLE No. N75-106N-B4-2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.4	Pt		PEAT - amorphous, fine fibrous, rust brown, spongy		UF							MA, combined, samples 1 & 2 G = 83% S = 34% F = 3% (GW)					0.4	
1.1	GW		GRAVEL - some cmf sand, trace silt, orange brown rootlets, pebbles rounded to 2", occasional cobbles to 5", darker brown from 1.1'										B1				1	
2.0			some cmf sand, pebbles rounded to 1 1/2", loose, cementation										B2				2	
2.8																	3	
	SW		SAND - medium to fine grain, trace gravel (to 1"), fairly clean										B3				4	
6.0			Bottom of pit														6	

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°51'51"W, 132° 01'55"W	ELEVATION:
DRWN BY: B.D.	AIRPHOTO No.: A 21583-148	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 27°C
METHOD: TEST PIT		
START: D 20 M 08 Y 75 TIME:	FINISH: D 20 M 08 Y 75 TIME:	

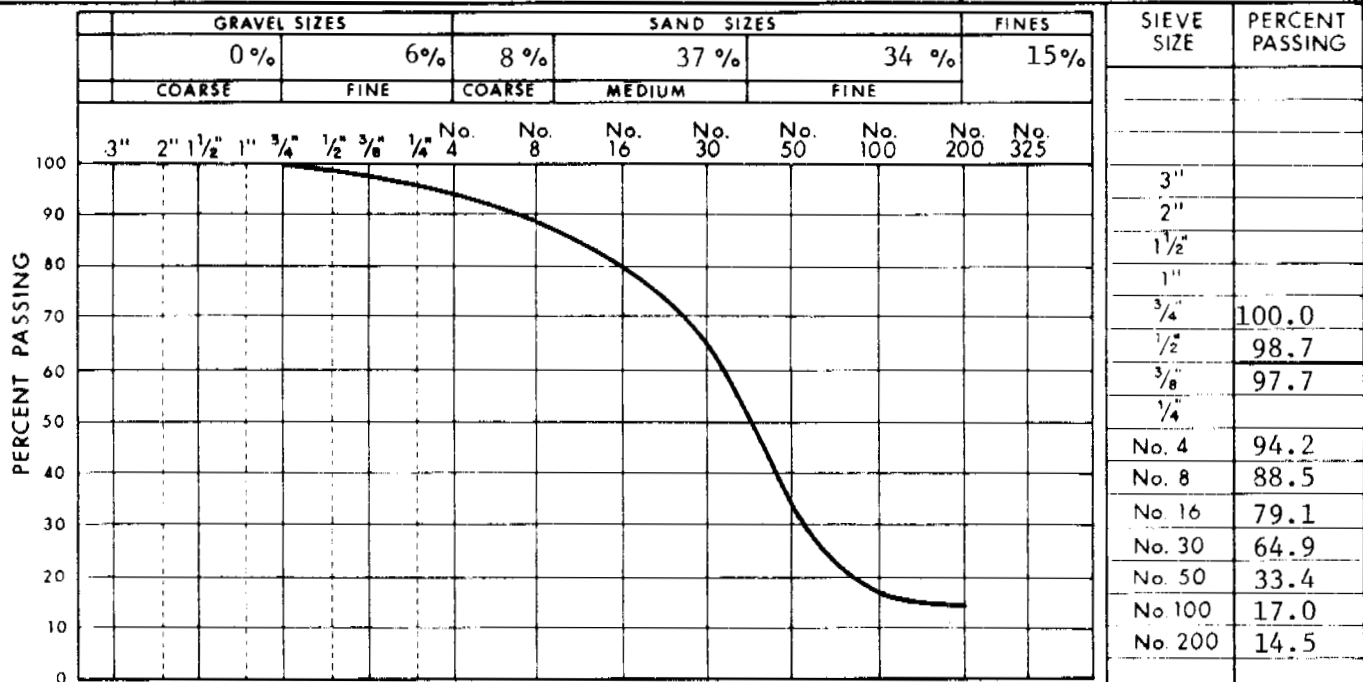
1975 BORROW INVESTIGATION	TEST HOLE No. N75-106N-B4-3
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	
SHEET 1 OF 1	

- 328 -

TEST HOLE No. N75-106N-B4-3

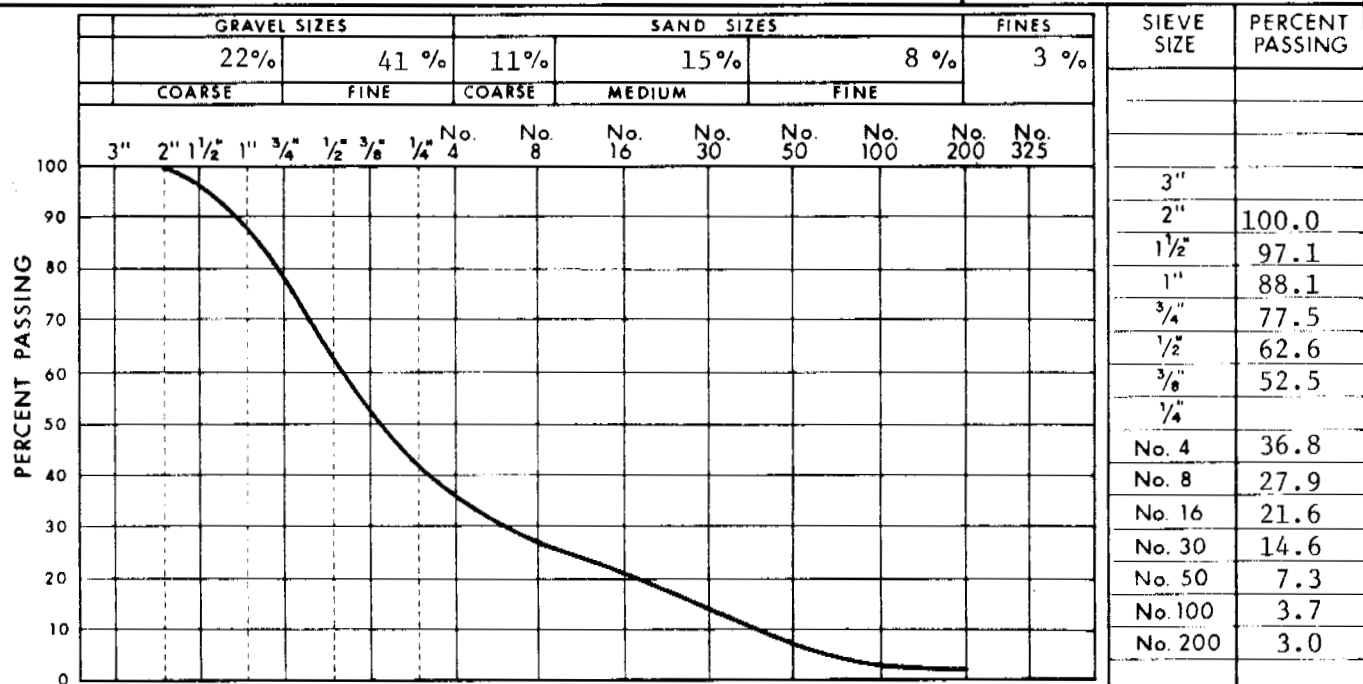
SIEVE ANALYSIS REPORT

SAMPLE N75-106N-B4-1 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 20, 1975 SAMPLED BY NESCL 137



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-106N-B4-3 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 20, 1975 SAMPLED BY NESCL 31

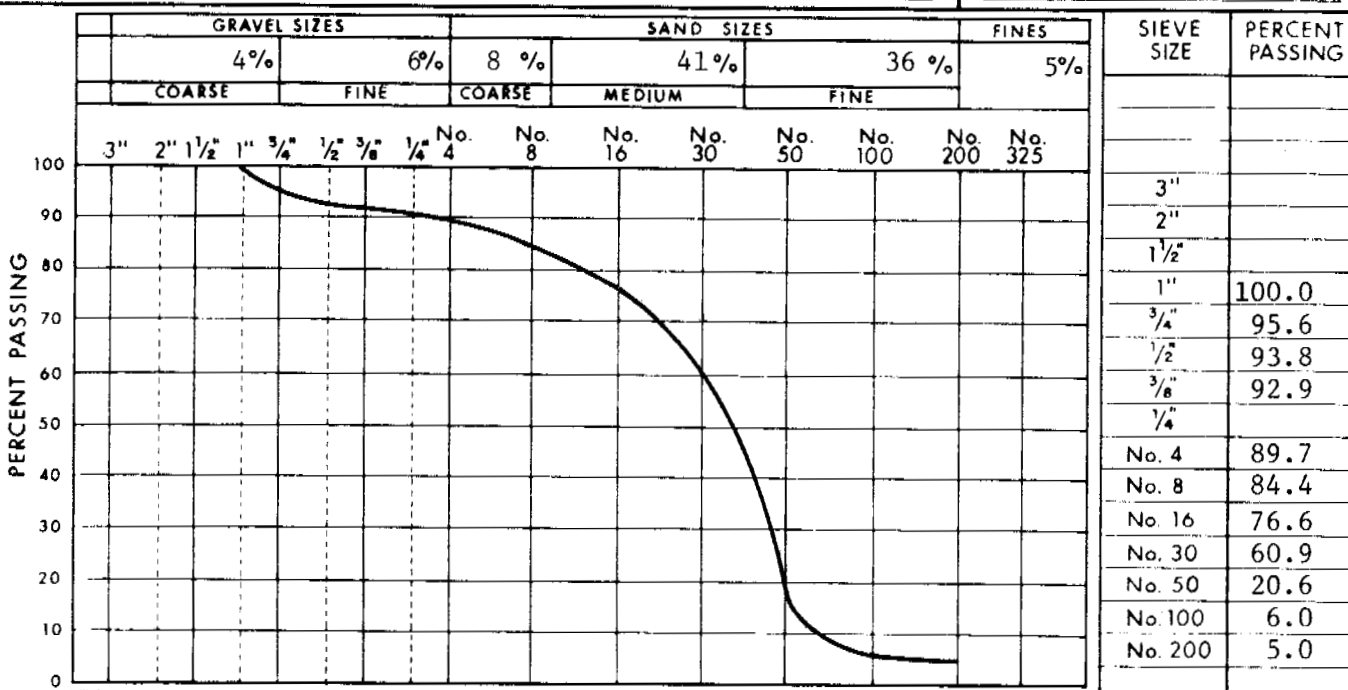


COMMENTS OVERSIZE (>3") = 0.0 %

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-106N-B4 PAGE 329
---	--	---	---

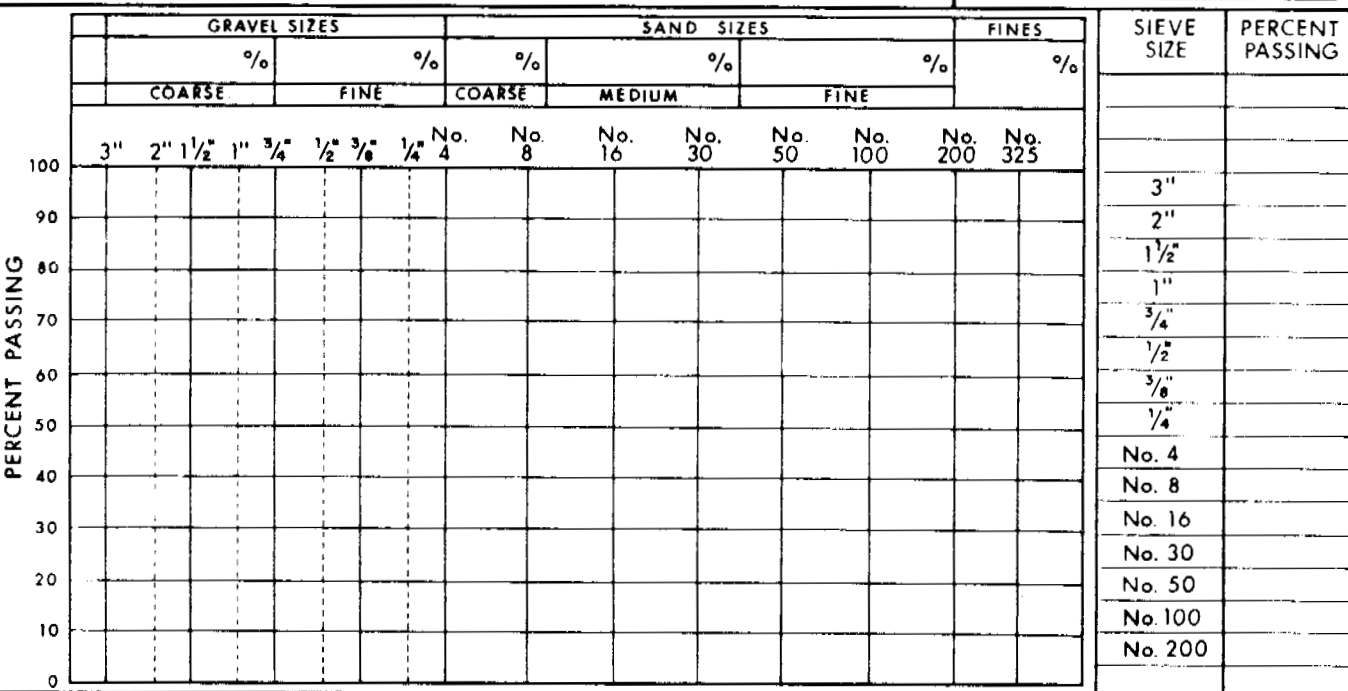
SIEVE ANALYSIS REPORT

SAMPLE N75-106N-B4-3 DEPTH 3.0-5.0 R.M.HARDY REPORT NUMBER 30
 DATE SAMPLED August 20, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS OVERSIZE (>3") = %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-106N-B4

PAGE
 330

1060 - B1 - A 377880 E 7531900N

UTM Zone 29

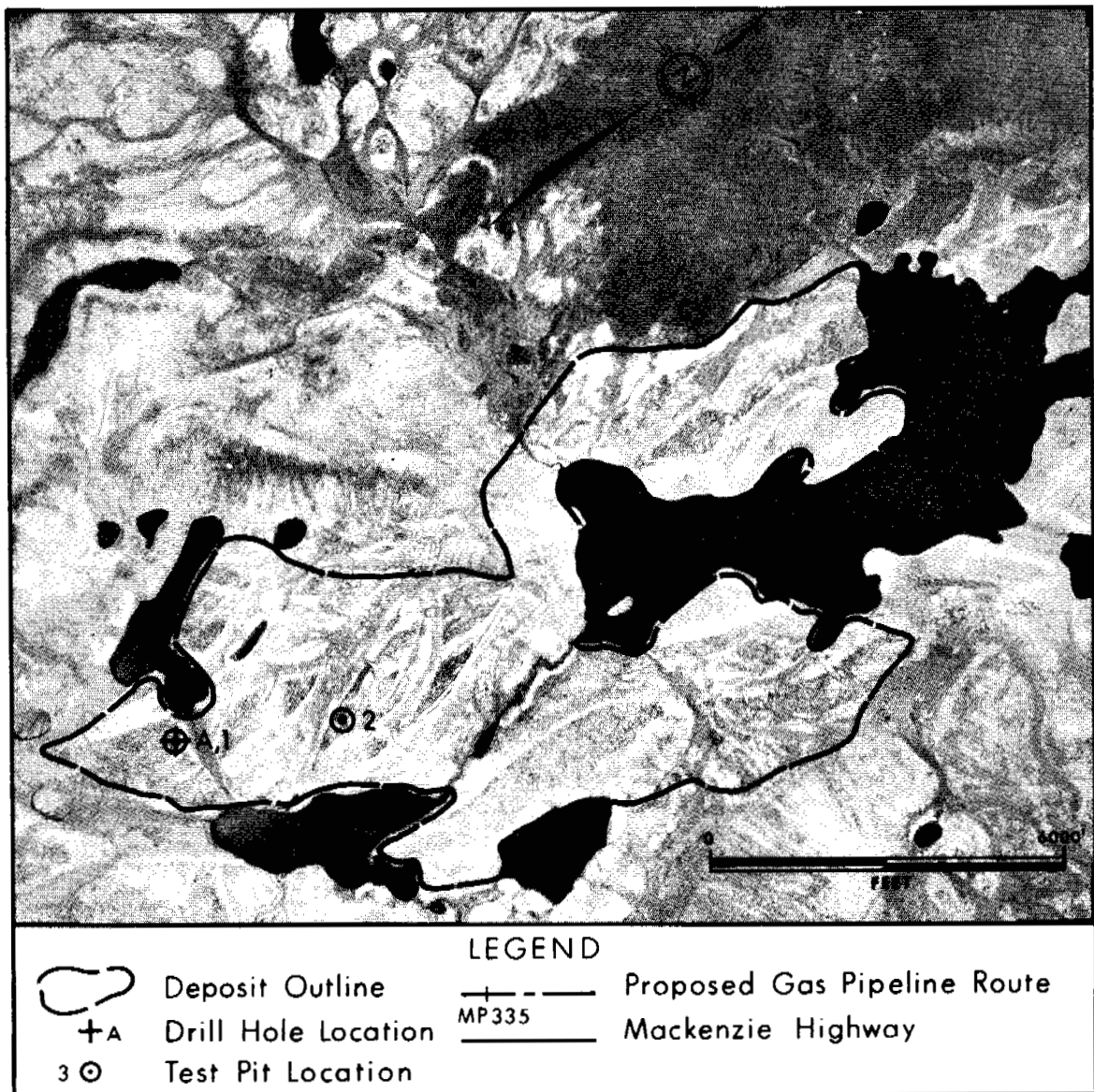
x ref EBA 1138
Tech B04-36

Physical Setting: Deposit 1060-B1 is a channeled outwash plain located 11 miles north of Travaillant Lake and 4 miles north-east of milepost 137 on the proposed pipeline.

Material: GRAVEL - well graded, and sand.

Volume: 16,700,000 cubic yards.

Assessment: Deposit 1060-B1 is a source of good to excellent quality granular material suitable for general fill, backfill, building pads, and possible concrete and asphalt aggregate. The access to the right of way is fair.



Airphoto No. A22935-99
 Approximate Scale: 1" = 3100'

Latitude: 67° 53'
 Longitude: 131° 53'

DEPOSIT 1060-B1

PHYSICAL SETTING

Deposit 1060-B1 is a channeled outwash plain located 11 miles north of Travaillant Lake and 4 miles northeast of milepost 137 on the proposed pipeline right of way. This deposit corresponds to part of source number 1138 in EBA DIAND Granular Materials Inventory Volume IV (1974) report.

The surface of the outwash plain is a mosaic of large bars and abandoned channels that are separated by 10 to 15 foot scarps. The bars have a negligible cover of peat and silt and are well to imperfectly drained. The abandoned channels are poorly drained and probably contain thicker overburden. The active layer ranges between 6 and 8 feet and material below this depth is frozen with low ice content.

Terrain between the pipeline route and the deposit consists of a flat, marshy plain with poorly defined drainage and a drift covered upland with rolling topography.

BIOLOGICAL SETTING

Vegetation on the bars consists of a dense stand of black spruce up to 20 feet in height with a thick shrub understory and a ground cover of moss and lichen. Abandoned channels are covered by sedges with scattered shrubs. This area provides winter range for caribou and moderately productive habitat for upland furbearers, black and grizzly bear and moose. No beaver lodges were observed in the adjacent lakes. The area provides limited denning opportunities for small mammals. No information is available on waterfowl use of the area or the fisheries potential of nearby streams, ponds and lakes.

MATERIAL

Drill hole and test pit logs plus the DIAND report indicate that this deposit consists of at least 18 feet of well graded gravel and sand.

Gravel is generally rounded and contains a trace of silt periodically. At the sites sampled there was less than 1 foot of peat covering the deposit. Water was encountered at 2.8 feet in test pit 1060-B1-2 and this could cause problems during development. Material quality is good to excellent.

VOLUME

The total estimated volume, based on an area of 1460 acres and a conservative depth estimate of 15 feet, is 16,700,000 cubic yards. Volumes could be doubled by including outwash along this valley to the north. The recovery of granular material may be restricted because of the relatively high water table.

DEVELOPMENT AND REHABILITATION

Deposit 1060-B1 is a source of good to excellent quality granular materials. Location of areas to be exploited will be dictated by haul distances, overburden thicknesses, insitu material quality, and material requirements. Depth of water table is about 3 feet or less in places and this will also be a factor in locating areas for development. Granular material from this deposit may be used for general fill, backfill in pipeline construction, building pads, and concrete and asphalt aggregate. The gravel will require further testing before use in concrete.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit would probably be via the pipeline right of way. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the

right of way, a distance of at least 4 miles across a flat marshy area and a drift covered upland.

Trees and vegetative cover would have to be removed and disposed of or harvested in accordance with existing land use regulations. Peat cover and overburden is negligible at this site, therefore minimizing stripping.

Development of this deposit would involve excavating borrow material in stages from the higher, better drained bars. If very large quantities of borrow are required, dugout pit development could be established depending on the depth of water table. Either type of development could probably be accomplished by conventional earthmoving techniques since ice contents are low. The excavated material may have to be stockpiled, thawed, and drained before it is used. An adequate buffer zone would have to be maintained between the excavation and any water courses or lakes to prevent siltation. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing, concrete and asphalt plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0	Pt	0.1	PEAT - black, fibrous		UF													4 1/2" Walmac bit 20:00
3	SM		GRAVEL - fine, very sandy, silty, pebbles to to 3/4", rounded, isolated large pebbles, rusty brown turning to dark brown with depth. Dry to 8.5°, occasional layers of cleaner well graded fine gravel,															
6				8.5														
8					F													
10			Damp to wet when thawed below 8.5°															
12																		
14																		
16	SM	16.0	SAND - medium fine, silty															
17	GM	17.0	GRAVEL - fine, silty															
18		18.0	End of hole															3 7/8" Walmac bit 20:10
																		20:25

TEST HOLE No. N75-1060-B1-A

- 336 -

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 87°52'43"N, 131°53'35"W	ELEVATION:
DRWN. BY: G.B.	AIRPHOTO No.: A 22935-99	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 24°C
	METHOD: AIR	
START: D 20 M 06 Y 75 TIME: 20:00	FINISH: D 20 M 08 Y 75 TIME: 20:25	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B1-A
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE, %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	Pt	0.4	PEAT - fine fibrous, dark brown	UF														
1	GM	0.9	GRAVEL - silty, roots, orange brown															
2	GW	3.0	GRAVEL - and cmf sand, trace fines, cementation on gravel, brown, moist		○							4	B1					
3	SW	4.0	SAND - medium to coarse, some gravel to 2", cementation on pebbles		○							3	B2				13:30	
4		4.0	Bottom of pit		○							4	B3				13:50	
			NOTE: Bottom of pit was cleared and is either a large flat rock or sandstone bedrock															

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°52'43"N, 131°53'35"W	ELEVATION:
DRWN BY: F.B.	AIRPHOTO No.: A 22835-98	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 21 M 08 Y 75 TIME: -	FINISH: D 21 M 08 Y 75 TIME: 13:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR




CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.

N75-1060-B1-1


SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC ICE TYPE	VISUAL ICE %	▲ Dry density (pcf)	○ Water content %	Plastic limit	Liquid limit							
0.3	Pt		PEAT, - fine fibrous, brown														
0.8	ML		SILT - low plastic, little gravel to 3/8", rootlets, brown														
1.0 - 4.0	GW		GRAVEL - fine to coarse, and cwf sand, rounded, platy, fairly clean, moist, cementation on grave!														
			2.8 water entering pit														
4.0			Bottom of pit Free water														
										WS MA, combined Samples 1 - 3 G = 81% S = 37% F = 2% (GW)	B1 B2 B3				20:00 20-08-75 11:00 21-08-75 Pit abandoned at depth 4.0' due to entry of water. Sample B3 may have lost some fines content during sampling from water		

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°53'04''N, 131°52'51''W	ELEVATION:
DRWN BY: G.B.	AIRPHOTO No.: A 22835-88	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 20 M 08 Y 75 TIME:	FINISH: D 21 M 08 Y 75 TIME: 11:30	

1975 BORROW INVESTIGATION


 NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED

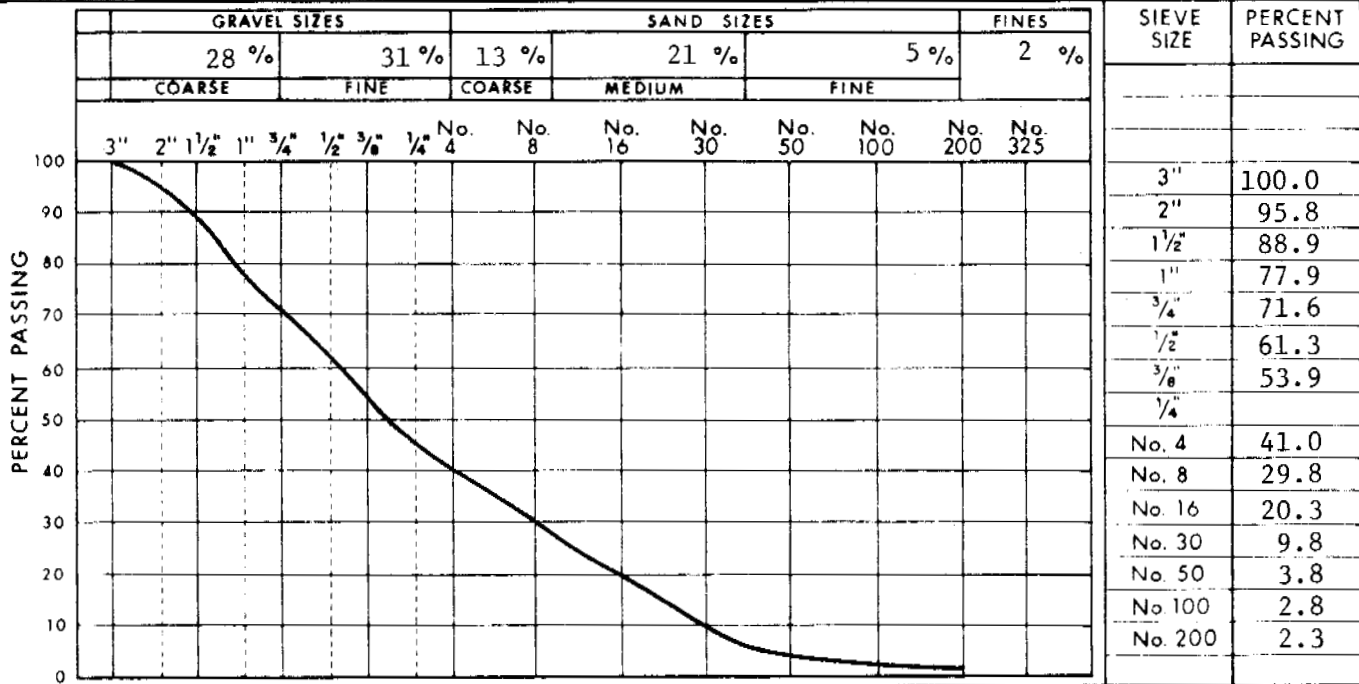
TEST HOLE No.

 N75-1060-B1-2

SHEET 1 OF 1

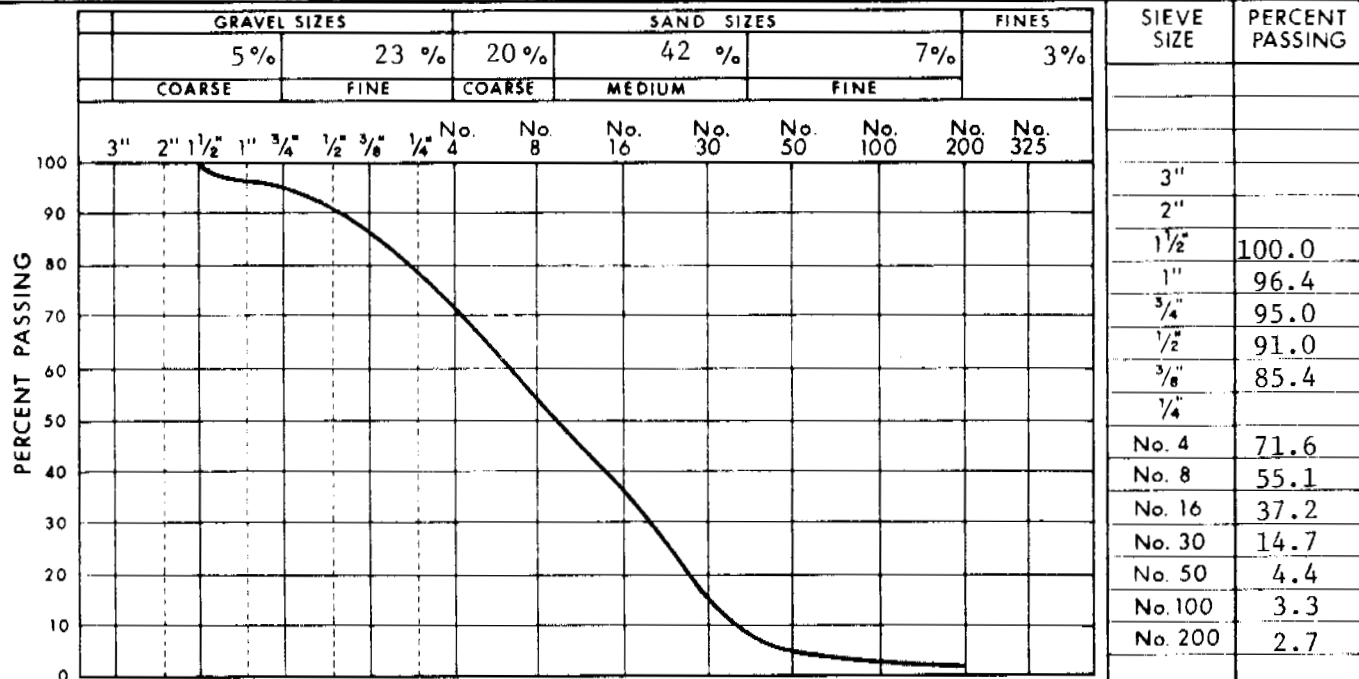
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B1-1 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER 47
 DATE SAMPLED August 21, 1975 SAMPLED BY NESCL



COMMENTS Moisture contents range from 3.0% to 4.0% OVERSIZE (>3") = 0.0%

SAMPLE N75-1060-B1-1 DEPTH 3.0-4.0 R.M.HARDY REPORT NUMBER 46
 DATE SAMPLED August 21, 1975 SAMPLED BY NESCL

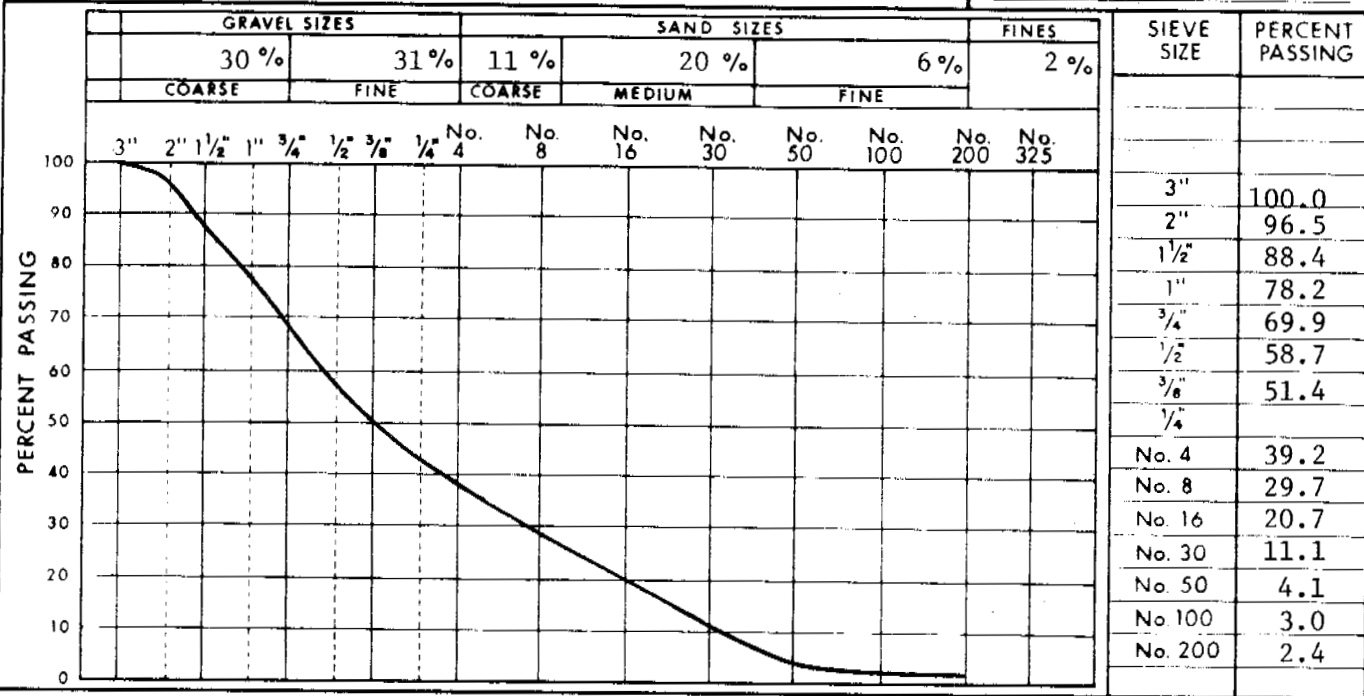


COMMENTS Moisture content is 3.8% OVERSIZE (>3") = 0.0%

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-1060-B1 <hr/> PAGE 339
---	--	---	---

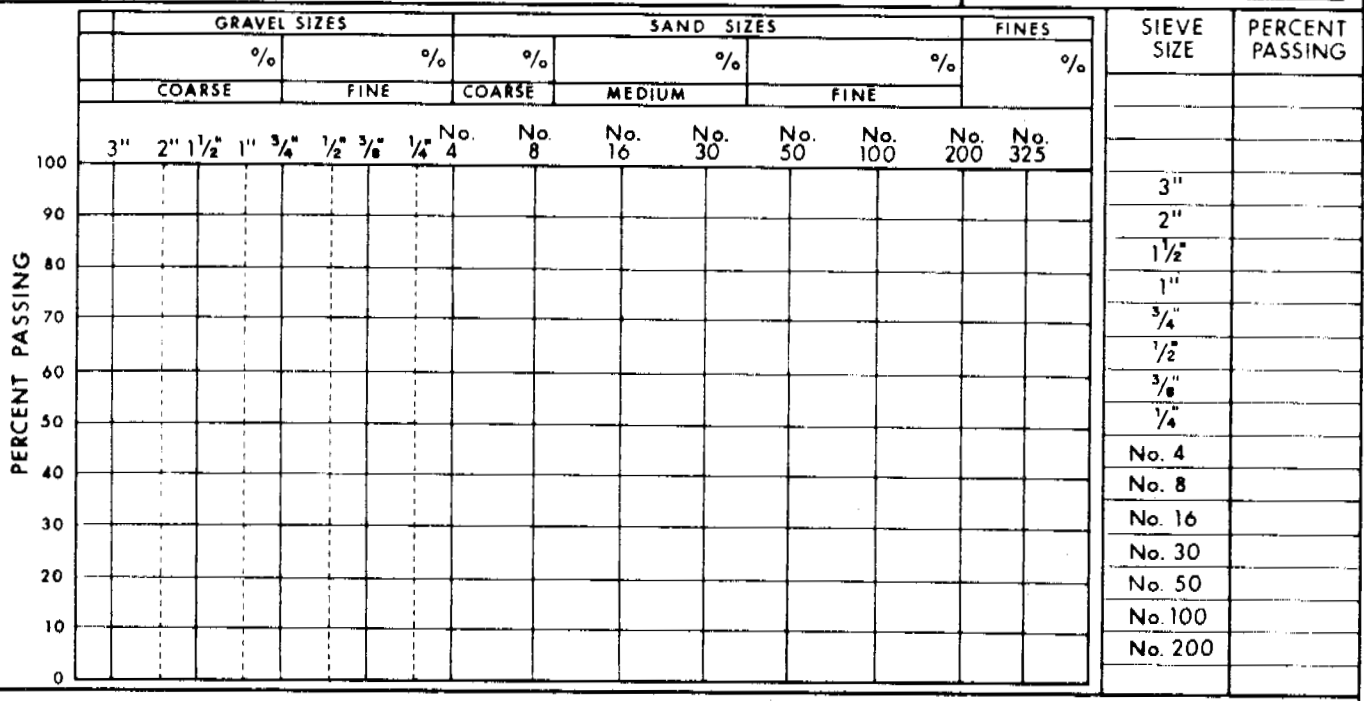
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B1-2 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 20, 1975 SAMPLED BY NESCL 45



COMMENTS Moisture content ranges from 3.5% to 4.3% OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = _____ %

 <p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	 <p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-1060-B1
		PAGE 340

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-1060-B1-1 DATE SAMPLED : August 21, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 0-2 DATE TESTED : March, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 1.1 %
 FINE AGGREGATE : LOSS = 9.9 %

ORGANIC IMPURITIES TEST

NUMBER : 5
 COAL REMOVED : 5
 COAL & ROOTLETS
 REMOVED : 5
 COAL CONTENT : Trace
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 21.0 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	22.20
Sandstone	Medium strong, Good	44.25
Siltstone		7.15
Chert	Potentially reactive, Fair	1.95
Flint		4.74
PN = 118	INTERPRETATION : Good quality aggregate	80.30

COMMENTS : See also page 342.



R.M. HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-1060-B1

PAGE 341

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-1060-B1-1 DATE SAMPLED : August 21, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 0-2 DATE TESTED : March, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 1.1 %
 FINE AGGREGATE : LOSS = 9.9 %

ORGANIC IMPURITIES TEST

NUMBER : 5
 COAL REMOVED : 5
 COAL & ROOTLETS
 REMOVED : 5
 COAL CONTENT : Trace
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 21.0 %

SUMMARY OF ROCK TYPES, FINE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	9.58
Sandstone	Strong, Good	3.13
Siltstone		4.84
	Potentially reactive, Fair	
Chert		0.87
Flint		1.28
PN = 118	INTERPRETATION : Good quality aggregate	19.70

COMMENTS : See also page 341.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-1060-B1

PAGE 342

1060 -B2 -A	378230E	7530160N
B2 - B	377960E	7530440N
B2 - C	378580E	7530440N

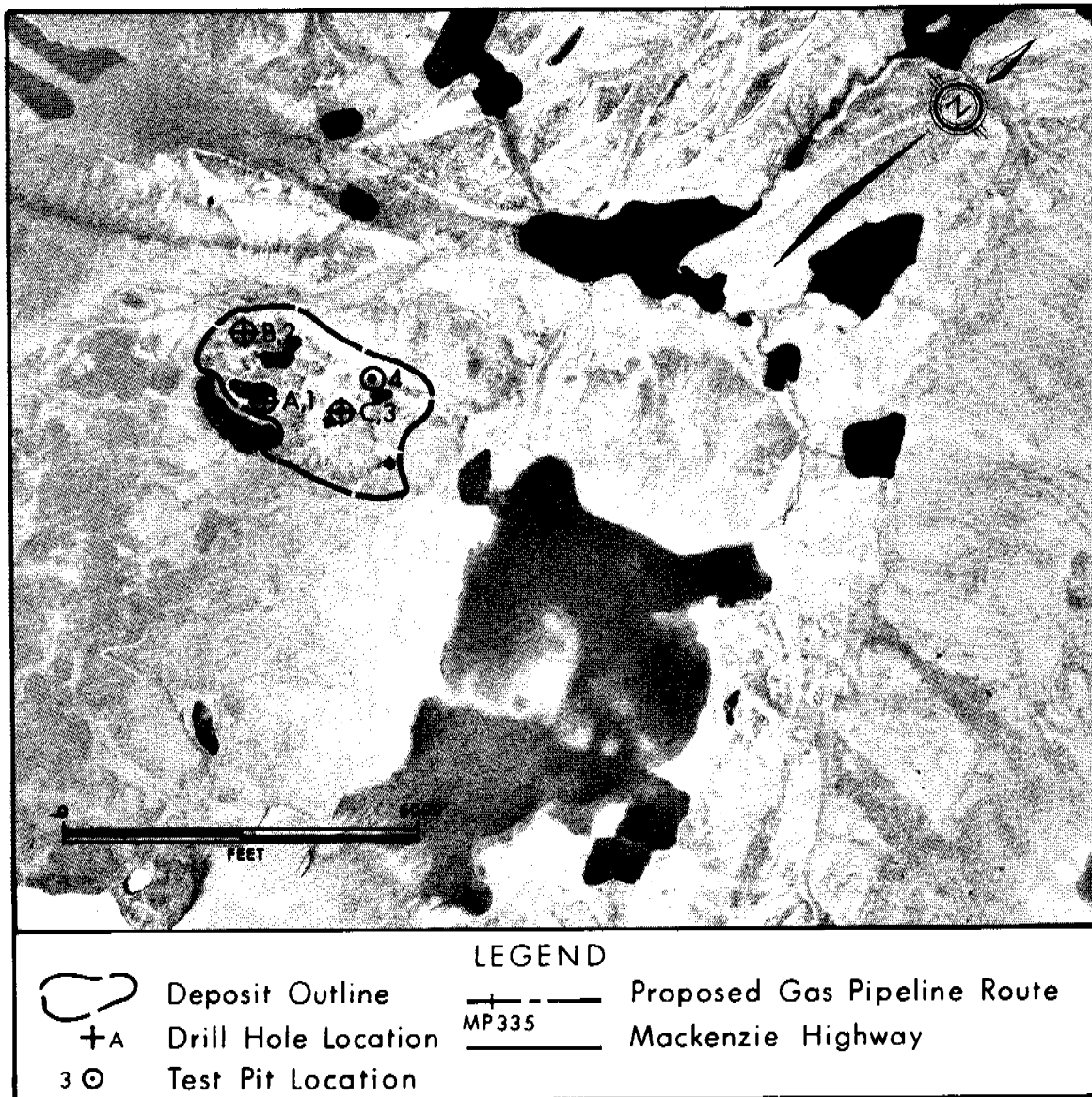
37 7530
37 7530

Physical Setting: Deposit 1060-B2 is a kame and kettle complex located 4 miles northeast of Crossing Creek Lake and 3 miles northeast of the right of way at milepost 137.

Material: SAND and GRAVEL - interbedded well graded sand and gravel.

Volume: 4,500,000 cubic yards.

Assessment: Deposit 1060-B2 is a source of good quality granular material suitable for general fill, backfill, building pads and possible concrete aggregate. Access presents no serious problems over the 3 miles of rolling upland.



Airphoto No. A22935-98

Approximate Scale: 1" = 3100'

Latitude: 67° 52'

Longitude: 131° 53'

DEPOSIT 1060-B2

PHYSICAL SETTING

This deposit is a kame and kettle complex 4 miles northeast of Crossing Creek Lake and 3 miles northeast of the pipeline right of way at mile-post 137. This deposit corresponds to part of source number 1137 in EBA DIAND Granular Materials Inventory Volume IV (1974) report.

The complex has local relief between 50 and 100 feet with slopes up to 15 degrees. Generally, hills and slopes are well drained, with gentler slopes and depressions imperfectly to poorly drained. Overburden is less than 1 foot, except possibly in depressions.

The active layer varies from 1 to 6 feet or more and below this the deposit is frozen. Ice contents appear to be low, although some excess ice was observed in some strata.

A rolling drift covered upland is typical of the terrain located between the deposit and pipeline right of way.

BIOLOGICAL SETTING

Vegetation at this site consists of a dense stand of black and white spruce up to 30 feet in height. The understory consists of alder and willow and a ground cover of dwarf shrubs, lichen and moss. The area provides winter range for caribou and moderately productive habitat for upland furbearers, black and grizzly bear and moose. Caribou and fox sign were observed at the site. There was no evidence of beaver in the small adjacent lake. No information is available on waterfowl use or fisheries potential of the small lakes and streams in the area. The adjacent lake does not appear to support fish populations.

MATERIAL

Material at this deposit consists of interbedded well graded sand and rounded gravel with varying amounts of sand and silt. Sand beds contain small quantities of silt and fine gravel.

VOLUME

The maximum depth of gravel and sand is probably slightly in excess of the local relief, which for hills and ridges is in the order of 75 feet. Using this depth and an area of 160 acres, the total estimated volume is 4,500,000 cubic yards. The DIAND report indicates there is a similar deposit of somewhat smaller area to the north across a nearby lake.

DEVELOPMENT AND REHABILITATION

Deposit 1060-B2 is a source of good quality granular material suitable for general fill, backfill in pipeline construction, building pads, and possibly concrete aggregate. Location of areas to be exploited would be determined by further exploratory drilling.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the pipeline right of way, over 3 miles of rolling drift covered upland presents no serious problems, although steeper slopes should be avoided to prevent initiation of bimodal flows. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the pipeline right of way. Excavation would be done carefully to minimize siltation in adjacent lakes.

Initially, the tree cover would have to be removed from selected sites and along the haul road right of way and harvested according to land use regulations. Overburden is thin over the deposit necessitating some stripping. Development of this deposit would involve excavating borrow material evenly or in stages from the higher, well drained areas to a level that promotes good drainage over the site. Detailed development plans would be prepared after further exploratory investigations were completed. Conventional earthmoving techniques would be used as ice contents are low. Blasting might be necessary if material with a high degree of ice cementation is encountered. The excavated material may have to be stockpiled, thawed and drained before it is used.

Crushing and/or screening of the material may be required to produce quality construction aggregates. Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing and concrete plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2	PT		PEAT - fine fibrous, amorphous, woody, light brown		UF													4 1/2" Walmac bit 11:37
0.5																		
2			GRAVEL - very silty, sandy, fine, pebbles rounded to 3/8"		Vx Yc													
3.0																		
4.0	ML		SILT - low plastic															
4.0			SILT - and fine gravel, low plastic		Nbn													
6.0																		
6.0	SM		SAND - medium, silty, grey		Nbe													
7.0																		
8	GM		GRAVEL - fine, silty, pebbles to 3/8", occasionally coarse, occasional cobbles to 8"															3 7/8" Walmac bit 11:45
9.0			low plastic silty clay layer at 9.0'		Yc													
10																		
12																		
13.0																		
14	SM		SAND - medium, trace coarse, silty, trace fine gravel, grey brown		Nbe													
16																		

- 348 -

TEST HOLE No. N75-1060-B2-A

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.V.	LAT. & LONG: 67°51'52"N, 131°54'00"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-98	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 14°C
	METHOD: AIR	
START: D 21 M 8 Y 75 TIME: 11:37	FINISH: D 21 M 8 Y 75 TIME: 12:06	


<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-1060-B2-A</p> <p>SHEET 1 OF 2</p>
--	---

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
17.0	SM		SAND (cont'd)	+														
18	GM		GRAVEL- and silt, sand, medium, coarse	+													11:55	
20				+														
22				+														
24				+														
26.0			End of hole	+													Loss of circulation 12:06	

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.V.	LAT. & LONG: 67°51'52"N, 131°54'00"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 22935-88	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 14°C
	METHOD: AIR	
START: D 21 M 8 Y 75	TIME: 11:37	FINISH: D 21 M 8 Y 75
		TIME: 12:06

1975 BORROW INVESTIGATION



**NORTHERN ENGINEERING SERVICES
COMPANY LIMITED**
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B2-A
SHEET 2 OF 2

- 349 -

TEST HOLE No. N75-1060-B2-A

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE	TYPE	VISUAL	ICE	%							
					40	60	80	100	120	140	▲						
					0	20	40	60	80	100	○						
0.5	Pt		PEAT - fibrous, black														
2	ML		SILT - and fine gravel to coarse sand, low plastic, dark brown														
4	SM		SAND - medium and fine gravel, silty transitional														
8.0	GC		GRAVEL - fine, clayey, very sandy, medium pebbles rounded to 3/8"														
13.0	SM		SAND - medium to coarse, silty, trace fine gravel increasing sand														

- 350 -

TEST HOLE No. N75-1060-B2-B

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.Y.	LAT. & LONG: 67°52'01"N, 131°54'00"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-98	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 18°C
	METHOD: AIR	
START: D 21 M 8 Y 75 TIME: 13:00	FINISH: D 21 M 8 Y 75 TIME: 13:20	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B2-B

SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						Plastic limit ————— Liquid limit 40 60 80 100 120 140 ▲ ○ 20 40 60 80 100 ○													
17.0		[Symbol]	SAND (cont'd)	[Symbol]	Nbs														
18.0		[Symbol]	GRAVEL - fine, silty, pebbles to 3/4", occasional coarse to 2"	[Symbol]															
20.0		[Symbol]	End of hole	[Symbol]													20.0	Loss of circulation 13:20	

TEST HOLE No. N75-1060-B2-B

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: D.V.	LAT. & LONG 67°52'01"N, 131°54'00"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No. A 22935-98	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-DRILL	AIR TEMP: 18°C
	METHOD: AIR	
START: D 21 M 8 Y 75 TIME: 13:00	FINISH: D 21 M 8 Y 75 TIME: 13:20	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B2-B

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG		LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
				NRC	ICE TYPE	▲ Dry density (pcf)		○ Water content %		Plastic limit									Liquid limit
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt	0.4	PEAT - fine fibrous, brown, roots		UF							MA, combined samples 1 - 5 G = 53% S = 40% F = 7%							
1	GB	2.5	GRAVEL - silty, and cmf sand, pebbles rounded to 3", possibly also gap-graded, whitish grey, dry										B1						
2																			
3			gravel to 3", rounded and sub-angular, cementation, rootlets										B2						
4	BW	3.4	GRAVEL - fine to coarse, and cmf sand, brown, cobbles rounded to 4"										B3						
5													B4						
6			Bottom of pit									B5							

- 352 -

TEST HOLE No. N75-1060-B2-1

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°51'44"N, 131°53'33"W	ELEVATION:
DRWN. BY: F.B.	AIRPHOTO No.: A 22935-88	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 21°C
	METHOD: TEST PIT	
START: D 21 M 08 Y 75	TIME: 09:00	FINISH: D 21 M 08 Y 75
		TIME: 11:45

1975 BORROW INVESTIGATION NORTHWEST ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-1060-B2-1 SHEET 1 OF 1
--	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %		Plastic limit								
					40	60	80	100	120	140	▲						
					0	20	40	60	80	100	○						
0.4	Pt		PEAT - coarse fibrous, dark brown	UF													
0.8	GM		GRAVEL - silty, orange brown coarse to fine, some cmf sand cobbles subrounded to 4"														
4.0			occasional cobble to 6" occasional ironstone														
5.8			boulder, rounded, 12" at 5.8'														
6.0			Bottom of pit														

MA, combined samples 1 - 5
G = 60%
S = 27%
F = 13%
(GM)


B1
B2
B3
B4
B5

- 353 -

TEST HOLE No. N75-1060-B2-2

LOGGED BY: R.H.	FACILITY:	PROJECT: 13611
CHKD: R.H.	LAT. & LONG: 67°51'52"W, 131°54'00"W	ELEVATION:
DRWN BY: G.B.	AIRPHOTO No.: A 22935-90	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 21 M 08 Y 75 TIME:	FINISH: D 21 M 08 Y 75 TIME:	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B2-2

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
							40	60	80	100	120	140 ▲								
							0	20	40	60	80	100 ○								
0.3	Pt		PEAT - amorphous																	
1.0	GM		GRAVEL - silty, some cmf sand, rust brown, dry		UF															
1.0 - 5.0	GM		GRAVEL - and cmf sand, trace silt pebbles rounded to 2", whitish grey, moist, loose										MA, combined samples 1 - 3 G = 54% S = 37% F = 9%	B1 B2 B3						
5.0			Bottom of pit																	

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°52'01"N, 131°53'12"W	ELEVATION:
DRWN BY: G.B.	AIRPHOTO No.: A 22935-98	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 21 M 08 Y 75	TIME: 17:00	FINISH: D 21 M 08 Y 75
		TIME: 19:20

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	1975 BORROW INVESTIGATION TEST HOLE No. N75-1060-B2-3 SHEET 1 OF 1
--	---

- 354 -


TEST HOLE No. N75-1060-B2-3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.4	Pt		PEAT - coarse fibrous, dark brown, dry		UF												18:50	
1.2	SM		SAND - medium grain, silty, trace gravel to 3/8", slight plastic, red-brown, dry														1	
3.2	GM		GRAVEL - silty, some fmc sand, cobbles rounded to 4", cementation, loose, dirty									MA, combined samples 1 - 5 Oversize 6.2% G = 62% S = 29% F = 8% (GW-GM)	B1			1.5		
													B2			2.0		
													B3			3.0	17:40	
													B4			4.0		
													B5			5.0		
6.0	GW		GRAVEL - some fmc sand, brown, cementation on gravel, cobbles rounded to 8"													6.0	18:10	
			Bottom of pit															Kame-like mound

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°51'53"N, 131°53'12"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 22935-98	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 21 M 08 Y 75	TIME: 16:50	FINISH: D 21 M 08 Y 75
		TIME: 18:10

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B2-4

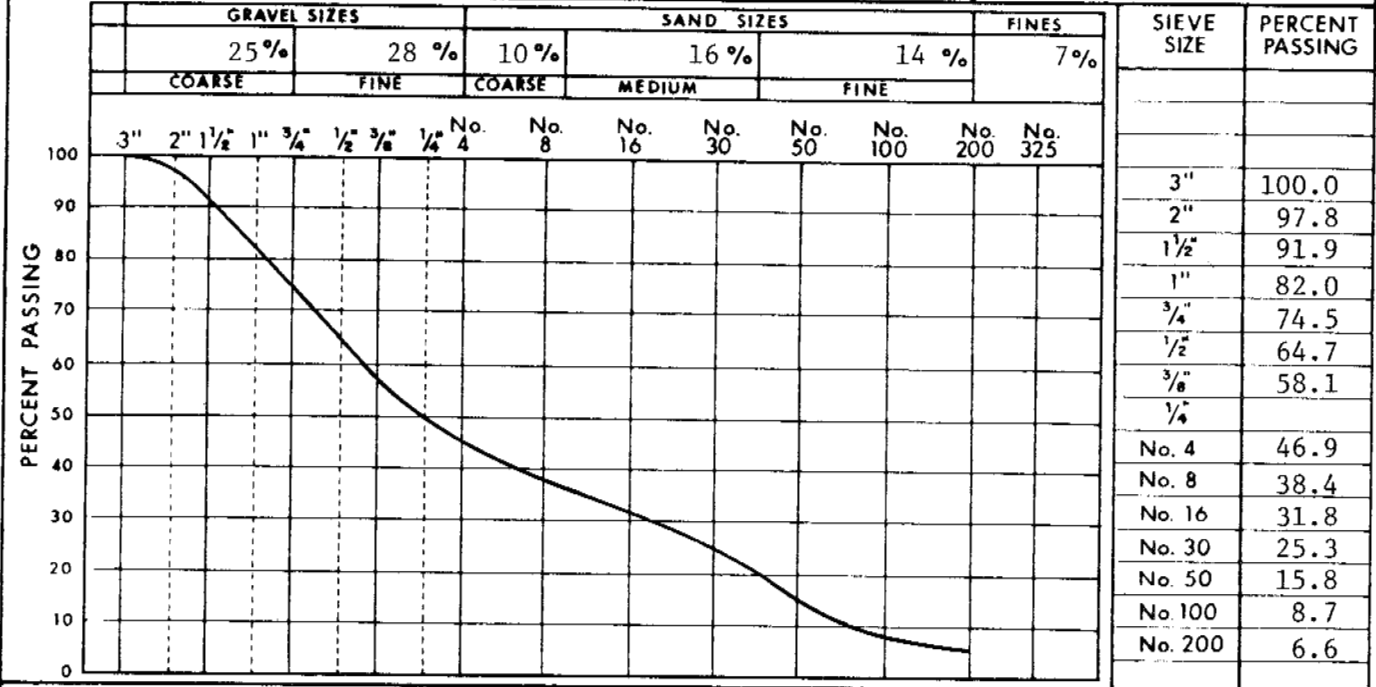
SHEET 1 OF 1

- 355 -

TEST HOLE No. N75-1060-B2-4

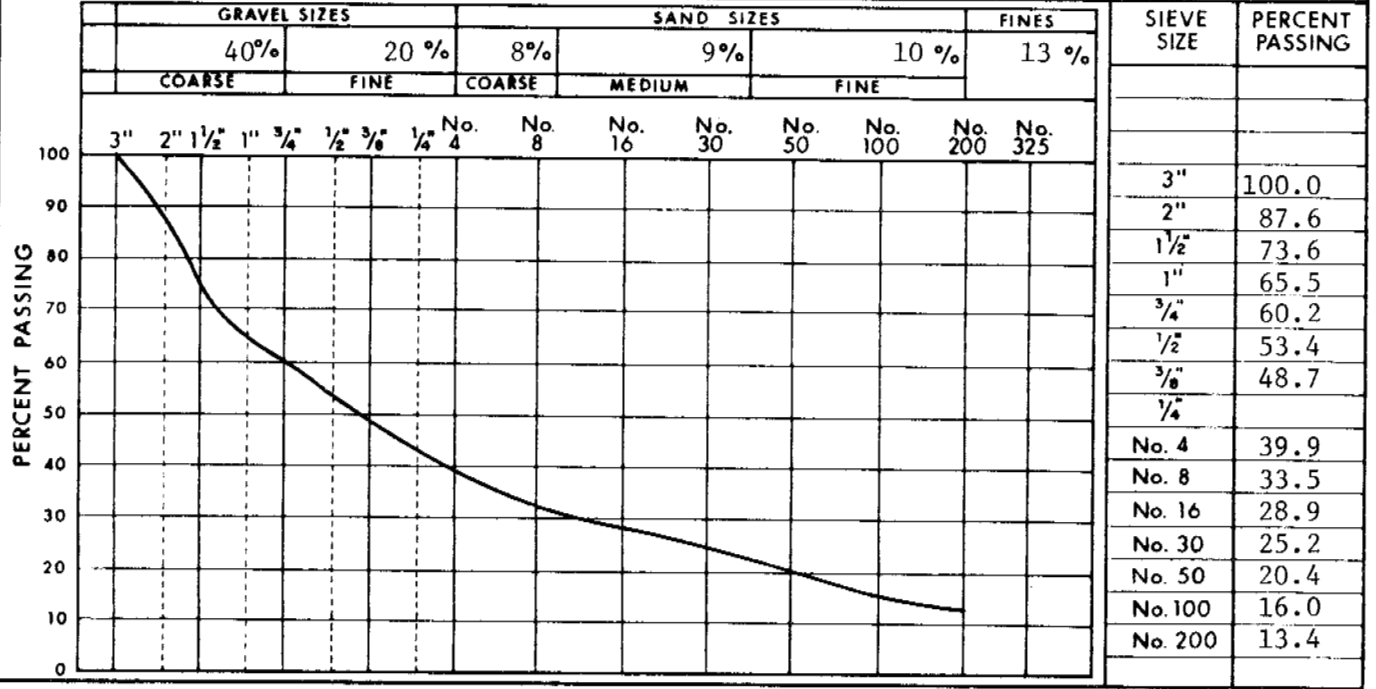
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B2-1 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 21, 1975 SAMPLED BY NESCL 54



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-1060-B2-2 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 21, 1975 SAMPLED BY NESCL 53



COMMENTS Moisture contents range from 3.5% to 8.3% OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

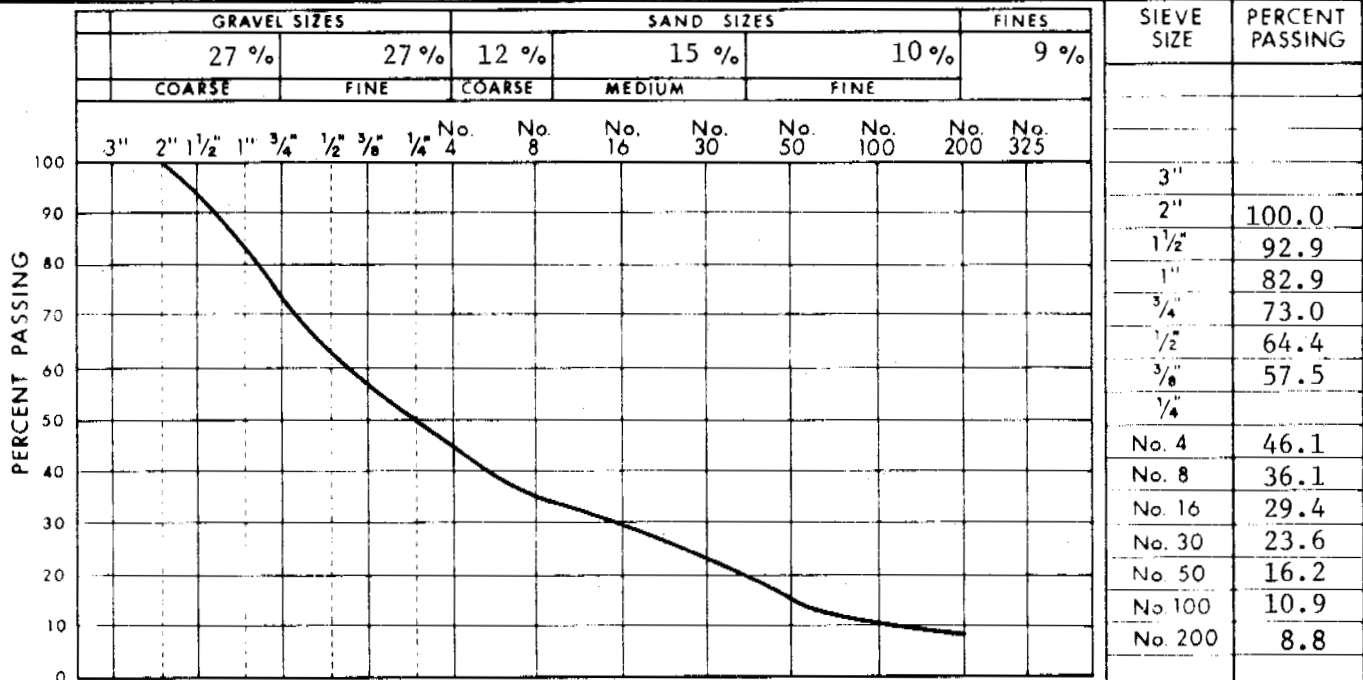


DEPOSIT No.
 N75-1060-B2
 PAGE
 356

SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B2-3 DEPTH 1.0-4.0
 DATE SAMPLED August 21, 1975 SAMPLED BY NESCL

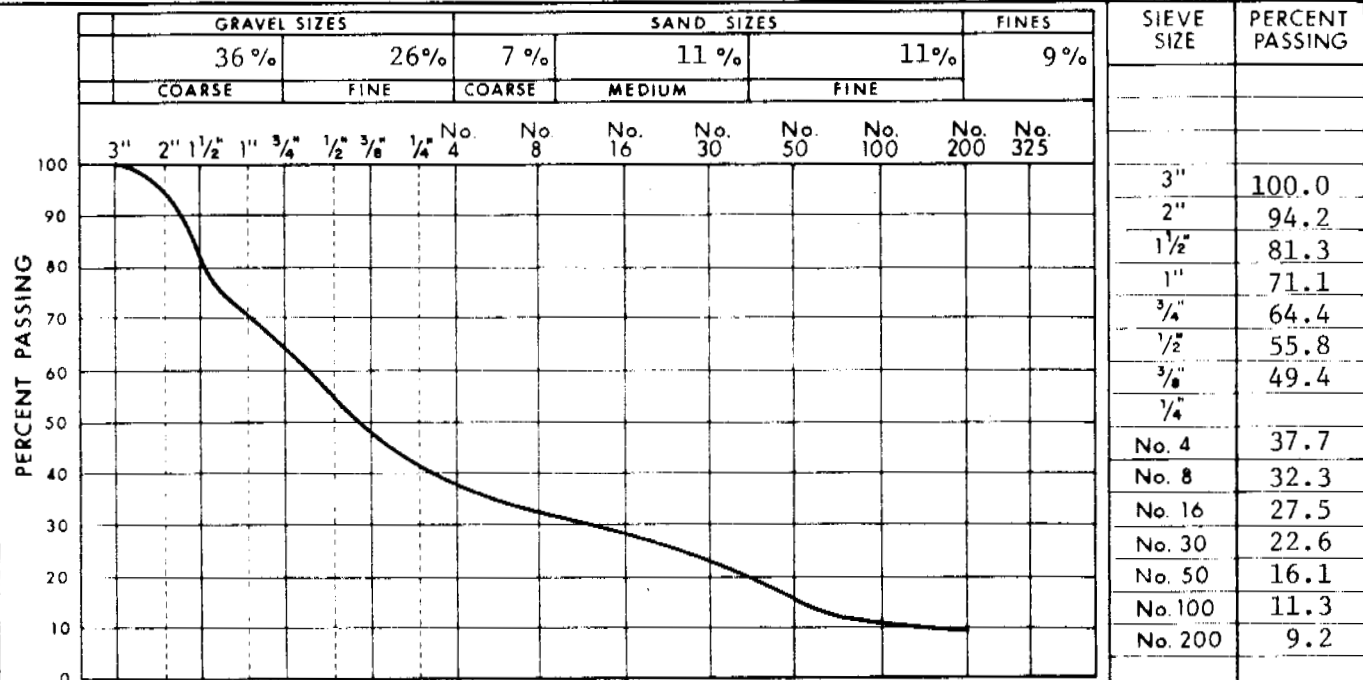
R.M.HARDY REPORT NUMBER
34



COMMENTS Moisture contents range from 3.9% to 6.0% OVERSIZE (>3") = 0.0%

SAMPLE N75-1060-B2-4 DEPTH 1.5-6.0
 DATE SAMPLED August 21, 1975 SAMPLED BY NESCL

R.M.HARDY REPORT NUMBER
154



COMMENTS OVERSIZE (>3") = 6.2%

R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

NORTHERN
 Engineering Services
 Company Limited

DEPOSIT No.
N75-1060-B2
 PAGE
357

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-1060-B2-2 DATE SAMPLED : August 21, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 1-6 DATE TESTED : January, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 3.25 %
 FINE AGGREGATE : LOSS = 12.30 %

ORGANIC IMPURITIES TEST

NUMBER : 2+
 COAL REMOVED : Nil
 COAL & ROOTLETS
 REMOVED : Nil
 COAL CONTENT : Nil
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 21.5 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Strong to very strong, Good	33.75
Granite		12.55
Basalt		0.35
Siltstone	Strong, Good	1.55
Limestone		4.55
Chert	Potentially reactive, Fair	0.3
Flint		1.9
Sandstone		4.85
Soft siltstone		0.25
Clay	Soft, Weak, Poor	1.35
Ironstone		1.2
PN = 192	INTERPRETATION : Poor	62.6

COMMENTS : Chert sandstone may be source of aggregate instability.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-1060-B2
 PAGE 358

1060 - B3 - A 392320E 7510420N

B3 - B 392760E 7511240N

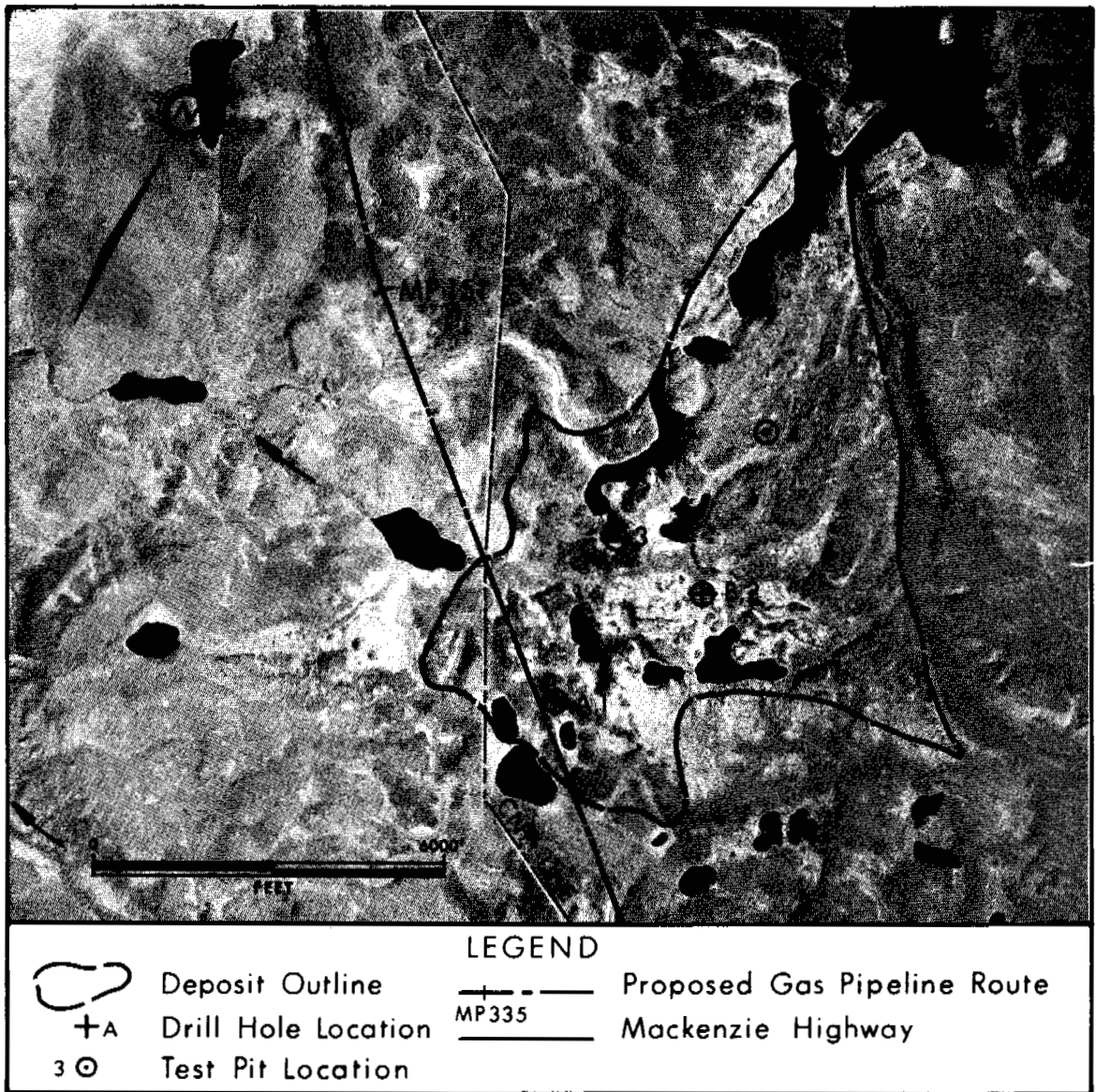
400 200 400
400 400

Physical Setting: Deposit 1060-B3 is a kame and kettle complex and channeled outwash plain located 3 miles east of Travaillant Lake and crossed by the right of way at milepost 153.

Material: SAND and GRAVEL - interbedded silty sand and gravel.

Volume: 10,000,000 cubic yards.

Assessment: Deposit 1060-B3 is a source of fair to good quality granular material suitable for general fill, backfill, and building pads. Access presents no problem as the right of way crosses the deposit.



Airphoto No. A22935-210
 Approximate Scale: 1" = 3100'

Latitude: 67° 42'
 Longitude: 131° 32'

DEPOSIT 1060-B3

PHYSICAL SETTING

Deposit 1060-B3 is a kame and kettle complex and channeled outwash plain located 3 miles east of Travaillant Lake. The proposed pipeline right of way crosses the deposit at milepost 153. This deposit corresponds to part of source number 1098 in EBA DIAND Granular Materials Inventory Volume III (1974) report.

The kame and kettle complex at the southern end of the deposit has relief in the order of 100 feet with slopes up to 20 degrees. Relief on the outwash plain is about 15 feet between bars and abandoned channels. Meltwater channels and lakes within the plain are inset about 100 feet below the outwash surface. Except for depressions, the site has very little overburden and drainage is moderately good to good. Peat and silt in excess of 5 feet are found in the depressions which are poorly drained. The active layer ranges from 1 to 8 feet in depth, below this the deposit is frozen with low ice content.

BIOLOGICAL SETTING

The vegetation at the site consists of light to moderately dense tree cover made up of white and black spruce and paper birch, a thick understory of soapberry, willow, alder, ericaceous shrubs and moss. The deposit is located in moose and caribou habitat. It is moderately productive lynx, fox, wolf, and marten habitat. The adjacent lakes appear to offer suitable waterfowl habitat but none were seen during the 1975 survey. Travaillant Lake, approximately 3 miles away, supports several fish species but the small lakes adjacent to the deposit appear to be unsuitable fish habitat. The site is located in an active trapping area.

MATERIAL

Drill hole, test pit logs and the DIAND report indicate that the material in this deposit is interbedded sand and gravel. Both gravel and sand are well graded, but silty. Further drilling would be required to assess material quality in the northern part of the deposit.

VOLUME

A total estimated volume for the kame-kettle complex, based on an area of 500 acres, and an average depth of 30 feet is 5,700,000 cubic yards. A total volume for the outwash plain, based on 600 acres and 10 foot depth over half the area, is 4,300,000 cubic yards. The conservative total volume for the deposit is 10,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 1060-B3 is a source of fair to good quality granular materials. Location of areas to be exploited will be dictated by haul distances, overburden thicknesses, insitu material quality, and material requirements. Granular material from this deposit may be used for general fill, backfill in pipeline construction and building pads.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Since the pipeline right of way crosses the southwest corner of the deposit, access is not a problem and haul distances will be short. Snow roads would be constructed to transport the borrow material from the deposit to haul points on the pipeline right of way.

Vegetative cover would have to be removed or disposed of in accordance with land use regulations. Overburden is negligible at this site, thus very little stripping and stockpiling will be necessary in the excavation area.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be maintained over the area. A perched water table exists in flatter areas and will have to be considered in development. Open face excavations could be developed along the steep slopes within the deposit. Smaller areas would be developed by this method and less clearing would be required. Excavations would be kept away from adjacent lakes to minimize siltation. Either type of development could be accomplished by using blasting or conventional earthmoving techniques. The excavated material may have to be stockpiled, thawed, and drained before it is used.

Equipment required for development would be dozers, rippers, end-dump trucks and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt		PEAT - fine fibrous, amorphous, woody inclusions, black		UF													4 1/4" Walmac bit 17:28
1.5																		
2	ML		SILT - little fine gravel, sandy, occasional coarse gravel, low plastic, pebbles to 3/4", grey brown		Vx Yr													
4.0																		
4.0	GM		GRAVEL - coarse, very silty, sandy		Nb													
5.0																		
6.0	SM		SAND - fine to medium, very silty, trace gravel															
8.0																		
8.0			SAND - and gravel, trace silt, medium to coarse, fine pebbles, occasionally coarse to 2"															3 7/8" Walmac bit 17:43
11.0																		
12.0	GM		GRAVEL - coarse, silty, sandy, fine, trace coarse, pebbles angular to 1/2"															
16.0																		

- 364 -

TEST HOLE No. N75-1060-B3-A

LOGGED BY: J. X. W.	FACILITY:	PROJECT: 13011
CHKD: D. V.	LAT. & LONG: 87°41'26"N, 131°32'48"W	ELEVATION:
DRWN BY: A. M.	AIRPHOTO No.: A 22935-209	PIPE MILEAGE:
CHKD: D. O.	RIG: HELI-DRILL	AIR TEMP: 18°C
	METHOD: AIR	
START: D 21 M 8 Y 75 TIME: 17:28	FINISH: D 21 M 8 Y 75 TIME: 18:45	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B3-A

SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	—————		Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
16	SC		SAND - very fine to medium, clayey, trace coarse gravel, moist when thawed															
18																		3 7/8" Walmac bit 18:00
20																		
21.0																		
22	GM		GRAVEL - coarse, and coarse sand, silty, angular		Yx													3 7/8" Tricone 18:20
23.0																		
24	SM		SAND - silty, trace coarse gravel, pebbles to 1.5" in upper 3.0'															
26																		
28	ML		SILT - sandy, fine to medium, low plastic															
28.0																		
29.0																		28.0 18:45
			End of hole															

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No.
CHKD: D.V.	LAT. & LONG: 67°41'26"N, 131°32'48"W	ELEVATION:		 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED
DRWN BY: A.M.	AIRPHOTO No.: A 22935-209	PIPE MILEAGE:		
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: 18°C		
	METHOD: AIR			
START: D 21 M 8 Y 75	TIME: 17:28	FINISH: D 21 M 8 Y 75	TIME: 18:45	SHEET 2 OF 2

- 365 -


TEST HOLE No. N75-1060-B3-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
2	GM		Very thin peat cover GRAVEL—fine to coarse, some fine to coarse sand, little silt, light brown, cobbles to 4".		UF													4 1/2" Walmac bit removed 8" cobble
4			4.0 --- large cobble or small boulders															cobbles and large pebbles falling into hole.
5			5.0 End of hole															to 4 1/2" rock bit. Hole going askew.
			NOTE: drill rig positioned on top of small mound, possibly kame. Cobbles, boulders exposed at surface.															At 5.0' depth hole is approx. 12" diameter with subsequent loss failure of air circulation.

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.Y.	LAT. & LONG: 67°41'51"N, 131°31'56"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No: A 22935-209	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 22 M 88 Y 75	TIME: 11:30	FINISH: D 22 M 08 Y 75
		TIME: 12:15

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.

N75-1060-B3-B

SHEET 1 OF 1

- 366 -

TEST HOLE No. N75-1060-B3-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○								
0.7	Pt		PEAT - amorphous, fine fibrous, black, spongy		UF													
1.3	Cl		CLAY - trace gravel, medium plastic, pebbles, subrounded 3/4", occasionally to 2", soft, wet, boulder to 12" at 1.3'															
2.1	GC		GRAVEL - coarse to fine, some cmf sand, some clayey fines, dark brown, till-like, occasional Vx to 3/8"		Nbe occ Vx													
4.0			Bottom of pit															

MA, sample 1
G = 46%
S = 33%
F = 21%
(GC)

B1

TEST HOLE No. N75-1060-B3-1

- 367 -

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011	NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-1060-B3-1 SHEET 1 OF 1
CHKD: D.O.	LAT. & LONG: 87°41'28"N, 131°32'48"W	ELEVATION:		
DRWN. BY: F.B.	AIRPHOTO No.: A 22935-208	PIPE MILEAGE:		
CHKD: D.O.	RIG:	AIR TEMP: 21°C		
	METHOD: TEST PIT			
START: D 22 M 08 Y 75 TIME: 12:30		FINISH: D 22 M 08 Y 75 TIME: 14:30		

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %		Plastic limit									
0.5	Pt		PEAT - amorphous, coarse fibrous, roots, black	UF														
1.0			GRAVEL - and cmf sand, little silt, rust brown, cobbles subrounded to 5", occasional boulder app. 8"															
1.8			--- cementation, platy 8" x 3", whitish grey, occasional soft laminated sandstone															
3.0			--- frequent boulders, rounded to 13"															
4.0			--- ironstone, rust brown															
5.0			Bottom of pit															

LOGGED BY: R.H.	FACILITY:	PROJECT: 130 11
CHKD: R.H.	LAT. & LONG: 87°41'51"N, 131°31'58"W	ELEVATION:
DRWN. BY: G.B.	AIRPHOTO No.: A 22835-208	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 24°C
	METHOD: TEST PIT	
START: D 22 M 08 Y 75 TIME: 13:00	FINISH: D 22 M 08 Y 75 TIME: 14:30	

<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>TEST HOLE No.</p> <p>N75-1060-B3-2</p> <p>SHEET 1 OF 1</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	

- 368 -

TEST HOLE No. N75-1060-B3-2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	Pt		PEAT - amorphous, fine fibrous, dark brown		UF													No samples taken
			0.8															
1	PT + DL		PEAT- with silt (organic) non-plastic, black, occasional organic inclusions to depth of 1.5', then numerous inclusions		No occ. Yx													
			1.0															
			1.5															
2			2.0		Yx 25													
2	ICE +		ICE - clear (85%) with SILT (organic), black		ICE +													
			2.0															
3			3.0															Abandoned
			Bottom of pit															

TEST HOLE No. N75-1060-B3-3

- 369 -

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°41'55"N, 131°32'41"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-209	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 10°C
	METHOD: TEST PIT	
START: D 22 M 08 Y 75 TIME: 11:45	FINISH: D 22 M 08 Y 75 TIME: 12:15	

<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-1060-B3-3</p> <p>SHEET 1 OF 1</p>
--	---

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
	Pt		0.3 PEAT - coarse fibrous, brown		UF	40	60	80	100	120	140 ▲							19:40	
1	SM		SAND - med, and fine to coarse gravel, some silt, roots, brown			0	20	40	60	80	100 ○							1	
2	Cl		2.0 CLAY - medium plastic, grey, nuggetted, moist, cool									MA, sample 1 G = 35% S = 45% F = 20% Oversize = 10.15	B1				20:10 21/08/75 11:15 22/08/75	2	
3			3.2 Bottom of pit														3.2		

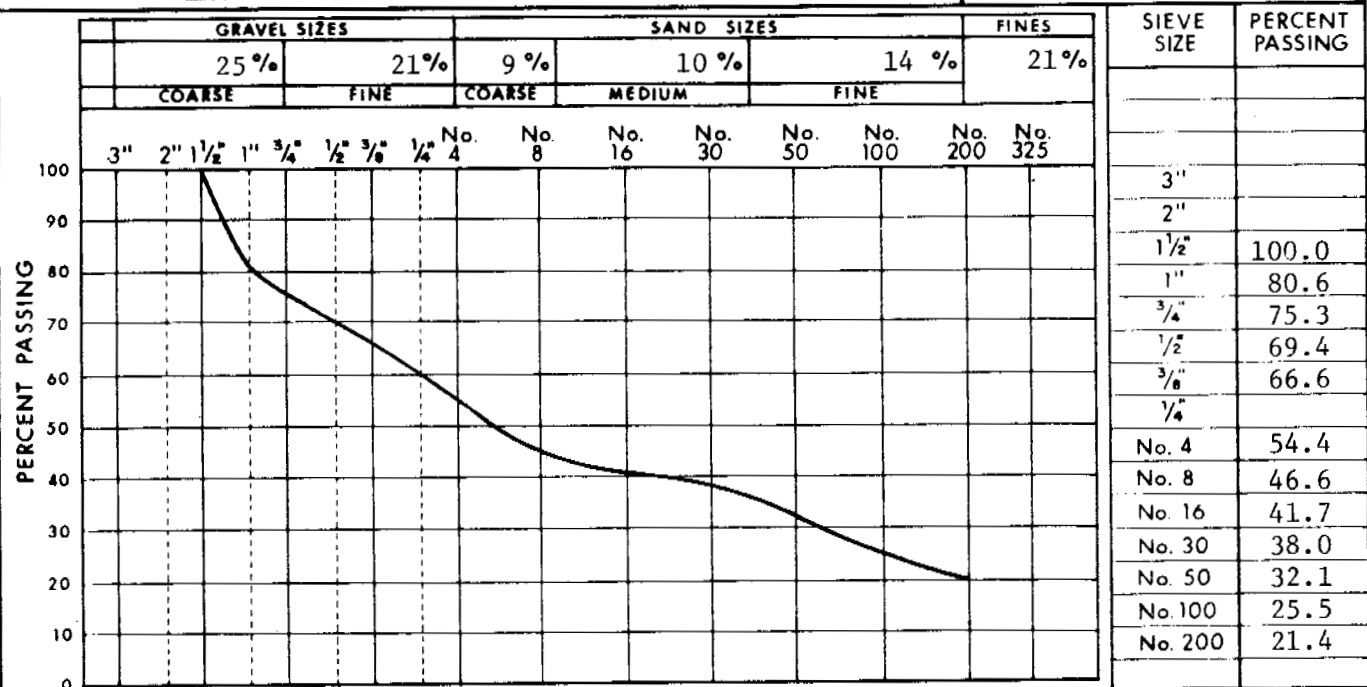
TEST HOLE No. N75-1060-B3-4

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°42'19"N, 131°32'00"W	ELEVATION:
DRWN BY: F.F.B.	AIRPHOTO No.: A 22935-209	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 21 M 08 Y 75	TIME: 19:40	FINISH: D 22 M 08 Y 75
		TIME: 11:40

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	1975 BORROW INVESTIGATION TEST HOLE No. N75-1060-B3-4 SHEET 1 OF 1
CANADIAN ARCTIC GAS STUDY LIMITED	

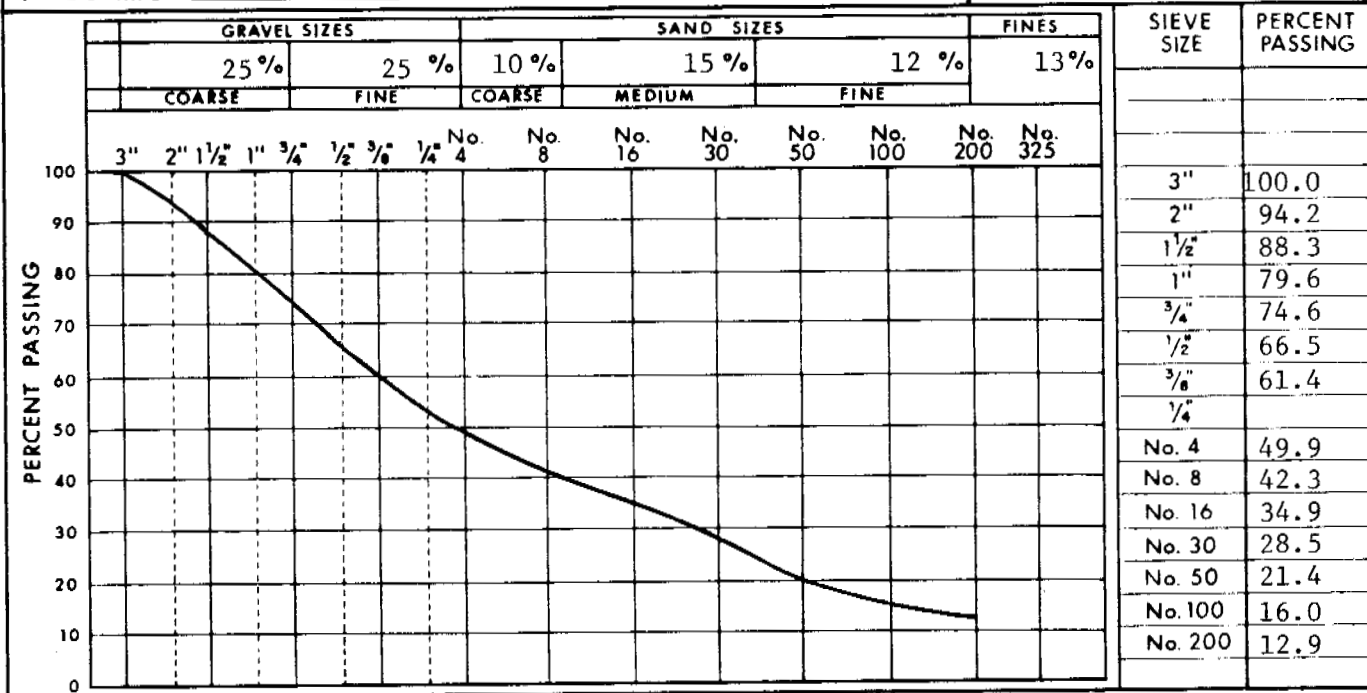
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B3-1 DEPTH 3.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 22, 1975 SAMPLED BY NESCL 50



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-1060-B3-2 DEPTH 2.0-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 22, 1975 SAMPLED BY NESCL 43

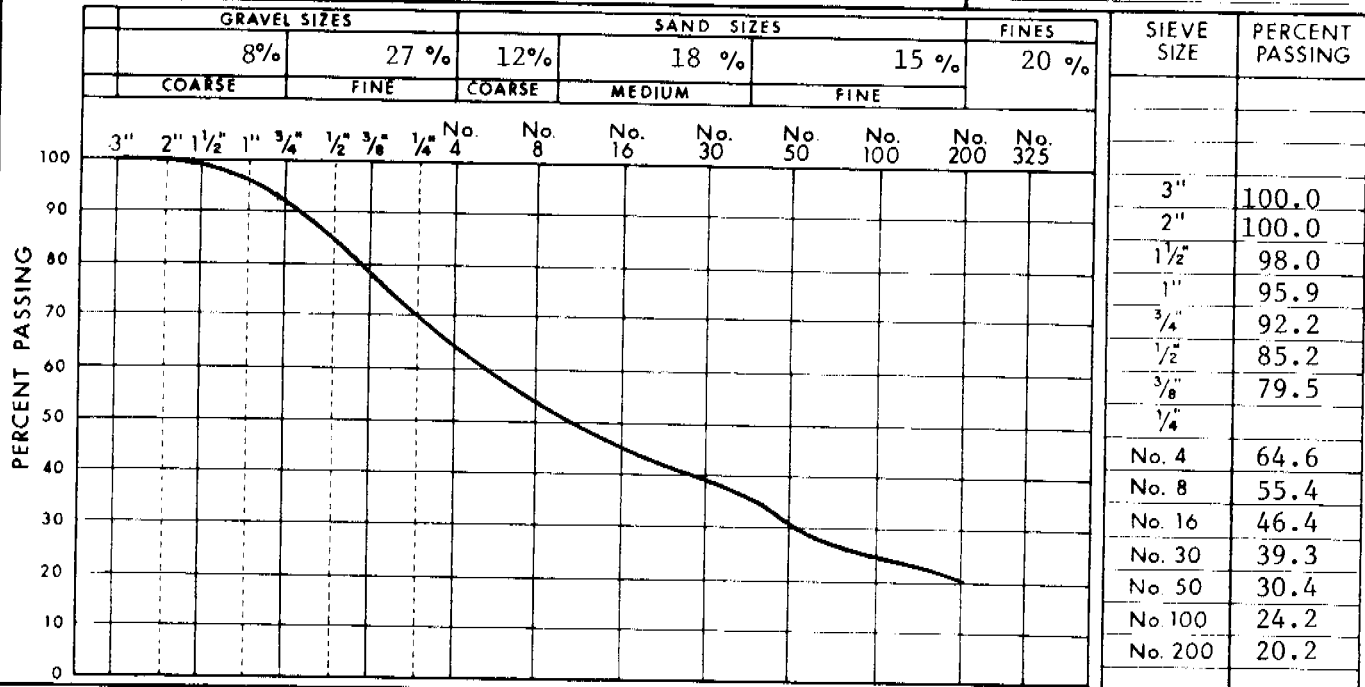


COMMENTS OVERSIZE (>3") = 21.8 %
 Moisture contents range from 3.9% to 11.3%.

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-1060-B3 <hr/> PAGE 371
---	--	---	---

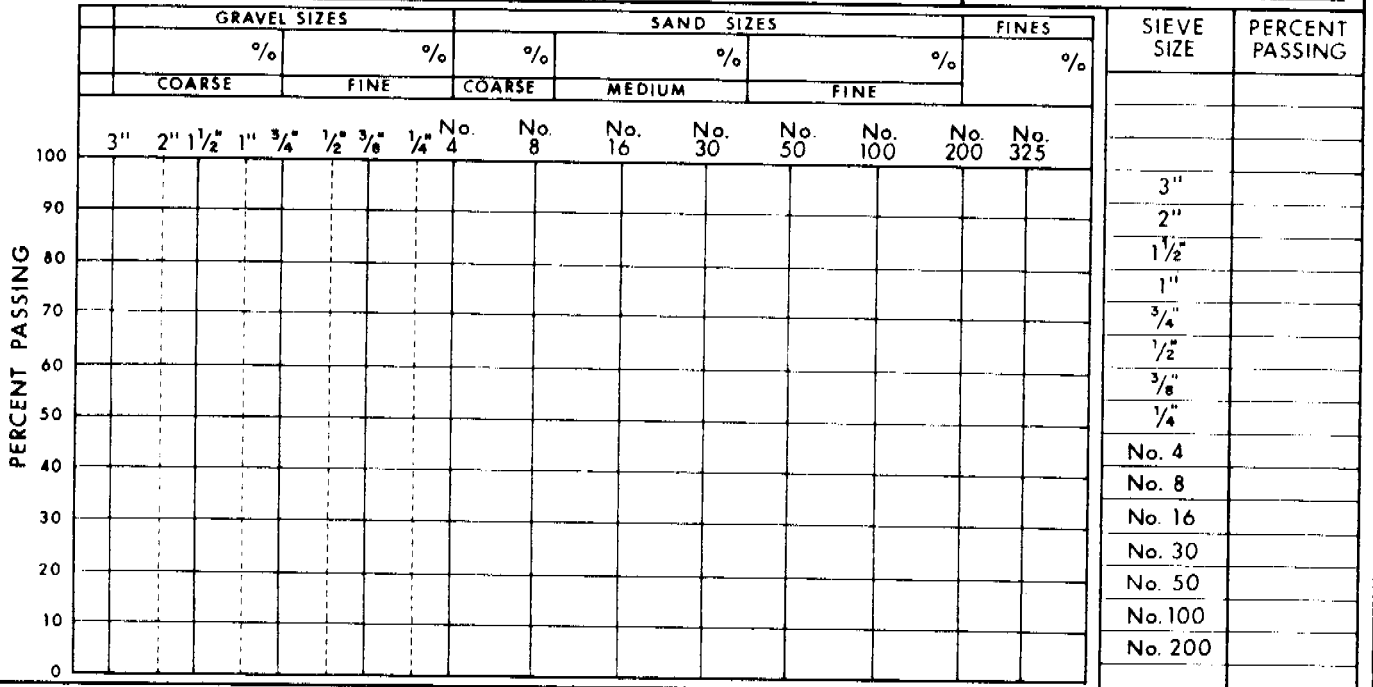
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B3-4 DEPTH 1.5-2.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 21, 1975 SAMPLED BY NESCL 77



COMMENTS OVERSIZE (>3") = 10.1%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS OVERSIZE (>3") = %

<p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	<p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-1060-B3
		PAGE 372

1060 - B4 - A 417710E 7487520N

B4 - B 420720E 7491780N

DEPOSIT 1060-B4

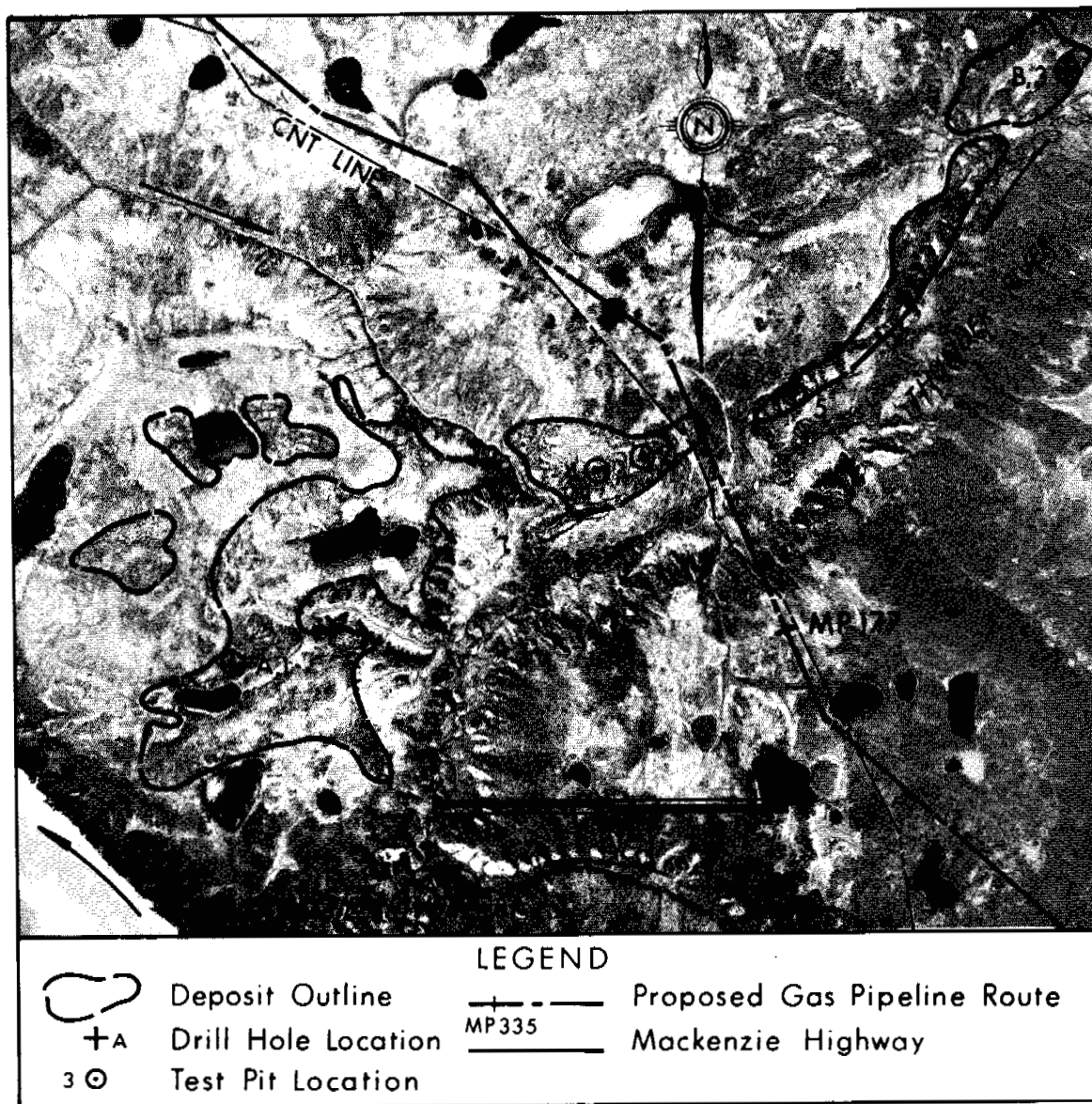
See 1064-1 EBA

Physical Setting: Deposit 1060-B4 consists of an eroded kame terrace, an outwash plain and a fluvial terrace along the western edge of Thunder River canyon and is crossed by the proposed pipeline at milepost 174.

Material: SAND - fine to medium, with a varying silt content.

Volume: 13,000,000 cubic yards.

Assessment: Deposit 1060-B4 is a source of fair quality granular material suitable for general fill and backfill. Haul distances to the right of way are up to 2 miles.



Airphoto No. A22935-81
Approximate Scale: 1" = 3050'

Latitude: 69° 31'
Longitude: 130° 53'

DEPOSIT 1060-B4

PHYSICAL SETTING

Deposit 1060-B4 is a combination of remnants of an eroded kame terrace, an outwash plain and a fluvial terrace. It extends from 1 mile north of the Thunder River and Mackenzie River confluence in a northerly direction along the western edge of the Thunder River canyon. The proposed pipeline right of way crosses the centre of the deposit at milepost 174. This deposit corresponds to source numbers 1084 and part of 1089 in EBA DIAND Granular Materials Inventory Volume III (1974) report.

The southern portion of the deposit consists of fragments of an outwash plain with a flat to gently sloping surface. Channels have been incised into the outwash to depths of 30 feet.

The middle of the deposit consists of fluvial terraces formed during postglacial excavation of the Thunder River valley. These terraces stand 150 to 200 feet above the river valley and 50 to 100 feet below the level of the upland, and are separated by steep scarps. Their upper surfaces slope gently to the east. Some gullies have formed perpendicular to the valley, but are presently inactive.

The northern segment of the deposit is either an esker, or more likely, an eroded kame terrace that parallels the Thunder River canyon. It is defined by a 300 foot scarp on the river side and a 50-foot scarp on the upland side.

All parts of the deposit are moderately to well drained with negligible overburden, except for some of the abandoned channels where peat and silt cover is thicker and drainage is poor. The active layer varies from 1 to 8 feet and is deepest in well drained areas. Generally, ice content is low although a few ice lenses were encountered in drill hole 1060-B4-A.

A deep gully separates the southern part of the deposit from the pipeline right of way.

BIOLOGICAL SETTING

Vegetation at this extensive site consists of white spruce, black spruce, paper birch, Labrador tea, lichen, and moss. In the better drained areas, spruce reach heights of 50 feet or more while stunted spruce, shrubs, and sedges are more prevalent in imperfectly to poorly drained areas. Banks of the Thunder River valley provide good denning habitat for bear and other denning species. The general area is used by caribou, marten, lynx, fox, snowshoe hare and wolf. Year-round habitat is available for moose. Several well-used game trails cross the site. Bear, snowshoe hare, and red squirrel sign were observed during the 1975 survey. Nearby lakes and streams provide suitable habitat for aquatic furbearers and waterfowl. Waterfowl are most numerous during the April to May period when they congregate on the Mackenzie River. No raptor sign was observed in the area although potential habitat is available. Grouse and ptarmigan are common in the area. The Thunder River supports populations of grayling, lake trout, round whitefish, broad whitefish, pond smelt, pike and longnose suckers.

MATERIAL

The material in this deposit is mainly fine to medium sand with varying silt content. Occasional thin, poorly graded gravel beds are scattered throughout the section.

VOLUME

In the southern section of the deposit the drill hole log shows 20 feet of sand without excess ice and a further 5 feet of icy sand before encountering silt and clay. A conservative volume estimate of 4,300,000 cubic yards is based on a depth of 15 feet and area of 300 acres.

Granular material in the two northern parts of the deposit is probably in excess of 50 feet thick. A very conservative depth of 20 feet and area of 300 acres gives a total estimated volume of 8,700,000 cubic yards.

The combined volume of the whole deposit is conservatively estimated at 13,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 1060-B4 is a source of fair quality granular materials. Location of areas to be exploited will be dictated by haul distances, overburden thicknesses, insitu material quality, material requirements, and any required protection of the Thunder River valley environment.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit with equipment may be achieved by barge to Thunder River, and overland via the pipeline right of way, from there to the deposit. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way.

Tree and vegetative cover will have to be removed and harvested or disposed of in accordance with land use regulations. Overburden is negligible, therefore little or no stripping will be required.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas to a grade that would maintain good drainage over the area. Open face pit development could be

established on the steep slopes within the deposit. Either type of development could be accomplished by conventional earthmoving techniques since drainage is generally good and ice content low. Excavations will be kept away from lakes and the Thunder River to prevent siltation. Granular material from this deposit may be used for general fill and backfill in pipeline construction. The excavated material may have to be stockpiled, thawed, and drained before it is used.

Equipment required for development would be dozers, rippers, end-dump trucks and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.5	PT		PEAT cover		UF													
2.0	SP		SAND - fine to medium, trace silt, light rust brown, moist															
3.0			grey brown, less silt															
4.0			damp when thawed		Nbn													
6.0	SM		SAND - silty, grey															
10.0	SP		SAND - fine to medium, fairly clean															
12.0			trace silt															

Nearby test pit frozen at depth 4.8'

TEST HOLE No. N75-1060-B4-A

- 379 -

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No. N75-1060-B4-A
CHKD: D.O.	LAT. & LONG: 67°29'27"N, 130°55'10"W	ELEVATION:		
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-81	PIPE MILEAGE:	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 7°C		
	METHOD: AIR			
START: D 24 M 8 Y 75	TIME: 11:00	FINISH: D 24 M 8 Y 75	TIME: 11:20	CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
18	SP	17.0	SAND (cont'd)		Mbn													
18	SW	18.0	SAND - medium to coarse, little fine gravel															
18	ICE +		JCE - fine to medium grained sand, silty at 18.0' but possibly ICE + SM		ICE + ?													
20																		
22																		
24	SM	24.0	SAND - silty		Nb													
28																		
28	ICE +	27.0	ICE + SILT - some fine to medium sand, trace clay		ICE +												27	no cutting return
30																		
30		30.0	ICE + CLAY - silty, trace fine sand														30	cutting return
			End of hole															

- 380 -

TEST HOLE No. N75-1060-B4-A

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°28'27"N, 130°55'10"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-81	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 7°C
	METHOD: AIR	
START: D 24 M 8 Y 75 TIME: 11:00	FINISH: D 24 M 8 Y 75 TIME: 11:20	


 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>TEST HOLE No. N75-1060-B4-A</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>SHEET 2 OF 2</p>

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0			peat cover 0.1' thick on surface															4 1/4" Walmac bit
2	SM		SAND - fine, silty, light brown		UF													
4	SP		SAND - medium-grained, clean, trace fine sand, light grey brown		Nb													
7	SC 7		stratified visible ice layer in one piece of clay return		Vs													To new 3 7/8" Walmac bit.
8	CL		CLAY - silty, and fine to coarse gravel, pebbles average 3/4"		Nb													
10																		
12	SP		SAND - medium, trace silt.															
14	SP		GRAVEL - coarse, some medium sand, trace clay to 14.9'															
16			GRAVEL - fine, fairly clean															drill chatter 15:35

TEST HOLE No. N75-1060-B4-B

LOGGED BY: B.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.V.	LAT. & LONG: 67°32'32"N, 130°50'13"W	ELEVATION:
DRWN. BY: A.W.	AIRPHOTO No.: A 22935-81	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 22 M 08 Y 75 TIME: 15:15	FINISH: D 22 M 08 Y 75 TIME: 18:30	

<p>1975 BORROW INVESTIGATION</p>  <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>TEST HOLE No. N75-1060-B4-B</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>SHEET 1 OF 3</p>


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
16	GP		GRAVEL—fine, some medium sand		Nb												18	
18			18.0 coarse gravel, some coarse sand, little fine gravel															
20			20.0 gravel coarser, less medium sand														20	15:40
22			23.0 SAND—medium to coarse, little fine gravel, clean.															
24	GP		GRAVEL—fine to coarse, little medium to coarse sand.															
26			27.0 medium to coarse sand, clean.															
28	SP		SAND—medium grained, trace coarse.															
30																		
32																	32	16:00

TEST HOLE No. N75-1060-B4-B

LOGGED BY: D.M.H	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 87°32'32"W, 130°50'13"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 22935-81	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 22 M 08 Y 75	TIME: 15:15	FINISH: D 22 M 08 Y 75
		TIME: 18:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B4-B


SHEET 2 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
32	SP		SAND		Nb											32		
34																		
36			medium grained, little coarse grained.															
38																		
40																		
42																		
44			44.0 End of hole													44	18:30 Stem difficult to withdraw, end of hole.	

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.G.	LAT. & LONG: 67°32'32"N, 130°50'13"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 22835-81	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI DRILL	AIR TEMP: Approx. 24°C
	METHOD: AIR	
START: D 22 M 09 Y 75	TIME: 15:15	FINISH: D 22 M 08 Y 75
		TIME: 18:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No. **N75-1060-B4-B**

SHEET 3 OF 3

- 383 -

TEST HOLE No. N75-1060-B4-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.3	Pt		PEAT - amorphous, coarse fibrous		UF												24/08/75	
1.0			SAND - fine-grained, and silt, rust brown															
1.8			occasional red brown layers to 1/4"															
2.0			1.0' - grey brown															
4.6			Bottom of pit															
4.8			Excavation in one corner of test pit		Non												logged 11:00 25/08/75	

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 87°28'27"N, 130°55'10"W	ELEVATION:
DRWN. BY: G. B.	AIRPHOTO No.: A 22935-81	PIPE MILEAGE:
CHKD: D. O.	RIG:	AIR TEMP: Approx. 4°C
	METHOD: TEST PIT	
START: D 24 M 08 Y 75	TIME:	FINISH: D 24 M 08 Y 75
		TIME:

1975 BORROW INVESTIGATION	 NORTHEN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No.
CANADIAN ARCTIC GAS STUDY LIMITED		N75-1060-B4-1
		SHEET 1 OF 1

- 384 -

TEST HOLE No. N75-1060-B4-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
0.3	Pt		PEAT		UF														No samples taken
	SM		SAND - fine-grained, trace clayey silt																
			trace gravel to 3'', dilatant																
4.2			GRAVEL - some sand, fine-grained, pebbles to 1'', subrounded																
4.5	GP		Bottom of pit																Possibly a pocket of gravel
			Fine sand																

TEST HOLE No. N75-1060-B4-2

LOGGED BY: W.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG.: 67°30'21"N, 130°53'10"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22835-81	PIPE MILEAGE:
CHKD: D.D.	RIG:	AIR TEMP.: Approx. 21°C
METHOD: TEST PIT		
START: D 22 M 08 Y 75 TIME:	FINISH: D 22 M 08 Y 75 TIME:	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B4-2


SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.5	Pt		PEAT - amorphous, fine fibrous, woody inclusions, dark brown		UF														
1.5	SM		SAND - medium to fine, silty, rust brown																
1.5			medium to fine grained, some fine gravel (to 1/2") little silt, gray, well bonded by ice		Nbn								MA, sample 1 G = 24% S = 83% F = 13%	B1				1.5	probable iron oxides
2.5													MA, combined samples 2 & 3 G = 9% S = 85% F = 8%	B2				2	
3.2	SM		SAND - medium grain, trace coarse, non-plastic, brown, clean 1 1/4" layer with organic silt at 3.2'											B3				3	Difficult to excavate from 1.5'
4.0			Bottom of pit															4	
			Refer also to drillhole N75-1060-B4-B approximately 25' N.W. of test pit																

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°32'32"W, 130°50'13"W	ELEVATION:
DRWN. BY: F.B.	AIRPHOTO No.: A 22895-81	PIPE MILEAGE:
CHKD: B.B.	RIG:	AIR TEMP: 24°C
	METHOD: TEST PIT	
START: D 22 M 08 Y 75 TIME: 17:00	FINISH: D 22 M 08 Y 75 TIME: 18:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B4-3

SHEET 1 OF 1

- 386 -

TEST HOLE No. N75-1060-B4-3


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○									
0	Pt	0.2	PEAT - coarse, fibrous, roots		UF														
1	GM		GRAVEL - and sand, medium, silty, rust brown, dry, cobbles to 5", rounded																
2	GM	2.0																	
3	GM		GRAVEL - little sand, medium grain, pebbles to 1½", transition to SAND - medium, coarse, fine, little gravel									MA, sample 1 G = 30% S = 84% F = 8% (SW) MA, combined samples 2 - 4 G = 23% S = 72% F = 5% (SW)	B1				2	combined horizons SAND, mcf, some gravel	
4	SW	3.5											B2				3	combined SAND, mcf, some gravel	
5			SAND - medium grain, some gravel to 1½", clean, moist, loose										B3						
6		5.5	damp										B4						
6		6.0	Bottom of pit																
			Frozen at 6.0'		F														

TEST HOLE No. N75-1060-B4-4

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°30'14"N, 130°53'21"W	ELEVATION:
DRWN BY: F.B.	AIRPHOTO No.: A 22935-81	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: 21°C
	METHOD: TEST PIT	
START: D 22 M 08 Y 75	TIME: 20:15	FINISH: D 22 M 08 Y 75
		TIME: 21:20

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS 700

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B4-4
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.7	Pt		PEAT - woody, very sandy, black, compact		UF													
0.7 - 2.3	SN		SAND - fine, silty, damp, brown									MA, combined samples 1 - 4 G = 32% S = 57% F = 11% (SW-SM)	B1				1	Combined samples from 0.7' to 5.9' "Sand, fine to medium grain, some fine to coarse gravel, little silt"
2.3 - 3.2	GM		GRAVEL - fine, silty, little sand, medium pebbles to 3/4", occasionally to 2"										B2				2	
3.2 - 3.9	SP		SAND - medium to fine, trace silt, trace fine gravel, damp medium grained, some gravel, trace silt, pebbles to 2"										B3				3	
3.9 - 5.9	SP		SAND - medium to fine, trace silt, trace fine gravel, damp medium grained, some gravel, trace silt, pebbles to 2"										B4				4	
5.9			Bottom of pit														5	
			Frozen at 5.9'														6	

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°30'45" N, 130°52'28" W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 22935-81	PIPE MILEAGE:
CHKD: B.O.	RIG:	AIR TEMP: Approx. 18°C
	METHOD: TEST PIT	
START: D 23 M 08 Y 75	TIME:	FINISH: D 23 M 08 Y 75
		TIME: 14:00

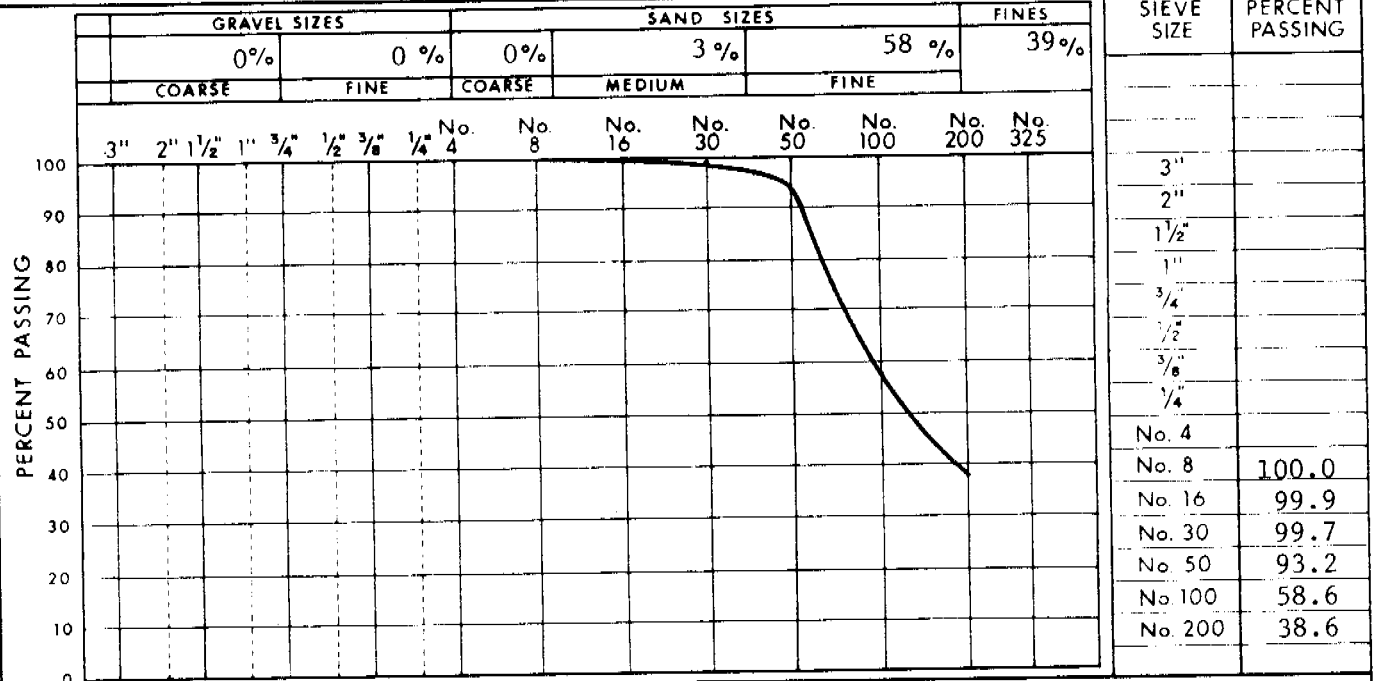
1975 BORROW INVESTIGATION	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No.
CANADIAN ARCTIC GAS STUDY LIMITED		N75-1060-B4-5
		SHEET 1 OF 1

- 388 -

TEST HOLE No. N75-1060-B4-5

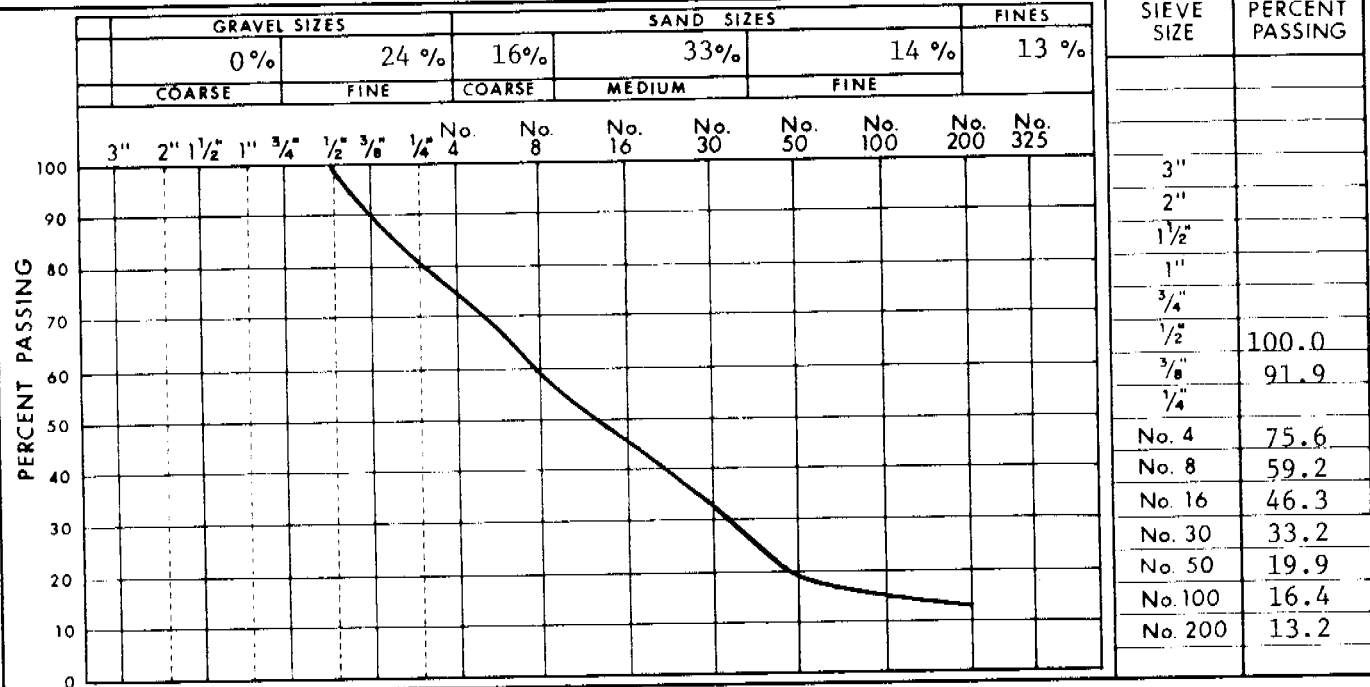
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B4-1 DEPTH 0.5-4.5 R.M.HARDY REPORT NUMBER 44
 DATE SAMPLED August 24, 1975 SAMPLED BY NESCL



COMMENTS Moisture contents range from 7.7% to 20.0% OVERSIZE (>3") = 0.0%

SAMPLE N75-1060-B4-3 DEPTH 1.5-2.0 R.M.HARDY REPORT NUMBER 16
 DATE SAMPLED August 22, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0%



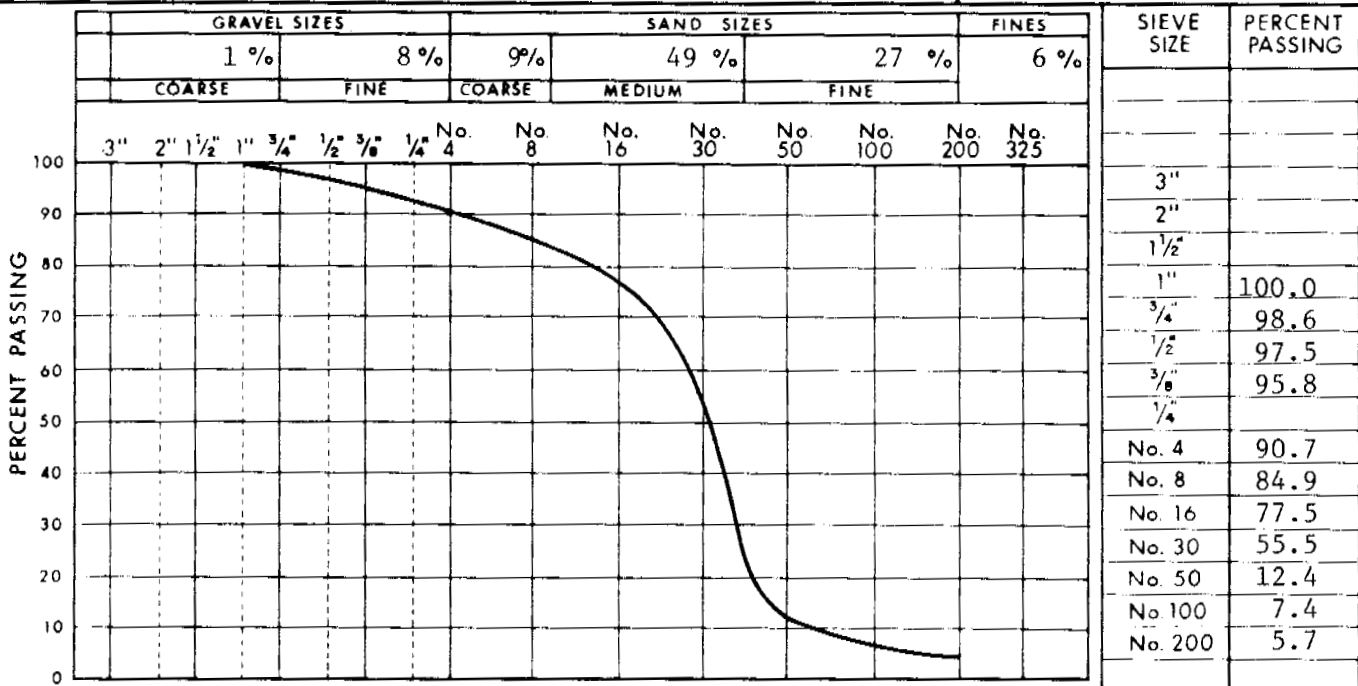
R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-1060-B4
 PAGE
 389

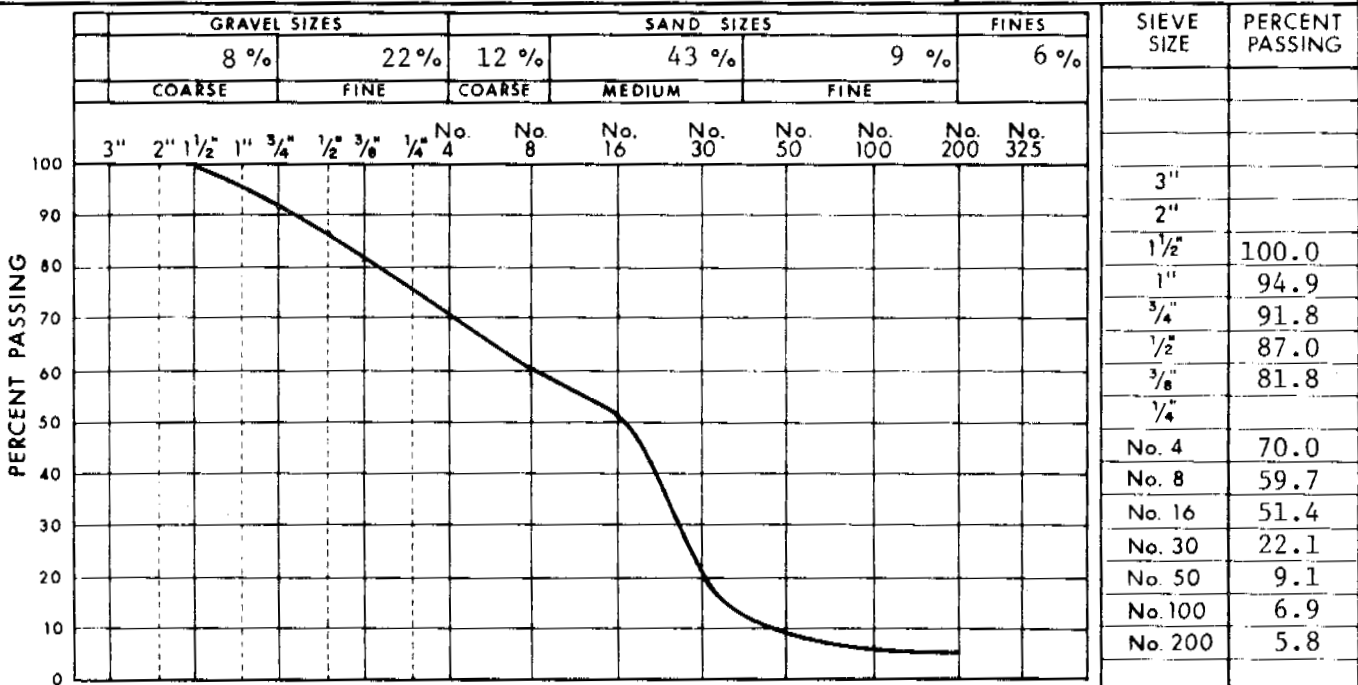
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B4-3 DEPTH 2.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 22, 1975 SAMPLED BY NESCL 15





COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-1060-B4-4 DEPTH 2.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 22, 1975 SAMPLED BY NESCL 21

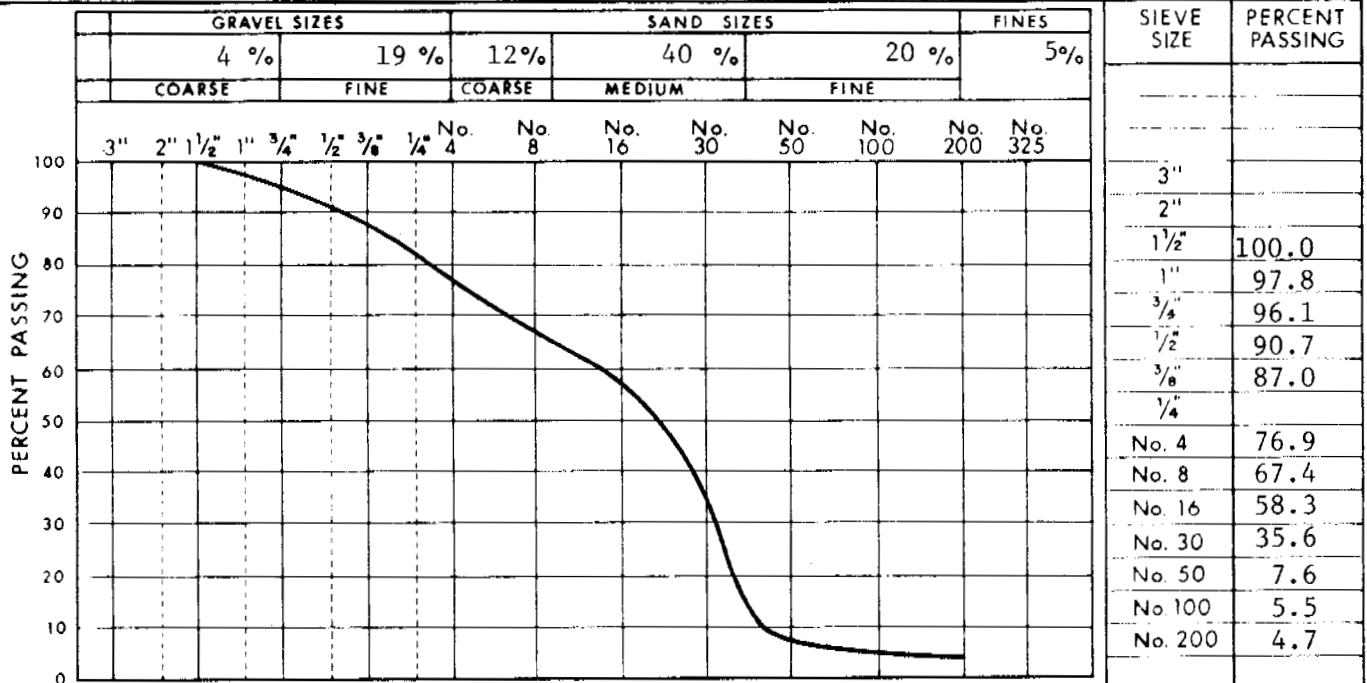


COMMENTS OVERSIZE (>3") = 0.0 %

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-1060-B4
			PAGE 390

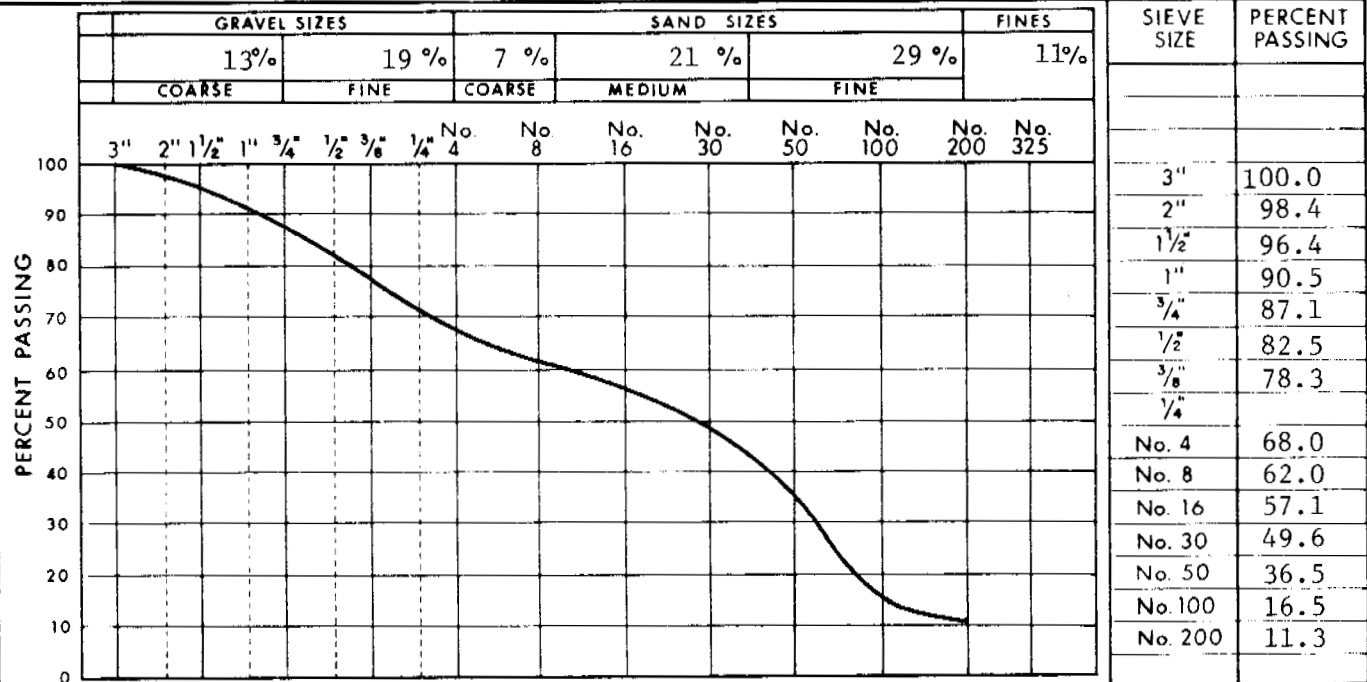
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B4-4 DEPTH 3.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 22, 1975 SAMPLED BY NESCL 20



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-1060-B4-5 DEPTH 0.7-5.9 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 23, 1975 SAMPLED BY NESCL 148



COMMENTS OVERSIZE (>3") = 0.0 %

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-1060-B4-5 DATE SAMPLED : August 23, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 0.7-5.4 DATE TESTED : January, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 3.91%
 FINE AGGREGATE : LOSS = 6.48%

ORGANIC IMPURITIES TEST

NUMBER : 2
 COAL REMOVED : Nil
 COAL & ROOTLETS
 REMOVED : Nil
 COAL CONTENT : Nil
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 17.9%

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Strong to very strong, Very good	22.8
Granite		1.15
Gneiss		0.05
Sandstone	Medium strong, Good	1.1
Siltstone		2.8
Limestone		2.15
Chert	Potentially reactive, Fair	0.4
Flint		1.2
Ironstone	Soft, Friable, Poor	0.35
PN = 135	INTERPRETATION : Fair quality	32.0

COMMENTS : Majority of rock types present in sample are fresh and sound, strong to very strong, with no tendency to split or to flake. Alkali Aggregate Reaction (ASTM C227-71 & CSA A23.2.24 expansion after 3 months = 0.031%; 6 months 0.04% (satisfactory)).



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-1060-B4

PAGE 392

1060 - B5 - A	422130E	7485900N
B5 - B	421960E	7486240N
B5 - C	421170E	7485260N

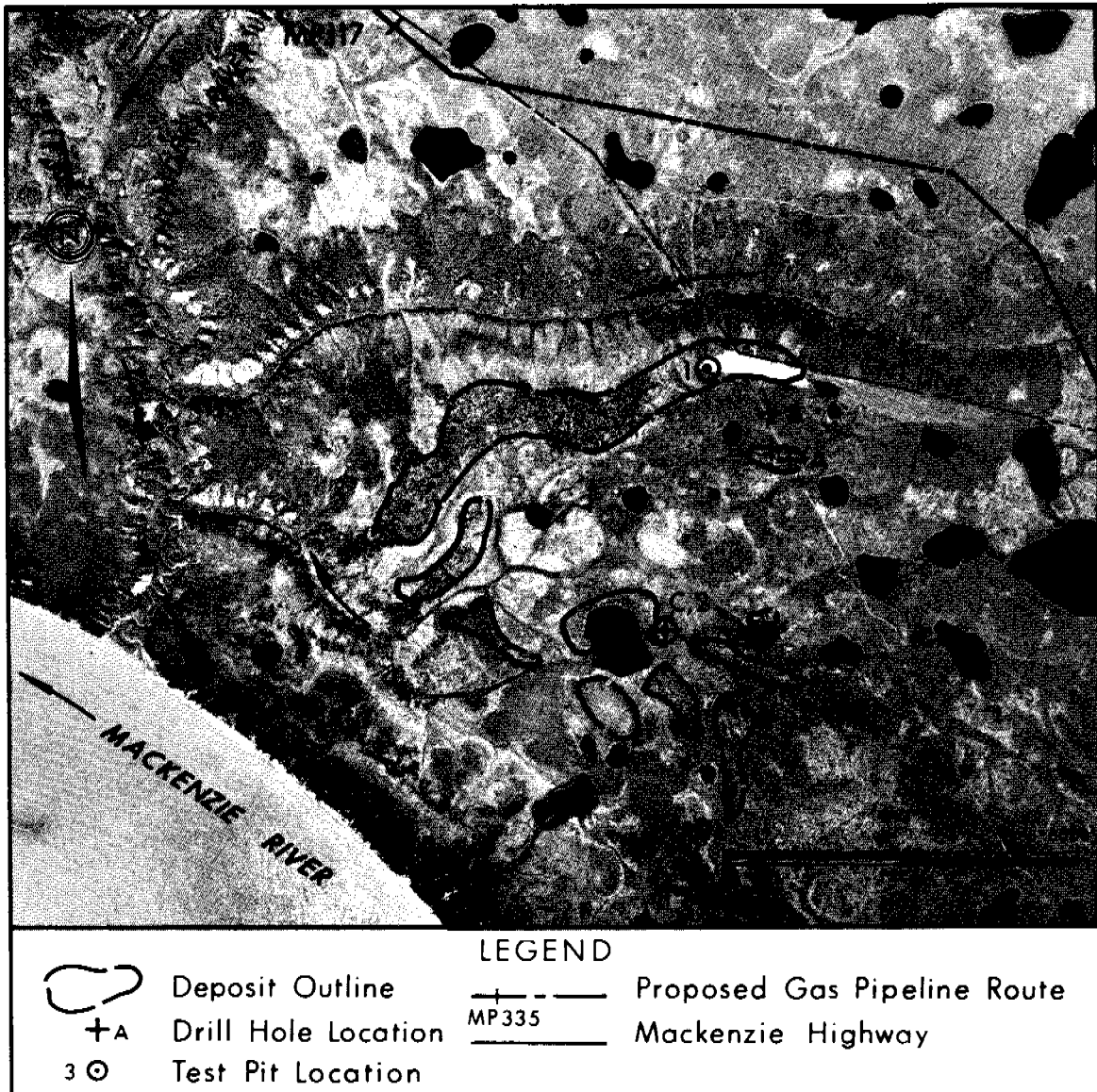
SECRET

Physical Setting: Deposit 1060-B5 consists of a number of kames located 1.5 miles east of the Thunder River mouth and 2 miles south of the right of way at milepost 177.

Material: SAND - poorly graded, silty, and some fine gravel.

Volume: 1,000,000 cubic yards.

Assessment: Deposit 1060-B5 is a source of fair quality granular material suitable for general fill and backfill. Access to the right of way is fairly good but a gully would have to be skirted.



Airphoto No. A22935-80
 Approximate Scale: 1" = 3100'

Latitude: 67° 31'
 Longitude: 130° 50'

DEPOSIT 1060-B5

PHYSICAL SETTING

This deposit consists of a number of kames located 1.5 miles east of the mouth of Thunder River, near the site of an existing airstrip. It is 2 miles south of milepost 177 on the present pipeline alignment. A proposed airstrip lies directly on the larger part of the deposit and a proposed compressor station is 2 miles away. This deposit corresponds to source number 1085 in EBA DIAND Granular Materials Inventory Volume III (1974) report.

The irregularly shaped flat-topped kames stand 5 to 10 feet above the surrounding terrain. Most of their surfaces have thin covers of peat and fine grained material but locally it may thicken to 5 feet. The kames stand slightly above the surrounding terrain, and therefore are well to moderately well drained. Drainage in the intervening areas is poorer. The active layer varies from 2 to 7 feet depending on the depth of overburden. Granular material in this deposit has low ice contents.

BIOLOGICAL SETTING

The vegetation in this area is composed of black spruce, white spruce, and paper birch, with an understory of alder, willow, Labrador tea, soap-berry, rose, dillberry, lichens and grasses. The general area provides habitat for caribou, moose, marten, lynx, fox, wolf, and black bear. Caribou, moose and bear sign were observed in the area during the 1975 survey. The area provides good denning potential for bear and other denning species. Waterbodies in the area provide suitable habitat for aquatic furbearers including muskrat, mink and beaver. Marten tracks were also observed in the area in 1975. Waterfowl are most numerous during the April to May migration period when they utilize open-water leads on the Mackenzie River. Ptarmigan and falcons have been reported from the area. The Thunder River supports populations of grayling, lake trout, round

whitefish, broad whitefish, pond smelts, pike and long-nosed suckers. Other small ponds and lakes in the vicinity of the site do not appear to support fish populations.

MATERIAL

NESCL drill hole and test pit logs and the DIAND report shows this deposit is mainly poorly graded, silty sand with some fine, rounded gravel. The granular material is underlain at shallow depths by fine grained sediments. Several drill holes encountered only fine grained material.

VOLUME

The total estimated volume, based on an area of 260 acres and a 4 foot depth is 1,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 1060-B5 is a source of fair quality granular materials. Location of areas to be exploited would be dictated by haul distances, overburden thicknesses, insitu material quality, and material requirements. Granular material from this deposit may be used for general fill and backfill in pipeline construction.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit with equipment may be achieved by barge to Thunder River and overland from there to the deposit, a distance of 1.5 miles.

This route crosses very hilly terrain. Access to the pipeline right of way from the deposit involves skirting a gully to avoid initiating bimodal flows. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way, a distance of at least 1 mile.

Tree and vegetative cover would have to be removed and harvested or disposed of in accordance with land use regulations. The peat cover and overburden would then be stripped from the area to be excavated, and stockpiled around the edge of the site.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas. Excavations would be kept away from nearby lakes to protect them from siltation.

Development could be accomplished by using conventional earthmoving techniques as ice contents are low. The excavated material may have to be stockpiled, thawed, and drained before it is used.

Equipment required for development would be dozers, rippers, end-dump trucks and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
2	SW		SAND - fine to coarse, occasional pebbles to 1/2" trace silt		UF												0	13:23 4 1/2" Walmac bit.
4																		
5.0																		
6			SAND - fine to medium, trace silt, light brown															
7.0																		
8	SP				Nd													
10			Increasing silt,															
11.0																		
12			SAND - fine to medium, silty, dark brown.															
14	SM																	
15.0 - 17.0			trace clay increasing silt															
18																	16	

- 398 -

TEST HOLE No. N75-1060-B5-A

LOGGED BY: G.W.H	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°31'08"N, 130°49'28"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 22935-80	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 23 M 08 Y 75	TIME: 13:23	FINISH: D 23 M 08 Y 75
		TIME: 13:45

1975 BORROW INVESTIGATION



NORTHERN
Engineering Services
Company Limited

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B5-A

SHEET 1 OF 2

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
18	SM		SAND (cont'd)		Nb														
18			19.0			fine-grained, silty, medium brown													
20																			
22																			
24	ML		SILT - clayey, little fine sand, dark brown																
24			23.0																
26	SM		SAND - fine to medium, little silt, trace clay																
26			27.5			less clay, trace silt below 27.5'													
28			28.0			End of hole													

12" of slough in hole.

TEST HOLE No. N75-1060-85-A

LOGGED BY: A.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°31'08"N, 130°49'48"W	ELEVATION:
DRWN BY: A.M.	AIRPHOTO No.: A 22935-80	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: APPROX. 18°C
	METHOD: AIR	
START: D 23 M 08 Y 75	TIME: 13:23	FINISH: D 23 M 08 Y 75
		TIME: 13:45

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-85-A

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt		PEAT - silty, (trace clay)		UF												14:10 4 1/2" Walmac	
1.5																	1.5 visible ice chunks in cutting return.	
2	CL		CLAY - silty, trace fine sand, dark to medium brown		F												3 to insert bit	
3.0																		
4	ML		SILT - clayey, med. to light brown low plastic.														6 ream hole	
6																		
8	CL		CLAY - very silty, pebble at 7.5														8 14:30 no cutting return	
8.0																		
10	ML		SILT - clayey, trace medium to coarse sand. visible ice chunks														12 hole plugging, reamed.	
12																		
14	CL		CLAY - silty														16 14:40 End of hole	
16			End of hole															

TEST HOLE No. N75-1060-B5-B

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°30'51"N, 130°49'54"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-00	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 23 M 08 Y 75	TIME: 14:10	FINISH: D 23 M 08 Y 75
		TIME: 14:40

1975 BORROW INVESTIGATION		TEST HOLE No. N75-1060-B5-B
NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR		
CANADIAN ARCTIC GAS STUDY LIMITED		SHEET 1 OF 1

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt		PEAT - fibrous, woody, brown		UF													
1.0			Ice visible in peat		F													
3.0																		
4	Bm		GRAVEL - fine, some med. to coarse sand, little silt		Nb													
6.0			trace clay, increasing silt															
7.0			coarse gravel															
8.5																		
10	ML		SILT - very sandy, trace coarse sand, occasional pebble															
11.0			pebble															
13.0																		
14	CL		CLAY - silty, trace fine to med. sand, low plastic, dark grey															
15																		

13 clay adhering to drill-stem during trip out 16:00 no cutting return, hard layer or object at 15'

TEST HOLE No. N75-1060-B5-C

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°31'35"N, 130°50'33"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22835-80	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 24°C
	METHOD: AIR	
START: D 23 M 8 Y 75 TIME: 15:45	FINISH: D 23 M 8 Y 75 TIME: 18:15	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR


CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B5-C

SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
18	E		CLAY (cont'd)		Nb													
18			17' trace gravel (occasional pebble)															
18			ice chunks in cutting return															
20																		
21.0			End of hole														21	No cutting return at 21', drillstem binding in hole

LOGGED BY: D.M.H.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION  NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-1060-85-C SHEET 2 OF 2
CHKD: D.O.	LAT. & LONG: 67°31'35"N, 130°50'33"W	ELEVATION:		
DRWN BY: A.M.	AIRPHOTO No.: A 22935-80	PIPE MILEAGE:		
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 24°C		
	METHOD: AIR			
START: D 23 M 8 Y 75 TIME: 15:45	FINISH: D 23 M 8 Y 75 TIME: 18:15			

- 402 -

TEST HOLE No. N75-1060-85-C


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.5	Pt	??	PEAT - fibrous, woody, dark brown		UF													18:20 Walmac bit Change to 4 1/2" insert bit
1.0	M		SILT - clayey, trace fine sand		F													Possibly Vs ice
3.5																		
4	CL		CLAY - silty, trace fine sand, low plastic, grey															
			chunks of ice in cuttings															
13.0			infrequent pebble from depth 13' to 18'															
18.0			decreasing plasticity, increasing sand, fine to coarse															
			less ice visible in the cutting return															
			trace sand															
28			End of hole															18:45

TEST HOLE No. N75-1060-B5-D

- 403 -

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°30'06"N, 130°51'29"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-80	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: APPROX. 24°C
	METHOD: AIR	
START: D 22 M 08 Y 75 TIME: 18:20	FINISH: D 22 M 08 Y 75 TIME: 18:45	

<p>1975 BORROW INVESTIGATION</p>  <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-1060-B5-D</p> <p>SHEET 1 OF 1</p>
--	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL ICE %		Plastic limit								
					40	60	80	100	120	140	▲						
					0	20	40	60	80	100	○						
0.5	Pt		PEAT														
1.5			SILT-(organic) dark grey	UF													20:00 4 1/4" Walmac bit
2.0	OL																
			SILT- some fine sand, brown to light brown	F													
	ML			(Vs)													
				?													
5.0			SAND- very fine, silty, light brown														
				Nb													
	SM																
10.0			SAND- medium grained, poorly graded, clean into med. to coarse, clean, light brown														
11.0	SP																
12.0																	
	ML		SILT- sandy, slight plasticity, light grey-brown, ice chunks visible in cutting return.	F													
				(V)													

- 404 -

TEST HOLE No. N75-1060-85-E

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 87°30'01"W, 130°52'15"W	ELEVATION:
DRWN. BY: A.W.	AIRPHOTO No.: A 22835-80	PIPE MILEAGE:
CHKD: B.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 22 M 08 Y 75 TIME: 20:00	FINISH: D 22 M 08 Y 75 TIME: 20:30	

1975 BORROW INVESTIGATION	 NORTHEN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No.
CANADIAN ARCTIC GAS STUDY LIMITED		N75-1060-85-E
		SHEET 1 OF 2


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
18	ML		SILT (cont'd)		F											18		
24			24.5' - 25.0' occasional pebble															
25			25.0													25		
26	CL		CLAY - silty, trace fine sand, low plastic, grey.													26	20:20, hole plugged - reamed 20:30 problems of poor circulation because of clay.	
			End of hole															

TEST HOLE No. N75-1060-B5-E

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°30'01''N, 130°52'15''W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22935-80	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 22 M 08 Y 75	TIME: 20:00	FINISH: D 22 M 08 Y 75
		TIME: 20:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B5-E
SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.8	SM		SAND - mfc, and fine to coarse gravel, little silt		UF													
0.8 - 3.4	GW		GRAVEL - fine to coarse, and mcf sand, clean, brown, occasional pebbles to 1", occasional medium to coarse sandy layers										B1	X				
3.4 - 4.4	CI-CN		CLAY - medium to high plastic, trace medium to coarse sand, Bottom of pit										B2	X				
4.4																		

MA, sample 1
G = 40%
S = 48%
F = 12%

MA, sample 2
G = 54%
S = 43%
F = 3%

- 406 -

TEST HOLE No. N75-1060-B5-1

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 130 11
CHKD: R. H.	LAT. & LONG.: 67°30'51"N, 130°49'54"W	ELEVATION:
DRWN. BY: D. J. M.	AIRPHOTO No.: A 22935-80	PIPE MILEAGE:
CHKD: D. O.	RIG:	AIR TEMP: Approx. 19°C
	METHOD: TEST PIT	
START: D 23 M 08 Y 75	TIME:	FINISH: D 23 M 08 Y 75
		TIME:


<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-1060-B5-1</p> <p>SHEET 1 OF 1</p>
--	---

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.3	Pt		PEAT - woody, fibrous, black		UF							MA, combined Samples 1 - 4 G = 17% S = 84% F = 19% (SM)							
1.2	SP		SAND - medium, trace fine gravel, pebbles to ½", damp, 0.3' to 1.1' - light brown, 1.1' to 1.5' - black																
1.5					Vs								B1				1	15:15	
2.0	SM		SAND - fine to medium, little silt, trace gravel, pebbles rounded ¾", light brown <div style="border: 1px solid black; padding: 2px; display: inline-block;">ice Vs to 1/8" 1" lenses</div>										B2				2		
4.8			trace silt, fine to medium sand, wet when thawed, occasional coarse gravel to 1.5" increasing coarse sand and fine gravel		Vx								B3				3	16:35	
4.9			Bottom of pit									B4				4			
			Drillhole indicates sand stratum to about 7', then into silt													4.8	17:30		

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°31'35"N, 130°50'33"W	ELEVATION:
DRWN. BY: D.J.M.	AIRPHOTO No.: A 22935-80	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 24°C
	METHOD: TEST PIT	
START: D 23 M 08 Y 75	TIME: 15:00	FINISH: D 23 M 08 Y 75
		TIME: 17:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

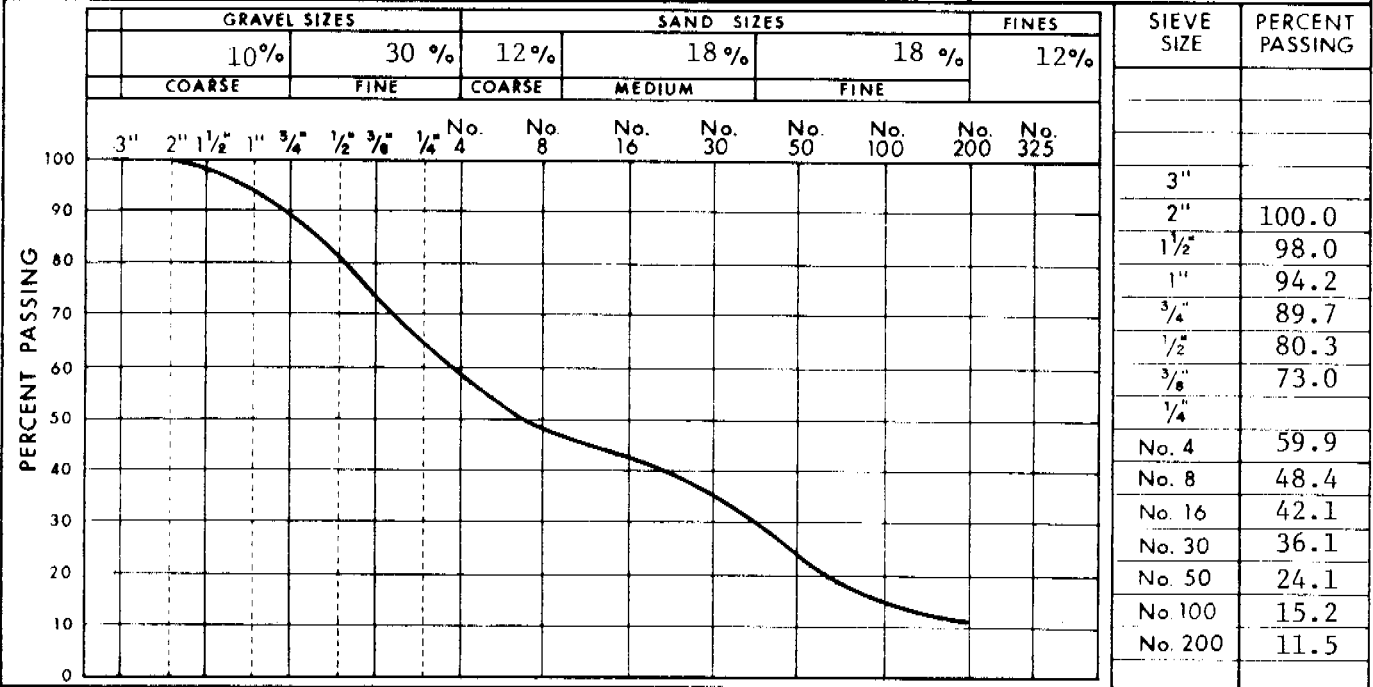
TEST HOLE No.
N75-1060-B5-2
SHEET 1 OF 1

- 407 -

TEST HOLE No. N75-1060-B5-2

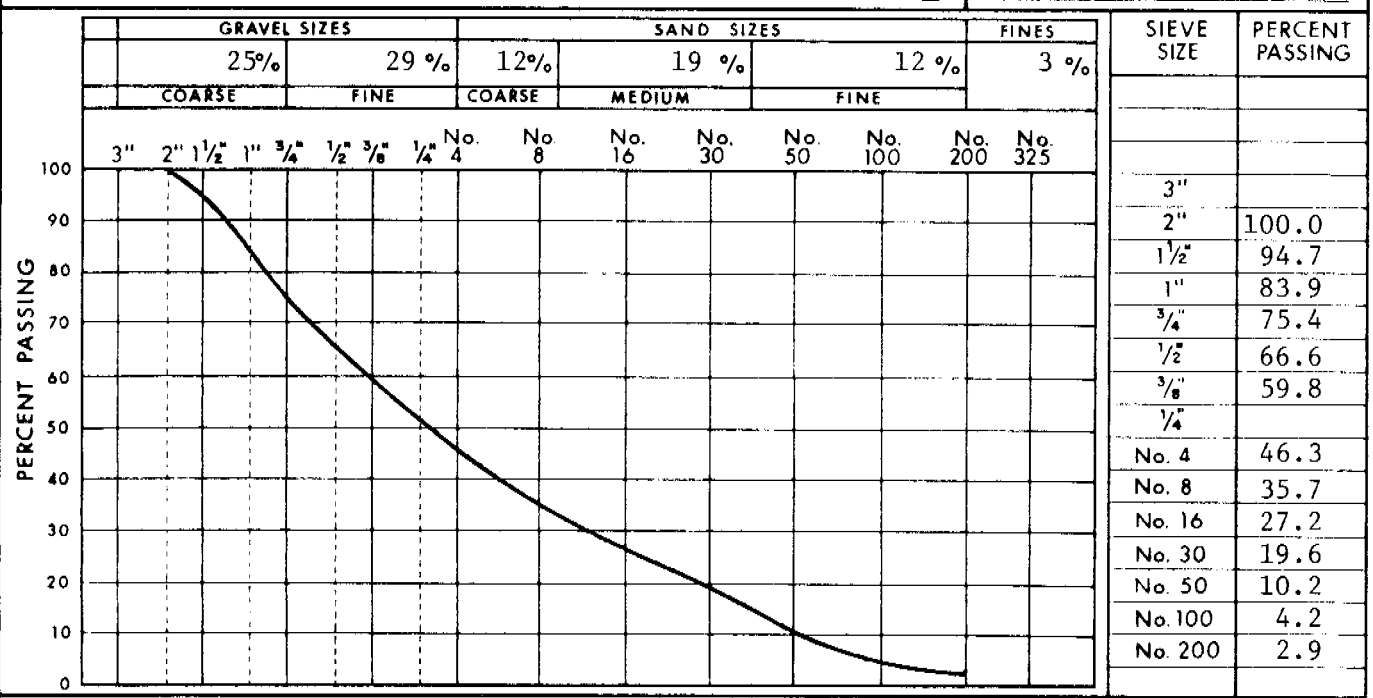
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B5-1 DEPTH 0.0-1.0 R.M.HARDY REPORT NUMBER 72
 DATE SAMPLED August 23, 1975 SAMPLED BY NESCL



COMMENTS Moisture content of 5.3% OVERSIZE (>3") = 0.0%

SAMPLE N75-1060-B5-1 DEPTH 2.0-3.0 R.M.HARDY REPORT NUMBER 73
 DATE SAMPLED August 23, 1975 SAMPLED BY NESCL

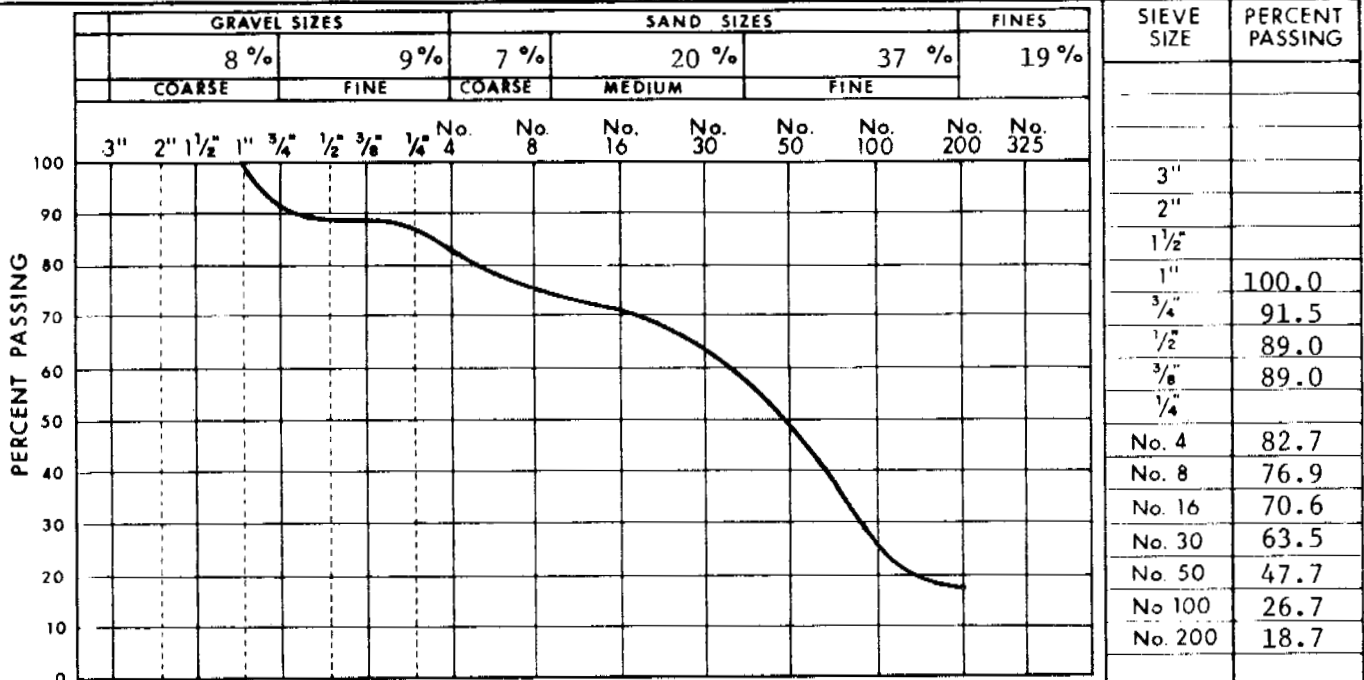


COMMENTS Moisture content of 2.8% OVERSIZE (>3") = 0.0%

<p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	<p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-1060-B5
		PAGE 408

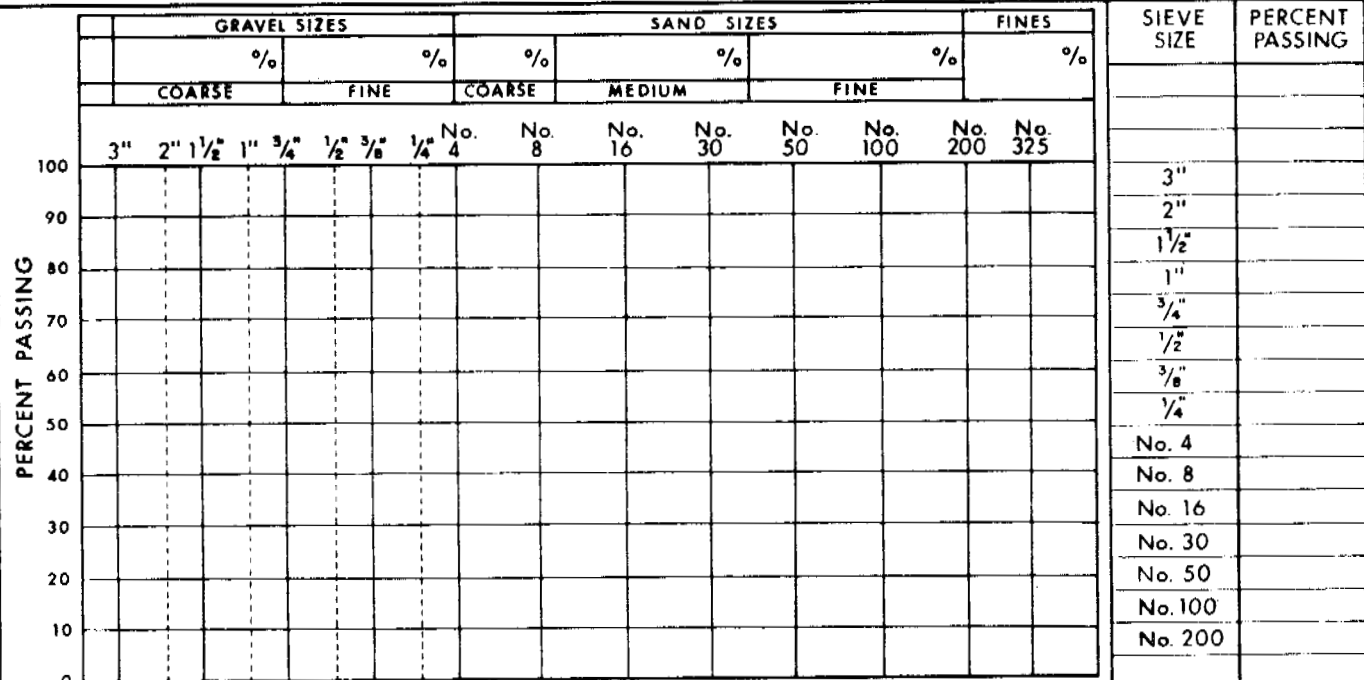
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B5-2 DEPTH 1.0-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 23, 1975 SAMPLED BY NESCL 69



COMMENTS _____ OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = %

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-1060-B5 PAGE 409
---	--	---	---

1060 - B6 - A	444310E	7465380N
B6 - B	444120E	7465350N
B6 - C	444480E	7468270N
B6 - D	444150E	7467810N

UTM - Zone 9

DEPOSIT 1060-B6

Physical Setting: Deposit 1060-B6 consists of hummocky morain with kames located 9 miles north of Little Chicago and 2 miles northeast of right of way milepost 197.

Material: GRAVEL - segment "a", gravel and till.
TILL - segments "b" and "c", till with minor gravel.

Volume: Segment "a" contains an estimated 5,000,000 cubic yards of granular material.

Assessment: Deposit 1060-B6 is not recommended for development. Further investigation of segment "a" should be done before a final assessment is made. Access may be difficult.

444000E
7468000N

445000E
7463000N

444000E
7466000N

445000E
7466000N



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A22859-174
Approximate Scale: 1" = 3200'

Latitude: 67° 18'
Longitude: 130° 18'

DEPOSIT 1060-B6

PHYSICAL SETTING

This deposit consists of hummocky moraine with numerous kames located 9 miles north of Little Chicago and 2 miles northeast of milepost 197 of the proposed pipeline right of way.

Parts "a" and "b" of this deposit are mainly clusters of kames with isolated morainic hills, whereas part "c" appears to be mainly hummocky moraine. In section "a" steep sided hills of 50 to 150 feet in height are present. Relief in the other two sections is generally less than 50 feet.

Overburden on most hills and ridges is negligible, although it may thicken to 2 or 3 feet on gentle north-facing slopes, and up to 10 feet in depressions. South-facing slopes, hills and ridges are all well to moderately well drained and depressions poorly drained. The active layer varies between 5 and 10 feet in the better drained areas. Ice content of the granular material is low, although icy zones may be present in the ablation till.

There is a 350 foot moderate to steep descent from the bench on which the deposits are situated to the lowland that the pipeline crosses.

BIOLOGICAL SETTING

Vegetation on the better drained areas of this site consists of spruce up to 40 feet or more in height, aspen, a light shrub understory and ground cover of herbs, lichen, and mosses. The more poorly drained areas support stunted spruce, shrubs, and a ground cover of moss and lichen. The area provides low to moderately productive habitat for marten, snowshoe hare, red squirrel, fox, lynx, caribou, black bear and moose. Waterfowl are most numerous during the April to May migration period when they utilize open-water leads on the Mackenzie River.

Raptors may nest in the area but no other important bird habitat has been identified. No suitable fish habitat occurs in the vicinity of the site.

MATERIAL

Material in segment "a" consists of either well graded, silty, sub-rounded gravel, with frequent cobbles or ablation till. Segment "b" was not tested but is probably gravel, sand and ablation till. Ablation till with interbedded coarse gravel was found in segment "c".

VOLUME

Material volumes were not calculated for segments "b" and "c" since the material is of very poor quality. Segment "a" contains an estimated 5,000,000 cubic yards based on an area of 400 acres and a 25 foot thickness ($\times \frac{1}{3}$ for topography).

DEVELOPMENT AND REHABILITATION

Since a large portion of this deposit consists of ablation till, it is not recommended for development unless there is insufficient borrow in nearby sources to meet construction requirements. Further testing of segment "a", to delineate areas underlain by good quality granular material, should be undertaken if such material is required. Access to the pipeline right of way involves crossing hilly terrain with moderate to steep slopes which could also cause difficult problems.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
1.0	Pt		PEAT - fibrous, woody, dark brown		UF													18:20	
2.0			CLAY - silty, trace fine to coarse sand, grey, occasional pebbles to 1/2", (possibly till), cobbles to 8" at surface		F														
8.0	CL		visible ice chunks in cutting return																
9.0			slightly more silt																
20.0			cobble, increase in coarse sand and fine gravel																
23.0			cobble End of hole																19:30 unfrozen soil at surface plugging hole to insert bit hole plugging
23.0																			18:50

TEST HOLE No. N75-1060-B6-A

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 87°18'03"N, 130°17'53"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A22859-174	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 7°C
	METHOD: AIR	
START: D 24 M 8 Y 75	TIME: 18:20	FINISH: D 24 M 8 Y 75
		TIME: 19:50

1975 BORROW INVESTIGATION



CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B6-A

SHEET 1 OF 1

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
1.0	Pt		PEAT - fibrous, brown, moist		UF													
2.0	SM-ML		SAND - fine, very silty, (trace coarse sand), brown, moist		Nb													
4.0	CL		CLAY - silty, trace coarse sand, grey, (till ?), cobble approx. 5"															
6.0	ML		SILT - little fine to coarse sand,															
8.0			occasional cobble, (cobble at 8.0') possibly till															
10.0			cobble at 10.0'															
12.0	GP		* GRAVEL - coarse, frequent cobbles, possibly occasional boulders (possibly till)															* No fines in cuttings, coarse gravel or very gravelly till layer
14.0																		
16.0																		Very wet at 16.0' due to thawing of permafrost

- 416 -

TEST HOLE No. N75-1060-86-B

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 87°17'58"N, 130°17'54"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22059-174	PIPE MILEAGE:
CHKD: D.O.	RIG: MELI-BRILL	AIR TEMP: Approx. 10°C
	METHOD: AIR	
START: D 24 M 8 Y 75 TIME: 20:15	FINISH: D 24 M 8 Y 75 TIME: 21:25	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-86-B
SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
					40	60	80	100	120	140	▲							
					0	20	40	60	80	100	○							
17	GP		GRAVEL (cont'd)		Nb												17	hole plugging
			17.5															
18	ML		SILT - sandy End of hole														18	

TEST HOLE No. N75-1060-B6-B

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°17'58"N, 130°17'54"W	ELEVATION:
DRWN BY: A.N.	AIRPHOTO No.: A 22858-174	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 10°C
	METHOD: AIR	
START: D 24 M 8 Y 75 TIME: 20:15	FINISH: D 24 M 8 Y 75 TIME: 21:25	

1975 BORROW INVESTIGATIONS

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B6-B

SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
0.5	Pt		Peat cover															
2	CL		CLAY - little fine to coarse sand, trace fine gravel		UF													17:15
4	GC		GRAVEL - fine to coarse, clayey, cobbles at depth 5.0'															
6.5			some med. to coarse sand		Nb													
9.0	GW		GRAVEL - little med. to coarse sand															
14.0			large (8") cobble															cobble, to 3 7/8" Walmac
15.0			some med. to coarse sand															
18																		

TEST HOLE No. N75-1060-B6-C

- 418 -

LOGGED BY: G.W.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 87°19'24"N, 130°17'39"W	ELEVATION:
DRWN. BY: F.B.	AIRPHOTO No.: A22859-174	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 7°C
	METHOD: AIR	
START: D 24 M 8 Y 75 TIME: 17:15	FINISH: D 24 M 8 Y 75 TIME: 18:35	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>TEST HOLE No. N75-1060-B6-C</p> <p>SHEET 1 OF 2</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
18	GW		GRAVEL (cont'd)		Nb													
18																		
20			18.0 --- cobble															
21			21.0 End of hole														Hole plugging at 18', no cuttings, caving	

TEST HOLE No. N75-1060-B6-C

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°19'24''N, 130°17'39''W	ELEVATION:
DRWN BY: F.B.	AIRPHOTO No.: A22859-174	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 7°C
	METHOD: AIR	
START: D 24 M 8 Y 75 TIME: 17:15	FINISH: D 24 M 8 Y 75 TIME: 18:35	

<p>1975 BORROW INVESTIGATIONS</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>TEST HOLE No.</p> <p>N75-1060-B6-C</p> <p>SHEET 2 OF 2</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.2	PT		PEAT - clayey silt, light rust brown		UF												15:20	
2	ML		SILT - (trace clay), very hard, (weak rock similar to siltstone or weathered shale), brown to grey, dry															
7.0																		
8.0			slightly more clay, slightly softer		Wb												drillstem clean	
10.0			increasing clay														10 15:30	
12.0			higher frozen water content, trace coarse sand to fine gravel															
14.0			cobble End of hole														14 Drill grinding	

- 420 -

TEST HOLE No. N75-1060-B6-D

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°18'28"N, 130°17'44"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 22859-174	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 7°C
	METHOD: AIR	
START: D 24 M 8 Y 75 TIME: 15:20	FINISH: D 24 M 8 Y 75 TIME: 15:40	

<p>1975 BORROW INVESTIGATION</p>  <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>TEST HOLE No.</p> <p>N75-1060-B6-D</p> <p>SHEET 1 OF 1</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt	0.2	PEAT - moss cover, dark brown amorphous, black, damp		UF													No samples taken
1.0	CL	1.1	CLAY - silty, trace sand, fine, grey brown, damp															
1.8	ICE +	1.8	ICE with CLAY, silty		ICE +													
2.0	CL	2.0	TILL, CLAY - trace gravel, pebbles subangular to 3/8", pockets of sandstone to 3/8", carbon specks Bottom of pit		ICE + Yx 25													Abandoned

TEST HOLE No. N75-1060-B6-1

LOGGED BY: J. R. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 67°18'03"N, 130°17'53"W	ELEVATION:
DRWN BY: A. M.	AIRPHOTO No.: A 22859-174	PIPE MILEAGE:
CHKD: D. D.	RIG:	AIR TEMP: Approx. 16°C
	METHOD: TEST PIT	
START: D 24 M 08 Y 75 TIME: 16:15	FINISH: D 24 M 08 Y 75 TIME: 16:30	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B6-1

SHEET 1 OF 1

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
	Pt	0.2	PEAT - amorphous, coarse fibrous, black, roots		UF												18:00	
	CL	1.0	CLAY - silty, trace sand, fine, low plastic, orange brown, dry														No samples taken	
1	CI		CLAY - trace gravel, trace sand, cmf, medium plastic, pebbles rounded, mainly fine, occasional to 2", (till-like), gray, slight mottled, gray orange, carbonaceous plant material, rust spots, fine sand pockets to ½", shale fragments														18:25	
2																	18:39	
3																		
4		3.5	ironstone concretion, and granitic cobble to 5", damp															
		4.0	Bottom of pit															

TEST HOLE No. N75-1060-B6-2

- 422 -

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°17'59"N, 130°17'54"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 22859-174	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 13°C
	METHOD: TEST PIT	
START: D 24 M 08 Y 75 TIME: 16:00	FINISH: D 24 M 08 Y 75 TIME: 16:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B6-2
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.3	Pt		PEAT - coarse fibrous, black, woody inclusions		UF							MA, combined samples 1 - 4 G = 48% S = 34% F = 18% (GM)							
0.9	CL		CLAY - silty, little sand, fine, burnt orange																
0.9	GM		GRAVEL - fine to coarse, some cmf sand, little fines, grey brown, pebbles rounded to 3", cobbles subrounded to 7", rootlets										B1						1
3.0			ironstone pocket										B2						2
3.5			ironstone pocket										B3						3
4.0			pocket to 2" of micaceous medium grain sand, moist, less content fines										B4						4
5.7			clump Bottom of pit									B5						5	
																		5.7	

- 423 -

TEST HOLE No. N75-1060-B6-3

LOGGED BY: R.H. - J.K.W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R.H.	LAT. & LONG: 87°19'24"W, 130°17'39"W	ELEVATION:		N75-1060-B6-3
DRWN BY: F.B.	AIRPHOTO No.: A 22858-174	PIPE MILEAGE:		
CHKD: D.O.	RIG:	AIR TEMP: Approx. 16°C		
	METHOD: TEST PIT			
START: D 24 M 08 Y 75	TIME: 13:00	FINISH: D 24 M 08 Y 75	TIME: 14:15	SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
0.2	Pt		PEAT - amorphous, coarse fibrous, dark brown, roots.															13:00	
0.5	CL		CLAY - silty, trace sand, fine, low plastic medium brown, desiccated, isolated pebbles.															13:10	
1.0	(ML)		(SILT.) - shale-like, badly weathered, very hard, "weak rock". consolidated, desiccated, dark brown, breaks into rectangular chunks on excavation.															13:35	
3.0			Bottom of pit										BI				3	Bulk sample 14:40 for identification	
			Note: top of esker-like mound. Refer also to N75-1060-B6-D																

Gradation of material as excavated.
 "Gravel" = 8 %
 "Sand" = 38 %
 "Fines" = 58 %

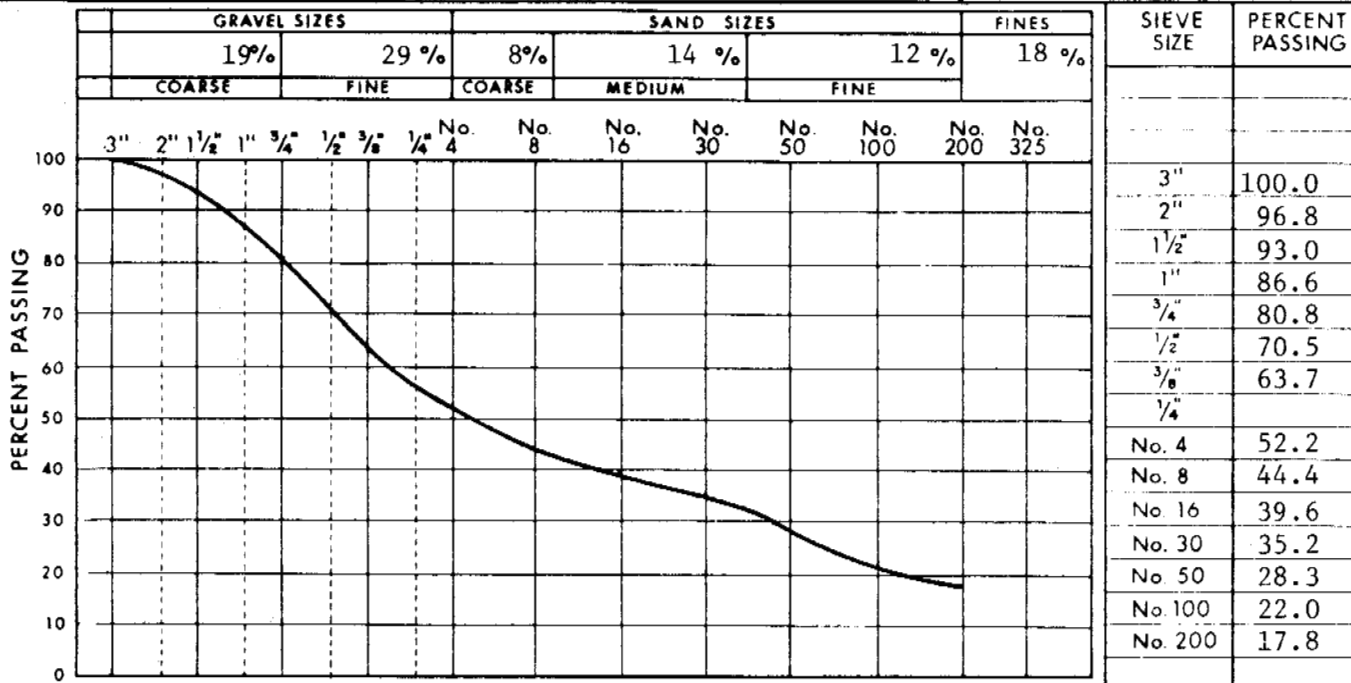
LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No. N75-1060-B6-4 SHEET 1 OF 1</p>
CHKD: R.H.	LAT. & LONG: 67°19'26"N. 130°17'44"W	ELEVATION:		
DRWN. BY: D.J.M.	AIRPHOTO No.: A 22859-174	PIPE MILEAGE:		
CHKD: D.D.	RIG:	AIR TEMP: Approx. 18°C		
METHOD: TEST PIT				
START: D 24 M 08 Y 75 TIME: 13:00	FINISH: D 24 M 08 Y 75 TIME: 14:10			

- 424 -

TEST HOLE No. N75-1060-B6-4

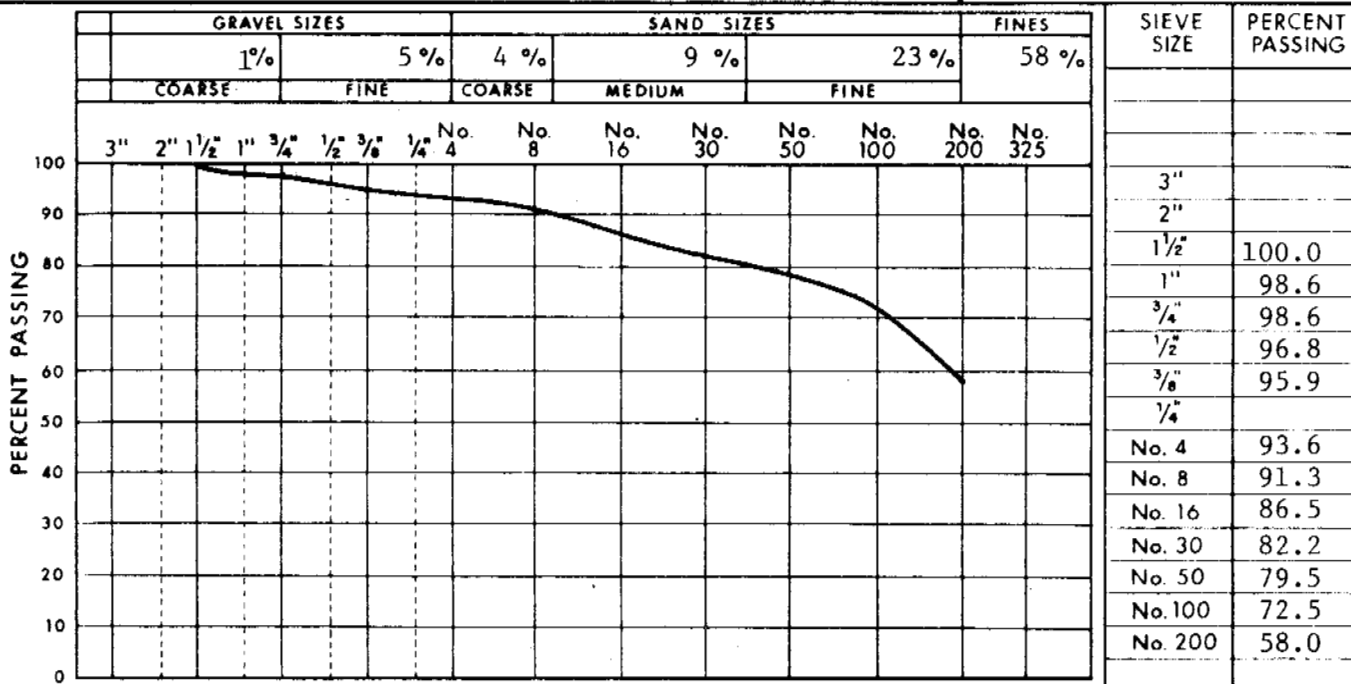
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B6-3 DEPTH 2.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 24, 1975 SAMPLED BY NESCL 60



COMMENTS _____ OVERSIZE (>3") = 0.0%

SAMPLE N75-1060-B6-4 DEPTH 2.7-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 24, 1975 SAMPLED BY NESCL 192



COMMENTS _____ OVERSIZE (>3") = 0.0%

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-1060-B6 PAGE 425
---	--	---	---

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-1060-B6-3 DATE SAMPLED : August 24, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 2-6 DATE TESTED : January, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 10.51%
 FINE AGGREGATE : LOSS = 9.03%

ORGANIC IMPURITIES TEST

NUMBER : 3
 COAL REMOVED : Nil
 COAL & ROOTLETS
 REMOVED : Nil
 COAL CONTENT : Nil
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 25.4 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Very strong, Good	21.4
Granite		2.95
Sandstone	Very strong	6.15
Siltstone		2.7
Limestone	Medium strong, Fair	11.55
Chert	Potentially reactive, Fair	0.1
Flint		0.6
Soft Sandstone	Friable, Weak, Poor	0.7
Clay	Soft, Deleterious	1.45
Ironstone		0.2
PN = 190	INTERPRETATION : Poor	47.8

COMMENTS : Indication of unstable aggregate, caution advised



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-1060-B6

PAGE 426

DEPOSIT 1060-B7

See 1057-1 EBA

Physical Setting: Deposit 1060-B7 consists of coalescing kame deltas along the crest of a broad bedrock ridge, located 7 miles north of Little Chicago and 2.5 miles from the right of way.

Material: GRAVEL - well graded, rounded, with variable silt and sand.

Volume: 12,000,000 cubic yards.

Assessment: Deposit 1060-B7 is a source of good to excellent quality granular material suitable for general fill, backfill, building pads and possible concrete and asphalt aggregate.



LEGEND



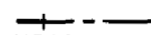
Deposit Outline



Drill Hole Location

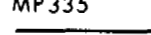


Test Pit Location



Proposed Gas Pipeline Route

MP335



Mackenzie Highway

Airphoto No. A22859-171, 172

Approximate Scale: 1" = 3000'

Latitude: 67° 16'

Longitude: 130° 06'



DEPOSIT 1060-B7

PHYSICAL SETTING

Deposit 1060-B7 is a moraine ridge consisting largely of coalescing kame deltas positioned along the crest of a broad bedrock ridge. It is located 7 miles north of Little Chicago and is 2.5 miles northeast of milepost 211 of the pipeline alignment. This deposit corresponds to source number 1057 in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The moraine ridge is rounded with a crest 30 to 100 feet across and has steep side slopes. It is generally free of overburden although the gentle north-facing slopes may have a peat cover of 1 or 2 feet. The site is well drained due to its form and topographic position, and has an active layer in excess of 20 feet; possibly the entire deposit is free of permafrost.

Access to the pipeline right of way involves a drop in elevation of 800 feet. In places the descent is marked by cliffs, but in other areas "ramps" with more moderate slopes are present. These slopes are covered by till and colluvium.

BIOLOGICAL SETTING

Much of this site has been recently burned and is now covered with a thick growth of shrubs and young trees. On the unburned sections a dense stand of spruce and aspen up to 40 feet in height occurs, with an understory of small shrubs and herbs. The area provides moderate to good habitat for marten, fox, and lynx. Caribou and moose sign were observed at the site during the 1975 survey. Lakes, streams, and associated areas provide moderate to good habitat for aquatic furbearers, black bear, and moose. Grouse and ptarmigan are common in the area. There is no raptor, waterfowl, or fish habitat in the immediate vicinity of the site. Waterfowl are most numerous in the area during the April-May migration period when they use open-water leads on the Mackenzie River.

MATERIAL

Drill hole and test pit logs and the DIAND report indicate material within the moraine ridge is predominately well graded, rounded gravel with variable silt and sand content, and zones of abundant cobbles and boulders. Occasional beds of well graded sand with variable silt are also present.

VOLUME

The maximum depth under the ridge crests is probably 50 feet. A total estimated volume based on an average depth of 25 feet and an area of 550 acres is 12,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 1060-B7 is a source of good to excellent quality granular materials. Location of areas to be exploited will be determined by further exploratory drilling. Granular material from this deposit may be used for general fill, backfill in pipeline construction, building pads, and possibly concrete and asphalt aggregate. The gravel will require further testing prior to use in concrete.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit with equipment may be achieved by barge to Little Chicago and overland from there to the deposit, a distance in excess of 5 miles. Access to the pipeline right of way from the deposit involves

a descent of 800 feet over drift covered slopes. No cliffs need be crossed. Some seismic lines could also be used for access. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way, a distance of at least 2 miles.

Vegetative cover would have to be removed from the haul road right of way and excavation areas and disposed of in accordance with land use regulations. The peat cover and overburden would then be stripped from the area to be excavated, and stockpiled around the edge of the excavation.

Development of this deposit would involve excavating borrow material evenly or in stages from the higher, well drained areas so that good drainage would be maintained over the area. Open face pit development could be established on the steeper slopes of the deposit. Conventional earthmoving techniques would be used as the deposit is well drained and thawed. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing, concrete and asphalt plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

borehole # N6007-A
 letter #

- 77 N600674 W ? 1 REF. i. E1057
 E. T551

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	SM		SAND - coarse, some silt, damp, rust brown		UF													
1.5																		
2	GM		GRAVEL - fine to coarse, little med. to coarse sand, some silt, occasional cobble, damp															
4																		
6																		
7																		losing air circulation
8	GC		GRAVEL - fine to coarse, trace to little clay, occasional cobble, damp <i>softer at 10 and 12.</i>															
9																		no cutting return to end of hole
10																		
11			11.0 --- cobble															
12			12.0 --- cobble															
13			13.0 End of hole															

- 432 -

TEST HOLE No. N75-1060-B7-A

LOGGED BY: G.W.H.	FACILITY:	PROJECT: 13611
CHKD: D.O.	LAT. & LONG: 87°15'19"N, 130°05'32"W	ELEVATION:
DRWN BY: J.W.B.	AIRPHOTO No.: A22859-171, 172	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 25 M 8 Y 75 TIME: 13:00	FINISH: D 25 M 8 Y 75 TIME: 13:25	

1975 BORROW INVESTIGATION

NORTHERN
 Engineering Services
 Company Limited

NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
 N75-1060-B7-A

SHEET 1 OF 1

X ↗ X ↗ Y ↗ Y ↗

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
18	SM	18.5	SAND - fine, silty, little coarse gravel, moist		UF													
20		20.0	increasing silt														no cutting return but stem very silty	
24		24.0	End of hole														18:20 lost air circulation	

TEST HOLE No. N75-1060-B7-B

LOGGED BY: G.W.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°16'01"N, 130°06'43"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A22859-171, 172	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 25 M 8 Y 75 TIME: 15:30	FINISH: D 25 M 8 Y 75 TIME: 18:20	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>TEST HOLE No. N75-1060-B7-B</p> <p>SHEET 2 OF 2</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	

- 434 -

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG		LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
				NRC	ICE TYPE	▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
0		xx	PEAT			40	60	80	100	120	140	▲					0	15:30
2	SM		SAND - fine to coarse, silty, rust brown, damp		UF	0	20	40	60	80	100	○						
4	GM		GRAVEL - fine to coarse, very silty, little fine to medium sand, brown, damp, occasional cobble and fine to med. sand														5.5	cobble
8	SM		SAND - fine to coarse, very silty, little coarse gravel, occasional cobble, (cobble at 8.5')														7	cobble, losing circulation in gravel stratum
12			SAND - gravelly														12	drill vibration and grinding
14	SP-SM		coarser sand, little fine to medium sand, less silt															
16			med. to coarse sand, slightly silty, little gravel, occasional cobble														16	

TEST HOLE No. N75-1060-B7-B

433 -

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°18'01''N, 130°08'43''W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A22859-171, 172	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 25 M 8 Y 75 TIME: 15:30	FINISH: D 25 M 8 Y 75 TIME: 18:20	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1060-B7-B

SHEET 1 OF 2

OVER!

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0.1	GM		PEAT - coarse fibrous, black, roots		UF												17:55	
0.6			GRAVEL - fine to coarse, silty, and fine to medium sand, rust brown to 0.6", grey from 0.6'								MA, combined samples 1 - 3 G = 49% S = 28% F = 23% (GM-GC)						1 18:15	
1.5			occasional ironstone, trace coarse sand									B1						2 18:35
2.0			boulder, 12", rounded									B2						3 18:55
2.5			GRAVEL - clayey, isolated pockets of clay, cream-coloured									B3						4 19:30
4.0	GC		GRAVEL - clayey, isolated pockets of clay, cream-coloured														Occasional boulder to 24" exposed on surface	
4.0			boulders (2) 18" +															
4.1			Bottom of pit															

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°15'19"N, 130°05'32"W	ELEVATION:
DRWN. BY: F.B.S.	AIRPHOTO No.: A 22859 - 171, 172	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 16°C
	METHOD: TEST PIT	
START: D 24 M 08 Y 75	TIME: 17:55	FINISH: D 24 M 08 Y 75
		TIME: 18:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.

N75-1060-B7-1

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.3	Pt		PEAT - coarse fibrous, black, roots		UF													11:20	
0.8	GM		GRAVEL - fine to coarse, silty (slight clay), some sand, cmf, rusty brown to 0.8', grey brown below 0.8'																
1.2																			
2.0			cementation on gravel from 1.2' to 2.0'																
3.0			boulder 18", dark grey, damp																
5.0			Bottom of pit															13:10	

MA, combined, samples 1-3
G = 40%
S = 33%
F = 27%

B1
B2
B3

- 436 -

TEST HOLE No. N75-1060-B7-2

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD: R.H.	LAT. & LONG: 87°16'01''N, 130°08'43''W	ELEVATION:		N75-1060-B7-2
DRWN. BY: G.B.	AIRPHOTO No.: A 22858-171, 172	PIPE MILEAGE:		
CHKD: D.O.	RIG:	AIR TEMP: Approx. 21°C		
	METHOD: TEST PIT			
START: D 25 M 08 Y 75 TIME: 11:20	FINISH: D 25 M 08 Y 75 TIME: 13:10			SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS																					
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit																													
					40	60	80	100	120	140 ▲																													
					0	20	40	60	80	100 ○																													
0.1	CI		PEAT - fine fibrous, black, rootlets														11:20																						
0.6			CLAY - trace gravel, coarse, trace sand, fine to medium, orange brown, roots														12:05																						
2.7	GM		GRAVEL - fine to coarse, silty, slight clay, and sand, cmf, grey brown, cobbles rounded and subangular to 8", isolated boulder to 10"														12:50																						
5.0	GW		GRAVEL - fine, little sand, cmf, dark brown, damp, occasional pebble to 1.5"														14:00																						
6.0	CL		CLAY - low plastic, brown, wet														14:05																						
			Bottom of pit																																				
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>LOGGED BY: J.K.W.</td> <td>FACILITY:</td> <td>PROJECT: 130 11</td> <td rowspan="5" style="text-align: center;"> 1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED </td> <td>TEST HOLE No.</td> </tr> <tr> <td>CHKD: R.H.</td> <td>LAT. & LONG: 67°15'58"N, 130°07'21"W</td> <td>ELEVATION:</td> <td rowspan="4" style="text-align: center;"> N75-1060-B7-3 </td> </tr> <tr> <td>DRWN BY: F.B.</td> <td>AIRPHOTO No.: A 22858-171, 172</td> <td>PIPE MILEAGE:</td> </tr> <tr> <td>CHKD: D.O.</td> <td>RIG:</td> <td>AIR TEMP: Approx. 16°C</td> </tr> <tr> <td></td> <td>METHOD: TEST PIT</td> <td></td> </tr> <tr> <td>START: D 25 M 08 Y 75 TIME: 11:20</td> <td>FINISH: D 25 M 08 Y 75 TIME: 14:05</td> <td></td> <td></td> <td>SHEET 1 OF 1</td> </tr> </table>																	LOGGED BY: J.K.W.	FACILITY:	PROJECT: 130 11	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.	CHKD: R.H.	LAT. & LONG: 67°15'58"N, 130°07'21"W	ELEVATION:	N75-1060-B7-3	DRWN BY: F.B.	AIRPHOTO No.: A 22858-171, 172	PIPE MILEAGE:	CHKD: D.O.	RIG:	AIR TEMP: Approx. 16°C		METHOD: TEST PIT		START: D 25 M 08 Y 75 TIME: 11:20	FINISH: D 25 M 08 Y 75 TIME: 14:05			SHEET 1 OF 1
LOGGED BY: J.K.W.	FACILITY:	PROJECT: 130 11	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.																																			
CHKD: R.H.	LAT. & LONG: 67°15'58"N, 130°07'21"W	ELEVATION:		N75-1060-B7-3																																			
DRWN BY: F.B.	AIRPHOTO No.: A 22858-171, 172	PIPE MILEAGE:																																					
CHKD: D.O.	RIG:	AIR TEMP: Approx. 16°C																																					
	METHOD: TEST PIT																																						
START: D 25 M 08 Y 75 TIME: 11:20	FINISH: D 25 M 08 Y 75 TIME: 14:05			SHEET 1 OF 1																																			

- 437 -

TEST HOLE No. N75-1060-B7-3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	GM	0.1	Moss cover, sparse		UF												17:45	
1		1.0	GRAVEL - coarse to fine, some fine to medium sand, roots, rust brown, dry brown, dry, roots, dirty									MA, combined samples 1 - 3 G = 45% S = 31% F = 24% (GM)	B1	X		1.0		
		1.2	cobble, rounded, 7"													1.5	18:10	
2		1.5	boulder, rounded, 12"													2.0	Difficult to excavate with hand tools - frequent cobbles and boulders	
		1.7	and sand, medium to fine, slight clayey silt binder													2.5		19:20
3		2.2	boulders, frequent, subrounded to 14"												3.0			
		2.7	damp												3.5			
4		3.0	some sand, medium to fine												4.0	20:35		
		4.0	Bottom of pit															

LOGGED BY: R.H.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°15'22" N, 130°05'39" W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 22859-171, 172	PIPE MILEAGE:
CHKD: D.O.	RIG:	AIR TEMP: Approx. 18°C
METHOD: TEST PIT		
START: D 24 M 08 Y 75 TIME: 17:45	FINISH: D 24 M 08 Y 75 TIME: 20:35	

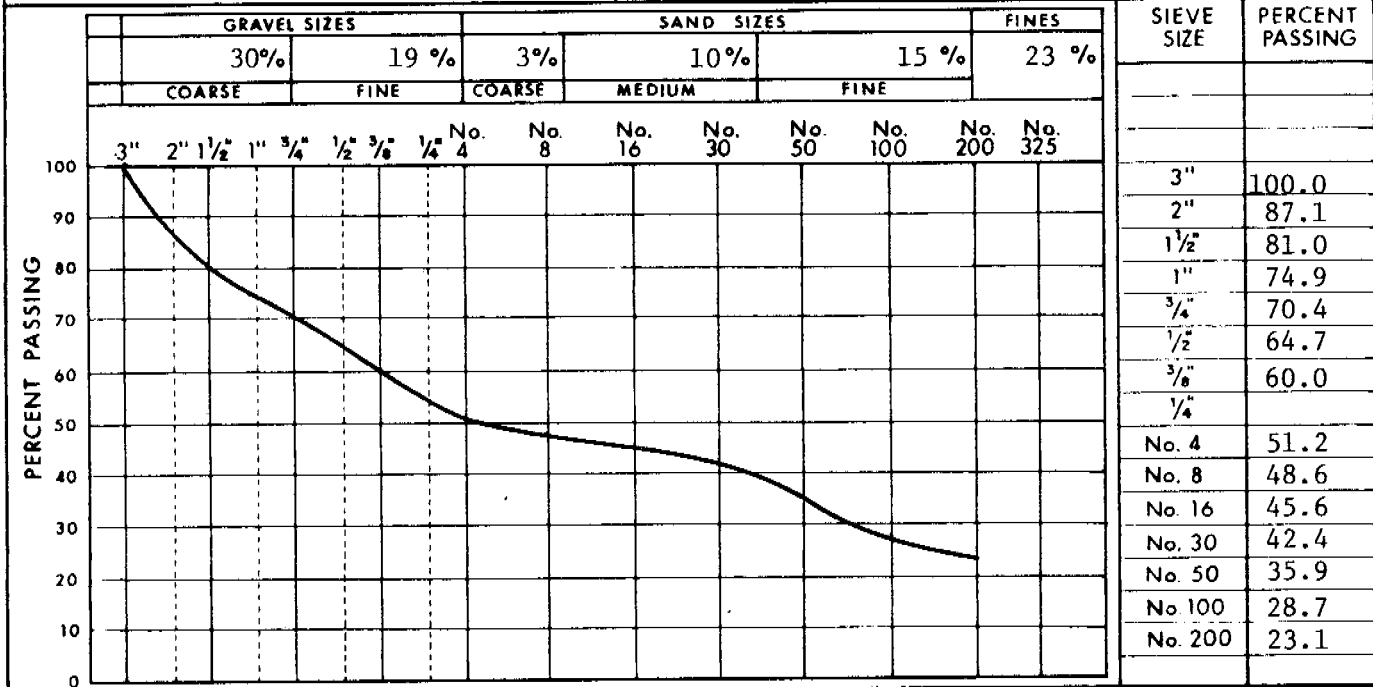
1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-1060-B7-4
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

- 438 -

TEST HOLE No. N75-1060-B7-4

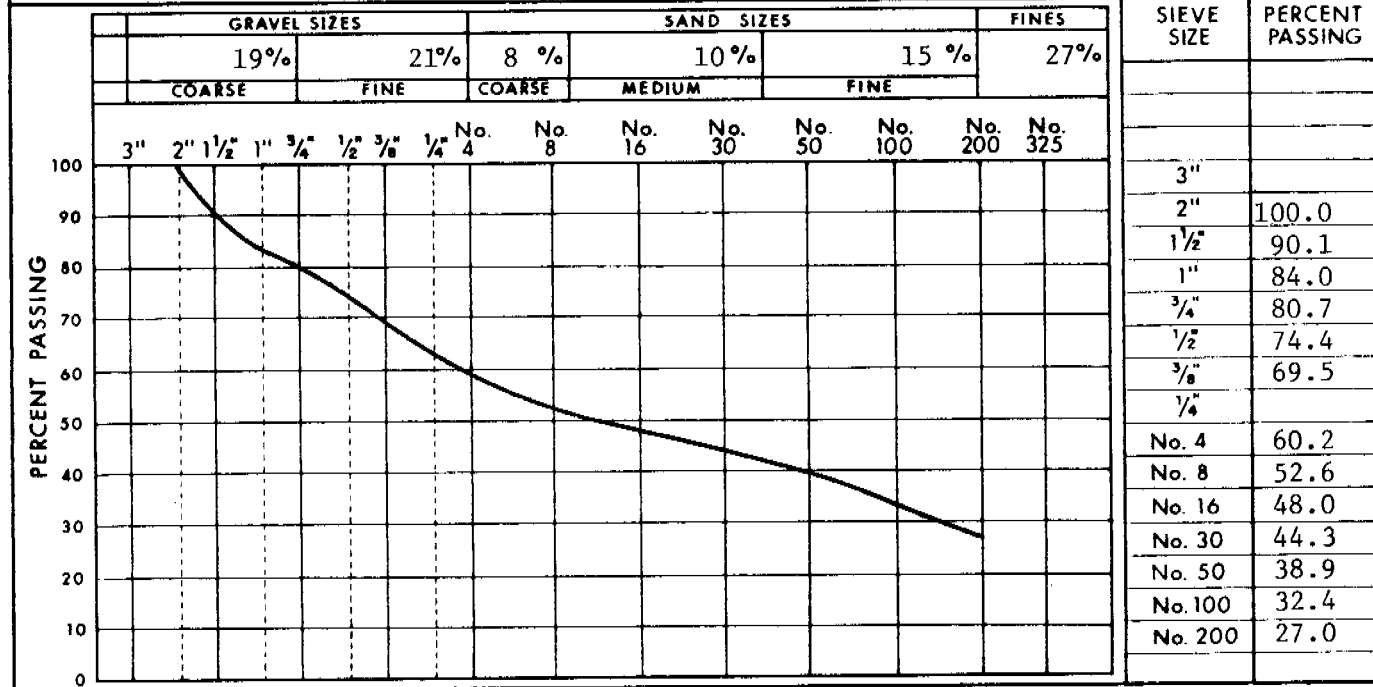
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B7-1 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER 163
 DATE SAMPLED August 24, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-1060-B7-2 DEPTH 0.0-5.0 R.M.HARDY REPORT NUMBER 4
 DATE SAMPLED August 25, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0 %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

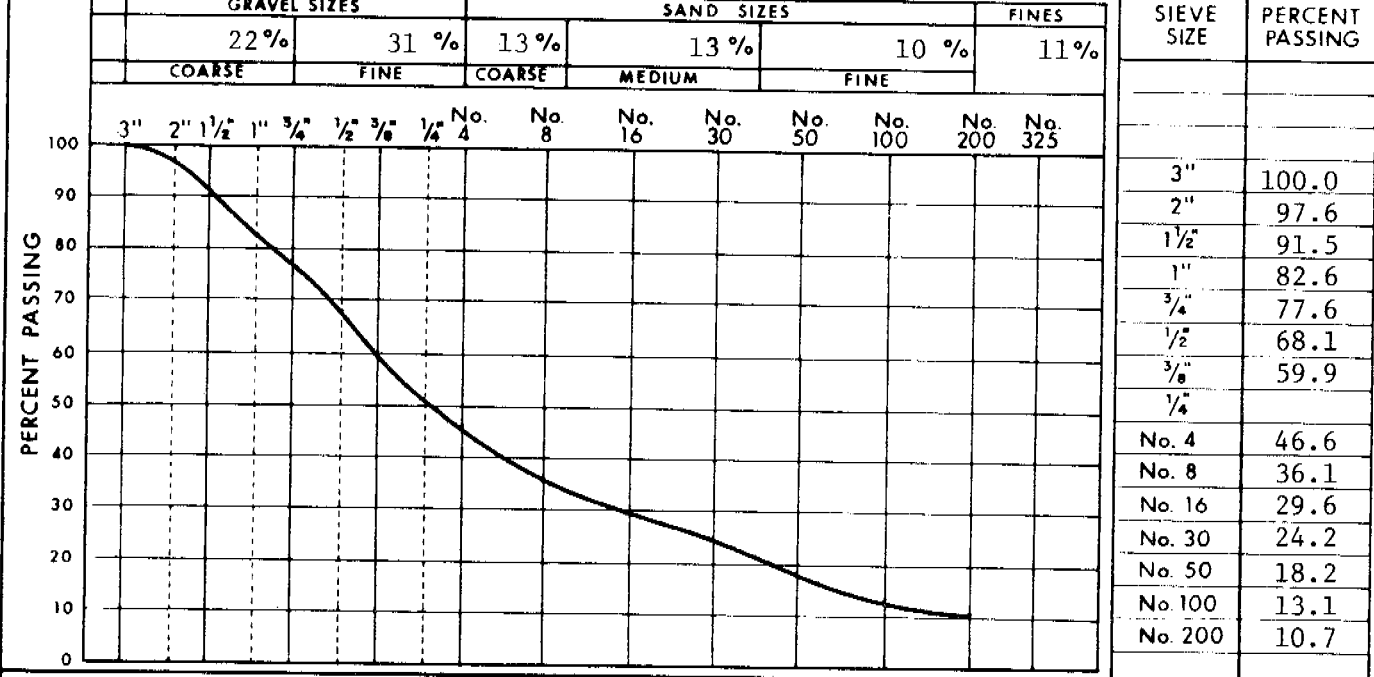


DEPOSIT No.
 N75-1060-B7

PAGE
 439

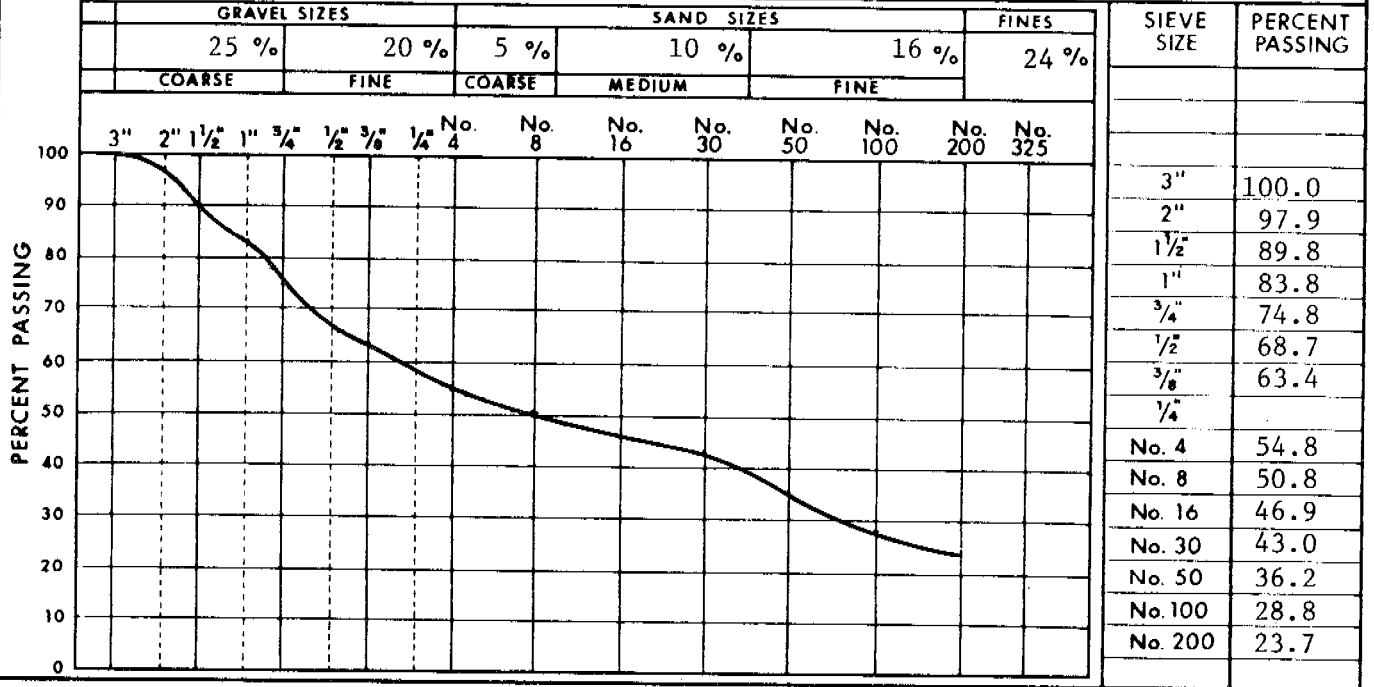
SIEVE ANALYSIS REPORT

SAMPLE N75-1060-B7-3 DEPTH 1.0-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 25, 1975 SAMPLED BY NESCL 19



COMMENTS Moisture content range from 4.2% to 7.8% OVERSIZE (>3") = 0.0%

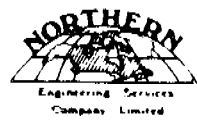
SAMPLE N75-1060-B7-4 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 24, 1975 SAMPLED BY NESCL 167



COMMENTS OVERSIZE (>3") = 0.0 %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-1060-B7

PAGE
 440

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-1060-B7-3 DATE SAMPLED : August 25, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 1-5 DATE TESTED : February, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 8.1 %
 FINE AGGREGATE : LOSS = 13.7 %

ORGANIC IMPURITIES TEST

NUMBER : 2
 COAL REMOVED : Nil
 COAL & ROOTLETS
 REMOVED : Nil
 COAL CONTENT : Nil
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 26.1 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Strong to very strong, Good	6.40
Granite		2.58
Sandstone	Medium strong, Good	1.92
Siltstone		3.85
Limestone	Soft, Medium strong, Good	31.55
Finegrained silicate altered rocks		3.5
Schist		0.45
Flint	Potentially reactive, Fair	0.32
Clay	Weak, Friable, Deleterious	0.25
Ironstone		0.18
PN = 109	INTERPRETATION : Excellent	51.0

COMMENTS : Satisfactory



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.

N75-1060-B7

PAGE 441

106D - B1-A 458280E 744947ON

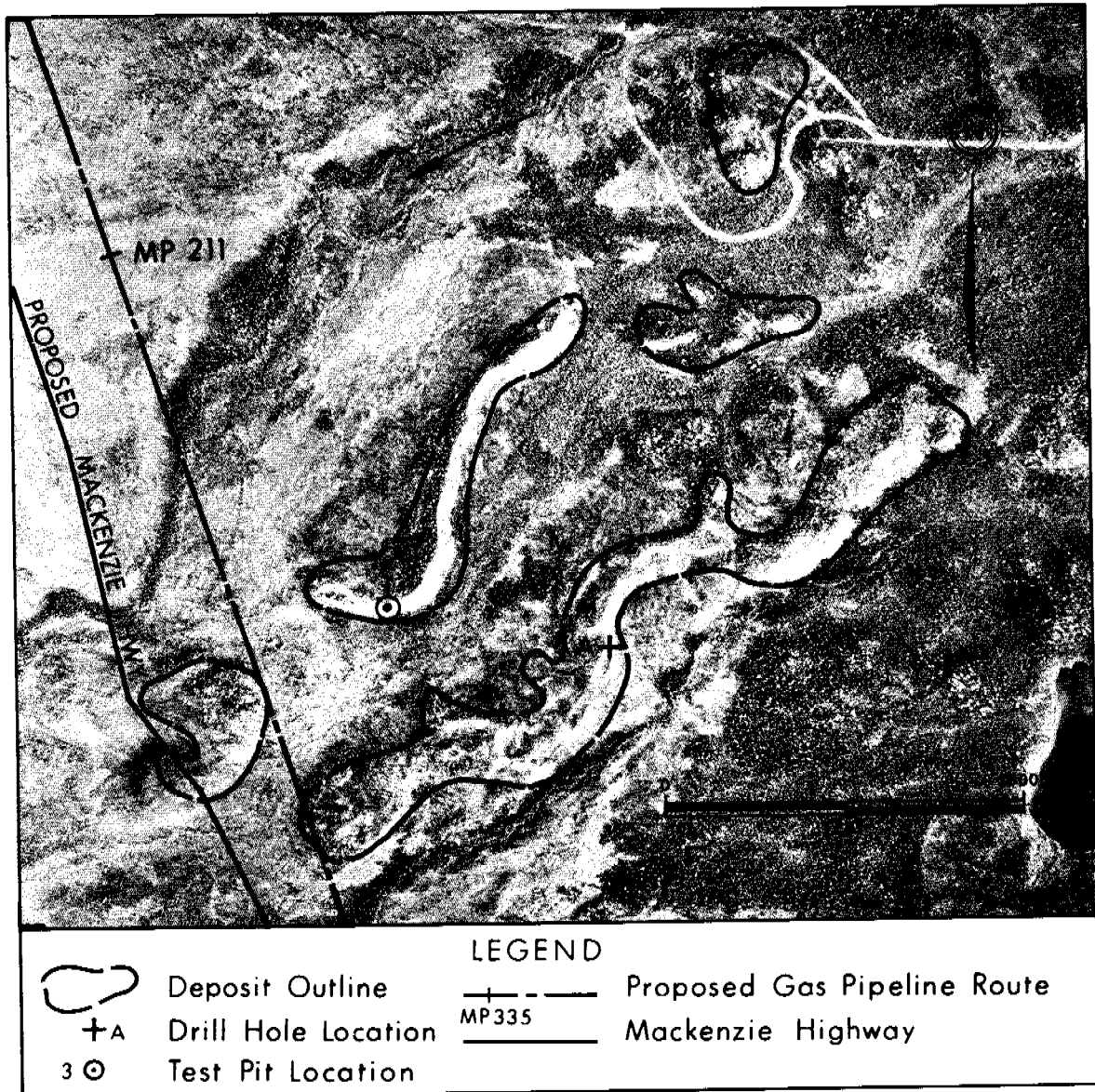
X ref EBA 1049
Tech BDB-2

Physical Setting: Deposit 106P-B1 consists of 2 small eskers and a series of kames located 8 miles southeast of Little Chicago and crossed by the right of way.

Material: SAND - well to poorly graded with a trace of gravel.

Volume: 1,400,000 cubic yards.

Assessment: Deposit 106P-B1 is a source of fair quality granular material suitable for general fill and backfill. The deposit is crossed by the right of way facilitating access.



Airphoto No. NW84872-118
 Approximate Scale: 1" = 1000'

Latitude: 67° 09'
 Longitude: 129° 57'

DEPOSIT 106P-B1

PHYSICAL SETTING

Deposit 106P-B1 consists of 2 small eskers and a series of kames located 8 miles east southeast of Little Chicago. The proposed pipeline right of way crosses the western end of these ridges. This deposit corresponds to source number 1049 in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The eskers and kames range between 30 and 80 feet in height. Crests are generally rounded and about 30 feet across. Side slopes are steep, ranging up to 30 degrees.

This deposit is free from overburden and the eskers and kames are well drained with intervening poorly drained flat areas. Water draining the uplands to the east of the deposit crosses the low lying areas by surface seepage and in poorly defined drainage courses. The active layer is 12 to 15 feet deep in this area. Below this depth the deposit is frozen with very low ice content.

BIOLOGICAL SETTING

Vegetation on the eskers consists of a discontinuous ground cover of grasses and herbs with occasional clumps of white birch and aspen. The kames are generally covered by spruce with willow, rose and fireweed. Much of the area has been burned within approximately the last 20 years. Burned areas provide good habitat for moose. Marten, fox, lynx, caribou, and black bear also occur in the area. Moose tracks were observed along a small lake and an inactive fox den was found at the site during the 1975 survey. Arctic loons and scotters were also observed on the lake. Waterbodies in the area provide good beaver habitat but do not appear to support fish populations.

MATERIAL

Material in this deposit is mainly well graded to poorly graded sand with a trace to little silt and trace of fine gravel. The DIAND drill hole encountered sandy silt and silty, sandy clay. Therefore, quality is not consistent throughout the deposit.

VOLUME

The total estimated volume based on an area of 70 acres and depth of 12 feet is 1,400,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106P-B1 is a source of fair quality granular material and would be suitable for general fill and backfill in pipeline construction. This source is conveniently located directly on the pipeline route and is free of overburden. The varied quality of material indicates further drilling would be required in order to locate the most promising areas for development.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Snow roads would be built to transport borrow the short distance from borrow areas to haul points on the right of way. This would eliminate any serious environmental damage. Trees and vegetative cover, though not extensive at this site, would be removed and harvested or disposed of in accordance with land use regulations. Overburden at this site consists only of top soil which would be stripped and stockpiled around the perimeter of the borrow pit areas.

Development would probably involve excavating borrow material in stages from the eskers and kames to a level which would retain the natural drainage over the area. Since drainage of the eskers and kames is good and ice contents very low, conventional earthmoving techniques would be used.

Equipment required for development would be dozers, rippers, end dump trucks, and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

N6P01-A copy N600454
 k# #

W. 9 742 470 458290

TEST HOLE LOG

xref D. E1049
 E. TD602


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0			SAND - fine to coarse, silty, trace fine gravel, light brown, dry, dusty		UF												20:31	4 1/2" Walmac
2	SM																	
4																		losing air through dry sand
6																		
7.0			damp, brown, trace silt															
8.0																		
8	SP		SAND - fine to medium, (trace coarse), clean, brown, damp															to 3 7/8" Walmac
10																		
12			(12.0) very slight silt															
12.0																		
23																		
24																		

- 448 -

TEST HOLE No. N/5-108P-B1-A

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 130E1
CHKD: B.O.	LAT. & LONG: 87°09'35"N, 129°57'37"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: NW 84872-118	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 25 M 8 Y 75 TIME: 20:30	FINISH: D 25 M 8 Y 75 TIME: 21:10	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
 N75-106P-B1-A
 SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
24	SP		SAND (cont'd)		Nbn												24	
26			26.0 → fine to medium, trace silt, moist when thawed, grey brown															
28																		
29.0			29.0															
30	SW		SAND - coarse, trace fine, little silt, trace fine gravel.		F													
32			32.0 → visible ice chunks in returns															
32.0			32.0															
34	SP		SAND - fine to medium, trace silt, (poorly graded)		Nb													
36																		
38																		
38.0			38.0 End of hole														38	21:10

TEST HOLE No. N75-106P-B1-A

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 67°09'35"N, 129°57'37"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: NW 84672-11B	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-BRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 25 M 8 Y 75 TIME: 20:30	FINISH: D 25 M 8 Y 75 TIME: 21:10	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B1-A

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS		
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit										
0.2	Pt		PEAT - coarse fibrous, sandy, orange brown															14:45		
1.1	SW		SAND - fine, trace gravel, orange brown, pebbles rounded to 3/4"									Samples 1 - 4 MA, combined SW-SC G = 2% S = 87% F = 11%								
3.5	SW		SAND - coarse, medium, fine, trace gravel, cementation on gravel from 1.1' to 3.0', rootlets, light brown, dry										B1							
4.5	SC		SAND - fine, trace medium and coarse sand, in layers to 0.4', medium brown, damp, isolated clay pockets										B2							
4.7	SC		4.5' to 4.7', layer of coarse sand and fine gravel										B3							
8.0			Bottom of pit										B4							15:20

- 450 -

TEST HOLE No. N75-106P-B1-1

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°09'35"N, 129°57'37"W	ELEVATION:
DRWN BY: F.B.	AIRPHOTO No.: NW 84872-118	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 13°C
METHOD: TEST PIT		
START: D 25 M 08 Y 75	TIME: 14:45	FINISH: D 25 M 08 Y 75
TIME: 14:45		TIME: 15:20

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY, ALBERTA
 ENGINEERS FOR

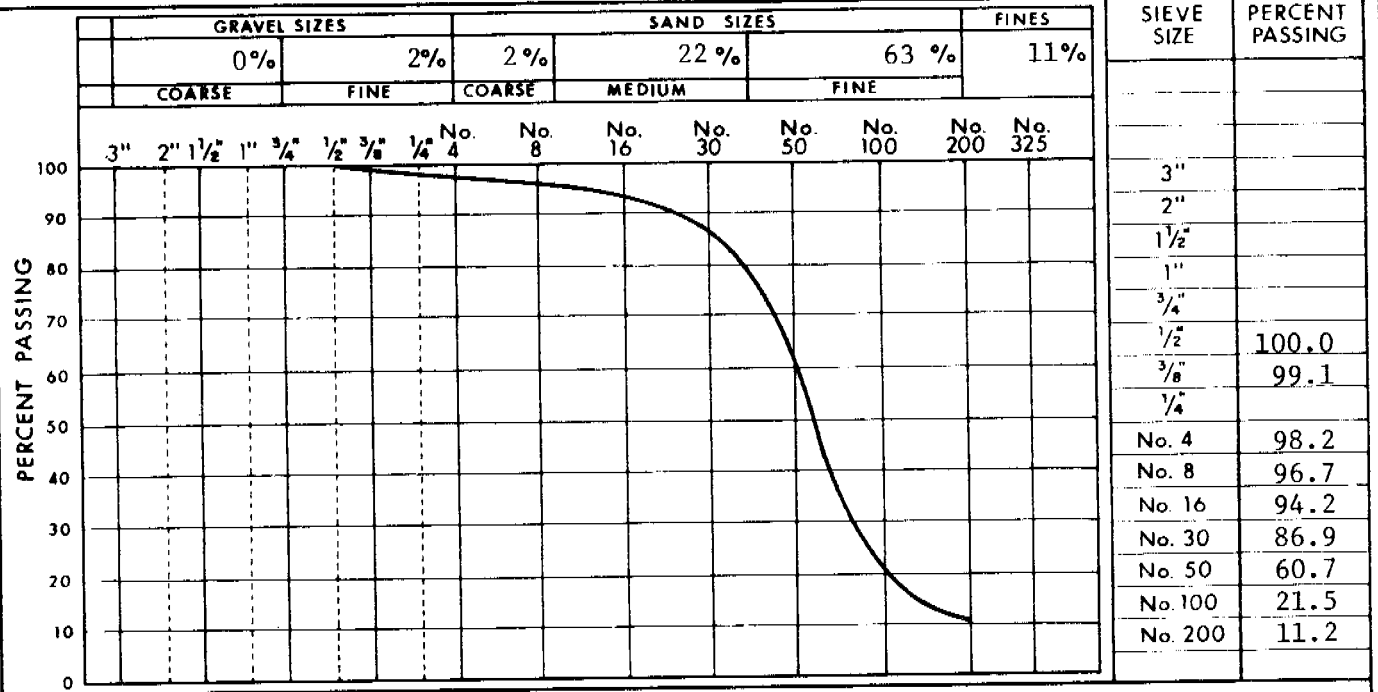
CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B1-1

SHEET 1 OF 1

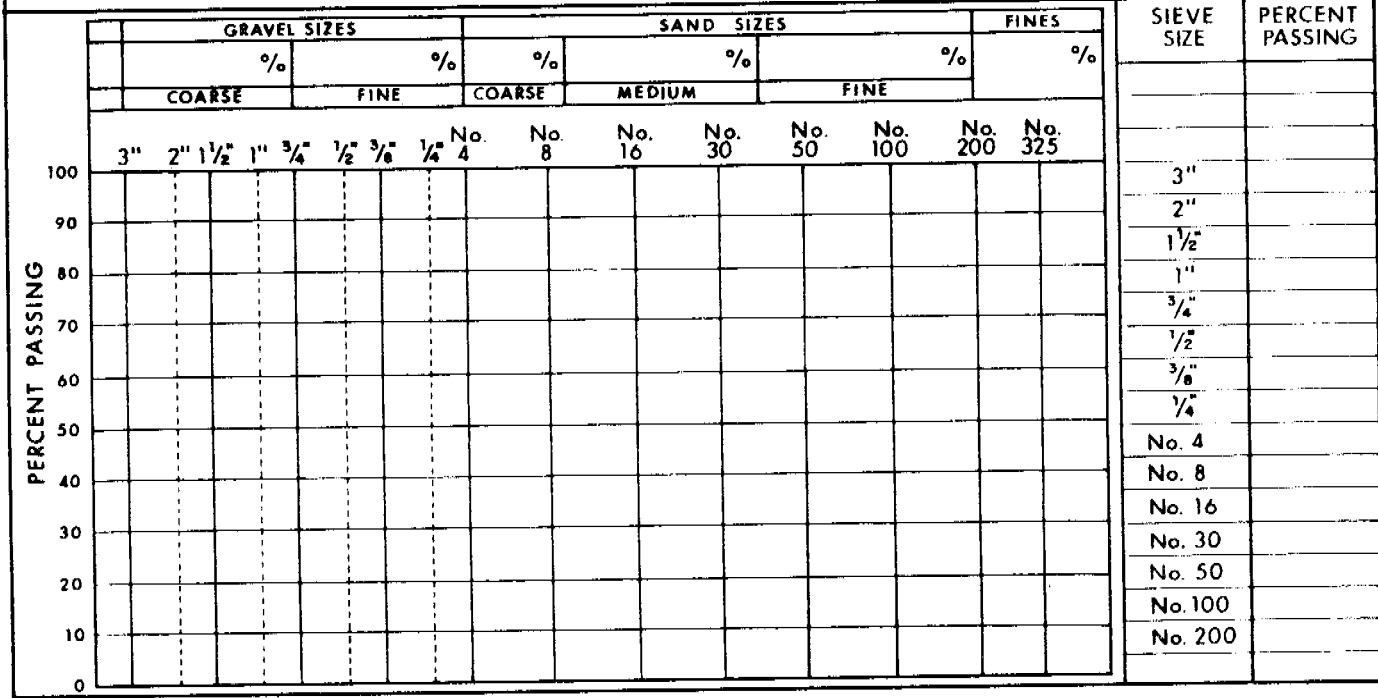
SIEVE ANALYSIS REPORT

SAMPLE N75-106P-B1-1 DEPTH 2.0-6.0 R.M.HARDY REPORT NUMBER 1
 DATE SAMPLED August 25, 1975 SAMPLED BY NESCL



COMMENTS Moisture contents range from 4.6% to 5.6% OVERSIZE (>3") = 0.0%

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = _____ %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-106P-B1

PAGE
 451

106P - B2 - A 460850E
(C) correction

7447830N

DEPOSIT 106P-B2

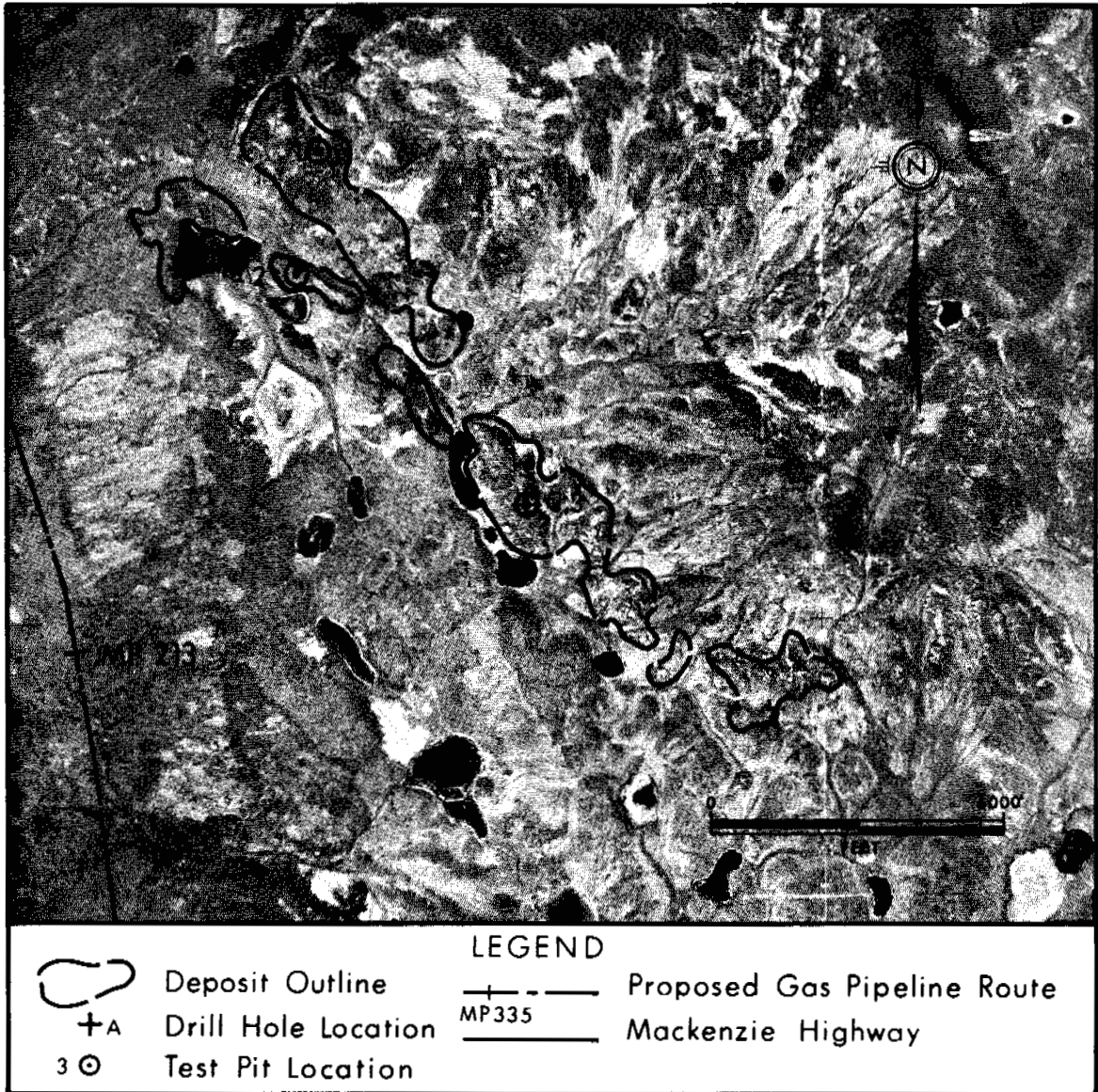
See 1050-1 EBA

Physical Setting: Deposit 106P-B2 is a kame complex located 9.5 miles ESE of Little Chicago and less than 2 miles north-east of milepost 212 on the right of way.

Material: SAND and GRAVEL - interbedded.

Volume: 5,500,000 cubic yards.

Assessment: Deposit 106P-B2 is a source of fair quality granular material suitable for general fill and backfill.



Airphoto No.

A12704-11

Latitude: 67° 09'

Approximate Scale: 1" = 3700'

Longitude: 129° 55'

DEPOSIT 106P-B2

PHYSICAL SETTING

This deposit is a kame complex located about 9.5 miles east-southeast of Little Chicago and less than 2 miles northeast of milepost 212 on the proposed pipeline right of way. This deposit corresponds to source number 1050 in EBA DIAND Granular Materials Inventory Volume II (1974).

The kame complex has local relief of about 50 feet. In the northeastern part of the deposit a creek has incised 100 feet or more below the general level of the surrounding terrain. The complex has less than 1 foot of overburden and is well drained. Drill hole 106P-B2-C indicates an active layer of at least 15 feet and low ice content.

A moderately steep escarpment lies between the pipeline alignment and the deposit. However, the creek valley that dissects the deposit provides good access to the pipeline route.

BIOLOGICAL SETTING

Most of this site has been burned and, except for scattered groves of spruce, now supports a thick growth of shrubs with a grass-herb ground cover. The area provides low to moderately productive habitat for marten, fox, lynx, black bear and moose. Limited areas of caribou habitat also occur. Lakes and streams provide low to moderately productive habitat for aquatic furbearers and are used throughout the open-water season by migratory and resident waterfowl. It is unlikely that any of these lakes support fish populations.

MATERIAL

Material in this deposit consists of interbedded sand and gravel. Sands are well graded with variable silt and gravel content. Gravel is poorly graded, fine and rounded with a high percentage of sand and a trace of silt.

VOLUME

Total estimated volume, based on a maximum depth of 30 feet under hill crests and an area of .370 acres is 5,500,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106P-B2 is a source of fair quality granular material and is suitable for general fill, and backfill in pipeline construction. Initially, extensive drilling would be required on the deposit to locate areas of better quality material.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigations. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

In order to minimize environmental damage, snow roads would be built for transporting the material a distance of 1.8 miles from the deposit to haul points on the right of way. This road would probably follow the creek valley in order to avoid crossing the escarpment that lies west of the deposit.

The thick brush cover would be removed and disposed of in accordance with land use regulations followed by a minimal amount of stripping to remove the thin peat and silt overburden. This material would be stockpiled around the edge of the selected sites.

Borrow material could be excavated evenly from the higher, well drained areas so that good drainage would be established. Open face pit development could also be accomplished on some of the steep slopes of the deposit. This site has fairly low ice contents so that conventional earth moving techniques would be used. However, any areas of high ice cementation might require blasting. The excavated material may have to be stockpiled, thawed and drained before it is used.

Equipment required for development would be dozers, rippers, end-dump trucks and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

11-2-75 - k copy 11-2-75 - k

0.1 7747350 460990

TEST HOLE LOG

x ref D. 5150
E. 10300


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
2	SM		GRAVEL - fine (trace coarse), very silty, light brown, damp		UF												4 1/2" Walmac	
5.0	SM		SAND - fine to coarse, silty, little fine gravel, damp, brown														losing air circulation	
9.0	SP		SAND - (less silty)														18:48	
11.0			moist, less coarse sand															
12.0			more coarse gravel to approx. depth 14.0'															
14.0	SM		SAND - fine to medium, silty, trace gravel, moist, dark brown, infrequent cobble														hole plugging silt sticking to stem	
18.0																		

- 458 -

TEST HOLE No. N75-106P-B2-A

LOGGED BY: G.W.H.	FACILITY:	PROJECT: 13011
CHKD: J.G.W.	LAT. & LONG: 87°08'44"N, 128°54'14"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 12704-11	PIPE MILEAGE:
CHKD: B.B.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 25 M 8 Y 75 TIME: 18:40	FINISH: D 25 M 8 Y 75 TIME: 19:20	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B2-A

SHEET 1 OF 3.

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
16	SM		SAND (cont'd)		Nd												16	Very little cutting return
18			wet when thawed															
19.5																		
20	SP-SM		SAND, coarse, little fine gravel, trace silt, trace fine sand		F													
22																		
24			visible ice chunks in cutting return, possibly Vx or Ys															
26	GP		GRAVEL - fine to coarse, some coarse sand, (trace silt)															
28			visible ice chunks															
30																		
31.0			trace medium sand															
32																	32	

- 459 -

TEST HOLE No. N75-106P-B2-A

LOGGED BY: G. M. H.	FACILITY:	PROJECT: 13011
CHKD: J. K. W.	LAT. & LONG: 67°08'44"N, 128°54'14"W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: A 12704-11	PIPE MILEAGE:
CHKD: D. D.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 25 M 8 Y 75	TIME: 18:40	FINISH: D 25 M 8 Y 75
		TIME: 19:20

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B2-A

SHEET 2 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	-----		Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
32	GP		GRAVEL (cont'd)		F												32	
34																		
35.0			little coarse gravel															
36																		
37.5																		
38	ICE +		ICE with medium sand, fine sand, trace clay and silt.		ICE +													
40			End of hole														40	19:20 No cutting return. Hole plugging
			Note: low plastic clay found at 40'.															

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: J.N.W.	LAT. & LONG: 67°08'44"N, 129°54'14"W	ELEVATION:
DRWN BY: F.M.B.	AIRPHOTO No.: A 12704-11	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 25 M 8 Y 75 TIME: 18:40	FINISH: D 25 M 8 Y 75 TIME: 19:20	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B2-A
SHEET 3 OF 3

- 467 -

TEST HOLE No. N75-106P-B2-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit			Liquid limit								
							40	60	80	100	120	140 ▲								
							0	20	40	60	80	100 ○								
0.4	Pt		PEAT - coarse fibrous, orange brown		UF															
0.7	ML		SILT and gravel, fine, trace sand, coarse, pebbles rounded to 3/8"																	
1.2	CL		CLAY - low plastic, some sand, trace fine gravel, dry, light brown, white calcified layers at 1.2' and 1.8'										MA, combined, samples 1 - 4 G = 10% S = 38% F = 54%	B1				1	isolated iron stains	
2.3			CLAY - low plastic, grey, friable											B2				2		
2.7														B3				3		
3.7	SP		SAND - fine, some fine gravel, trace silt, medium brown, damp											B4				4		
4.8														B5				5		
5.2	SM		SAND - cml, trace fine gravel, brown															6		
6.4			SAND - some silt, trace gravel, brown, damp															8		
6.4			Bottom of pit															8.4		

- 461 -

TEST HOLE No. N75-106P-82-1

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	1975 BORROW INVESTIGATION TEST HOLE No. N75-106P-82-1
CHKD: R.H.	LAT. & LONG: 67°09'48"N, 128°55'51"W	ELEVATION:		
DRWN. BY: F.B.	AIRPHOTO No.: A 12704-11	PIPE MILEAGE:		
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 13°C		
	METHOD: TEST PIT			
START: D 25 M 08 Y 75 TIME:	FINISH: D 25 M 08 Y 75 TIME:			SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						Plastic limit	Liquid limit												
					40	60	80	100	120	140 ▲									
					0	20	40	60	80	100 ○									
	Pt		0.2 PEAT - coarse fibrous, black, roots		UF														
	CL		CLAY - trace sand, fine, orange, roots																
1	ML		0.8 SILT - and fine sand, trace fine gravel, low to nonplastic, 1.1' - 2.0', white calcified zone																
2			2.0 increasing gravel																
3	GM		2.8 GRAVEL - silty, little cwf sand, pebbles rounded av. 3/4", to 2", subangular, rust pockets								MA, combined samples 1 - 3 G = 42% S = 40% F = 18% (GM)	B1					Combined samples 2' to 5' "GRAVEL, fine to coarse, and mfc sand, little fines"		
4	SM		4.0 SAND - medium, trace gravel, trace silt, pebbles to 3/8", moist									B2							
5	GM		4.7 GRAVEL - fine, silty, and medium sand, pebbles to 3/8", moist										B3						
			5.4 Bottom of pit																

- 462 -

TEST HOLE No. N75-106P-B2-2

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-106P-B2-2 SHEET 1 OF 1
CHKD: R. H.	LAT. & LONG: 67°09'29" N, 128°55'59" W	ELEVATION:		
DRWN. BY: F. B. B.	AIRPHOTO No.: A 12704-11	PIPE MILEAGE:		
CHKD: J. K. W.	RIG:	AIR TEMP: Approx. 21°C		
	METHOD: TEST PIT			
START: D 25 M 08 Y 75 TIME: 18:20	FINISH: D 25 M 08 Y 75 TIME:			

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.3	Pt		PEAT - coarse fibrous, sandy, dark brown, dry		UF												14:45		
1.0	SM		SAND - very fine, silty, trace gravel, dry to desiccated									MA, combined samples 1 - 5 G = 28% S = 80% F = 12% (SW-SM)					14:55		
1.3			1.0 - 1.5' calcified zone																
2.0	GM		GRAVEL - fine, and fine sand, trace silt. pebbles av. 3/8" to 3".										B1				15:00	easy to excavate	
3.0			cleaner										B2						
3.8													B3						
4.0	SP		SAND - medium to coarse, trace fine gravel, clean										B4				15:20	+3" = 6.3% of total samples	
5.0												B5							
6.0	GP		GRAVEL - little sand, medium to coarse, pebbles to 3/4", occasionally to 2". Bottom of pit														15:30		

TEST HOLE No. N75-106P-B2-3

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°08'44"N, 129°54'14"W	ELEVATION:
DRWN. BY: G.B.	AIRPHOTO No.: A 12704-11	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 21°C
	METHOD: TEST PIT	
START: D 25 M 08 Y 75 TIME: 14:45	FINISH: D 25 M 08 Y 75 TIME: 15:30	

1975 BORROW INVESTIGATION

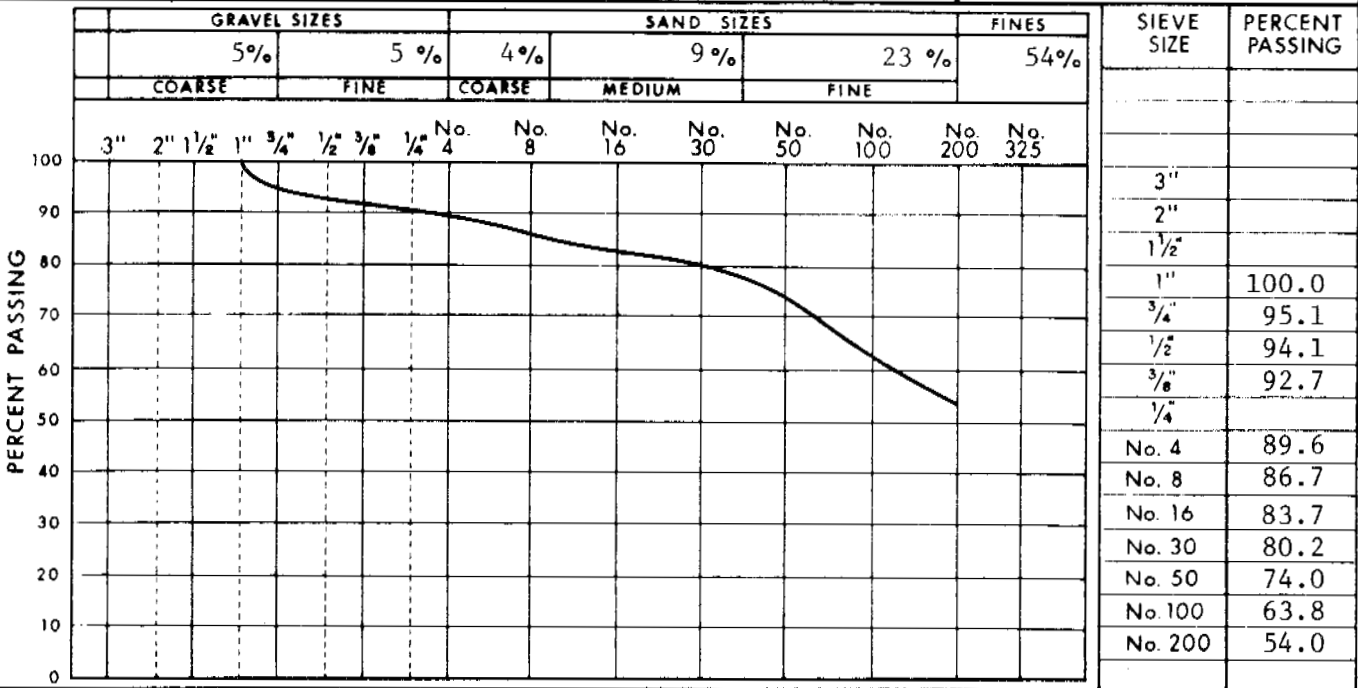
NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B2-3
SHEET 1 OF 1

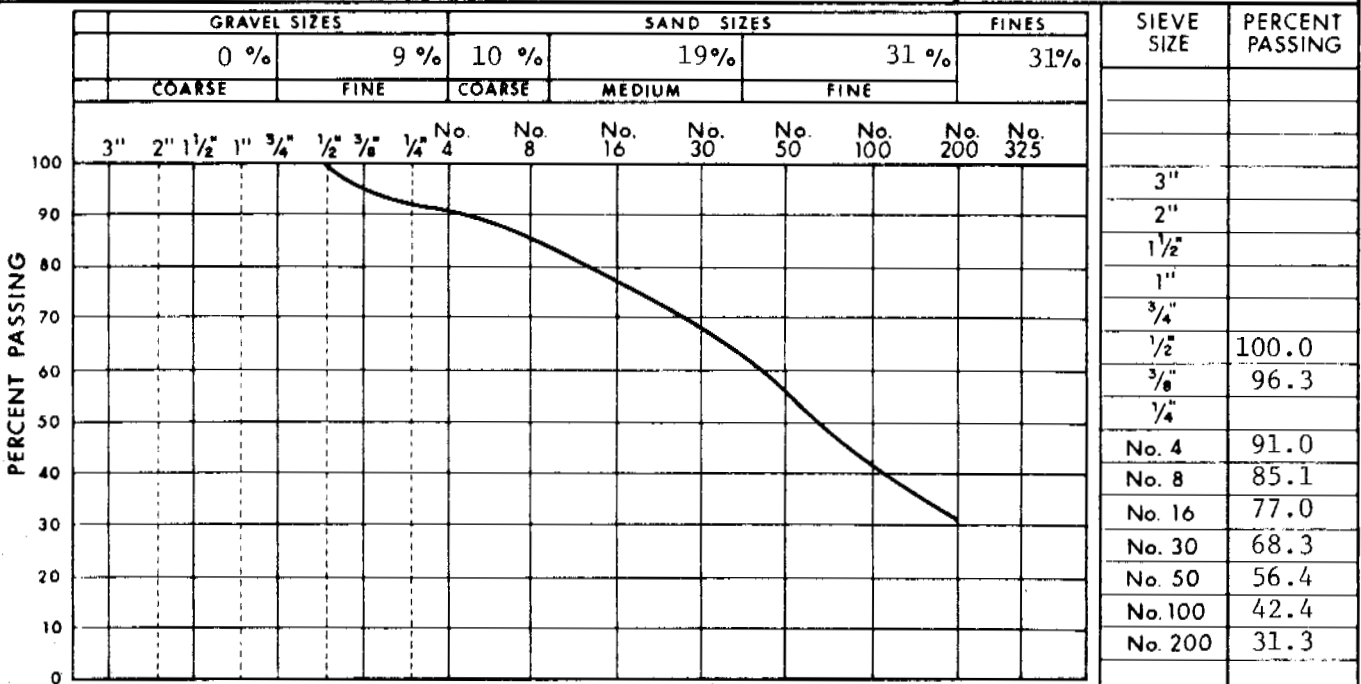
SIEVE ANALYSIS REPORT

SAMPLE N75-106P-B2-1 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 25, 1975 SAMPLED BY NESCL 33



COMMENTS _____ OVERSIZE (>3") = 0.0%

SAMPLE N75-106P-B2-1 DEPTH 4.0-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 25, 1975 SAMPLED BY NESCL 32

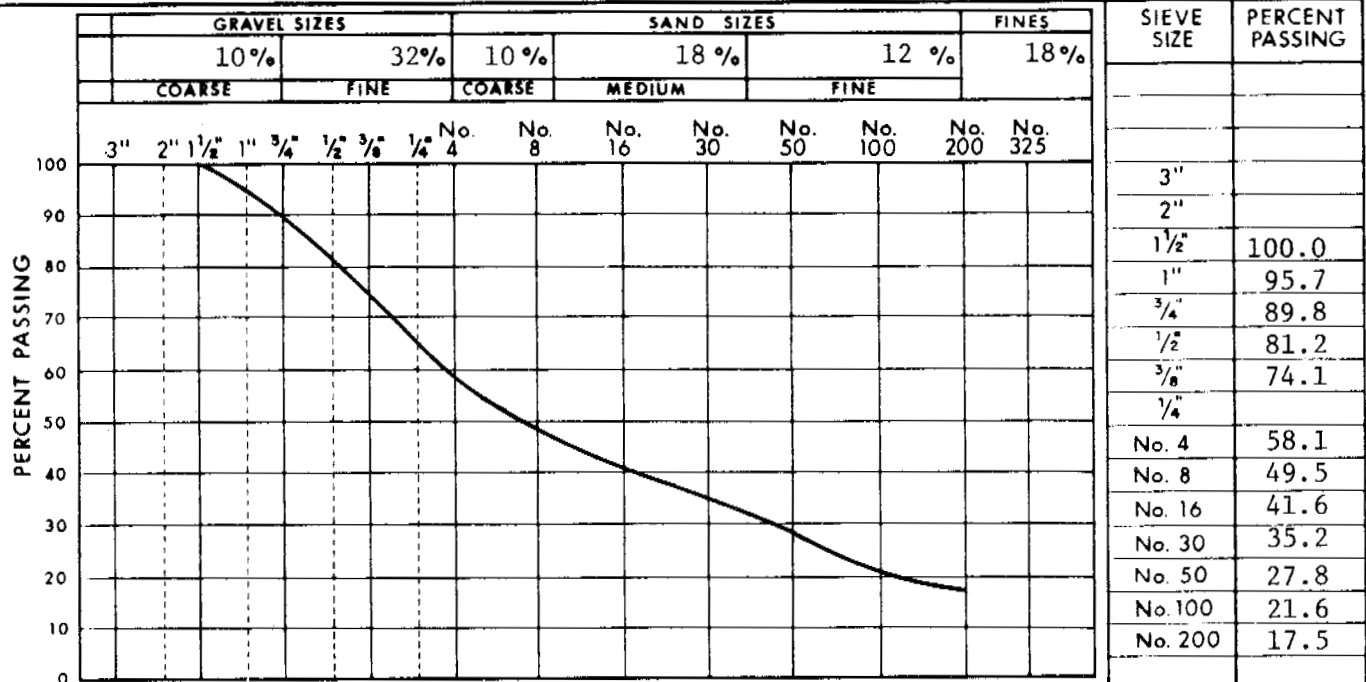


COMMENTS _____ OVERSIZE (>3") = 0.0%

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-106P-B2
			PAGE 464

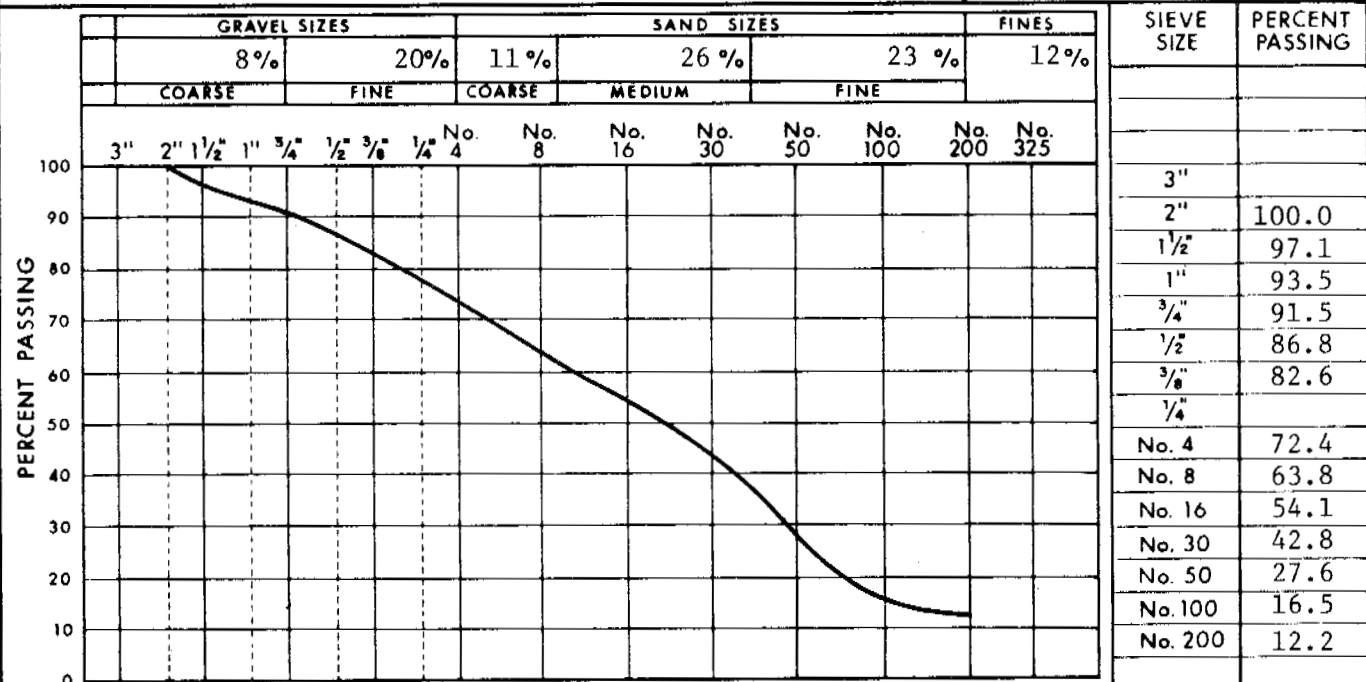
SIEVE ANALYSIS REPORT

SAMPLE N75-106P-B2-2 DEPTH 2.0-5.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 25, 1975 SAMPLED BY NESCL 170



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-106P-B2-3 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 25, 1975 SAMPLED BY NESCL 41



COMMENTS OVERSIZE (>3") = 6.3%

	<p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>		DEPOSIT No. N75-106P-B2 PAGE 465
---	---	---	---

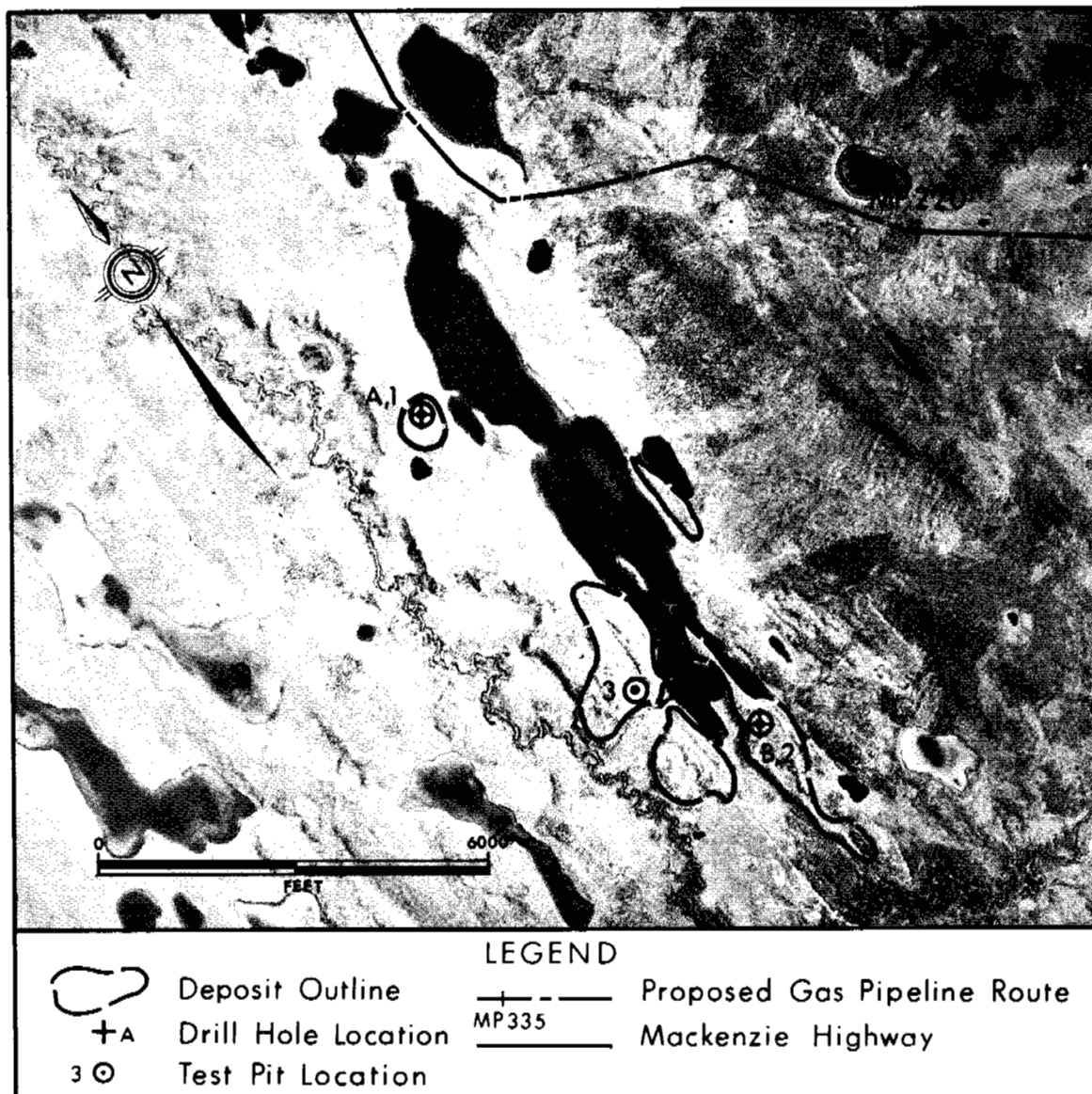
106P - B3 - A	456420E	7436140N
B3 - B	456570E	7433810N

Physical Setting: Deposit 106P-B3 is an esker and kame complex located 13 miles southeast of Little Chicago and about 2 miles west of milepost 220 on the right of way.

Material: SAND and GRAVEL - variable throughout the deposit.

Volume: 4,200,000 cubic yards.

Assessment: Deposit 106P-B3 is a source of fair quality granular material suitable for general fill and backfill. Access to the deposit is good overland from the right of way.



Airphoto No. A22890-85
Approximate Scale: 1" = 2750'

Latitude: 67° 02'
Longitude: 130° 00'

DEPOSIT 106P-B3

PHYSICAL SETTING

This deposit is an esker and kame complex located 13 miles southeast of Little Chicago and about 2 miles west of milepost 220 of the proposed pipeline right of way. The deposit corresponds to a portion of source number 1047 in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The complex has local relief to about 50 feet with steep slopes flanking the hills and ridges. The small northern part of the deposit is a flat topped kame with sides defined by 10 foot scarps. Overburden is negligible except in depressions where it may exceed 5 feet. Kames and eskers are all well drained; intervening low lying areas are less perfectly drained. The active layer is about 5 feet deep in the north and 10 to 15 feet deep in other parts of the deposit.

East of the deposit, a lacustrine plain with high ice contents is present.

BIOLOGICAL SETTING

Much of this site has been recently burned, although scattered clumps of spruce and birch up to 40 feet high are present. The understory consists largely of alder, rose, and willow with a ground cover of grasses and sedges in low lying areas. The area provides habitat for caribou, lynx, fox, marten, black bear, moose, and caribou. Moose may migrate through this area in late fall and early spring enroute to or from islands in the Mackenzie River. An unidentified eagle and an occupied beaver lodge were observed at the site in 1975. The small lakes in the area do not appear to provide suitable fish habitat.

MATERIAL

Material in this deposit appears to be quite variable. Sand is predominant and is generally medium grained and clean with occasional

fine gravel. Two test pits encountered interbedded sand and gravel. The gravel in this case is rounded, and either fine grained or well graded with considerable sand. Traces of silt and thin lenses of clay occur periodically. Low moisture contents were found at all test sites.

VOLUME

Maximum depths of granular material at this deposit are in excess of 50 feet. Total estimated volume based on this depth and an area of 210 acres is 4,200,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106P-B3 is a source of fair quality granular material which is suitable for general fill and backfill in pipeline construction. Extensive drilling and test pitting would be required to locate areas of better quality material prior to any excavation.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit from the pipeline right of way would be 2 miles overland to the deposit. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way after the right of way has been cleared of trees and scrub brush.

At selected sites, the tree and vegetative cover, although minimal, would be removed and disposed of in accordance with land use regulations. The kames and eskers are essentially free of overburden, therefore, little or no stripping will be required.

Excavation would involve removing the borrow material evenly from higher, well drained areas so that good drainage would be established over the site. Open face pit development could also be carried out at steeper slopes on eskers and kames. Conventional earthmoving techniques would probably be all that is required for excavation at this site as ice contents are low. However, blasting would be used if areas of high ice cementation were encountered.

Equipment required for development would be dozers, rippers, end-dump trucks and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

115P03-H COPY N1900-1

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
2	SP	[Stippled]	SAND - fine grained, clean light rust brown to brown, damp, poorly graded	[Stippled]	UF												0	13:15 Insert bit
3.5																		
4	CL	[Diagonal lines]	CLAY - trace fine sand, grey, damp.	[Diagonal lines]														
5.0																		
6	SP	[Stippled]	SAND - medium, trace coarse, clean; B.D.	[Stippled]	Nb												6	new 3 7/8" Walmac
8			little coarse															
10	SW	[Stippled]	SAND - med. little fine gravel clean	[Stippled]														
14																		
14.0																		
16			SAND - medium, trace coarse, clean poorly graded.														16	

B1
B2
C1
- 472 -
C2

TEST HOLE No. N75-106P-B3-A

LOGGED BY: G.M.H	FACILITY:	PROJECT: 13011
CHKD: J.K.W.	LAT. & LONG: 67°02'33"N, 130°00'05"W	ELEVATION:
DRWN. BY: J.M.B	AIRPHOTO No.: A 22890-85	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 28 M 08 Y 75	TIME: 13:15	FINISH: D 26 M 08 Y 75
		TIME: 13:30

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B3-A
SHEET 1 OF 2

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
16	SP		SAND (cont'd)		Nb	40	60	80	100	120	140 ▲							
18						0	20	40	60	80	100 ○							
20	SW		SAND - medium to coarse, little fine to coarse gravel, clean.															
22																		
24			24.0 trace fine gravel															
26																		
30	SP		SAND - medium, clean, poorly graded.															
32																		
34																		
38			38.0 End of hole															13:38

- 473 -

TEST HOLE No. N75-106P-B3-A

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: J.K.W.	LAT. & LONG: 67°02'33"N, 130°00'05"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 22890-85	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 26 M 08 Y 75	TIME: 13:15	FINISH: D 26 M 08 Y 75
		TIME: 13:38

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No. N75-106P-B3-A
SHEET 2 OF 2

N6P03-B copy N6P03-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	SM	0.5	SAND - silty to 0.5'															
2			SAND - fine to coarse, little fine gravel, trace silt, brown, damp to 4.5'		UF													
4	SM	4.5	moist															
8																		
8	SP	8.0	SAND - fine to medium, moist															
10																		
10		10.0			Nd													
12																		
14																		
16			trace silt															

some caving due to thawing.


474

2

TEST HOLE No. N75-106P-B3-B

LOGGED BY: G.M.H	FACILITY:	PROJECT: 13011
CHKD: J.K.W.	LAT. & LONG: 87°01'18"N, 128°59'58"W	ELEVATION:
DRWN. BY: J.M.B	AIRPHOTO No.: A 22890-85	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-BRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 28 M 08 Y 75 TIME: 14:30	FINISH: D 28 M 08 Y 75 TIME: 15:15	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B3-B
SHEET 1 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS		
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit										
						40	60	80	100	120	140 ▲									
						0	20	40	60	80	100 ○									
16		SP	SAND (cont'd)	Nb																
	17.5		fine to medium grained																	
18																				
20																				
22																				
			22.0	some coarse sand to fine gravel																
			23.0	trace fine gravel																
			24.0	trace coarse sand (very little gravel)																
			25.0	trace fine gravel																
			26.0																	
26		GP	GRAVEL - fine, and med. to coarse sand.	F																
	28.0																			
28		SP	SAND - medium to coarse, little fine gravel, trace silt.	F (v)																
	30				ice visible in cutting return															
32																				

LOGGED BY: G.W.H	FACILITY:	PROJECT: 13011
CHKD: J.K.W.	LAT. & LONG: 87°01'18"N, 129°59'50"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 22890-85	PIPE MILEAGE:
CHKD: D.O.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 28 M 08 Y 75	TIME: 14:30	FINISH: D 28 M 08 Y 75
		TIME: 15:15

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B3-B

SHEET 2 OF 3

- 475 -
TEST HOLE No. N75-106P-B3-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
32	SP	33.0	SAND - (cont'd) cobble, some fine gravel		F (V)												32	
34	GP	34.0	GRAVEL - fine, some medium to coarse sand															
36		36.5																
38	SP	38.0	SAND - medium grained, clean															
38		38.0	End of hole														38	

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: J.K.W.	LAT. & LONG: 87°01'18"N, 129°59'50"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 22690-85	PIPE MILEAGE:
CHKD: D.D.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 28 M 88 Y 75 TIME: 14:30	FINISH: D 28 M 08 Y 75 TIME: 15:15	

1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-106P-B3-B
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 3 OF 3

- 476 -

TEST HOLE No. N75-106P-B3-B

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit										
0	Pt		0.2 PEAT - coarse fibrous, sandy, black, burnt, roots		UF														12:55	
1	SP		SAND - medium, trace silt, orange brown, moist																13:00	
2	CL		1.8 CLAY - med. plastic, grey, damp, thickness varies from 0.2' to 0.5'																	
3	SC & CL		2.0 Alternate layers of SAND, medium to fine, clayey, with CLAY, tan brown to grey																13:15	
4	SW-SC		3.8 SAND - and gravel, cmf, trace to little fines																	
8			8.0 Bottom of pit																13:30	

MA, combined, samples 1 & 2
 G = 0%
 S = 42%
 F = 58%
 (SC-CL)


MA, combined, samples 3 & 4
 G = 38%
 S = 52%
 F = 10%
 (SW-SC)

- 477 -

TEST HOLE No. N75-106P-B3-1

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°02'33"N, 130°00'05"W	ELEVATION:
DRWN. BY: F.B.	AIRPHOTO No.: A 22880-85	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 13°C
	METHOD: HAND TOOLS	
START: D 28 M 08 Y 75 TIME: 12:55	FINISH: D 28 M 08 Y 75 TIME: 13:30	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B3-1

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
0.1	Pt		PEAT - coarse fibrous, sandy		UF														
0.8	SM		SAND - very fine, silty, orange - fine to medium grain, little silt, occasional pebble to 1/8", medium brown, clean										MA, combined samples 1 - 6 G = 3% S = 8% F = 18%	B1				1	
3.0			cobbles, rounded, 8", gray-brown alternating with medium brown											B2				2	
														B3				3	
														B4				4	
														B5				5	
			moist to damp											B6				6	
7.0			Bottom of pit															7	

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 130 11
CHKD: R.H.	LAT. & LONG: 67°01'18"N, 129°59'50"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 22890-85	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 18°C
	METHOD: TEST PIT	
START: D 28 M 08 Y 75 TIME:	FINISH: D 28 M 08 Y 75 TIME:	

1975 BORROW INVESTIGATION	TEST HOLE No. N75-106P-B3-2
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

- 478 -

TEST HOLE No. N75-106P-B3-2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt		0.3 PEAT - coarse fibrous, black, roots		UF													
	ML		0.9 SILT - trace sand, fine, low to nonplastic, orange brown, roots															
1	SW-SM		SAND - fine to coarse, silty, and some gravel, grey brown, dry, pebbles rounded 3/8", occasional to 1.5"									MA, combined, samples 1 - 5 G = 38% S = 58% F = 0% (SW-SM)						
2			1.8' to 2.4', pocket medium sand															
3			1.3' to 3.5', white, cementation															
			3.0 fine gravel, coarse sand															
			3.8															
4	GW		GRAVEL - coarse to fine, little sand, pebbles to 2", rounded															
			4.7															
5	SG		SAND - medium, slight coarse, clean															
			5.0															
	GP		GRAVEL - and cmf sand, light brown, occasional cobble to 6", dry to moist															
			5.8 Bottom of pit															

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°01'34"N, 130°00'20"W	ELEVATION:
DRWN. BY: F.B.	AIRPHOTO No.: A 22880-85	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 17°C
	METHOD: TEST PIT	
START: D 26 M 08 Y 75 TIME:	FINISH: D 28 M 08 Y 75 TIME:	

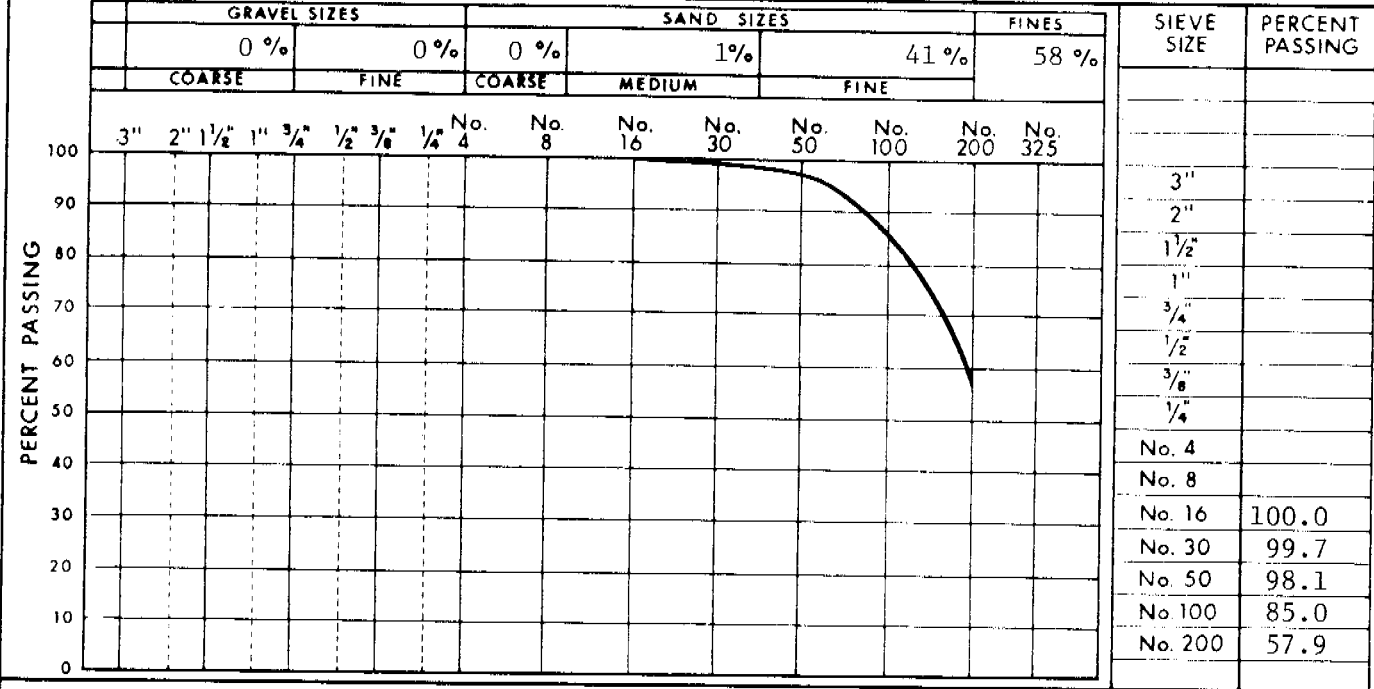
1975 BORROW INVESTIGATION	TEST HOLE No. N75-106P-B3-3
NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	
CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 1 OF 1

TEST HOLE No. N75-106P-B3-3

- 479 -

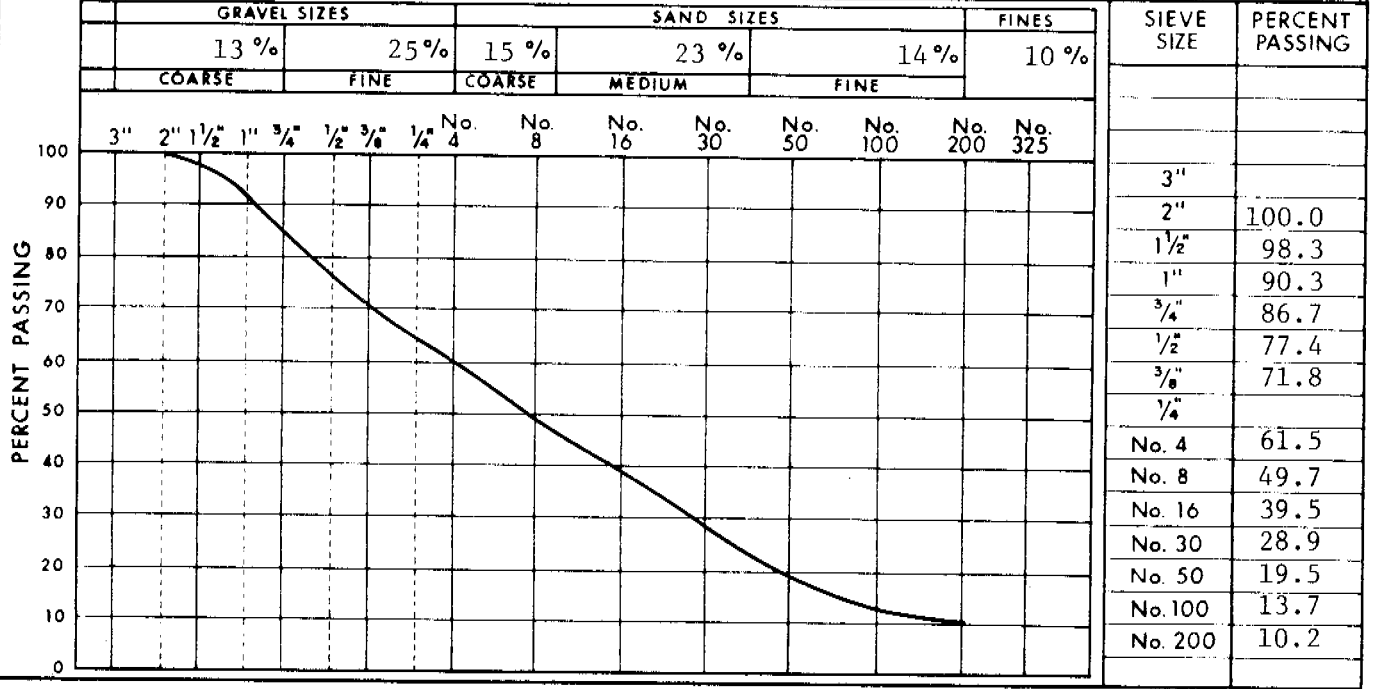
SIEVE ANALYSIS REPORT

SAMPLE N75-106P-B3-1 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER 26
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL



COMMENTS Moisture content from 10.4% to 20.7% OVERSIZE (>3") = 0.0 %

SAMPLE N75-106P-B3-1 DEPTH 3.0-6.0 R.M.HARDY REPORT NUMBER 25
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL



COMMENTS Moisture content from 2.5% to 3.9% OVERSIZE (>3") = 0.0 %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

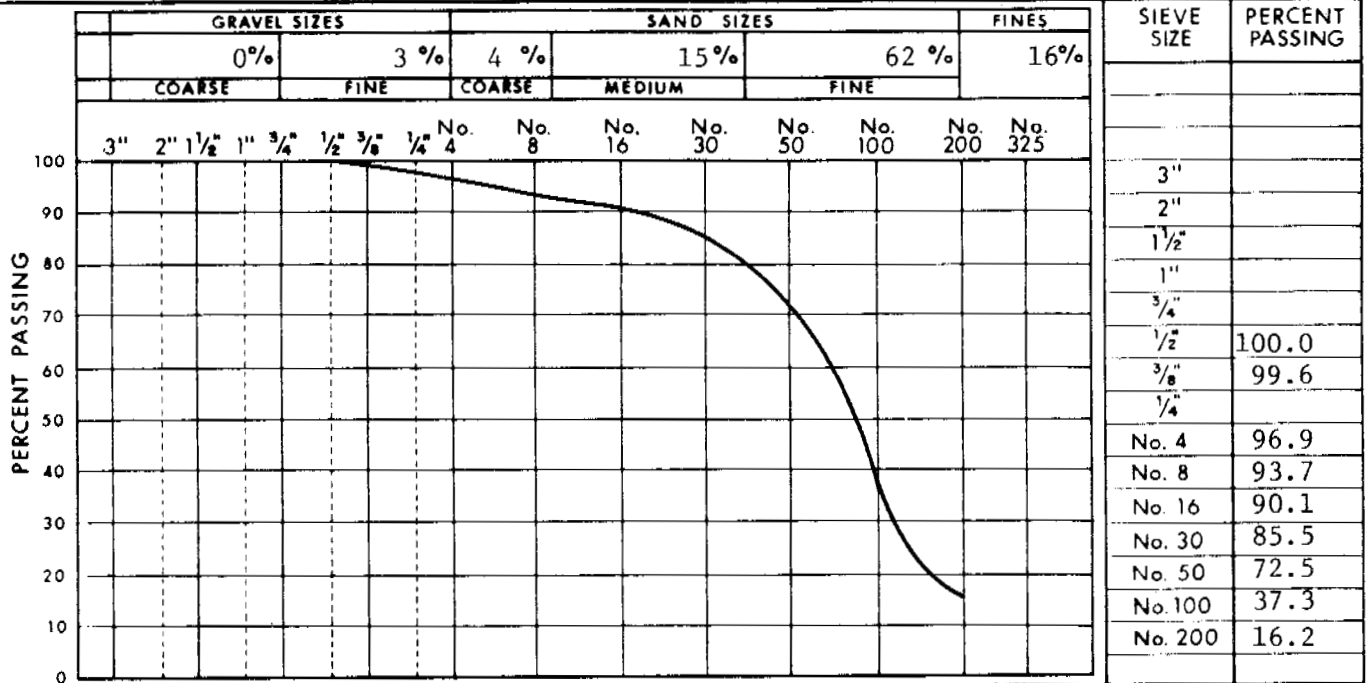


DEPOSIT No.
 N75-106P-B3

PAGE
 480

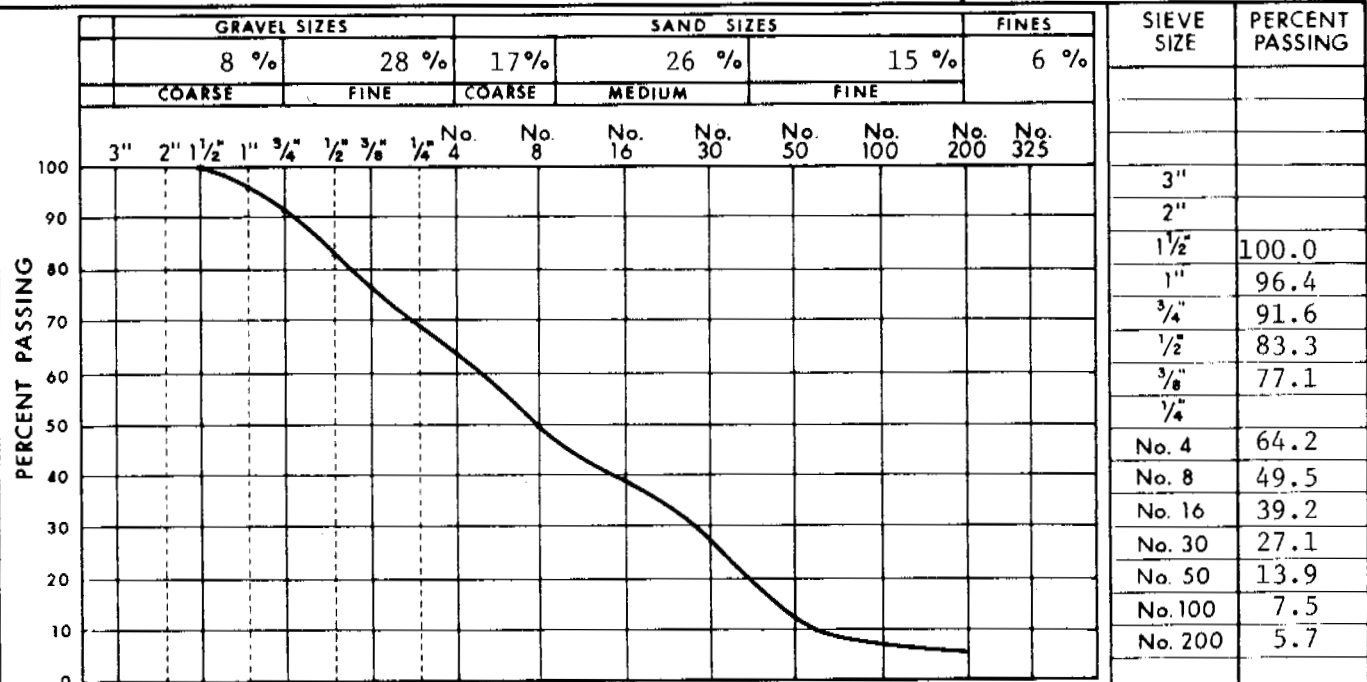
SIEVE ANALYSIS REPORT

SAMPLE N75-106P-B3-2 DEPTH 1.0-7.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL 169




COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-106P-B3-3 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL 8



COMMENTS OVERSIZE (>3") = 0.0 %

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-106P-B3 PAGE 481
---	--	---	---

106 P - B4 - C 468560 E 7436830 N

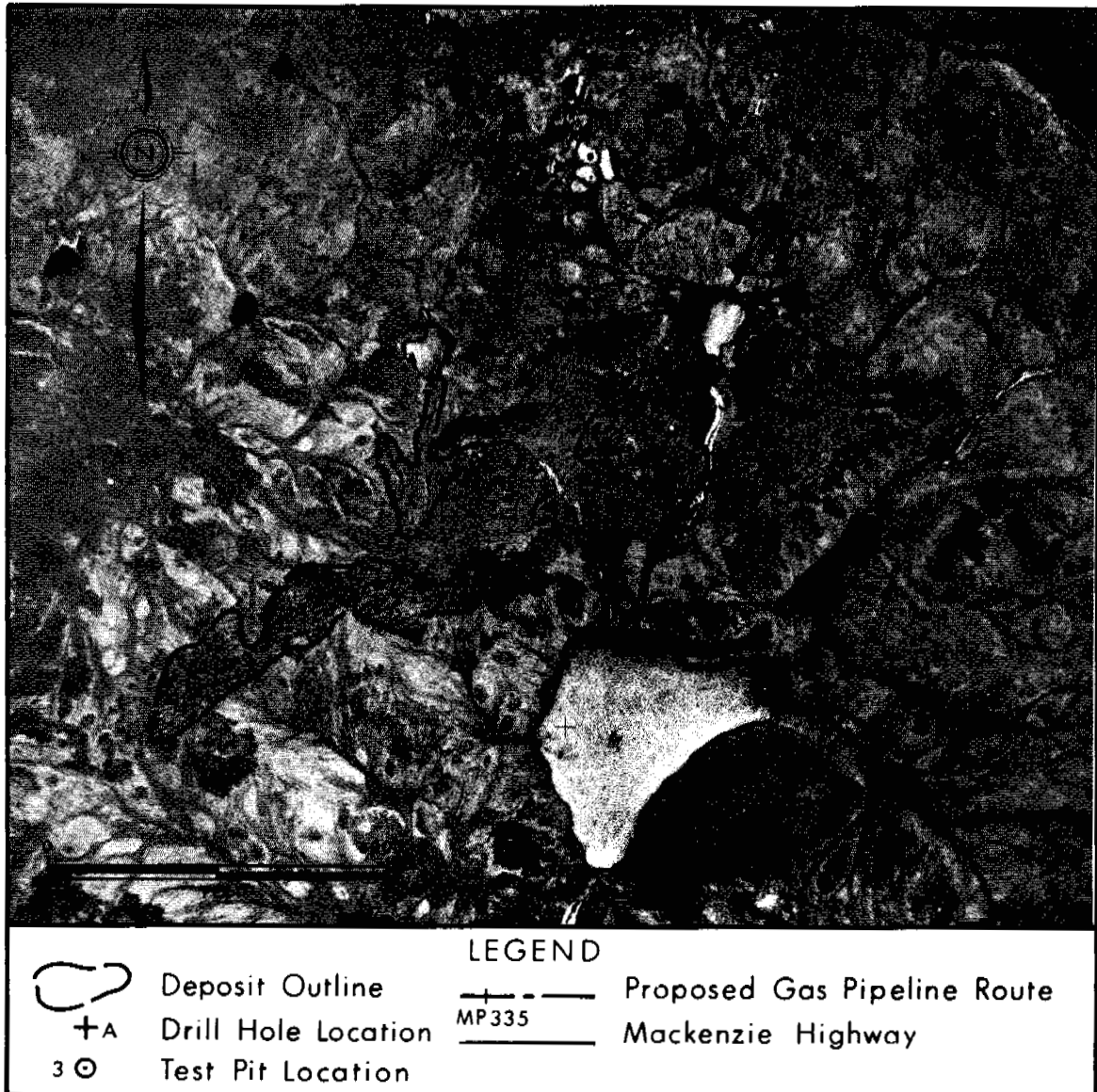
(Drill Hole A; B?)

Physical Setting: Deposit 106P-B4 consists of 2 kame complexes located 11 miles southeast of Little Chicago and 5 miles east of milepost 220 on the right of way.

Material: SAND and GRAVEL - interbedded.

Volume: 9,300,000 cubic yards.

Assessment: Deposit 106P-B4 is a source of good to excellent quality granular material suitable for general fill, backfill, building pads and possibly concrete and asphalt aggregate.



Airphoto No. A13402-131

Latitude: 67° 02'

Approximate Scale: 1" = 3200'

Longitude: 129° 44'

DEPOSIT 106P-B4

PHYSICAL SETTING

This deposit consists of 2 kame complexes located 11 miles southeast of Little Chicago and 5 miles east of the pipeline alignment milepost 220. This deposit corresponds to source number 1045 in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The kame complexes are separated by a moraine plain and each complex contains hills and ridges with maximum local relief of 50 feet. Overburden is slight except in depressions and the deposit is well drained. The deposit was unfrozen to a depth of 8 feet.

A till covered upland with moderate slopes lies between the deposit and proposed pipeline right of way.

BIOLOGICAL SETTING

This site is covered by spruce up to 40 feet in height with an understory of shrubs including ericaceous species. Parts of the area show evidence of an old burn. The area provides productive habitat for beaver, lynx, fox, marten, black bear, moose and caribou. The small lakes in the area do not appear to provide suitable fish habitat.

MATERIAL

This deposit is a source of good quality granular material. Interbedded sand and gravel were found at all test pit and drill hole locations. Sand is mainly well graded, with a variable amount of gravel. Some silt is present near the surface, but the sand beds become cleaner with depth. The largest percentage of material is well graded, rounded gravel with fairly high sand content and a trace of silt. Occasional boulders to 10 inches were encountered.

VOLUME

Total estimated volume, based on an area of 440 acres and a maximum depth of 30 feet under hill and ridge crests is 9,300,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106P-B4 is a source of fair to excellent quality granular material and would be suitable for general fill, backfill in pipeline construction, building pads, and possibly concrete and asphalt aggregate. The gravel will require further testing before use in concrete production. Further drilling would be required to locate areas of the best quality material.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit with equipment would probably be via the pipeline right of way and overland from there to the deposit, a distance of 5 miles. In order to minimize environmental damage, snow roads would be built to transport the borrow material across the till covered upland from the deposit to haul points on the right of way. The access right of way would have to be cleared of the tree cover. Trees and vegetation would be removed in accordance with land use regulations. The thin layer of peat and silt would then be stripped from the area to be excavated, and stockpiled around the edge of the site.

Development of this deposit would involve excavating borrow material evenly from the higher, well drained areas so that good drainage would be maintained over the deposit. Conventional earthmoving techniques would probably be used at this site, however, if areas of high ice cementation are encountered, blasting may be necessary. The excavated material may have to be stockpiled, thawed, and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing, washing, concrete and asphalt plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.


N6P03-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.5	Pt		PEAT - fibrous, woody, dark brown, moist		UF												0.5	18:00 4 1/2" Walmac
2			GRAVEL - fine to coarse, very silty, little fine to coarse sand, damp brown, frequent cobbles, frequent boulders to 24"														2	10' boulder
4			GRAVEL - some fine to coarse sand, trace silt, frequent cobbles and boulders.														4	Using shovel, loose material.
5.8			GRAVEL - some fine to coarse sand, trace silt, frequent cobbles and boulders.														4.5	Boulder
8			End of hole														8	To rock bit, bit "walked" off boulder causing incline of drill rig.
			Note: large boulders exposed at the surface															Caved in at depth 5.8' after removal of bit. At 8.8' large diameter hole and air return too low to return cuttings.

LOGGED BY: <i>B. G.</i>	FACILITY:	PROJECT: 13011
CHKD: J.K.W.	LAT. & LONG: 87°02'22"N, 128°45'00"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 13402-131	PIPE MILEAGE:
CHKD: B.O.	RIG: MELI-DRILL	AIR TEMP: Approx. 13°C
	METHOD: AIR	
START: D 28 M 08 Y 75 TIME: 18:00	FINISH: D 28 M 08 Y 75 TIME: 19:50	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B4-A

SHEET 1 OF 1

- 887 -

TEST HOLE No. N75-106P-B4-A

17:10 4 1/2" Wal mac

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit			Liquid limit								
					40	60	80	100	120	140 ▲									
					0	20	40	60	80	100 ○									
0.5	SM		SAND - fine to coarse, silty, some fine gravel		UF													17:10 4 1/2" Wal mac	
2	GM		GRAVEL - fine to coarse, and coarse, medium, fine sand, silty, brown, damp, occasional cobble															3 to rock bit	
4.0	SM		SAND - fine to coarse, silty, some fine gravel, damp, brown, cobble at 4.5'																
4.5	GM		GRAVEL - fine to coarse, very silty, some fine to med. sand															5.0 17:25 no air circulation, therefore no cuttings, hole caving	
			End of hole																

- 489 -

TEST HOLE No. N75-106P-B4-B

LOGGED BY: B.M.H.	FACILITY:	PROJECT: 13011
CHKD: J.K.W.	LAT. & LONG: 87°02'55"N, 128°43'42"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 13402-131	PIPE MILEAGE:
CHKD: D.G.	RIG: HELI-DRILL	AIR TEMP: Approx. 13°C
	METHOD: AIR	
START: D 28 M 8 Y 75	TIME: 17:10	FINISH: D 28 M 8 Y 75
		TIME: 17:25

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B4-B
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt	0.3	PEAT - coarse fibrous, black, roots		UF												17:00		
1	GM		GRAVEL - fine to coarse, silty, some sand, cmf, red brown									MA, combined, samples 1 - 5 G = 55% S = 39% F = 6% (GM - GM)	B1				17:15		
2		1.8	--- boulder, subrounded, 10", granite										B2					17:40	
3	SP	2.8	SAND - med, trace gravel, rounded 3/4"										B3					17:50	
4	GM		GRAVEL - some sand, cmf, medium brown, moist, damp spots										B4					18:05	
5	GP	4.2	GRAVEL - fine to coarse, and coarse to medium sand, moist, uniform										B5						
6		6.0	Bottom of pit																

- 490 -

TEST HOLE No. N75-106P-B4-1

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°02'13"N, 129°45'55"W	ELEVATION:
DRWN. BY: G.B.	AIRPHOTO No.: A 13402-131	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 16°C
	METHOD: TEST PIT	
START: D 26 M 08 Y 75	TIME: 17:00	FINISH: D 26 M 08 Y 75
		TIME: 18:05

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B4-1
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	Pt	0.4	PEAT - fine fibrous, amorphous, black		UF												No samples taken difficult to excavate 20:00	
	(OL)		SILT (organic) with COBBLES, BOULDERS to 24" (oversize material with silt filler)															
		1.7	Bottom of excavation															
			Note: Refer also to N75-106P-B4-A, drillhole at lower elevation															

TEST HOLE No. N75-106P-B4-2

- 67 -

LOGGED BY: J. K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 67°02'22"N, 129°45'00"W	ELEVATION:
DRWN. BY: A.M.	AIRPHOTO No.: A 13402-131	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 16°C
	METHOD: TEST PIT	
START: D 26 M 08 Y 75	TIME: -	FINISH: D 26 M 08 Y 75
		TIME: 20:00

	NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No. N75-106P-B4-2 SHEET 1 OF 1
1975 BURROW INVESTIGATION		CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)			○ Water content %									
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
0.3	Pt		PEAT - coarse fibrous, black, roots		UF														
0.9	SM		SAND - medium, silty, and gravel, pebbles rounded to 3", rust brown																
2.4	GM		GRAVEL - fine, silty, pebbles 3/4", rounded to 3", rust brown, moist, boulder 10"																
2.4	SW		SAND - cmf, trace gravel, fine to coarse, moist, 2.4' - 2.5' rusty band																
4.0	GW		GRAVEL - little sand, medium pebbles rounded to 3", 4.0' - charcoal spot																
5.8	SP		SAND - and gravel, coarse to medium, occasional pebble to 2.5" damp, uniform Bottom of pit																


MA, combined samples 1 - 5
G = 81%
S = 38%
F = 3%
(GW)

Combined samples from 1.0' to 6.0' "GRAVEL, coarse to fine, and mfc sand"

TEST HOLE No. N75-106P-B4-3

LOGGED BY: J. K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 87°02'55" N, 129°43'42" W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 13402-131	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 18°C
	METHOD: TEST PIT	
START: D 28 M 08 Y 75 TIME: -	FINISH: D 26 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION



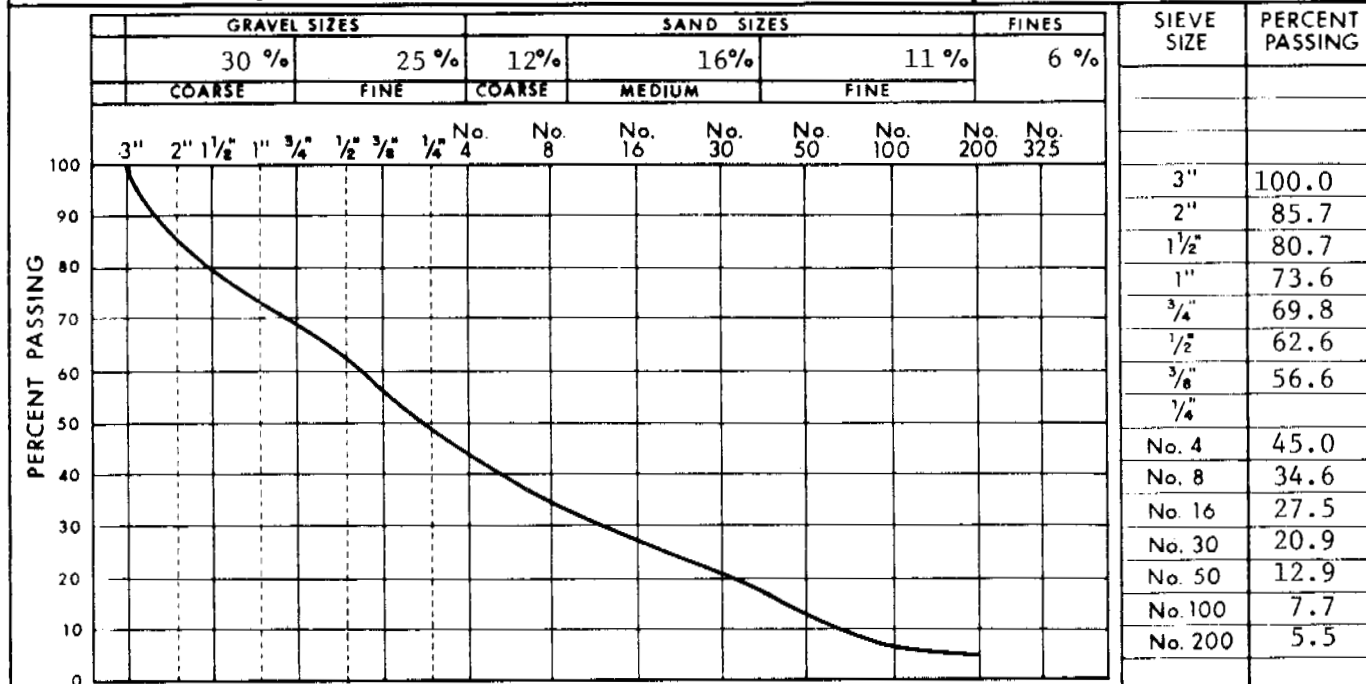
NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-106P-B4-3
SHEET 1 OF 1

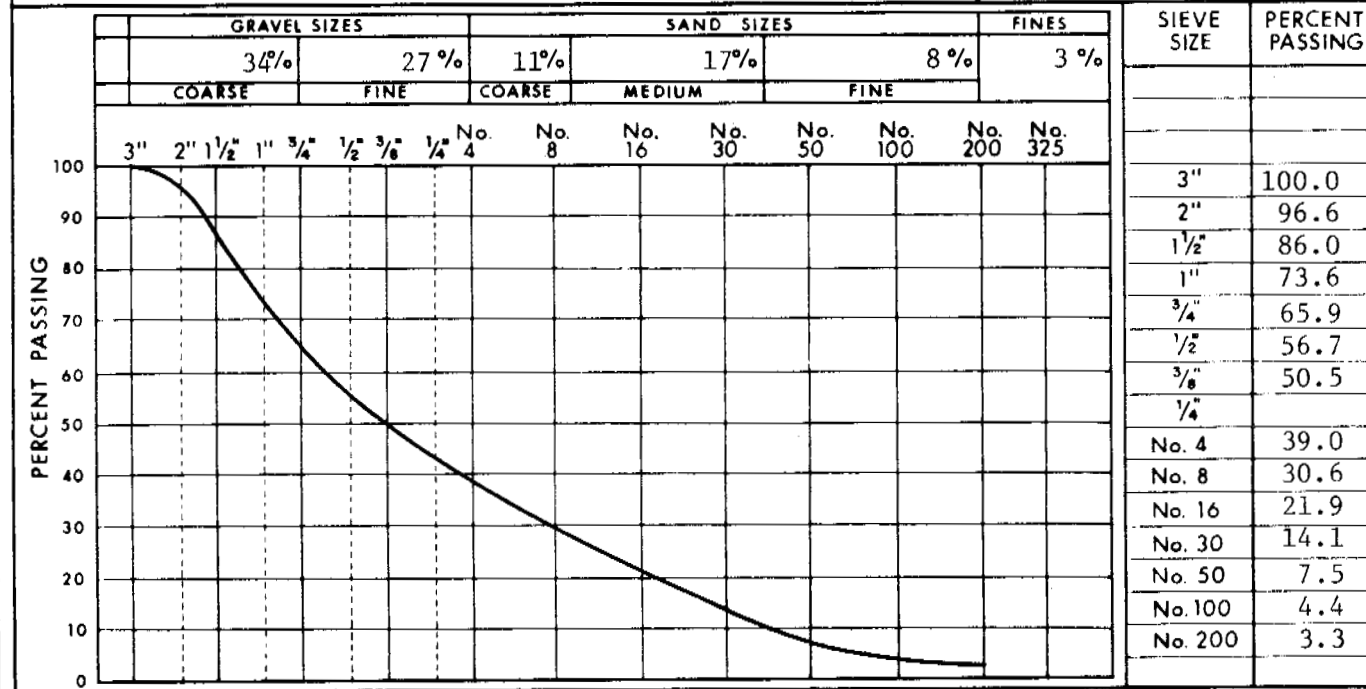
SIEVE ANALYSIS REPORT

SAMPLE N75-106P-B4-1 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL _____ 22



COMMENTS _____ OVERSIZE (>3") = 0.0 %

SAMPLE N75-106P-B4-3 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER _____
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL _____ 174



COMMENTS _____ OVERSIZE (>3") = 0.0 %

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-106P-B4 PAGE 493
---	--	---	---

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-106P-B4-3 DATE SAMPLED : August 26, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 1-6 DATE TESTED : January, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 6.97 %
 FINE AGGREGATE : LOSS = 16.72 %

ORGANIC IMPURITIES TEST

NUMBER : 4+
 COAL REMOVED : 4
 COAL & ROOTLETS
 REMOVED : 4
 COAL CONTENT : Trace
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS \pm 20.1 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Strong to very strong, Very good	20.8
Granite		3.6
Basalt		1.3
Sandstone	Medium strong, Good	12.75
Siltstone		1.9
Limestone		13.0
Impure Limestone		6.0
Chert		0.3
Flint	Potentially reactive, Fair	0.45
Ironstone	Weak, Friable, Deleterious	0.65
Clay		0.25
PN = 116	INTERPRETATION : Good quality	61.0

COMMENTS : Approximately 10% of the pebble surfaces are covered with a carbonate coating. Strength tests required.



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-106P-B4

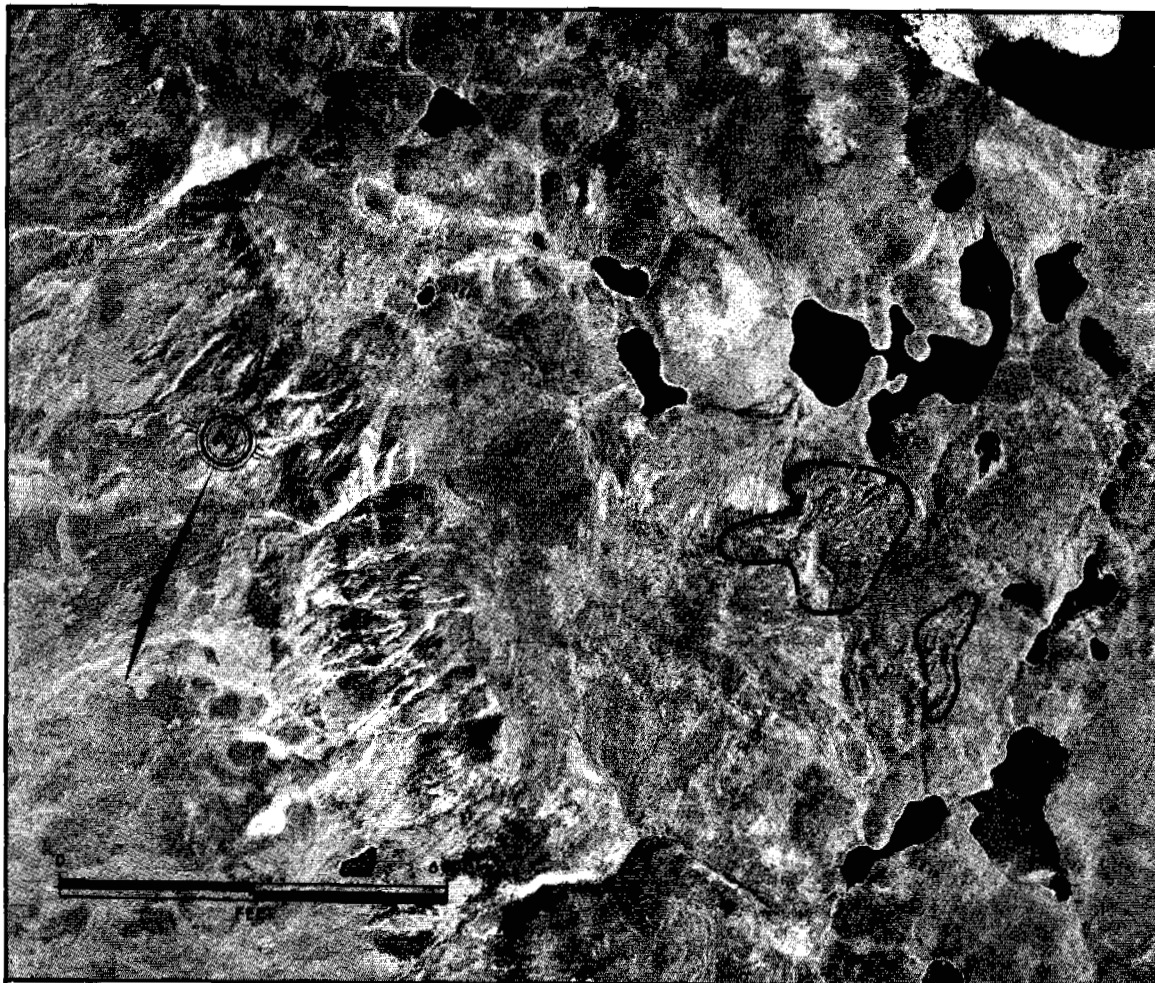
PAGE 494

Physical Setting: Deposit 106P-B5(R) consists of several small esker ridges and a kame delta located 1 mile south of Tutsieta Lake and 3 miles northeast of milepost 208 on the right of way.

Material: GRAVEL - silty, and sand.

Volume: 120,000 cubic yards.

Assessment: Deposit 106P-B5(R) is a source of fair quality granular material suitable for general fill and possible backfill. Access would involve crossing an escarpment. Because of low quality, quantity, and access, this source would probably not be developed.



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A22859-169
Approximate Scale: 1" = 3000'

Latitude: 67° 14'
Longitude: 130° 00'

PHYSICAL SETTING

Several small esker ridges and a kame delta make up this deposit. They are located 1 mile south of Tutsieta Lake and 3 miles northeast of milepost 208 on the proposed pipeline right of way. Deposit 106P-B5(R) forms part of source 1052 in the EBA DIAND Granular Materials Inventory Volume II (1974) report.

Relief within the deposit varies locally from 15 to 30 feet. Ridges are well-drained and intervening depressions are imperfectly to poorly drained. The site has a general northeast slope and surface drainage is toward lakes to the northeast.

Peat and silt cover is less than 1 foot except in depressions where it may be as much as 10 feet thick. Thaw depths of 12 feet can be expected during summer months.

Terrain between the deposit and pipeline right of way consists of three types; rolling moraine, a colluvium covered escarpment characterized by skin flows, and gently sloping alluvial fans.

BIOLOGICAL SETTING

Portions of this site have been recently burned. The dominant vegetation consists of spruce, with scattered birch. Ground cover consists of willow, grasses and herbs with sedges in isolated depressions. The area provides low to moderately productive habitat for marten, fox, lynx, beaver, muskrat, black bear, moose, and caribou. An unidentified active eagle nest was located at the site in 1975. Nearby lakes are used by waterfowl but do not appear to provide suitable fish habitat. Tutsieta Lake, approximately 1 mile north of the site, supports several fish species including whitefish, grayling, pike and lake trout.

MATERIAL

No drilling or test pitting was carried out at this deposit, however, the DIAND (1974) Granular Materials Inventory Report, Vol. II shows this deposit consists of silty gravel and sand. This site was checked by an NESCL geologist during the field reconnaissance.

VOLUME

The DIAND report estimated a volume of 120,000 cubic yards. This volume could probably be increased by including the adjacent deposits of similar material.

DEVELOPMENT AND REHABILITATION

Deposit 106P-B5(R) is a source of fair quality granular material according to previous investigations. This material would be suitable for general fill and possibly backfill in pipeline construction. Further drilling and test pitting would be required to accurately assess the quality and quantity of aggregate in this deposit.

Access to the deposit from the pipeline right of way would involve crossing an escarpment, and care would have to be taken not to initiate skin flows over this area.

Because of the low quality, volume, and possibly difficult access, this deposit would probably not be developed unless sources 1060-B7, 106P-B1 and 106P-B2 were not adequate to meet local requirements for borrow material.

106I - B1 - A	456710E	7421790N
B1 - B	456870E	7418230N

DEPOSIT 106I-B1

PHYSICAL SETTING

This deposit consists of remnants of an outwash plain located 5 to 10 miles north of the mouth of Payne Creek and 4.5 miles west of milepost 230 on the proposed pipeline right of way. This deposit corresponds to source numbers 1035 and 1036 in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The outwash remnants stand 20 to 50 feet above the surrounding terrain. Their surfaces are flat to gently undulating and the scarps marking the edges are steep, with slopes up to 20 degrees or more.

Most of the deposit appears to be relatively free of overburden, although some flat central areas could have a cover of 1 foot of peat and silt. The remnants are well drained around the edges and well to moderately well drained in the centre. Many of the intervening areas have very poor drainage, although the gravelly alluvial fan separating the two main sections of the deposit has moderately good drainage. The active layer was not determined but is probably in excess of 15 feet.

Moderately sloping till plain with local marshy areas lies between the deposit and pipeline alignment.

BIOLOGICAL SETTING

A wide range of vegetation communities is found on this extensive site. Vegetation consists of dense stands of white spruce, black spruce, white birch, and scattered aspen with individual trees up to 50 ft. in height. Scattered shrubs make up the understory and ground cover consists of isolated patches of herbs, grasses and lichen. Low lying areas support sedges, mosses and scattered, stunted black spruce. The area provides productive habitat for beaver, wolf, lynx, fox, marten, black bear, moose, and caribou. An abandoned trapper's cabin was located at the site during the 1975 survey.

Numerous ungulate tracks suggest the possible existence of a mineral lick in the vicinity. Waterfowl are most numerous in the area in the April-June period when they congregate on the Mackenzie River. Waterfowl occur in lesser numbers on waterbodies adjacent to the site throughout the open-water season. Some of the larger lakes in the vicinity support fish populations including whitefish, pike, lake trout and suckers.

MATERIAL

Shallow drill holes and test pits indicate that the deposit is predominately well graded sandy gravel with variable silt and occasional cobbles. Interbedded sand and gravel was encountered in 3 test holes with the sand beds being clean and well graded. Moisture content at shallow depths is very low.

VOLUME

The geomorphology of the deposit and the drill hole described in the DIAND report for Site 1035, indicate that these outwash remnants are at least 20 feet thick. Total estimated volume, based on this depth and an area of 1,140 acres is 35,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

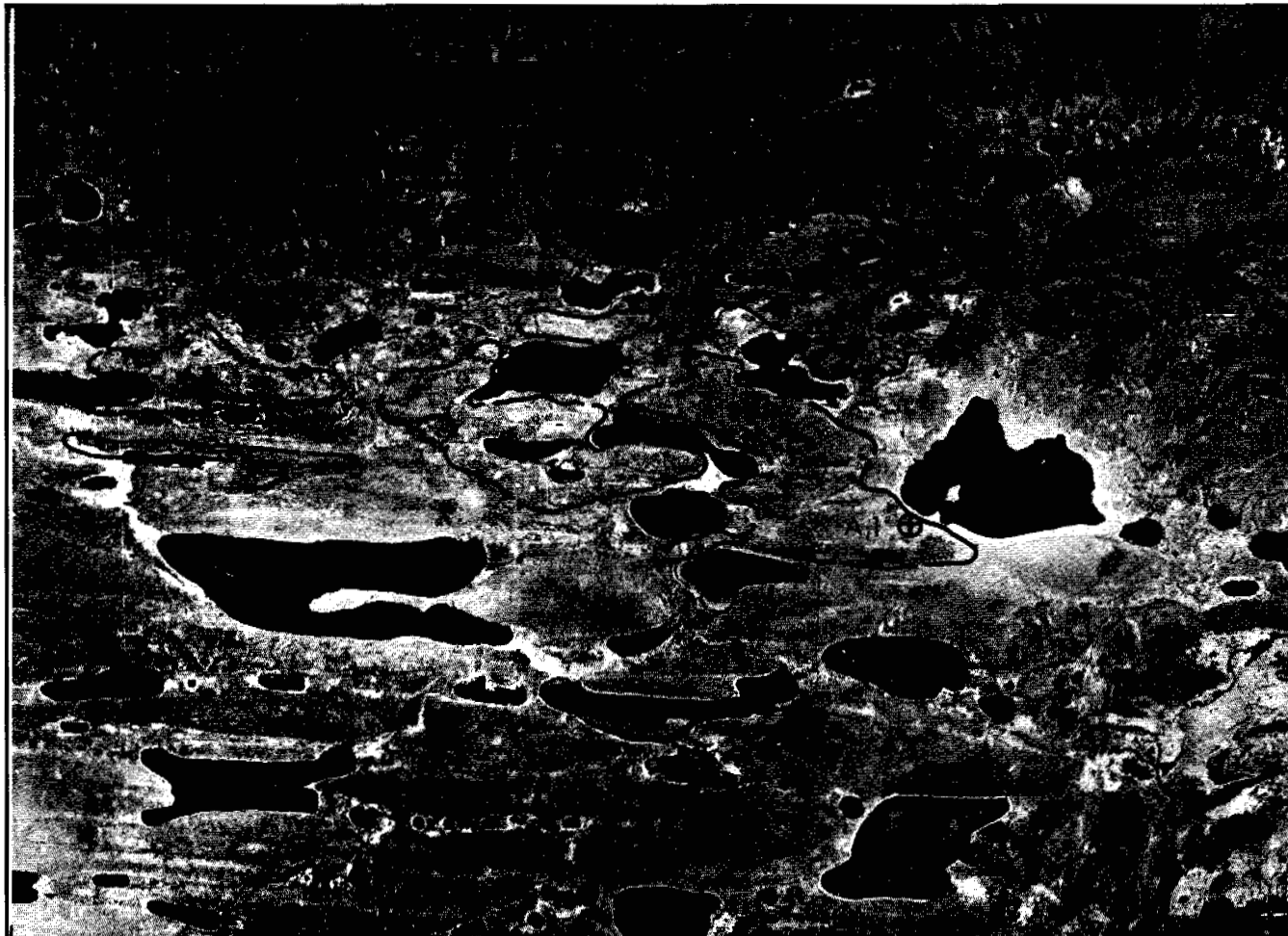
Deposit 106I-B1 is a source of good to excellent quality granular material which is suitable for general fill, backfill in pipeline construction, building pads, and concrete and asphalt aggregate production. The gravel will require further testing before use in concrete. A detailed drilling program would be necessary to accurately determine the best areas for borrow pit development.


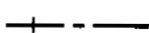

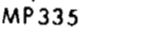


Physical Setting: Deposit 106I-B1 consists of remnants of an outwash plain located 5 miles north of the mouth of Payne Creek and 4.5 miles from the right of way.

Material: GRAVEL - well graded, sandy, with variable silt content.

Volume: 35,000,000 cubic yards.

Assessment: Deposit 106I-B1 is a source of good to excellent quality granular material suitable for general fill, backfill, building pads and concrete and asphalt aggregate.



		LEGEND	
	Deposit Outline		Proposed Gas Pipeline Route
	Drill Hole Location		Mackenzie Highway
	Test Pit Location		MP335

Airphoto No. A12574-318, 319

Latitude: 66° 54'

Approximate Scale: 1" = 3300'

Longitude: 129° 59'



No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit would probably be achieved via the pipeline right of way and then overland about 4.5 miles west to the deposit crossing a moderately sloping till plain and some local marshy areas. In order to minimize environmental damage care would be taken to provide adequate siltation and drainage controls and snow roads would be built to transport borrow material to haul points on the right of way.

Initially, trees and other vegetation would be removed from the selected sites and access right of ways and harvested or disposed of in accordance with land use regulations. Most of the deposit is free of overburden, therefore, little stripping will be required.

Development of this deposit would involve excavating borrow material evenly from higher well drained areas so that good drainage would be established over the area. Conventional earthmoving techniques would be used as the deposit has low moisture content and is unfrozen to a depth of over 15 feet. If ice was encountered blasting could be used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing, concrete and asphalt plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

14-11-75
 40m I log

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	SP		GRAVEL - fine to coarse, (trace silt), occasional cobbles		UF												0	4 1/2" Waimac
2	SP		SAND - fine to medium, trace coarse sand, light brown to grey, clean, moist														4	losing air circulation in sand, no cutting return, hole caving
8			End of hole														8	At 8.0', difficult to extract stem due to sand in hole

LOGGED BY: G. M. H.	FACILITY:	PROJECT: 13011
CHKD: J. K. W.	LAT. & LONG: 87°52'15"N, 132°01'02"W	ELEVATION:
DRWN. BY: J. N. B.	AIRPHOTO No.: A12574-31B, 319	PIPE MILEAGE:
CHKD: D. G.	RIG: HELI-DRILL	AIR TEMP: Approx. 2°C
	METHOD: AIR	
START: D 28 M 8 Y 75 TIME: 09:25	FINISH: D 28 M 8 Y 75 TIME: 09:40	

1975 BORROW INVESTIGATION		TEST HOLE No.
		N75-1061-B1-A
CANADIAN ARCTIC GAS STUDY LIMITED		SHEET 1 OF 1

- 505 -

TEST HOLE No. N75-1061-B1-A

7810-B copy N75-1061-B

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	GM		GRAVEL - fine to coarse, silty, some fine to coarse sand, occasional cobble		UF												10:15 4 1/2" Walnac	
4.0	GM GC		GRAVEL - fine to coarse, trace clay, (trace silt)														lost air circulation. Difficulty in with- drawing drill stem	
8.5			End of hole														no cutting return, only dust	

- 506 -

TEST HOLE No. N75-1061-B1-B

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.G.	LAT. & LONG: 80°52'45"N, 128°58'55"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A12574-31B, 319	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 2°C
	METHOD: AIR	
START: D 28 M 08 Y 75 TIME: 10:15	FINISH: D 28 M 08 Y 75 TIME: 10:40	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B1-B
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS		
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit										
						40	60	80	100	120	140 ▲									
						0	20	40	60	80	100 ○									
	Pt		0.3 PEAT - coarse fibrous, black, roots		UF												20:55			
1	SM		SAND - medium fine, and silt, some gravel, coarse to fine, pebbles rounded to 3", rust brown														21:15			
2	GW		GRAVEL - coarse to fine, some sand, trace silt, occasional cobbles to 8", shale fragments									WA, combined samples 1 - 5 G = 51% S = 45% F = 4% (GW)	B1				21:25			
3													B2							
4	SP		SAND - medium to coarse, trace gravel, fine, medium brown, clean, moist										B3						21:35	
5	GW		GRAVEL - fine, and sand, cwf, pebbles rounded to 3", damp --- coarser from 5.2', gravel to 3"										B4							
6			8.0 Bottom of pit										B5						21:45	

TEST HOLE No. N75-1061-B1-1

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 66°55'18"W, 129°58'34"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 12574-319, 318	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 18°C
	METHOD: TEST PIT	
START: D 28 M 08 Y 75 TIME: 20:55	FINISH: D 26 M 08 Y 75 TIME: 21:45	

1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-1061-B1-1 SHEET 1 OF 1
---	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○								
0.3	Pt		PEAT - coarse fibrous, black, roots, dry		UF													
1			GRAVEL - fine to coarse, some sand, medium to fine, pebbles rounded to 2'', occasional cobbles to 8'', shale fragments weathered to 8'' x 3''									NA, combined samples 1 - 5 G = 82% S = 33% F = 5% (GW)	B1				1	
2	GW												B2				2	
3													B3				3	
4			3.5 - coarse gravel to sand moist										B4				4	18:10 27/08/75
5			4.5 - sandier coarser from 4.0' - 5.0'										B5				5	
5.8			5.0 Bottom of pit													5.8	18:35	

- 508 -

TEST HOLE No. N75-1081-B1-2

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.N.	LAT. & LONG: 66°55'18"W, 128°58'34"W	ELEVATION:
DRWN. BY: G.B.	AIRPHOTO No.: A 12574-318, 319	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 13°C
METHOD: TEST PIT		
START: D 28 M 08 Y 75	TIME: 20:55	FINISH: D 27 M 08 Y 75
		TIME: 18:35


 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p>	<p>TEST HOLE No. N75-1081-B1-2</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>		<p>SHEET 1 OF 1</p>

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt	0.3	PEAT - coarse fibrous, black, rootlets		UF												12:25		
1	GM		GRAVEL - and sand, silty, pebbles rounded to 3", rusty brown to 0.7", shale blocks to 6", fissile, sulphur stains, cream-coloured from 0.7'									Combined MA, Sample 1 - 3, G 48% S 30% F 22% (GC)	B1				1	12:50	
2	GC	2.0	GRAVEL - clayey at 2.0', isolated boulders to 9" (till?)										B2					2	13:10
3			weathered sandstone, cobbles to 5"										B3					3	13:20
4																		4	13:35
																		5	14:00
		4.5	clay layer 1" thick, isolated layers to 1/2"																
		4.8	Bottom of pit																

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 86°52'45"N, 129°58'55"W	ELEVATION:
DRWN. BY: G.B.	AIRPHOTO No.: A 12574-318, 319	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 3°C
	METHOD: TEST PIT	
START: D 28 M 08 Y 75	TIME: 12:25	FINISH: D 28 M 08 Y 75
		TIME: 14:00

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B1-3

SHEET 1 OF 1

- 509 -

TEST HOLE No. N75-1061-B1-3


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲									
						0	20	40	60	80	100 ○									
0.4	Pt		PEAT - coarse fibrous, gravelly, sandy, black		UF															
0.7			GRAVEL - coarse to fine, some medium sand, trace silt, pebbles rounded to 3", rust brown 0.7' to 1.3', black and increasing organic content 1.3' to 1.9', coarser, clay pockets from depth 2.0', cobbles to 7", isolated boulders to 9", rounded									MA, combined samples 1 - 5 Oversize = 3.2% G = 89% S = 23% F = 8% (GW-GM)	B1				1	Approximately 75 minutes to excavate pit		
1.3													B2						2	
														B3						3
														B4						4
														B5						5
4.7			brown, moist															6		
8.4			Bottom of pit															8.4		

TEST HOLE No. N75-1061-B1-4

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.K.	LAT. & LONG: 66°52'09"N, 129°59'10"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 12574-319, 318	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 7°C
	METHOD: TEST PIT	
START: D 28 M 08 Y 75 TIME: -	FINISH: D 28 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

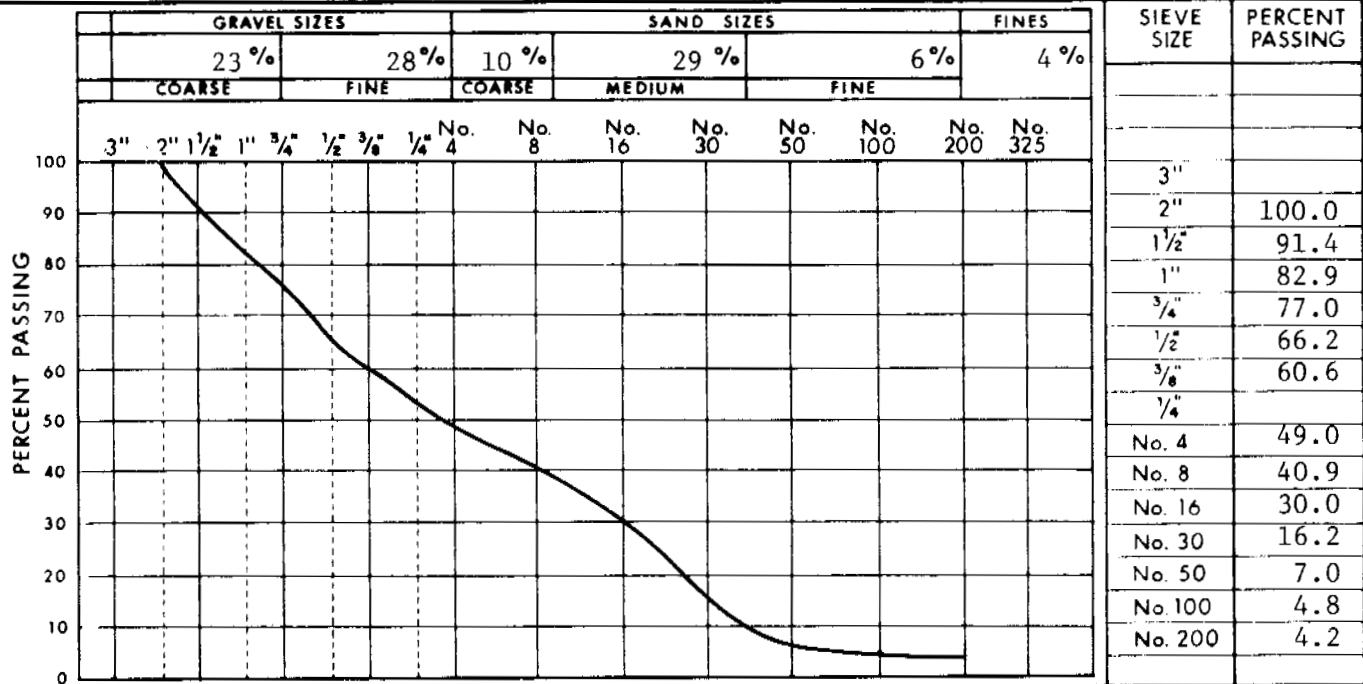
CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B1-4
SHEET 1 OF 1

SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B1-1 DEPTH 1.0-6.0
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL

R.M.HARDY REPORT NUMBER
166

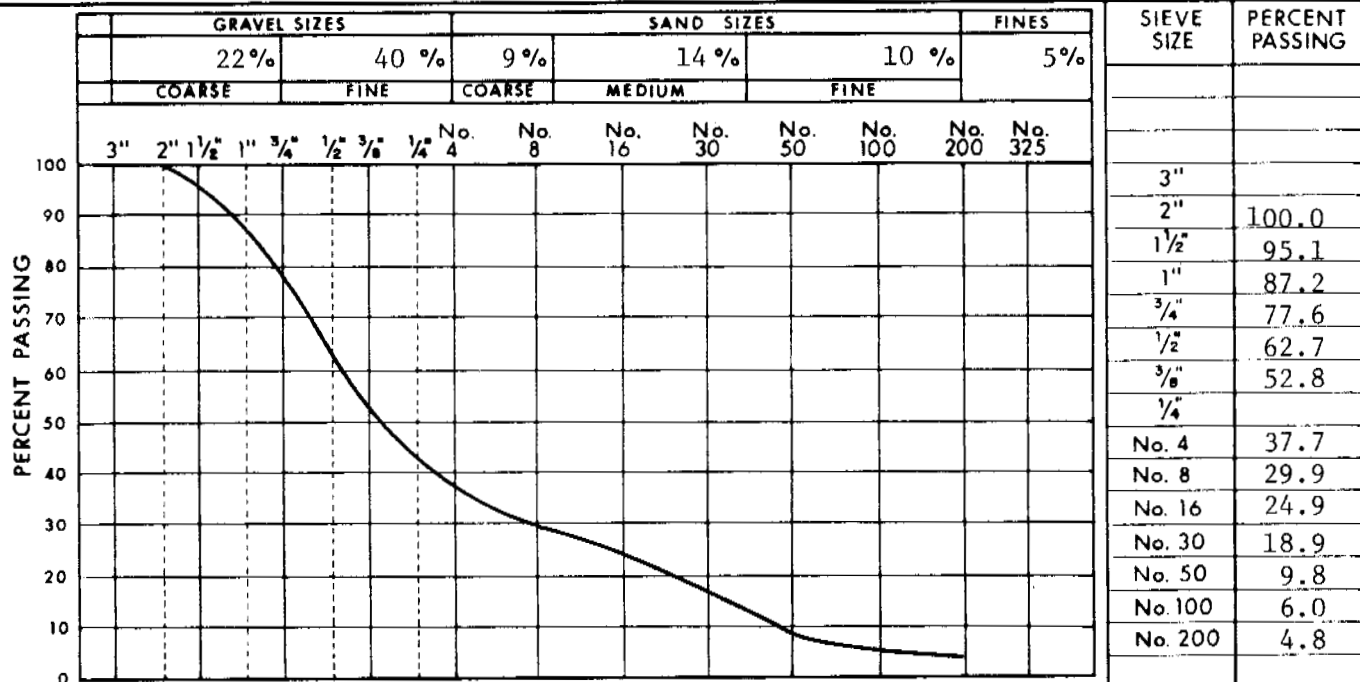


COMMENTS

OVERSIZE (>3") = 0.0%

SAMPLE N75-106I-B1-2 DEPTH 1.0-6.0
 DATE SAMPLED August 26, 1975 SAMPLED BY NESCL

R.M.HARDY REPORT NUMBER
38



COMMENTS

OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

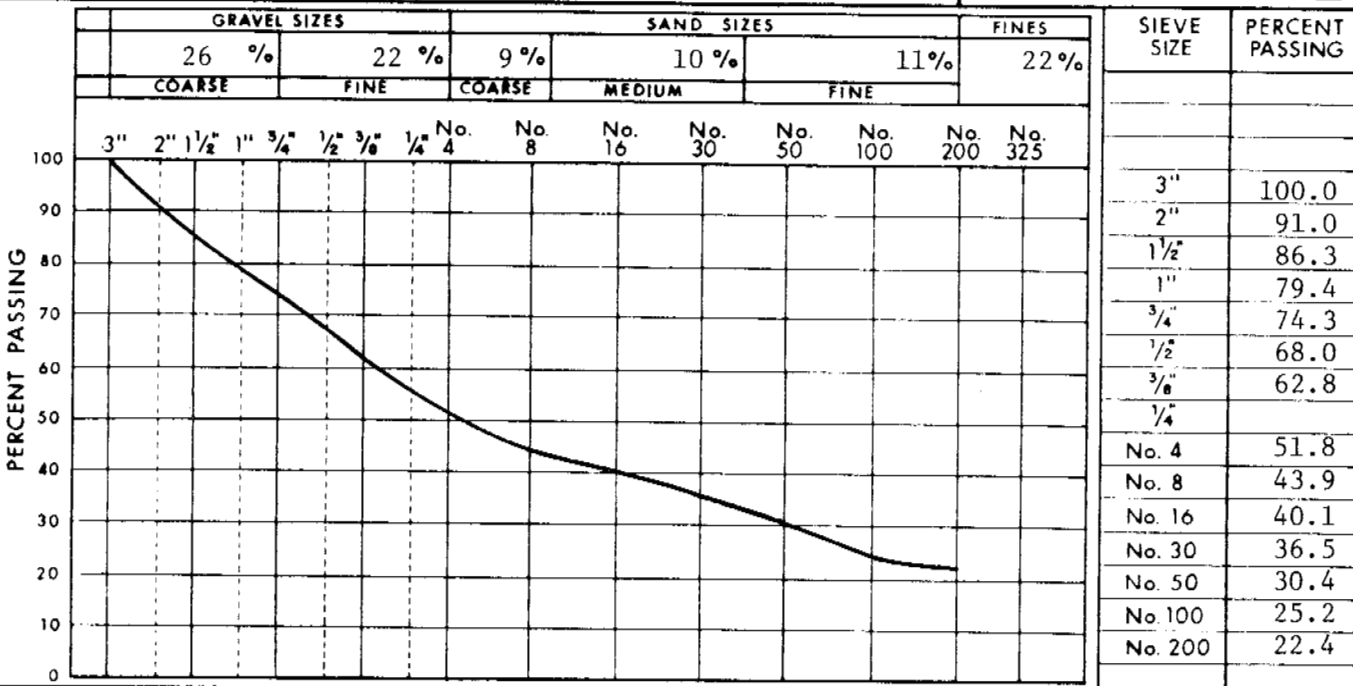


DEPOSIT No.
N75-106I-B1

PAGE
 511

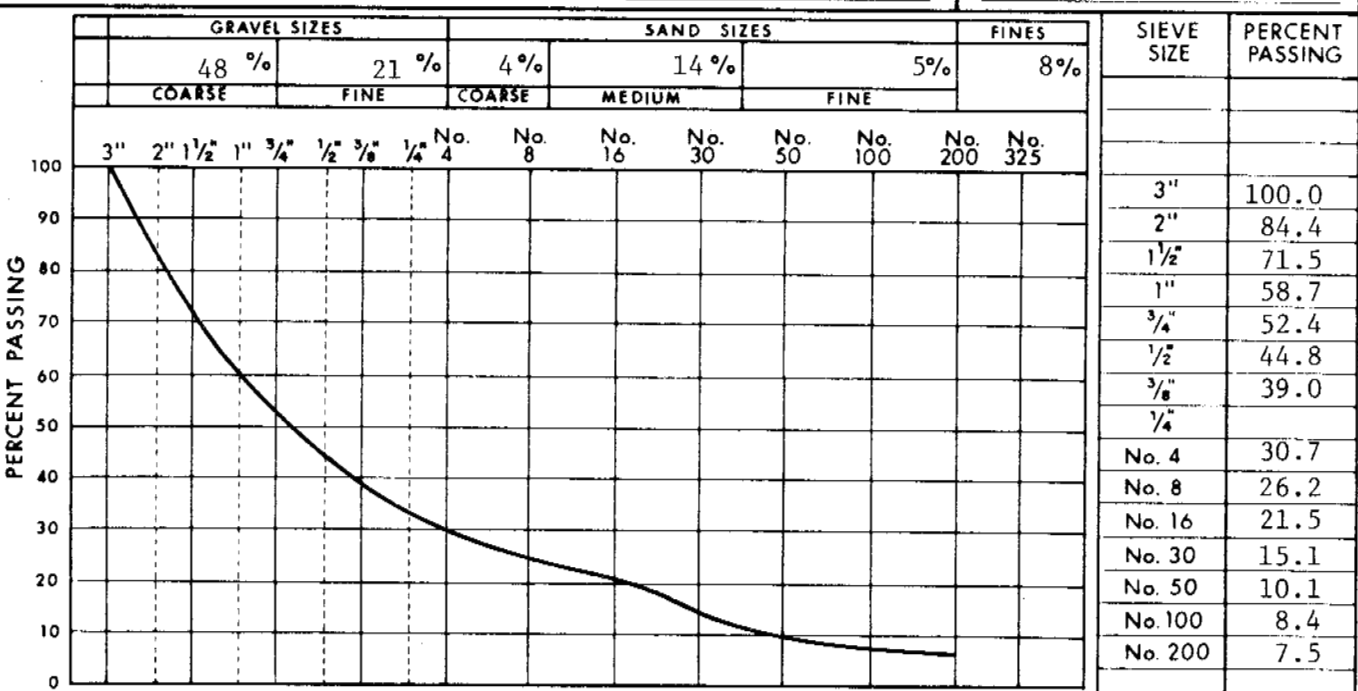
SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B1-3 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 28, 1975 SAMPLED BY NESCL 2



COMMENTS OVERSIZE (>3") = 0.0%

SAMPLE N75-106I-B1-4 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 28, 1975 SAMPLED BY NESCL 164



COMMENTS OVERSIZE (>3") = 3.2%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-106I-B1

PAGE
 512

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE No. N75-106I-B1-2 DATE SAMPLED : August 26, 1975 SAMPLED BY : NESCL
 DEPTH (FT.) : 1-6 DATE TESTED : February, 1976 TESTED BY : RMHA

SOUNDNESS OF AGGREGATE SULPHATE TEST

COARSE AGGREGATE : LOSS = 6.70%
 FINE AGGREGATE : LOSS = 10.35%

ORGANIC IMPURITIES TEST

NUMBER : 3+
 COAL REMOVED : 3
 COAL & ROOTLETS
 REMOVED : 3
 COAL CONTENT : Trace
 SIGNIFICANCE :

LOS ANGELES ABRASION TEST

PERCENT LOSS = 21.6 %

SUMMARY OF ROCK TYPES, COARSE AGGREGATE. (PETROGRAPHIC ANALYSIS)

ROCK TYPE	CLASSIFICATIONS	TOTAL WEIGHTED COMPONENT %
Quartzite	Strong to very strong, Good	34.75
Granite		5.55
Sandstone		1.9
Siltstone		8.0
Limestone	Medium strong, Fair	8.65
Chert	Potentially reactive, Fair	0.85
Flint		2.3
Ironstone	Weak, Poor	0.3
PN = 142	INTERPRETATION : Poor quality coarse aggregate	62.3

COMMENTS : Check stability of chert



R.M. HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

DEPOSIT No.
 N75-106I-B1

PAGE 513

106 I - B2 - A - 488150E

7400530N

B2 - B 488270E

7400590N

with Figure 9

DEPOSIT 106I-B2

Physical Setting: Deposit 106I-B2 consists of terraced kames on the east side of the Tieda River, about 3 miles south of Yeltea Lake, and 2.5 miles northeast of milepost 250 of the proposed pipeline right of way.

Material: SAND - poorly graded, fine, with variable silt and gravel content. Underlain by till.

Volume: 2,500,000 cubic yards.

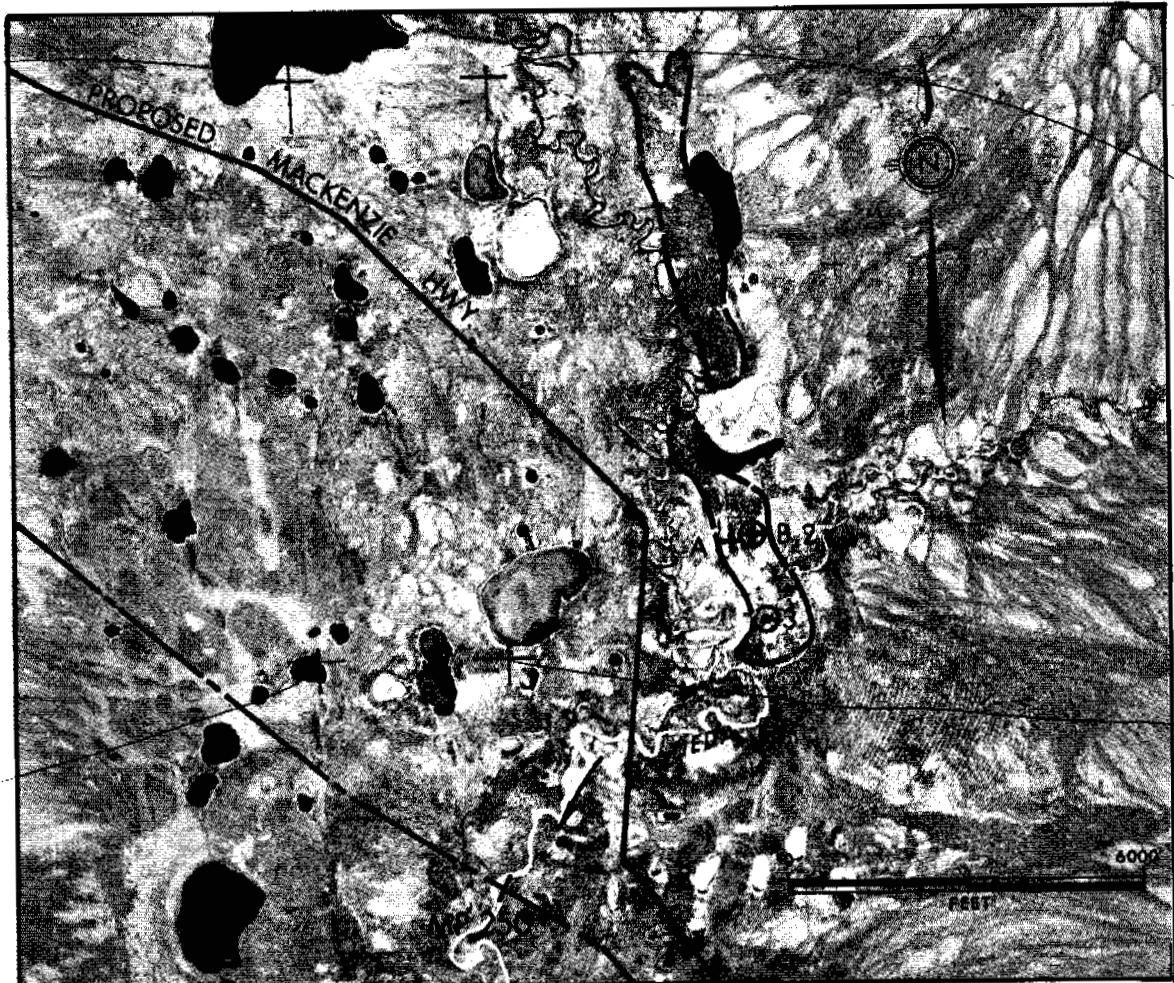
Assessment: Deposit 106I-B2 is a source of poor quality granular material marginally suitable for general fill. Access is not considered to be a problem over the 2.5 miles from the deposit to the pipeline right of way. Development is unlikely to take place unless extreme shortages of material exist in the area.




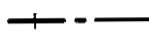
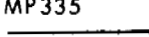
482000E
7403000N

487000E
7403000N

482000E
7400000N

487000E
7400000N



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A12607-97
Approximate Scale: 1" = 3300'

Latitude: 66° 52'
Longitude: 129° 59'

DEPOSIT 106I-B2

PHYSICAL SETTING

This deposit consists of terraced kames located on the east side of the Tieda River about 3 miles south of Yeltea Lake. It is 2.5 miles north-east of milepost 250 on the proposed pipeline right of way.

Kame crests stand about 50 feet above the surrounding terrain. The western flank of the southern section is marked by flat benches separated by scarps 5 to 15 feet high. Other slopes are generally moderate. Overburden is negligible along the crests of the kames, but may be up to 5 feet thick on the back edges of some of the benches. The site is well drained except for flat areas on the benches which have imperfect drainage. The active layer varies from 1 to 6 feet depending on vegetation cover. Although one ice lense was encountered, the material generally has a low ice content.

A small creek and a gently rolling morainic plain lie between the deposit and the pipeline route.

BIOLOGICAL SETTING

Vegetation on the better drained portions of this deposit consists of a dense stand of white spruce up to 40 ft. in height and a mixed ground cover dominated by dwarf shrubs, mosses and lichens. On poorer drained areas stunted spruce and tamarack are also present. The area provides productive habitat for lynx, mink, fox, wolf, black bear, moose, and occasional grizzly bear. Caribou are present in the area during the summer period. Moose migrate through the area in the November-December and March-April periods. No information is available on waterfowl use of the area. During the summer period grayling, long-nose suckers, round whitefish, pike, slimy sculpin, and lake chub are present in the Tieda River. There is no reported winter flow in this river. Spawning runs of grayling and whitefish move through the river enroute to Yeltea Lake.

MATERIAL

Drilling and test pit investigations were carried out only in the southern portion of the deposit. Results of this work indicate the deposit is a source of very poor quality granular material. Poorly graded fine sand with variable silt and gravel content was found to a depth of 25 feet. Locally however, the sand was only 1 to 4 feet thick and underlain by till.

VOLUME

Total estimated volume, based on a depth of 10 feet and an area of 370 acres is 2,500,000 cubic yards. Recoverable volumes may be lower depending on overburden thicknesses.

DEVELOPMENT AND REHABILITATION

Deposit 106I-B2 is a source of poor quality granular material which is marginally suitable for general fill. Although there is a lack of good quality material at this site, the scarcity of borrow in this area could necessitate its development.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain period of the year.

Access to the deposit along the east side of the Tieda River from the pipeline right of way presents no major problems. In order to prevent environmental damage, care would be taken to avoid siltation of the Tieda River and snow roads would be built to transport borrow material to haul points on the right of way.

A detailed drilling program would be required to delineate areas of the best quality material. Development of the better areas would involve excavating borrow material evenly from the higher well drained kame crests, or from the scarps on the western flank of the deposit. Blasting or conventional earthmoving techniques would be used, depending on the degree of ice cementation. The tree growth will require clearing and harvesting before the selected borrow areas are stripped of overburden and topsoil. The overburden will be stockpiled along the perimeter of the borrow excavation.

Equipment required for development would be dozers, ripper, end-dump trucks and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

N75-1061-B2-A

N610-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS		
						▲ Dry density (pcf)			○ Water content %											
						Plastic limit			Liquid limit											
					40	60	80	100	120	140	▲									
					0	20	40	60	80	100	○									
0	Pt		0.5 PEAT cover		UF															
1.0																				
2	SM		SAND - fine to medium, trace coarse, silty, scattered peat pockets (?) to depth 3.0'		Vx													0	0	Samples taken at intervals for possible laboratory verification
4	ML		4.0 SILT - clayey, little fine sand																	
5.0																				
6	CL		6.0 CLAY - silty, little fine to med. sand																	
8																				
8			visible ice in cutting return		Ys															
8			8.0 trace coarse gravel		?															
10	ML		SILT - clayey, little fine sand, trace coarse gravel																	
12			(12.0) little coarse gravel, occasional cobble (possibly till)																	
14																				
16																				
18																				

- 520 -

TEST HOLE No. N75-1061-B2-A

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 86°43'30"N, 128°18'13"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A12807-97	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 2°C
	METHOD: AIR	
START: D 28 M 8 Y 75 TIME: 14:55	FINISH: D 28 M 8 Y 75 TIME: 15:40	

1975 BORROW INVESTIGATION		TEST HOLE No. N75-1061-B2-A
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR		
CANADIAN ARCTIC GAS STUDY LIMITED		SHEET 1 OF 2


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC	ICE TYPE	VISUAL	ICE %	▲ Dry density (pcf)	○ Water content %							
18			SILT (cont'd)	Ys ?	40	60	80	100	120	140 ▲							
18	ML				0	20	40	60	80	100 ○							
20			20.0 --- clayey, trace to no coarse gravel													20	15:20
24			24.0 --- slightly clayey, little fine sand, occasional pebbles														
28			28.0 --- clayey													28	15:28
			29.0 --- cobble														
			at 32.0' - trace fine to coarse gravel.														
			at 35.0' - cobble														
37			37.0 End of hole													37	

TEST HOLE No. N75-1061-B2-A

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 88°43'30"N, 129°18'13"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A12607-97	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 2°C
	METHOD: AIR	
START: D 28 M 8 Y 75 TIME: 14:55	FINISH: D 28 M 8 Y 75 TIME: 15:40	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY, ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B2-A

SHEET 2 OF 2


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
0	SP		SAND - fine to medium, clean, brown, damp		UF	40	60	80	100	120	140 ▲						0	3 7/8" Walmac
2																		
4																		
6																		
8																		
10																		
12																		
14																		
16																		
18	SM		SAND - fine, trace medium, silty, grey, damp		Nb													
20																		
22																		
24																		
26																		
28																		
30																		
32																		
34																		
36																		
38																		
40																		
42																		
44																		
46																		
48																		
50																		
52																		
54																		
56																		
58																		
60																		
62																		
64																		
66																		
68																		
70																		
72																		
74																		
76																		
78																		
80																		
82																		
84																		
86																		
88																		
90																		
92																		
94																		
96																		
98																		
100																		

TEST HOLE No. N75-1061-B2-B

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 88°43'30"W, 128°18'04"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 12807-87	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 4°C
	METHOD: AIR	
START: D 28 M 8 Y 75 TIME: 18:35	FINISH: D 28 M 8 Y 75 TIME: 19:10	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B2-B
SHEET 1 OF 2

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						Plastic limit			Liquid limit										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
18			SAND (cont'd)		ND												18	3 7/8" Walrac	
18																	19	Hole sloughing . No cutting return	
20																			
22	ICE +		ICE + soil		ICE +														
24	SC		SAND - med. to coarse, clayey, silty, gray		Vx ?														
25			End of hole															25	New 3 7/8" Walrac at 25.0' but still unsuccessful

TEST HOLE No. N75-1061-B2-B

523

LOGGED BY: G.M.N.	FACILITY:	PROJECT: 13011
CHKD: D.D.	LAT. & LONG: 86°43'30"W, 120°18'04"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A12607-97	PIPE MILEAGE:
CHKD: J.N.W.	RIG: MELI-BRILL	AIR TEMP: Approx. 4°C
	METHOD: AIR	
START: D 28 M 8 Y 75 TIME: 18:35	FINISH: D 28 M 8 Y 75 TIME: 19:10	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B2-B

SHEET 2 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40 0	60 20	80 40	100 60	120 80	140 ▲ 100 ○								
0.4	Pt		PEAT - amorphous, coarse fibrous, black, roots, rootlets		VF													
0.9	SM		SAND - medium, silty, trace fine gravel, orange brown															
4.5	CI		CLAY - trace gravel, fine, trace sand, medium to coarse, medium plastic, grey, damp, rusty pockets, isolated cobbles to 8", cream-coloured weathered sandstone pockets															
4.5			Bottom of pit		F (Mbn)												4.5	Approximately 45 minutes to excavate pit

LOGGED BY: J. K. W.	FACILITY:	PROJECT: 13011
CHKD: R. H.	LAT. & LONG: 66°43'30"N, 129°16'04"W	ELEVATION:
DRWN. BY: A. W.	AIRPHOTO No.: A 12807-97	PIPE MILEAGE:
CHKD: D. O.	RIG:	AIR TEMP: Approx. 7°C
	METHOD: TEST PIT	
START: D 28 M 08 Y 75	TIME: -	FINISH: D 28 M 08 Y 75
		TIME: -

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B2-1

SHEET 1 OF 1

- 524 -


TEST HOLE No. N75-1061-B2-1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt		0.3 PEAT - coarse fibrous, black, roots		UF												09:00	
1	SP-SM		SAND - fine to medium, (slight coarse), rust brown, rootlets														09:10	
2			1.9 medium, trace coarse sand, some gravel rounded to 3", brown								12.2	MA, combined samples 1 - 3 G = 2% S = 90% F = 8%	B1			2	easy to excavate	
3			2.7								4.3		B2				3	
4			3.8 clean, fine, rusty brown pockets, grey brown, occasional pebbles to 3/4"								4.3		B3				4	09:20
6			8.0 Bottom of pit														6	09:30

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 130 11
CHKD: H.H.	LAT. & LONG: 86°43'18" N, 128°18'00" W	ELEVATION:
DRWN. BY: F.B.D.	AIRPHOTO No.: A 12807-97	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 7°C
METHOD: TEST PIT		
START: D 28 M 08 Y 75	TIME: 09:00	FINISH: D 28 M 08 Y 75
TIME: 09:30		

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B2-2

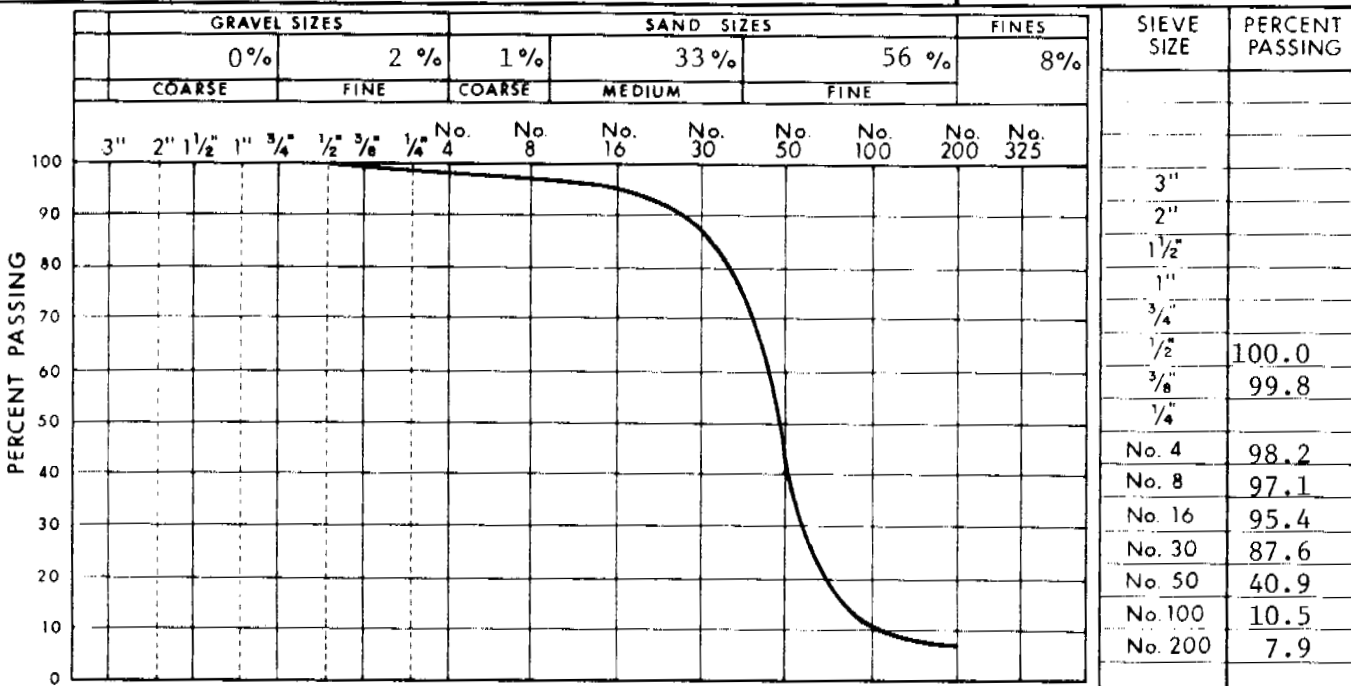
SHEET 1 OF 1

- 525 -

TEST HOLE No. N75-1061-B2-2

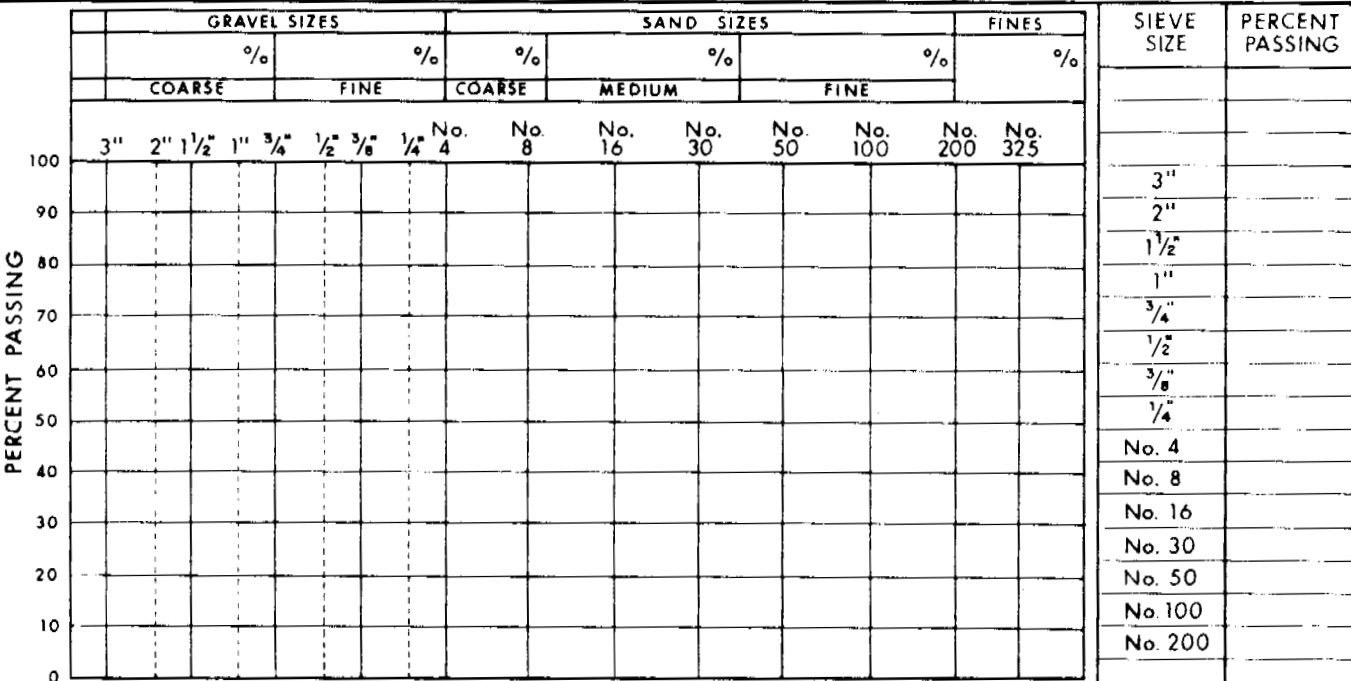
SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B2-2 DEPTH 1.0-4.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 28, 1975 SAMPLED BY NESCL 168



COMMENTS Moisture contents range from 4.3% to 12.2% OVERSIZE (>3") = 0.0 %

SAMPLE _____ DEPTH _____ R.M.HARDY REPORT NUMBER
 DATE SAMPLED _____ SAMPLED BY _____



COMMENTS _____ OVERSIZE (>3") = _____ %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING



DEPOSIT No.
 N75-106I-B2

PAGE
 526

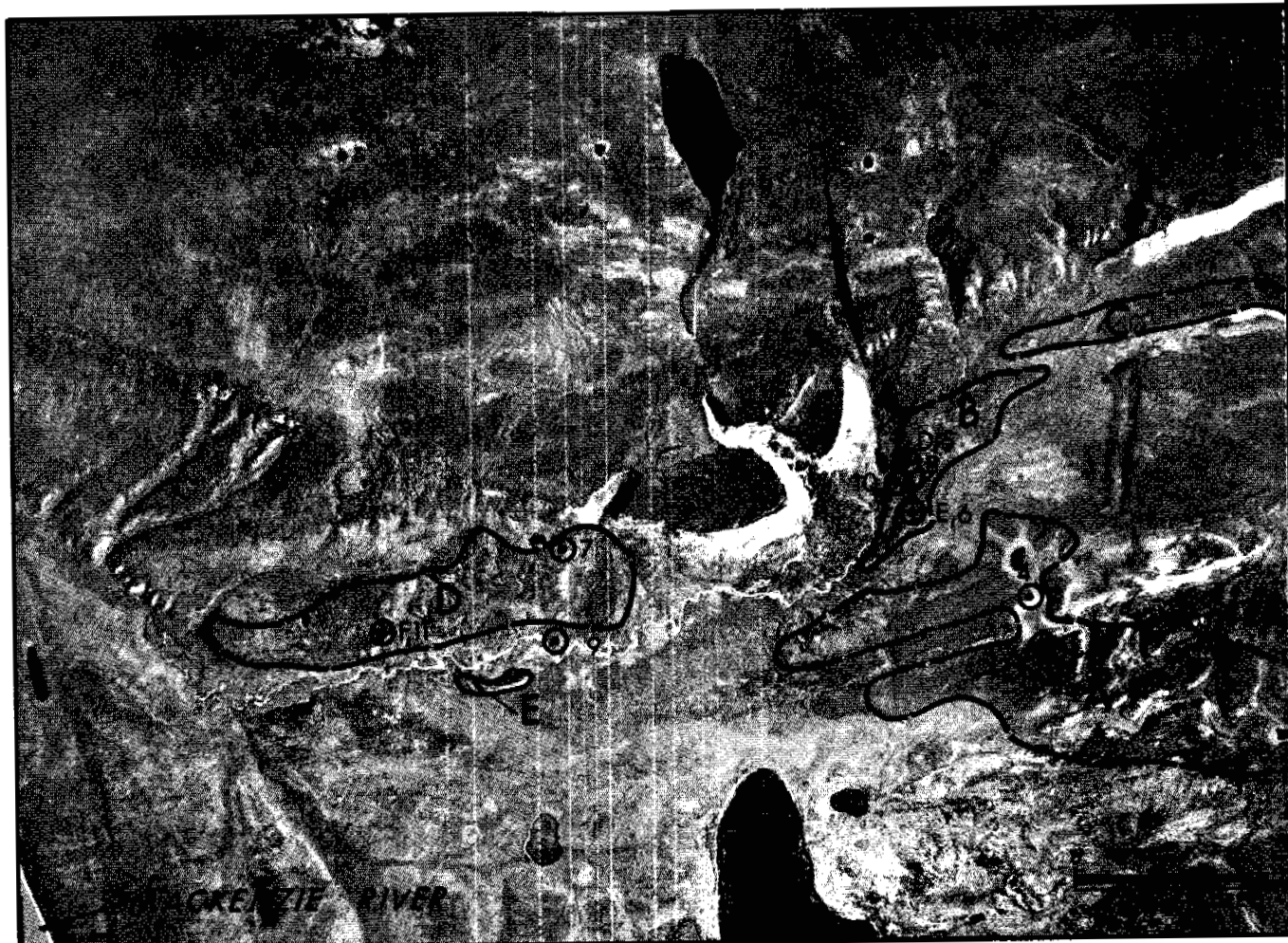
106 I - B3-A	496120E	7386510N
B3-B	496550E	7385970N
B3-C	494940E	7386350N
B3-D	494260E	7387710N
B3-E	494110E	7387490N
B3-F	491560E	7386420N







Physical Setting: Deposit 106I-B3 consists of broad kame terraces and a small esker located on the south flank of the Ramparts Plateau 1 mile west of milepost 260 on the right of way.

Material: SAND - fine to medium, with variable silt, clay and gravel content.

Volume: 6,200,000 cubic yards.

Assessment: Deposit 106I-B3 is a source of fair to good quality granular material suitable for general fill, backfill and possible building pads. Access would involve crossing steep to moderate slopes.



		LEGEND	
	Deposit Outline		Proposed Gas Pipeline Route
	Drill Hole Location		Mackenzie Highway
	Test Pit Location		

Airphoto No. A12697-73
 Approximate Scale: 1" = 3300'

Latitude: 66° 36'
 Longitude: 129° 07'



DEPOSIT 106I-B3

PHYSICAL SETTING

This deposit consists of broad kame terraces and a small esker situated on the south flank of the Ramparts Plateau. It is 5 miles east-south-east of the mouth of the Tieda River and 1 mile west of milepost 260 on the proposed pipeline alignment. This deposit corresponds to source number 1022 in EBA DIAND Granular Materials Inventory Volume II (1974) report.

Segment "A" of this deposit is a large kame terrace with meltwater channels cut 20 to 40 feet into its upper flat to gently rolling surface.

Segments "B" and "C" are similar but have linear shapes and a small creek has incised a channel through the centre of part B.

Segment "D" is a broad kame terrace that has been channeled and terraced. Its flat upper surface stands about 150 feet above the creek to the south. Channels and terraces are inset 20 to 100 feet below the main surface.

Segment "E" is a small esker whose rounded crest stands about 50 feet above the surrounding terrain. Slopes up to 30 degrees are common along its edge.

All segments of the deposit have a thin cover of peat and silt which may thicken to 3 feet on some of the broader flat surfaces. Drainage over most of deposit is moderately good to good. Section "E" and scarps along Section "D" are rapidly drained. Within the incised channels drainage is imperfect to poor.

Although the active layer may be deep in the esker and on south facing scarps, it appears to vary between 2 and 10 feet over most of the deposit.

Cliffs to the north and east of the deposit separate it from the pipeline right of way. To the southeast, the terrain appears to be a gently rolling moraine plain with some steep to moderate slopes closer to the pipeline alignment.

BIOLOGICAL SETTING

A wide range of vegetation communities are found on this extensive site. Vegetation on the terraces consists of spruce, 50 ft. or more in height, with clumps of birch scattered throughout. A shrub understory is present with a ground cover of herbs and mosses. Stunted spruce with sedges are found in the poorly drained areas, while rapidly drained slopes are characterized by scattered aspen with juniper and bearberry.

The area provides moderate to good habitat for a wide range of small and large mammals. Portions of the area may be used for denning. Red squirrel, grouse and Arctic loon sign were observed in the area in 1975. Nearby cliffs provide potential raptor nesting sites. The area is adjacent to the Mackenzie River where large numbers of waterfowl congregate during May and June. Migrating moose may move through the area in November-December, and April-May, enroute to and from islands in the Mackenzie River. The area also provides fair to good moose summer range. The adjacent small ponds and lakes do not appear to support fish populations.

MATERIAL

Material in this deposit is predominately fine to medium sand with a variable silt, clay and gravel content. Beds of coarse and well graded gravel with varying amounts of silt, sand and cobbles are interbedded with the sand in several drill holes and test pits. Drill hole 106I-B3-B encountered 9 feet of sand then 25' of gravel indicating that areas of fairly good quality borrow are available in this deposit.

VOLUME

Total estimated volume for all segments of the deposit, based on an area of 860 acres and an average depth of 10 feet is 6,200,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106I-B3 is a source of fair to good quality granular material which is suitable for general fill, backfill in pipeline construction and possibly building pads. Further drilling would be required to locate areas of the best quality borrow.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the deposit from the pipeline right of way would involve crossing steep to moderate slopes. Terrain to the southeast presents the least problems and would probably provide the best though longest route. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the deposit to haul points on the right of way.

Development of the selected sites would initially require the tree and vegetative cover to be removed and disposed of, or harvested in accordance with land use regulations. The thin cover of peat and silt would then be stripped from the site and stockpiled around the edge. Excavation of borrow material would be carried out according to development plans for upland borrow sources, when further information is available for all sections of the deposit. The borrow pit would involve excavating borrow material evenly from higher well drained areas to a grade

such that good drainage is maintained. Steep slopes may be opened up and the face of the scarps excavated. Blasting or conventional earth-moving techniques would be used depending on the degree of ice cementation.

The excavated material may have to be stockpiled, thawed, and drained before it is used. Natural mixing during excavation should be adequate to obtain good gradations. Equipment required for development would be dozers, rippers, end-dump trucks, and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.


N75-1061-B3-A

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt	0.4	PEAT cover														3 7/8" Walmac	
2	GM		GRAVEL - fine to coarse, silty, some fine to coarse sand, brown, moist, frequent cobbles, occasional boulders		UF													
6	SP	8.0	SAND - fine to medium, trace silt (<5%)		Nb												losing some air but cuttings returning	
8	GM	7.0	GRAVEL - fine to coarse, silty, some fine to coarse sand, brown, frequent cobbles, occasional boulder														15:50, hole sloughing	
10	SP	10.0	SAND - little coarse gravel (inferred)														inferred by action of drill no cutting return	
13		13.0	End of hole														hole plugging	

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 88°35'57"N, 129°05'13"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A12897-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 29 M 8 Y 75 TIME: 15:45	FINISH: D 29 M 8 Y 75 TIME: 18:05	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B3-A
SHEET 1 OF 1

- 533 -

TEST HOLE No. N75-1061-B3-A

N6I03-B 7/7 N6I03-A

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	SP		SAND—fine to medium, trace fine to coarse gravel, brown, damp.		UF													17:20 new 3 7/8" Walmac
2																		
4																		
6																		
8																		
10	GM		GRAVEL—fine to coarse, silty, some fine to coarse sand, brown, damp.															
12																		
14																		
16																		

- 534 -

TEST HOLE No. N75-1061-B3-B

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 88°35'40"N. 129°04'39"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No: A 12697-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 28 M 08 Y 75	TIME: 17:20	FINISH: D 29 M 08 Y 75
		TIME: 18:00

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B3-B

SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)			○ Water content %										
							Plastic limit		Liquid limit											
					40	60	80	100	120	140 ▲										
					0	20	40	60	80	100 ○										
18	GM				UF													18.5' water gushes out of hole		
20																		flow of water slows down		
22																		some slough in hole.		
24																				
26																				
28			at 28.0' free water. Very wet from 28.0' to end of hole at 34'																	
34			End of hole																	

- 535 -

TEST HOLE No. N75-1061-B3-B

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 86°35'40"N. 120°04'39"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 12697-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG: MELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 29 M 08 Y 75	TIME: 17:20	FINISH: D 29 M 08 Y 75
		TIME: 18:00

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No. N75-1061-B3-B
SHEET 2 OF 2

N8309 C July 1, 1975

TEST HOLE LOG


DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	ML		SILT- trace fine sand, brown, damp pieces of wood		UF													14:20
4.0																		
5.0	SM		SAND - fine to medium, trace coarse, silty, trace fine gravel, brown to rust brown, damp		Nb													
6.0																		
8.0			SAND - fine to medium, light brown, clear.															
9.0																		
9.0			occasional pebbles		Yx													
10	SP																	
12																		
14																		
16																		

- 536 -

TEST HOLE No. N75-1061-B3-C

LOGGED BY: G.M.W.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 88°35'57"N, 129°06'35"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A 12897-73	PIPE MILEAGE:
CHKD: J.N.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C
	METHOD: AIR	
START: D 29 M 08 Y 75	TIME: 14:20	FINISH: D 29 M 08 Y 75
		TIME: 14:43

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B3-C


SHEET 1 OF 3

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
18	SP		SAND (cont'd)	+ +	Vx												18	
18			19.0 --- cobble	+ +														
20				+ +														
22				+ +														
24			24.0 --- cobble	+ +														
26			26.0 --- trace fine to coarse gravel	+ +														
28				+ +														
28			28.0 --- 29.0	+ +													28	14:34
30	SM		SAND - fine to medium, silty, trace gravel, grey, loose.	+ +	Nb													
32	(SM-SW)		32.0 --- less silt	+ +													32	

- 537 -

TEST HOLE No. N75-1061-B3-C

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION	TEST HOLE No. N75-1061-B3-C
CHKD: D.O.	LAT. & LONG: 88°35'57"N, 128°08'35"W	ELEVATION:		
DRWN. BY: J.W.B.	AIRPHOTO No.: A 12697-73	PIPE MILEAGE:	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	SHEET 2 OF 3
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 21°C		
	METHOD: AIR			
START: D 29 M 08 Y 75 TIME: 14:20	FINISH: D 29 M 08 Y 75 TIME: 14:43			


TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140	▲						
						0	20	40	60	80	100	○						
32	SM		SAND (cont'd)		Nb												32	
34																		
35			35.0 --- silty, fine grained, grey, loose.															
36																		
38			38.0 End of hole.														38	

TEST HOLE No. N75-1061-B3-C

LOGGED BY: J.M.N.	FACILITY:	PROJECT: 13011
CHKD: B.B.	LAT. & LONG: 88°35'57"N, 128°08'35"W	ELEVATION:
DRWN. BY: J.M.B.	AIRPHOTO No.: A 12887-73	PIPE MILEAGE: -
CHKD: J.M.W.	RIG: WELL-DRILL	AIR TEMP: APPROX. 21°C
	METHOD: AIR	
START: D 28 M 08 Y 75	TIME: 14:20	FINISH: D 29 M 08 Y 75
		TIME: 14:43

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B3-C
SHEET 3 OF 3

1161013

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0	Pt	0.5	PEAT - brown, woody, damp		UF												3 7/8" Walmac	
2	ML	2.0	SILT - trace fine sand, slightly organic, brown to black, damp.														Samples taken at intervals for possible laboratory verification.	
4	GP	4.0	GRAVEL - fine to coarse, little coarse sand, occasional cobbles, clean.		Nd													
8	SP-SM	7.0	SAND - fine to medium, trace gravel, trace silt		F												11:00 new 3 7/8" Walmac	
10	GP	9.5	GRAVEL - fine to coarse, trace fine sand, brown, occasional cobbles														To rock bit	
12		12.0	mostly coarse gravel, occasional cobbles															
14	SM	16.0	SAND - fine to medium, silty, brown.														11:20 3 7/8" Walmac	
16																	hole wet, stem sticking	

TEST HOLE No. N75-1061-B3-D

539

LOGGED BY: G.M.H	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 86°38'29"N, 129°07'41"W	ELEVATION:
DRWN. BY: J.M.B	AIRPHOTO No.: A 12697-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 10°C
	METHOD: AIR	
START: D 29 M 08 Y 75 TIME: 10:50	FINISH: D 29 M 08 Y 75 TIME: 12:05	

1975 BORROW INVESTIGATION		 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No.
			N75-1061-B3-D
CANADIAN ARCTIC GAS STUDY LIMITED			SHEET 1 OF 2

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
16	(GP)	●●●●●●●●	GRAVEL fine to coarse, occasional cobbles (possible little coarse sand - inferred by action of drill)		F												16	
18			End of hole														18	cobble no cutting return approx. 12'' of slough in the hole.

LOGGED BY: G.M.H	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 85°38'28"N, 129°07'41"W	ELEVATION:
DRWN. BY: J.N.B	AIRPHOTO No.: A 12887-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 10°C
	METHOD: AIR	
START: D 28 M 08 Y 75 TIME: 10:50	FINISH: D 29 M 08 Y 75 TIME: 12:05	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>TEST HOLE No. N75-1061-B3-D</p> <p>SHEET 2 OF 2</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	

- 540 -

TEST HOLE No. N75-1061-B3-D

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
					40	60	80	100	120	140 ▲								
					0	20	40	60	80	100 ○								
0	SM		SAND - fine to coarse, silty, little fine to coarse gravel, moist, brown		UF												0	12:37
2																		
4	GW-GM		GRAVEL - some fine to coarse sand, trace silt, brown, damp, occasional cobbles														4	lost air circulation hole sloughing
6																		
8																		
9																		
10	SM		SAND - fine to medium, trace coarse, silty, brown, damp		Nb												9	12:45 regained circulation
12																		
13																		
14																		
16																		

LOGGED BY: G. M. H.	FACILITY:	PROJECT: 13011
CHKD: G. O.	LAT. & LONG: 88°38'21"N, 129°07'38"W	ELEVATION:
DRWN. BY: J. M. B.	AIRPHOTO No.: A12697-73	PIPE MILEAGE:
CHKD: J. K. W.	RIG: HELI-DRILL	AIR TEMP: Approx. 18°C
	METHOD: AIR	
START: D 29 M 08 Y 75 TIME: 12:35	FINISH: D 29 M 08 Y 75 TIME: 13:20	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B3-E

SHEET 1 OF 2

- 541 -

TEST HOLE No. N75-1061-B3-E

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)			○ Water content %									
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
16	SM		SAND (cont'd) 17.0 --- fine, some med. sand, silty, grey		Nb												16		
18																	18	13:02	
20																			
22																			
24																			
26																			
28																	28	13:10 drill stem sticking very little cuttings return hole plugging	
30	CL		29.0 CLAY - silty, low plastic, dark grey																
31			31.0 End of hole														31	13:20	

TEST HOLE No. N75-1061-B3-E

- 542 -

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011
CHKD: D.O.	LAT. & LONG: 86°38'21"N, 129°07'38"W	ELEVATION:
DRWN BY: J.M.B.	AIRPHOTO No.: A12697-73	PIPE MILEAGE:
CHKD: I.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 16°C
	METHOD: AIR	
START: D 28 M 08 Y 75	TIME: 12:35	FINISH: D 29 M 08 Y 75
		TIME: 13:20

1975 BORROW INVESTIGATION	TEST HOLE No.
 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	N75-1061-B3-E SHEET 2 OF 2
CANADIAN ARCTIC GAS STUDY LIMITED	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
					40	60	80	100	120	140	▲							
					0	20	40	60	80	100	○							
1	GN		GRAVEL - silty, some fine to coarse sand, brown, moist, frequent cobbles to 8"		UF												0	3 7/8" Walmac
2																		
3																	3	lost air circulation, large hole
4			4.0 End of hole														4	

- 543 -

TEST HOLE No. N75-1061-B3-F

LOGGED BY: G.M.H.	FACILITY:	PROJECT: 13011	1975 BORROW INVESTIGATION NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No. N75-1061-B3-F SHEET 1 OF 1
CHKD: D.O.	LAT. & LONG: 66°35'00"N, 129°11'00"W	ELEVATION:		
DRWN BY: J.M.B.	AIRPHOTO No.: A 12897-73	PIPE MILEAGE:		
CHKD: J.K.W.	RIG: HELI-DRILL	AIR TEMP: Approx. 7°C		
	METHOD: AIR			
START: D 29 M 08 Y 75	TIME: 09:45	FINISH: D 20 M 08 Y 75	TIME: 10:13	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
							▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit								
							40	60	80	100	120	140 ▲							
							0	20	40	60	80	100 ○							
0.2	Pt		PEAT and moss cover		UF														
0.2 - 2.0	GC		GRAVEL-some sand, trace clay, pebbles angular to 2"																
2.0 - 3.0			little gravel, little clay, pebbles subrounded and angular to 8", wet, brown, rootlets																
3.0 - 4.0	GW		GRAVEL-and sand, trace fines, pebbles angular to subrounded to 3", brown, damp																
4.0 - 5.0			little gravel, trace fines, pebbles angular, subrounded to 2" moist, brown																
5.0 - 6.0			as 4' to 5' but cleaner																
6.0			Bottom of pit																
			Note: borderline gravel/sand																

MA, combined samples 1 - 5
 Oversize = 3.7%
 -3" material
 G = 48%
 S = 44%
 F = 10%
 (GW-GC)






- 544 -

TEST HOLE No. N75-1061-83-1

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°35'57"W, 129°05'13"W	ELEVATION:
DRWN. BY: A.J.B.	AIRPHOTO No.: A 12897-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: -
METHOD: TEST PIT		
START: D 29 M 08 Y 75 TIME: -	FINISH: D 29 M 08 Y 75 TIME: -	

<p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	<p>TEST HOLE No.</p> <p>N75-1061-83-1</p> <p>SHEET 1 OF 1</p>
--	---

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt	777	0.2 PEAT cover		UF														
1	SM		SAND - fine to coarse, silty, brown, occasional pebbles subrounded to angular to 3/4", damp, occasional roots, organics,									MA, combined samples 1 - 4 G = 10% S = 53% F = 37% (SM)	B1				1	Combined 1' - 5' = "SAND, fine to medium, and silt, trace fine gravel".	
2			2.0 1" gravel seams, light brown, damp to moist										B2				2		
3			3.0 occasional cobbles										B3				3		
4													B4				4		
5																			5
6			6.0 Bottom of pit																6

TEST HOLE No. N75-1061-B3-2

- 545 -

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 86°35'40"N, 129°04'39"W	ELEVATION:
DRWN BY: N.L.	AIRPHOTO No.: A 12897-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: -
METHOD: TEST PIT		
START: D 29 M 08 Y 75 TIME: -	FINISH: D 29 M 08 Y 75 TIME: -	

 <p style="font-size: small;">NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR</p>	<p>1975 BORROW INVESTIGATION</p> <p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	TEST HOLE No. N75-1061-B3-2 SHEET 1 OF 1
--	---	--

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit	Liquid limit											
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt	???	0.2 PEAT cover		UF													
1	SC		SAND - fine to medium, and silty clay, trace fine gravel, rootlets, occasional cobble															
2																		
3																		
4																		
5			5.0 Bottom of pit		F													
			Permafrost at 5.0'															

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011	<div style="text-align: center;"> <p>1975 BORROW INVESTIGATION</p> <p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED</p> </div>
CHKD: R.N.	LAT. & LONG: 66°35'57"N, 129°08'35"W	ELEVATION:	
DRWN. BY: A.J.B.	AIRPHOTO No.: A 12887-73	PIPE MILEAGE:	
CHKD: J.K.W.	RIG:	AIR TEMP: -	
	METHOD: TEST PIT		
START: D 29 M 08 Y 75 TIME: -			FINISH: D 29 M 08 Y 75 TIME: -

TEST HOLE No.	N75-1061-B3-3
SHEET 1 OF 1	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
1	GM		GRAVEL - some sand fmc, silty, rootlets medium brown.		UF							MA, combined samples 1 - 5 Oversize = 7.0% G = 24% S = 32% F = 44%					1	Boulders on surface
2	SM-ML		SAND - fine to medium, silty, little coarse to fine gravel, pebbles subrounded, subangular to 2", dark brown, dry to damp, rootlets.										B1				2	Combined samples 1' - 6' = "SAND, fine and silt, some coarse to fine gravel".
3			3.0 — cobble to 5", fewer coarse rootlets.										B2				3	
4			(4.2)										B3				4	
5	SM		SAND - fine, silty, trace coarse gravel, pebbles to 3", dark brown.										B4				5	
6			6.0 Bottom of pit										B5				6	




TEST HOLE No. N75-1061-B3-4

- 547 -

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 66°36'05"N, 129°08'41"W	ELEVATION:
DRWN BY: H.L.	AIRPHOTO No.: A 12887-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Cool
	METHOD: TEST PIT	
START: D 29 M 08 Y 75 TIME: -	FINISH: D 29 M 08 Y 75 TIME: -	


1975 BORROW INVESTIGATION	TEST HOLE No. N75-1061-B3-4
NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	
SHEET 1 OF 1	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt		PEAT 0.5		UF														
1	SC		SAND - cmf, clayey, some coarse to fine gravel, medium plastic fines																
2																			
3	CI		CLAY - medium plastic, grey 2.6																
			3.8 Bottom of pit																
			Permafrost at bottom of pit		F														

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 88°38'29"N, 129°07'41"W	ELEVATION:
DRWN. BY: A.J.B.	AIRPHOTO No.: A 12887-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: -
	METHOD: TEST PIT	
START: D 28 M 08 Y 76 TIME: -	FINISH: D 28 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES
COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B3-5

SHEET 1 OF 1

- 548 -

TEST HOLE No. N75-1061-B3-5

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)			○ Water content %										
						Plastic limit			Liquid limit										
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
0.2	Pt		PEAT - cover		UF														
0.2			GRAVEL - coarse to fine, and sand, trace silty clay, rust-coloured, occasional cobbles, boulders.																
1																			
2																			
3																			
3.0			(3.0)																
4			transitional																
4			(4.0)																
5			*SAND - some gravel, little silty clay, pebbles to 1.5", wet.																
5			seams of silty clay.																
5.0			5.0																
6			Bottom of pit																
6			6.0																
			• Note: from 3' to 6' borderline sand/gravel based on -3" material. (on basis of total sample: Gravel = 47% Sand = 44% Fines = 9%)																
												MA, combined samples 1 & 2 G = 55% S = 37% F = 8% oversize = 0.8% (GW-GC)							
												MA, combined samples 3-5 Oversize = 6.8% -3" material: G = 44% S = 47% F = 9%							
												*(SW-SC)							
																	Would have been preferable to combine samples as follows: B1-B3, and B4&5.		

TEST HOLE No. N75-1061-B3-6

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 66°38'21"N, 129°07'36"W	ELEVATION:
DRWN BY: D.J.W.	AIRPHOTO No.: A 12687-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 10°C
	METHOD: TEST PIT	
START: D 29 M 08 Y 75 TIME: -	FINISH: D 29 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION

TEST HOLE No.

N75-1061-B3-6



NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG		LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
				NRC	ICE TYPE	▲ Dry density (pcf)	○ Water content %	Plastic limit	Liquid limit										
0	Pt	0.2	PEAT - coarse fibrous, black	UF		40													
1	SM		SAND - fine grain, trace silt, trace gravel, pebbles rounded to 3/4", orange brown from 0.5' to 1.1', then medium brown			60													
2		2.2 - 2.4	2.2'-2.4' lens coarse sand to fine gravel			80													
3			medium brown			100													
4						120													
5	SP	4.5	SAND - medium			140													
6			cleaner			0													
7		7.0	Bottom of pit																

LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13911
CHKD: R.H.	LAT. & LONG: 66°38'12"N, 129°10'13"W	ELEVATION:
DRWN. BY: F.B.B.	AIRPHOTO No.: A 12897-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 15°C
	METHOD: TEST PIT	
START: D 28 M 08 Y 75	TIME: -	FINISH: D 28 M 08 Y 75
	TIME: -	

1975 BORROW INVESTIGATION

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

TEST HOLE No.

N75-1061-B3-7

SHEET 1 OF 1

CANADIAN ARCTIC GAS STUDY LIMITED

- 550 -


TEST HOLE No. N75-1061-B3-7

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						Plastic limit			Liquid limit									
					40	60	80	100	120	140	▲							
					0	20	40	60	80	100	○							
	Pt	3 3 3 3	PEAT		UF													No samples taken
1	SC		SAND - medium, coarse to fine, clayey, some fine to coarse gravel, medium plastic fines, medium brown															
2	SM		SAND - fine, silty, organic inclusions															
			Bottom of pit Permafrost		F												2.4	

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 66°36'27"N, 129°07'38"W	ELEVATION:
DRWN. BY: A.J.B.	AIRPHOTO No.: A 12897-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: -
	METHOD: TEST PIT	
START: D 28 M 08 Y 75 TIME: -	FINISH: D 28 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No. N75-1061-B3-8	SHEET 1 OF 1
-----------------------------	--------------

- 551 -

TEST HOLE No. N75-1061-B3-8

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
	Pt 27	0.2	PEAT - moss cover		UF													
1	SM		SAND - fine to medium, silty, light brown, rootlets, wood inclusions, coal inclusions, layered.															
2																		
3																		
4		3.7	fine to medium, and coarse to fine gravel, little silt.															
5		4.4	4.4' to 5.2', layered seam of gravel.															
6		5.2																
7		7.0	Bottom of pit															

MA, combined samples 1 & 2
G = 41%
S = 48%
F = 13%


B1
B2

TEST HOLE No. N75-1061-B3-9

- 552 -

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 86°35'57"N, 129°10'19"W	ELEVATION:
DRWN. BY: H.L.	AIRPHOTO No.: A 12887-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: -
METHOD: TEST PIT		
START: D 29 M 08 Y 75 TIME: -	FINISH: D 29 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION



NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

TEST HOLE No.
N75-1061-B3-9

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS	
						▲ Dry density (pcf)	○ Water content %	Plastic limit		Liquid limit									
						40	60	80	100	120	140 ▲								
						0	20	40	60	80	100 ○								
	Pt	77 77	0.5 PEAT		UF														
1	SM		SAND - fine to coarse, and silt, trace gravel, subangular to 1", brown, damp, roots, rootlets.									MA, combined samples 1 - 5, Oversize = 8.8% -3" material: G = 29% S = 53% F = 18%	B1				1		
2			2.0 silty, little gravel, subrounded to 2".										B2					2	
3			3.0 occasional inclusions of angular weak sandstone to 1"										B3					3	
4			4.0 rust pocket, and gravel, angular, rounded to 5", damp to moist.										B4					4	
5	SC		5.0 SAND - fine to coarse, clayey, some gravel to 2 1/2". (medium plastic fines), brown.										B5					5	
6			8.0 Bottom of pit														6		

LOGGED BY: J.F.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°38'25"N, 129°07'46"W	ELEVATION:
DRWN BY: N.L.	AIRPHOTO No.: A 12697-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: -
	METHOD: TEST PIT	
START: D 29 M 08 Y 75 TIME: -	FINISH: D 29 M 08 Y 75 TIME: -	

1975 BORROW INVESTIGATION  NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR	TEST HOLE No. N75-1061-B3-10 SHEET 1 OF 1
CANADIAN ARCTIC GAS STUDY LIMITED	

- 553 -

TEST HOLE No. N75-1061-B3-10

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE VISUAL ICE %	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
						▲ Dry density (pcf)			○ Water content %									
						40	60	80	100	120	140 ▲							
						0	20	40	60	80	100 ○							
0.3	Pt		PEAT - fine to coarse fibrous, dense, black		UF												18:00	
0.8	SC		SAND - very fine grain, very clayey (low plastic fines), orange-brown to 0.8' then medium brown with mottled grey clay layers, occasional rust spots, damp														18:10	
4.2			fine to coarse, some fine to coarse gravel, little clayey fines														4	
4.6			light brown to white														5	
5.5	GC		GRAVEL - fine to coarse, little sand, medium to fine, (clayey)		Yx												18:32	
			Bottom of pit														18:35	

MA, combined, samples 1 & 2
 G = 21%
 S = 80%
 F = 13%
 (SC)

B1
 B2

- 554 -

TEST HOLE No. N75-1061-B3-11

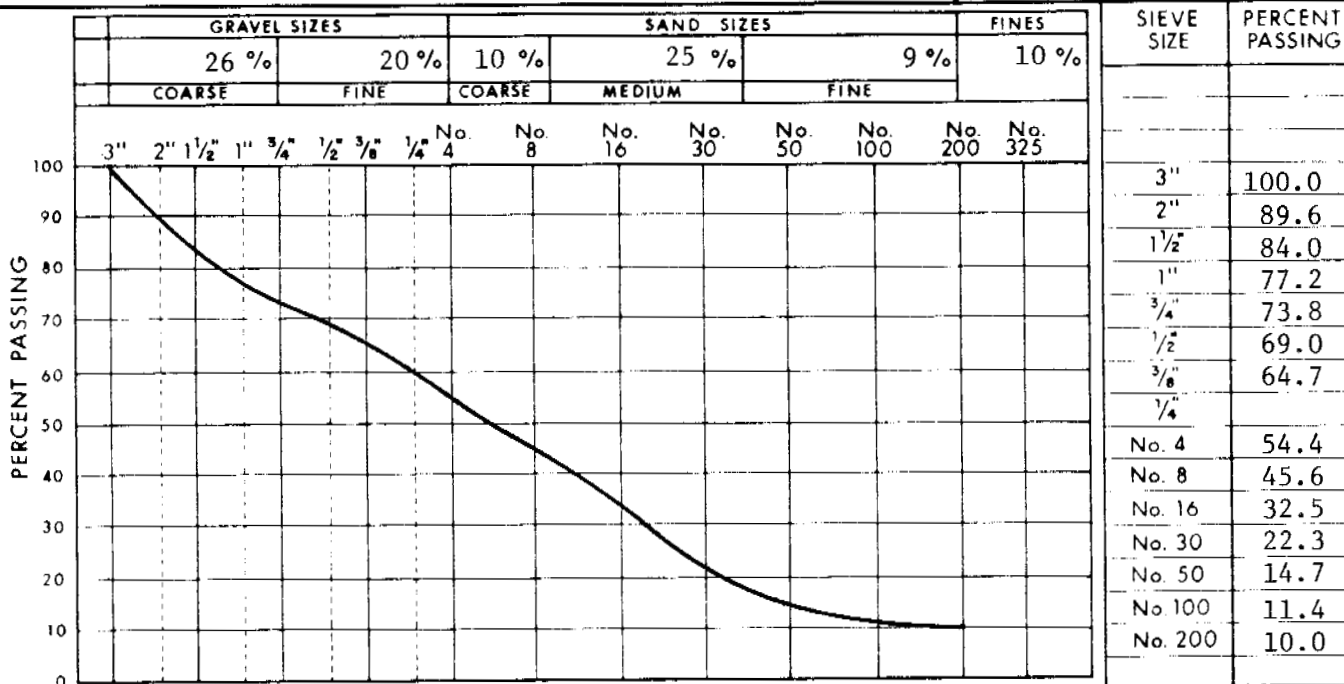
LOGGED BY: J.K.W.	FACILITY:	PROJECT: 13011
CHKD: R.H.	LAT. & LONG: 68°35'49"N, 128°11'36"W	ELEVATION:
DRWN. BY: R.J.S.	AIRPHOTO No.: A 12697-73	PIPE MILEAGE:
CHKD: J.K.W.	RIG:	AIR TEMP: Approx. 10°C
METHOD: TEST PIT		
START: D 28 M 08 Y 75 TIME: 18:00	FINISH: D 28 M 08 Y 75 TIME: 18:35	

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	1975 BORROW INVESTIGATION TEST HOLE No. N75-1061-B3-11 SHEET 1 OF 1
---	---

SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B3-1 DEPTH 1.0-6.0
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL

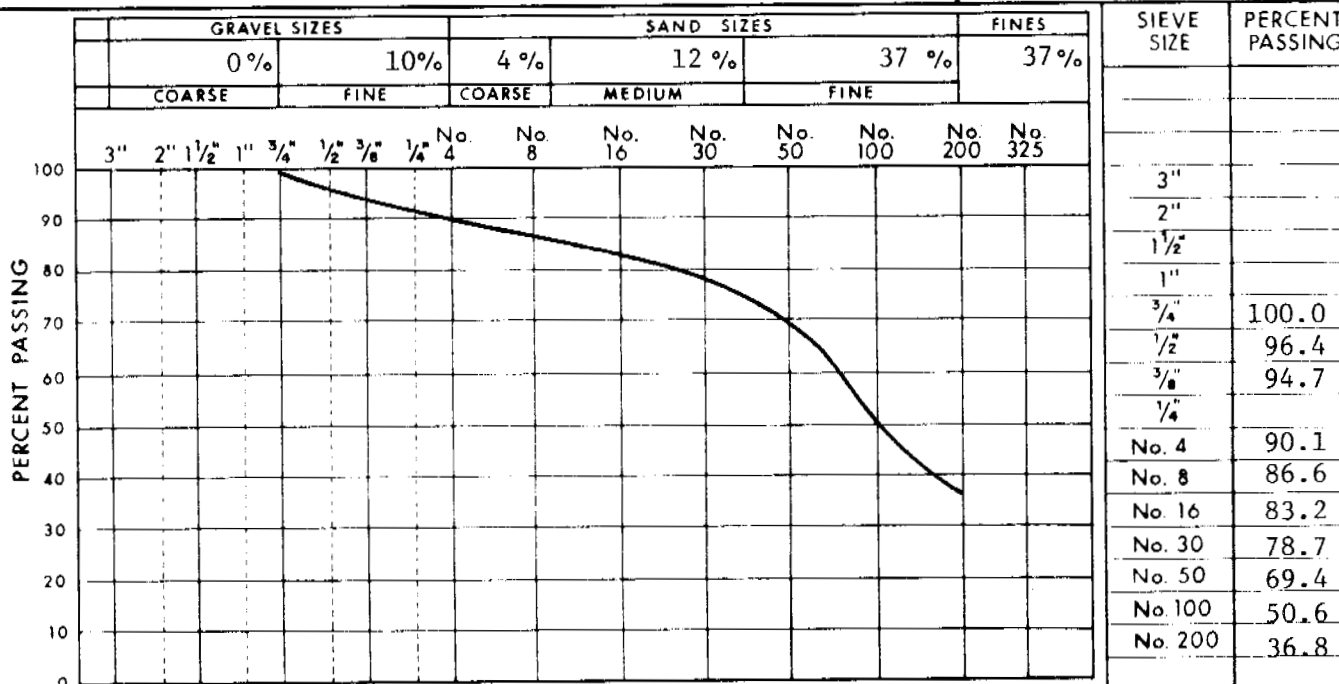
R.M.HARDY REPORT NUMBER
215



COMMENTS Moisture contents range from 5.8% to 14.2% OVERSIZE (>3") = 3.7%

SAMPLE N75-106I-B3-2 DEPTH 1.0-5.6
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL

R.M.HARDY REPORT NUMBER
224



COMMENTS OVERSIZE (>3") = 0.0%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

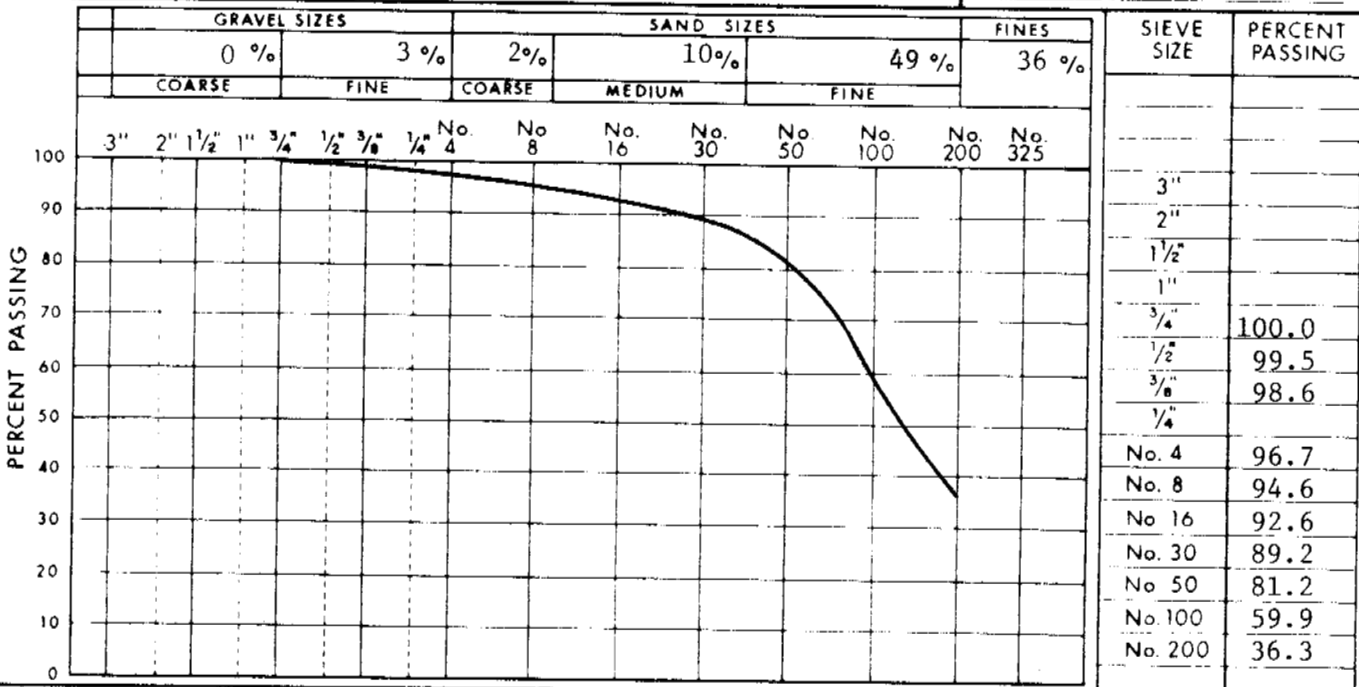


DEPOSIT No.
N75-106I-B3

PAGE
 555

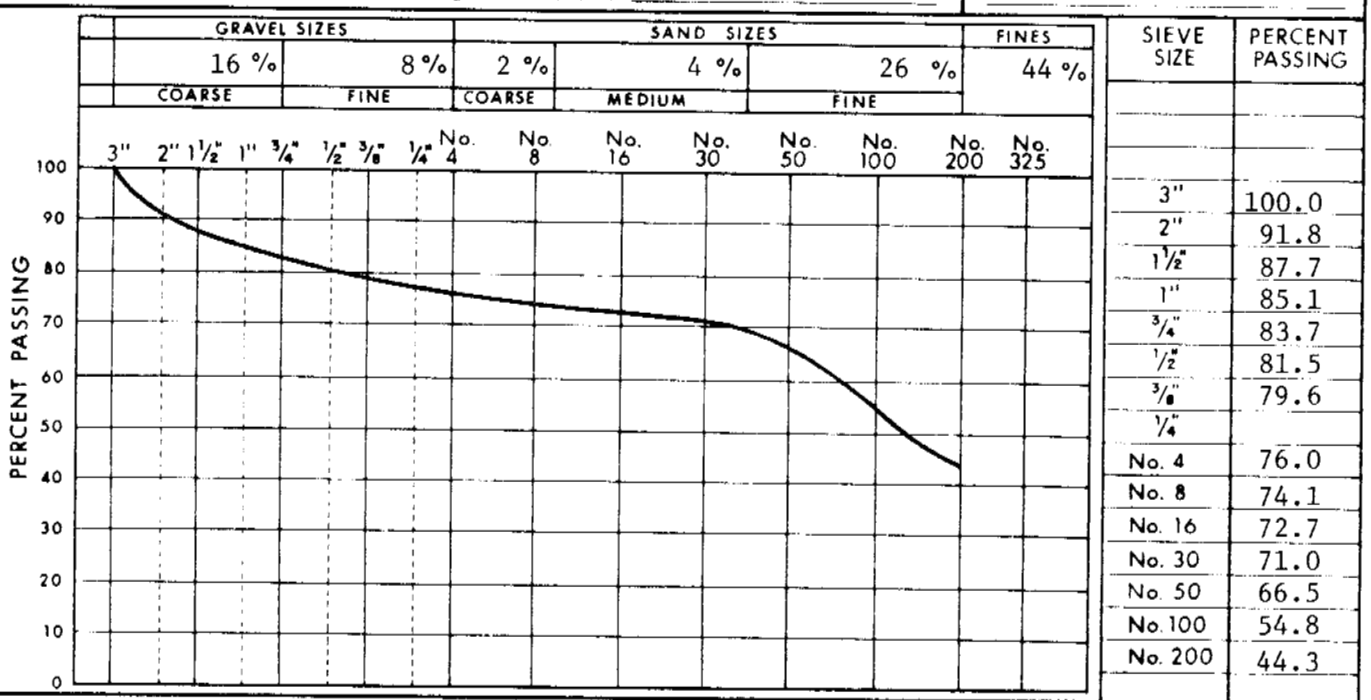
SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B3-3 DEPTH 2.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL 217



COMMENTS OVERSIZE (>3") = 0.0 %

SAMPLE N75-106I-B3-4 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL 229

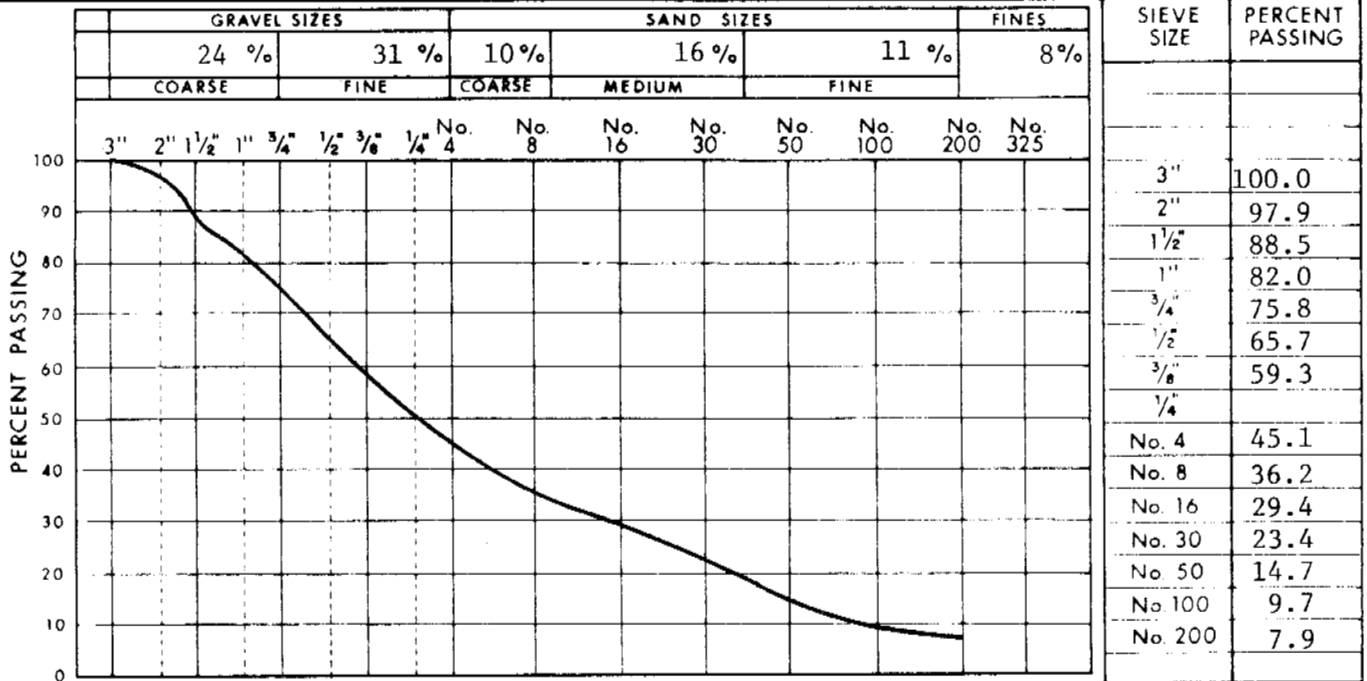


COMMENTS OVERSIZE (>3") = 7.8 %

	R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING		DEPOSIT No. N75-106I-B3
			PAGE 556

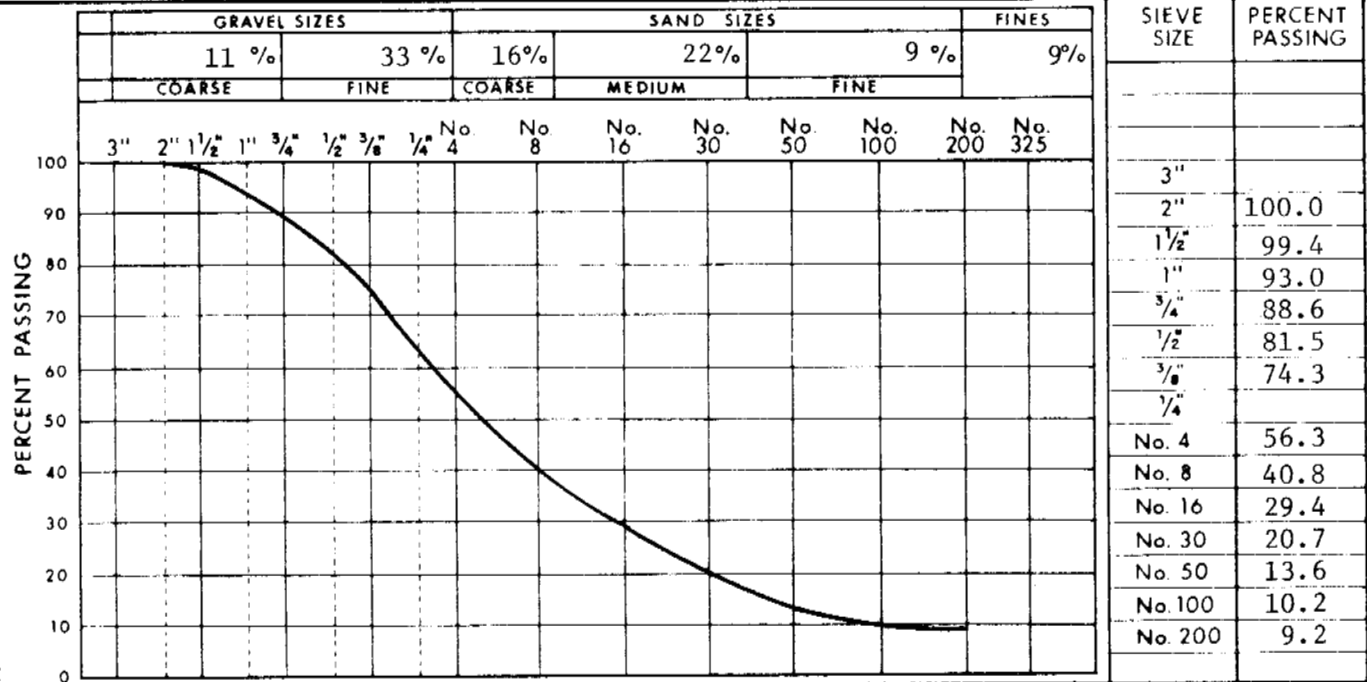
SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B3-6 DEPTH 1.0-3.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL 193



COMMENTS Moisture contents range from 3.4% to 6.0% OVERSIZE (>3") = 6.9 %

SAMPLE N75-106I-B3-6 DEPTH 3.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL 194



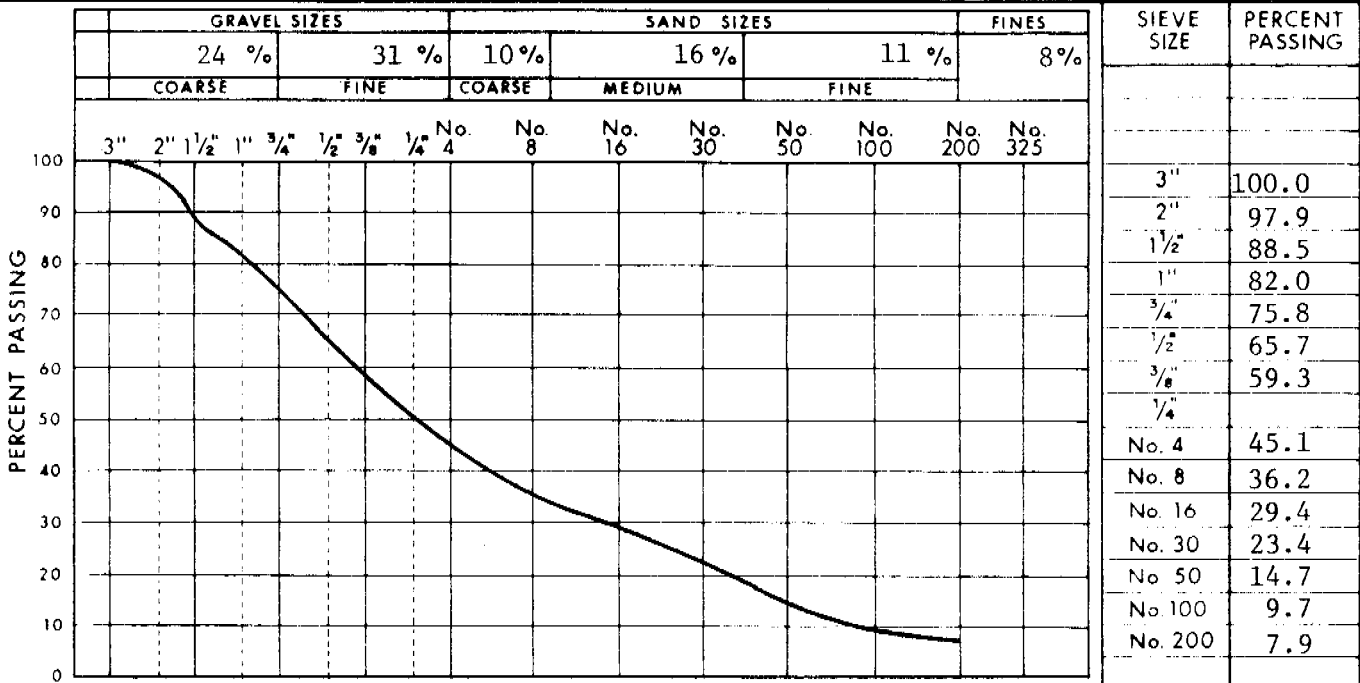
COMMENTS Moisture contents range from 5.1% to 7.4% OVERSIZE (>3") = 6.8 %

 <p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	 <p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-106I-B3
		PAGE 557

SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B3-6 DEPTH 1.0-3.0
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL

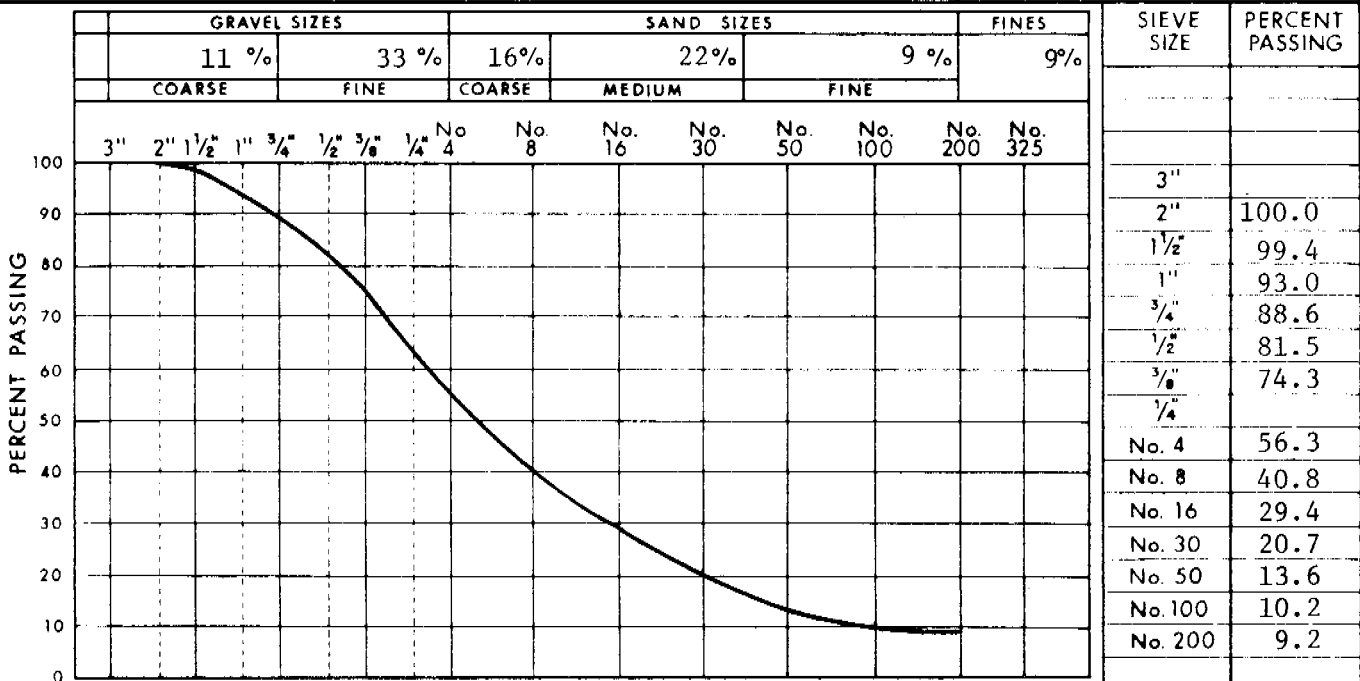
R.M.HARDY REPORT NUMBER
193



COMMENTS Moisture contents range from 3.4% to 6.0% OVERSIZE (>3") = 6.9%

SAMPLE N75-106I-B3-6 DEPTH 3.0-6.0
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL

R.M.HARDY REPORT NUMBER
194



COMMENTS Moisture contents range from 5.1% to 7.4% OVERSIZE (>3") = 6.8%



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

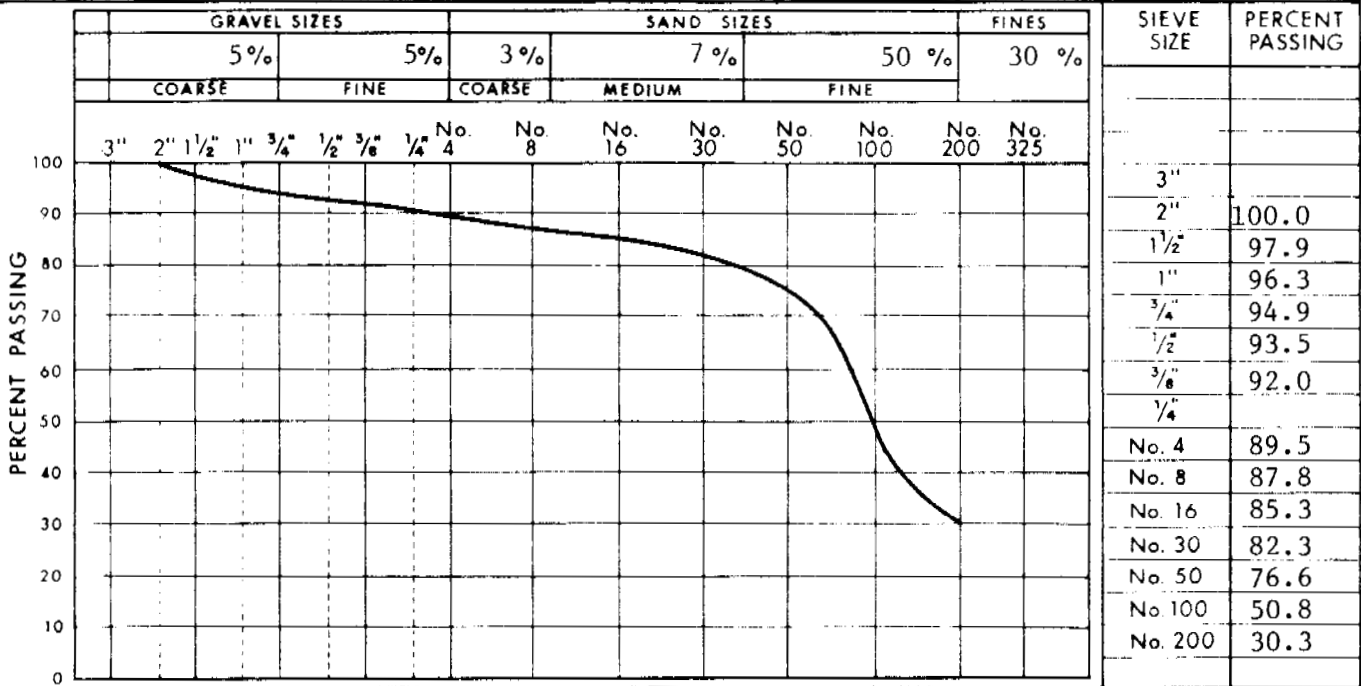


DEPOSIT No.
N75-106I-B3

PAGE
 557

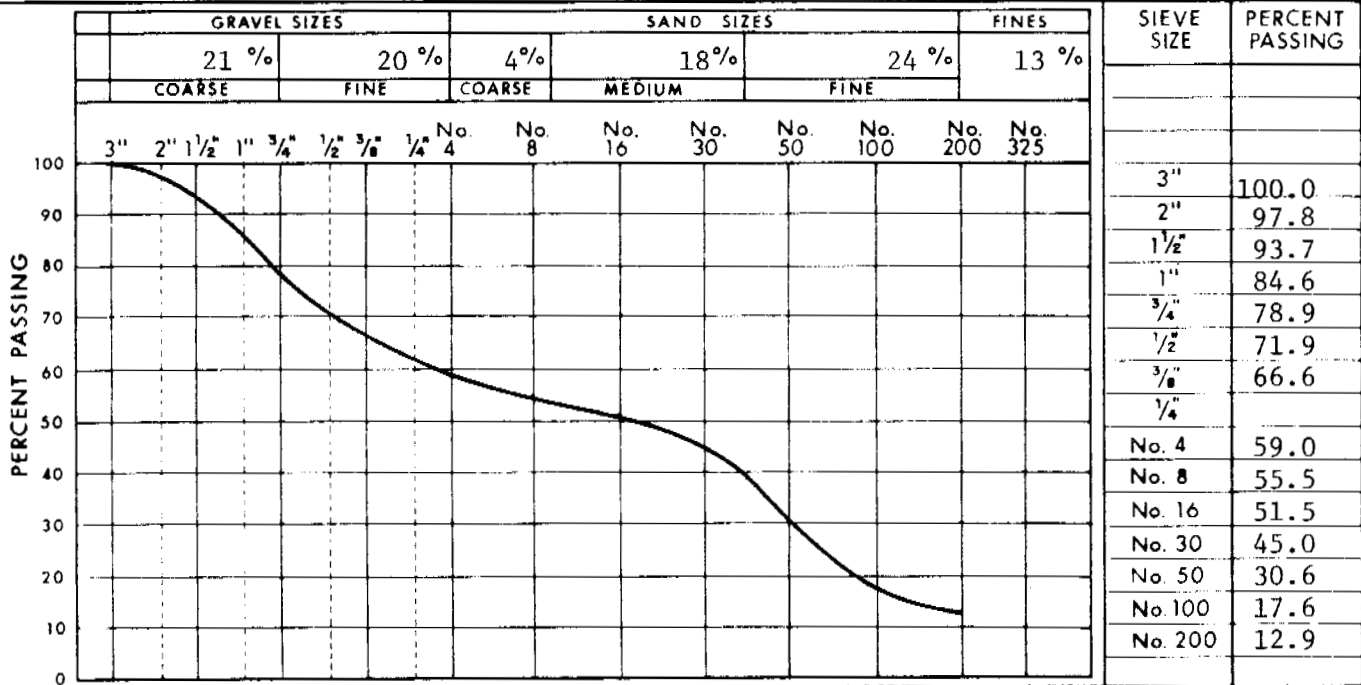
SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B3-7 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 28, 1975 SAMPLED BY NESCL 165



COMMENTS Moisture contents range from 4.8% to 10.6% OVERSIZE (>3") = 0.0 %

SAMPLE N75-106I-B3-9 DEPTH 4.0-5.0; 6.0-7.0 R.M.HARDY REPORT NUMBER
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL 222



COMMENTS OVERSIZE (>3") = 0.0 %



R.M.HARDY & ASSOCIATES LTD.
 CONSULTING ENGINEERING & TESTING

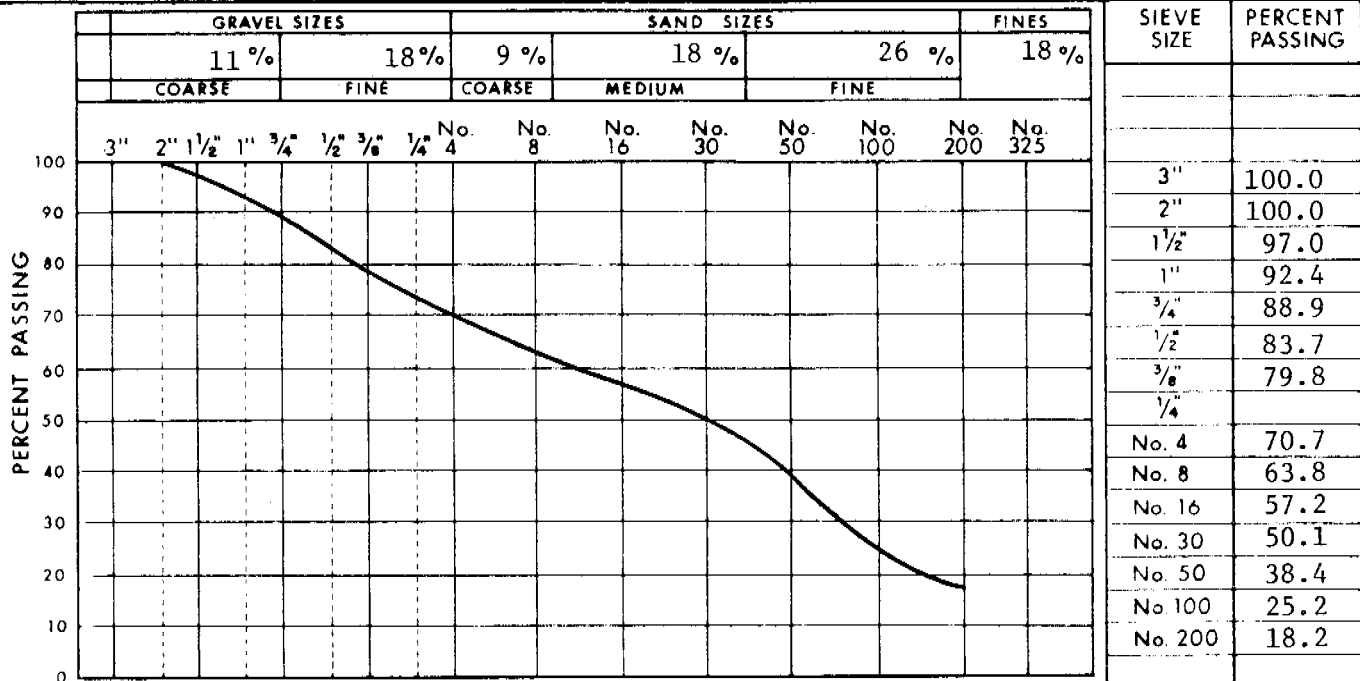


DEPOSIT No.
 N75-106I-B3

PAGE
 558

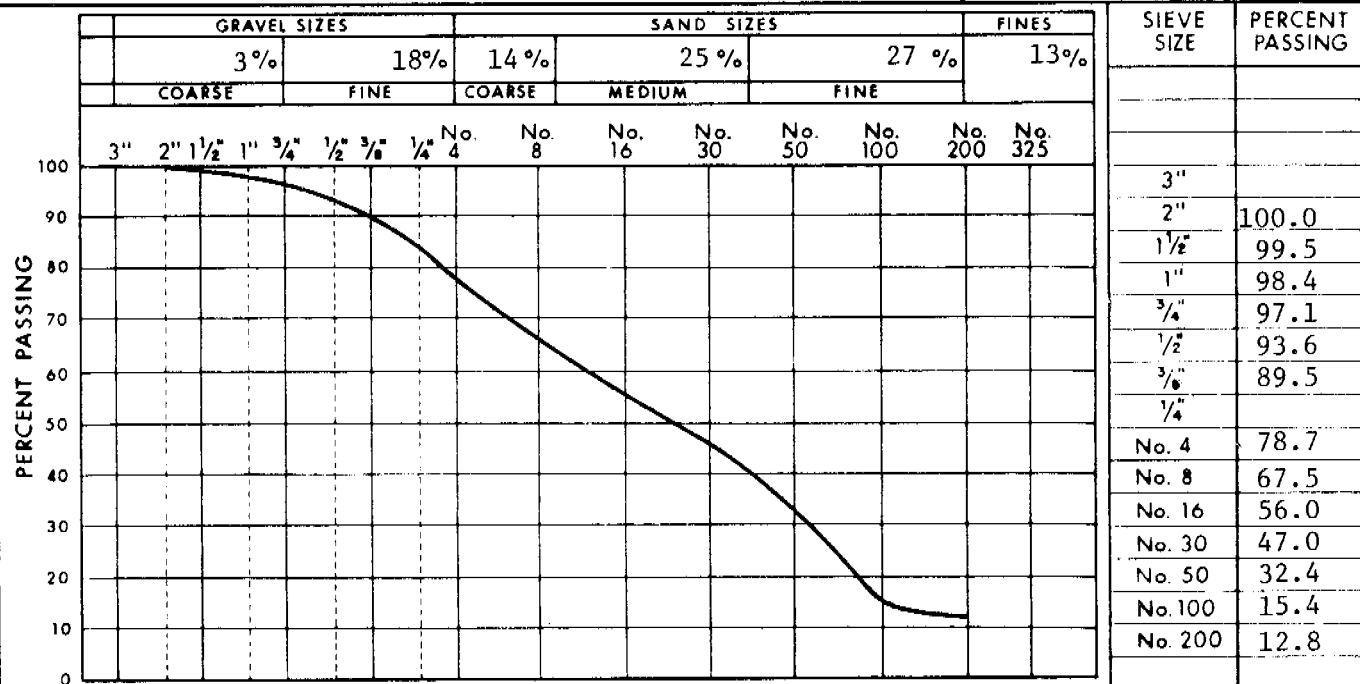
SIEVE ANALYSIS REPORT

SAMPLE N75-106I-B3-10 DEPTH 1.0-6.0 R.M.HARDY REPORT NUMBER 223
 DATE SAMPLED August 29, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 8.8%

SAMPLE N75-106I-B3-11 DEPTH 4.0-6.0 R.M.HARDY REPORT NUMBER 178
 DATE SAMPLED August 28, 1975 SAMPLED BY NESCL



COMMENTS OVERSIZE (>3") = 0.0 %

 <p>R.M.HARDY & ASSOCIATES LTD. CONSULTING ENGINEERING & TESTING</p>	 <p>NORTHERN Engineering Services Company Limited</p>	DEPOSIT No. N75-106I-B3
		PAGE 559

DEPOSIT 106I-B4(R)

Physical Setting: Deposit 106I-B4(R) is a group of kames and a small esker located 10 miles west of Yeltea Lake and about 1 mile east of milepost 226 of the proposed pipeline.

Material: SILT - sandy, with a trace of pebbles.

Volume: 1,800,000 cubic yards.

Assessment: Development of this deposit is not recommended due to its very poor quality material.




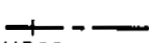
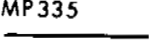
464000E
743000N

466000E
743000N



464000E
742700N

466000E
742700N

LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A12574-233

Approximate Scale: 1" = 3300'

Latitude: 66° 58'

Longitude: 129° 48'

DEPOSIT 106I-B4(R)

PHYSICAL SETTING

This deposit consists of a group of poorly defined kames and a small esker ridge located 10 miles west of Yeltea Lake and 12.5 miles north-east of the mouth of Payne Creek. It is about 1 mile east of milepost 226 on the proposed pipeline right of way.

A small stream dissects the deposit and the kames and esker stand 50 feet above the valley floor. The crests of the kames are flat to gently sloping and the stream-cut banks are moderate to steep. The esker is well drained, but drainage on the kames is imperfect to poor. The stream valley is marshy and very poorly drained. The peat and silt cover is estimated to be 1 to 2 feet thick.

Terrain between this deposit and the pipeline right of way is till covered bedrock with moderate slopes and fairly good drainage.

BIOLOGICAL SETTING

Vegetation on the kames consists of spruce with a moss ground cover. The esker ridge is partly covered with patches of aspen and juniper growing along its crest and south-facing slope. The area provides productive habitat for beaver, lynx, fox, marten, black bear, moose and caribou. Aspen in the area were observed to be heavily browsed by moose in 1975. A game trail is present along the ridge. No dens were observed. A small lake west of the site provides potential water-fowl habitat. None of the nearby lakes or streams appear to support fish populations.

MATERIAL

Drilling and test pit investigations were not carried out at this deposit. However, the field reconnaissance suggests that the deposit consists of sandy silt with a trace of pebbles.

VOLUME

An estimate of the total volume, based on 190 acres and 20 foot depth is 1,800,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Development potential of deposit 106I-B4(R) is low due to the very poor quality material present. However, this deposit should be proven out with test pitting and drilling before a final assessment is made.

UTM Zone 9

DEPOSIT 106I-B5(R)

Physical Setting: Deposit 106I-B5(R) is a number of kames located 10 miles west of Yeltea Lake and crossed by the proposed pipeline at milepost 230.

Material: SAND - silty.

Volume: 2,000,000 cubic yards.

Assessment: Deposit 106I-B5(R) is not recommended for development because it contains poor quality material.


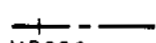

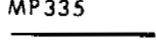

463000E
7423000N

467000E
7423000N

463000E
7421000N

467000E
7421000N



		LEGEND	
	Deposit Outline		Proposed Gas Pipeline Route
	Drill Hole Location		Mackenzie Highway
	Test Pit Location		

Airphoto No. A12574-235
Approximate Scale: 1" = 3250'

Latitude: 66° 54'
Longitude: 129° 48'

DEPOSIT 106I-B5(R)

PHYSICAL SETTING

This deposit consists of a number of irregularly shaped kames located 10 miles northeast of the mouth of Payne Creek and 10 miles west of Yeltea Lake. The pipeline right of way crosses the two northern portions of the deposit near milepost 230.

The kames have steep flanks and stand 20 to 80 feet above the surrounding valley floor. There appears to be minimal overburden and good drainage, however, the river valley is marshy and poorly drained.

BIOLOGICAL SETTING

Vegetation on the kames consists of white spruce and aspen up to 25 ft. in height, under which soapberry and moss are common. The area provides productive habitat for beaver, lynx, fox, marten, black bear, moose and caribou. No waterfowl or raptors were observed in the immediate vicinity. It is not known if fish are present in the small adjacent lake.

MATERIALS

Subsurface investigation at this deposit consisted of digging a few very shallow pits which encountered silty sand.

VOLUME

A rough estimate of total volume based on an area of 120 acres and average depth of 15 feet is 2,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

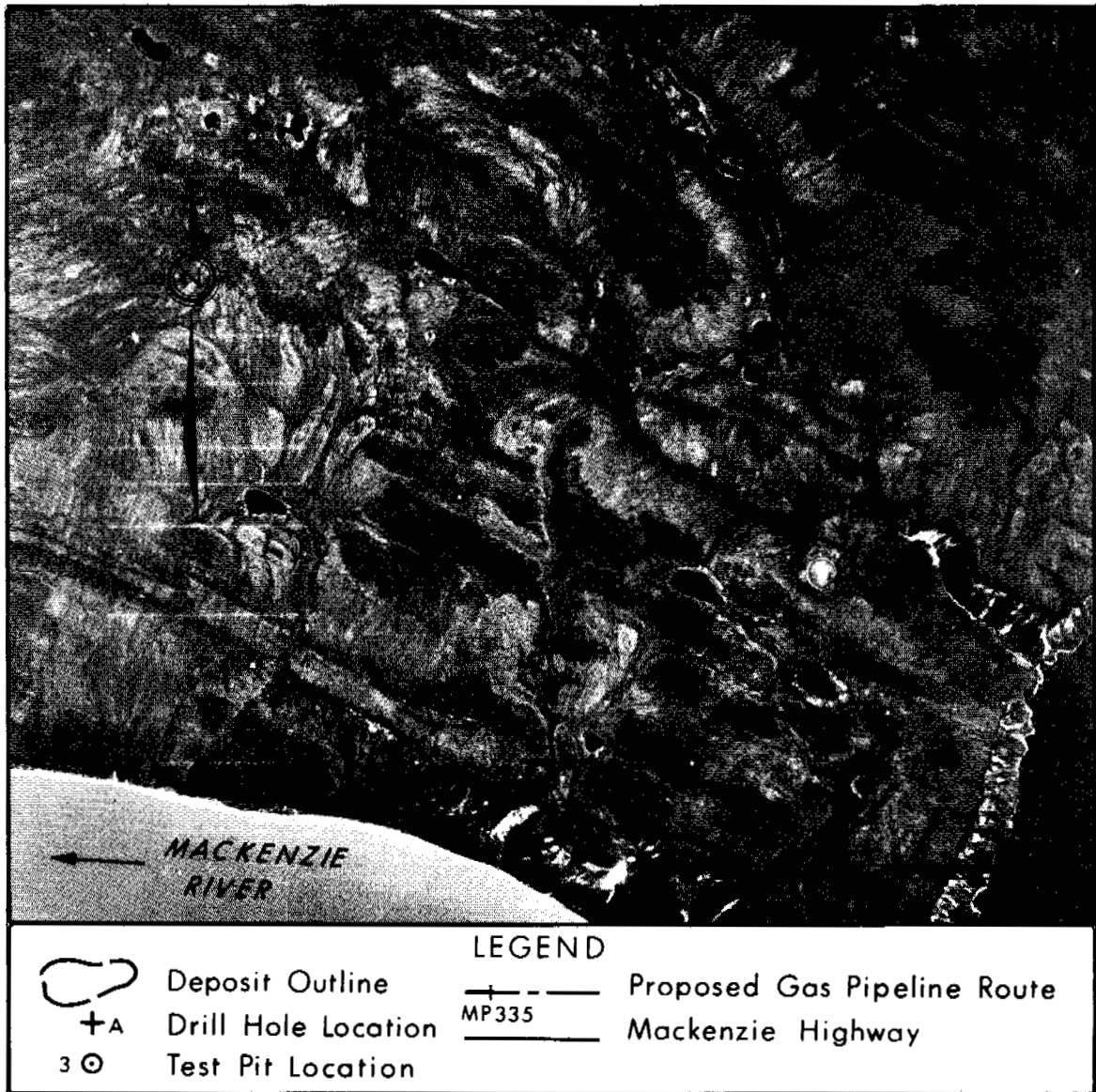
Reconnaissance investigations indicate deposit 106I-B5(R) is a source of poor quality granular material and is not recommended for development. Drilling and test pitting is recommended to provide an accurate evaluation of quality and quantity of available borrow, since the pipeline right of way crosses the two northern portions of the deposit, and would provide highly accessible borrow material that could be suitable for general fill and possibly backfill.

Physical Setting: Deposit 106I-B6(R) is a small esker located 8 miles west of Yeltea Lake, 2 miles north of the Mackenzie River and 3 miles southwest of mile 240 of the proposed pipeline right of way.

Material: SAND - clean, well graded, little gravel.

Volume: 900,000 cubic yards.

Assessment: Deposit 106I-B6(R) is a source of fair quality granular material suitable for general fill, back-fill, and building pads. Access should present few problems.



Airphoto No. A12702-42

Approximate Scale: 1" = 3200'

Latitude: 66° 46'

Longitude: 129° 37'

DEPOSIT 106I-B6(R)

PHYSICAL SETTING

This deposit consists of segments of a small esker located 8 miles west of the south end of Yeltea Lake and 2 miles north of the Mackenzie River. It is 3 miles southwest of milepost 240 on the proposed pipeline right of way.

The esker ridge has moderately sloping sides and rises 20 feet above the surrounding terrain. Overburden is negligible and the deposit is well drained. The small valley in which the esker is situated is marshy and poorly drained. Terrain between this deposit and the pipeline right of way is rolling moraine with moderately good drainage and a few wet peat-filled depressions.

BIOLOGICAL SETTING

Vegetation on the esker consists of white spruce and aspen up to 50 ft. in height with a ground cover of dwarf shrubs and lichens. The area immediately surrounding the esker is a fen with sedges, shrubs and stunted trees. The area provides low quality wildlife habitat. Because of the proximity of the site to the Mackenzie River, large numbers of waterfowl may be present in the vicinity during May and June. None of the small ponds, lakes, or streams in the area appear to provide suitable fish habitat.

MATERIAL

A very shallow pit encountered clean, well graded sand and a little gravel.

VOLUME

An estimated volume, based on an area of 50 acres and an average depth of 15 feet is 900,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Reconnaissance investigations indicate deposit 106I-B6(R) is a source of fair quality granular material, suitable for general fill, backfill in pipeline construction and building pads. Despite the rather low volume, shortages of good quality borrow in this area suggest a drilling and test pitting program should be carried out to properly assess this deposit.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Access to the pipeline right of way is over moderately well drained, rolling moraine and should present few problems. Snow roads would be built to transport the borrow material from the deposit to the pipeline right of way, a distance of 2 miles.

Development of the esker segments would first involve removal of vegetation, which would be disposed of or harvested according to current land use regulations. Overburden is negligible, therefore, minimal stripping and stockpiling of it would be required. Conventional earth-moving techniques should be sufficient for excavation of this unconsolidated, well drained material. Borrow would be removed in stages from higher well drained areas to a grade such that good drainage is maintained.

Equipment required for development would be dozers, rippers, end-dump trucks, and front-end loaders.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

DEPOSIT 106I-B7(R)

Physical Setting: Deposit 106I-B7(R) is a small kame complex located 1 mile west of Tieda River and 2 miles southwest of milepost 250 on the proposed pipeline.

Material: SAND - silty, with a trace of gravel.

Volume: 1,000,000 cubic yards.

Assessment: Deposit 106I-B7(R) is a source of poor quality granular material suitable only for marginal fill. Further work is required to determine its suitability for development.

485000E
7397000N

487000E
7397000N

483000E
737000N

487000E
7396000N



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A13306-101
Approximate Scale: 1" = 3400'

Latitude: 66° 41'
Longitude: 129° 20'

DEPOSIT 106I-B7(R)

PHYSICAL SETTING

This deposit is a small kame complex located about 1 mile west of the Tieda River and 2 miles southwest of milepost 250 on the proposed pipeline right of way.

The hills that constitute the kame complex rise 20 to 30 feet above the surrounding terrain. Moderate slopes are well drained, but drainage on the flatter areas is imperfect to moderate. Overburden appears to be negligible on the hills, however it may increase to depths of 10 feet or more in a few poorly drained depressions.

The terrain north toward the pipeline right of way is mainly moderately well drained rolling moraine, although some peat covered areas are present.

BIOLOGICAL SETTING

Vegetation on the kames consists of white spruce and birch up to 60 ft. in height. Soapberry, rose and alder are present in the understory. Surrounding depression, poorly drained areas are covered with stunted black spruce and sedges. The area provides low quality wildlife habitat. Snowshoe hare sign was observed at the site. The only birds seen in the area were passerines; otherwise this is poor quality habitat for raptors and waterfowl. Nearby streams and ponds do not appear to support fish populations.

MATERIAL

A shallow pit dug at this site encountered silty sand with a trace of gravel. Indications are that the material is of poor quality.

VOLUME

Based on an area of 80 acres and thickness of 10 feet, the volume of granular material in this deposit would be 1,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

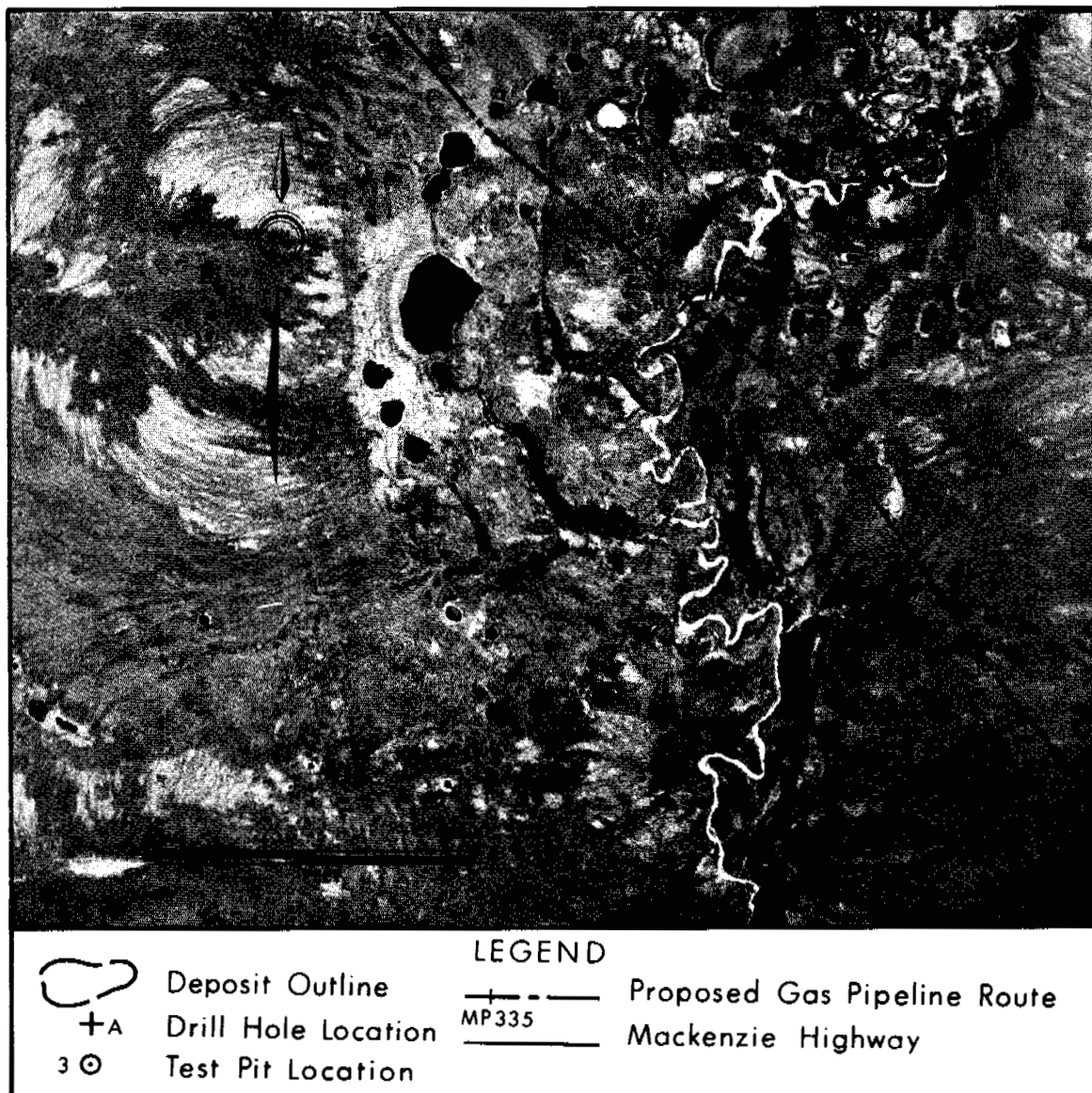
Reconnaissance observations at deposit 106I-B7(R) indicate it is a source of poor quality granular material suitable only for marginal fill. Additional drilling is recommended in order to accurately assess the suitability of this deposit for development.

Physical Setting: Deposit 106I-B8(R) is an esker located on the east side of Tieda River and just 1 mile from the proposed pipeline at milepost 251.

Material: SAND - silty, with a trace of pebbles.

Volume: 700,000 cubic yards.

Assessment: Deposit 106I-B8(R) is a source of poor quality granular material. However, due to its close proximity to the proposed pipeline in an area with a shortage of granular materials, this deposit should be investigated in detail.



Airphoto No. A13306-102

Approximate Scale: 1" = 3400'

Latitude: 66° 42'

Longitude: 129° 17'

DEPOSIT 106I-B8(R)

PHYSICAL SETTING

This deposit is a narrow esker flanking the east side of the Tieda River valley, about 5 miles above its mouth. Milepost 251 on the proposed pipeline right of way is within 1 mile of the northern end of the deposit. This deposit corresponds to source number 1025 in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The crest of the esker stands about 140 feet above river level and 15 feet above the adjacent upland. The esker is well drained, and overburden is nil except on its eastern edge. A narrow, poorly drained peatland is situated directly east of the esker between the deposit and pipeline right of way.

BIOLOGICAL SETTING

Vegetation on the esker consists of white spruce and birch up to 30 ft. in height. Willow, rose, soapberry and juniper are common in the understory and ground cover is mainly moss and lichen. The area provides productive habitat for caribou, lynx, mink, wolf, fox, black bear, moose and occasional grizzly bear. During the period November-December, and March-April, moose migrate through the area enroute to and from islands in the Mackenzie River. Areas of riparian vegetation along the Tieda River provide good moost habitat. A bear or wolf den was observed on the northwest shore of a small lake near the site. Snowshoe hare, squirrel and a wide range of passerine and upland bird species use the area. There is little waterfowl habitat in the vicinity. During the summer period, hrayling, long-nose suckers, round whitefish, pike, slimy sculpin, and lake chub are present in the Tieda River. There is no reported winter flow in this river. Spawning runs of grayling and whitefish move through the river enroute the Yeltea Lake.

MATERIAL

This deposit appears to be silty sand with a trace of pebbles. Trenches on the surface suggest that ice wedges are present. This deposit probably contains poor quality borrow material.

VOLUME

The thickness of the deposit is difficult to assess because of its peculiar position relative to the river valley. An average depth of 10 feet and area of 50 acres were used to estimate a total volume of 700,000 cubic yards.

DEVELOPMENT AND REHABILITATION

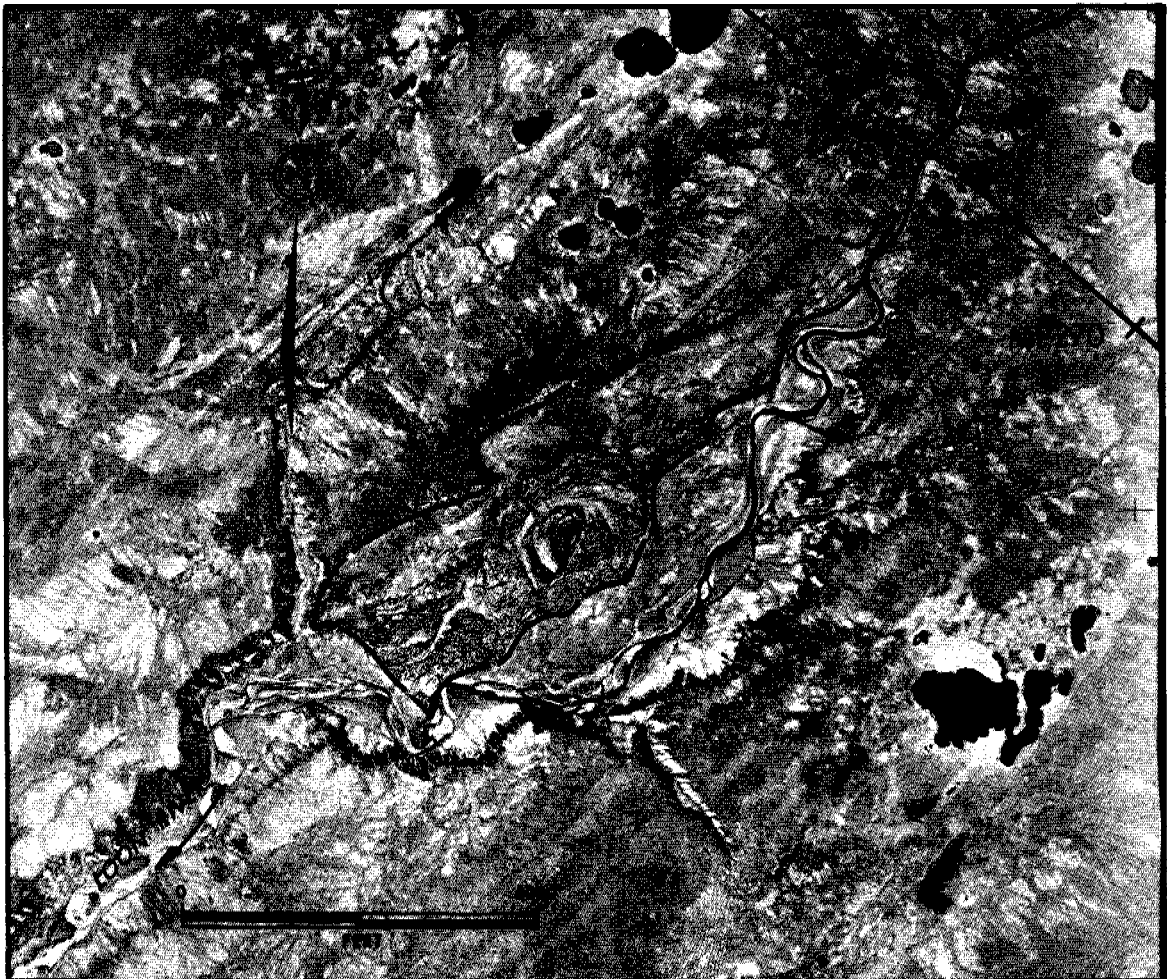
Reconnaissance investigations indicate deposit 106I-B8(R) is a source of poor quality granular material. Since this deposit is very close to the pipeline alignment and granular material is scarce in this area, further drilling is recommended to assess material quality and volume before eliminating this deposit as a source of construction materials.

Physical Setting: Deposit 106I-B9(R) is a series of fluvial terraces located on the north bank of the Loon River and skirted on its eastern end by the proposed pipeline at milepost 269.

Material: SAND and GRAVEL - interbedded sand and well to poorly graded gravel.

Volume: 7,600,000 cubic yards.

Assessment: Deposit 106I-B9(R) is a source of good quality granular material suitable for general fill, backfill, building pads, and possible concrete and asphalt aggregate. Access presents no problems as the right of way skirts the deposit.



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A12609-19
 Approximate Scale: 1" = 3250'

Latitude: 66° 29'
 Longitude: 128° 52'

DEPOSIT 106I-B9(R)

PHYSICAL SETTING

This deposit consists of a series of fluvial terraces located on the north bank of Loon River 3 miles upstream of its confluence with the Mackenzie River. The proposed pipeline alignment skirts its north-eastern end at mile 269. This deposit corresponds to a portion of source number 1003 described in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The terraces stand 20 to 70 feet above the level of Loon River floodplain and slope very gently to the west. Scarps separating the terrace levels are steep, and vary from 10 to 40 feet in height.

Drainage on the terraces is good near the scarps, but imperfect to poor on the central and back part of the benches. Overburden is thin near the terrace edges, but probably thickens to 10 feet or more in the poorly drained areas. Thaw depths will be variable, depending on cover conditions.

BIOLOGICAL SETTING

Much of the deposit is covered by white spruce up to 50 ft. in height with an understory of willow, Labrador tea, cinquefoil and blueberry. The poorly drained areas are covered by stunted black spruce and a ground cover of moss and lichens. The general area provides good habitat for upland furbearers, mink, and black bear. The Loon River valley provides excellent winter range for moose and serves as a migration corridor for moose moving to and from islands in the Mackenzie River. The Loon River serves as a spawning and nursery area for long-nose sucker, long-nose dace, pike and grayling, and is a possible spawning area for whitefish, cisco, ninespine stickleback and lake chub. There is a domestic fishery at the mouth of the Loon River and at Loon Lake.

MATERIAL

An exposed terrace and logs from the DIAND report indicates that this deposit is a source of good quality borrow material. Interbedded sand and wellgraded to poorly graded gravel were observed. Some of the gravel beds may contain an abundance of cobbles and boulders.

VOLUME

The estimated volume for this deposit, based on an area of 470 acres and a conservative depth of 20 feet, is 7,600,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106I-B9(R) is a source of good quality granular material suitable for general fill, backfill in pipeline construction, building pads, and concrete and asphalt aggregate. The gravel would require testing prior to use in concrete aggregate. Extensive drilling would be required to locate suitable areas for development.

No biological factors were identified which would preclude development of this deposit. To minimize biological, environmental and socio-economic impacts final locations of all facilities including roads, camps, pit boundaries, etc., will be subject to further field investigation. Development and operation of borrow sources may be scheduled and activity restricted to designated areas during certain periods of the year.

Since the pipeline right of way passes near the eastern end of the deposit, access presents no problems. In order to minimize environmental damage, snow roads would be built to transport the borrow material from the pits to haul points on the right of way and excavations would be kept away from the Loon River to prevent siltation.

At selected sites, trees and other vegetation would be removed and harvested or disposed of in accordance with land use regulations. The peat and overburden would then be stripped off and stockpiled around the edge of the excavation.

Development would involve excavating borrow material from the face of the scarps or evenly from the higher, better drained areas so that drainage is maintained. Blasting or conventional earthmoving techniques could be used depending on degree of ice cementation. The excavated material may have to be stockpiled, thawed and drained before it is used. Crushing and/or screening of the material may be required to produce quality construction aggregates.

Equipment required for development would be dozers, rippers, end-dump trucks, front-end loaders, as well as screening, crushing, concrete and asphalt plants if required.

A progressive rehabilitation plan will be developed for each deposit. This plan will have the objective of restoring disturbed areas to be compatible with their surroundings, and will outline the sequence of rehabilitation procedures to be used at each stage of development and at the abandonment of the site. This may include procedures such as: selective grading and shaping; selective stripping and replacing of top soil and overburden; installation of physical erosion control structures and material; seeding and mulching; and the planting of trees and shrubs.

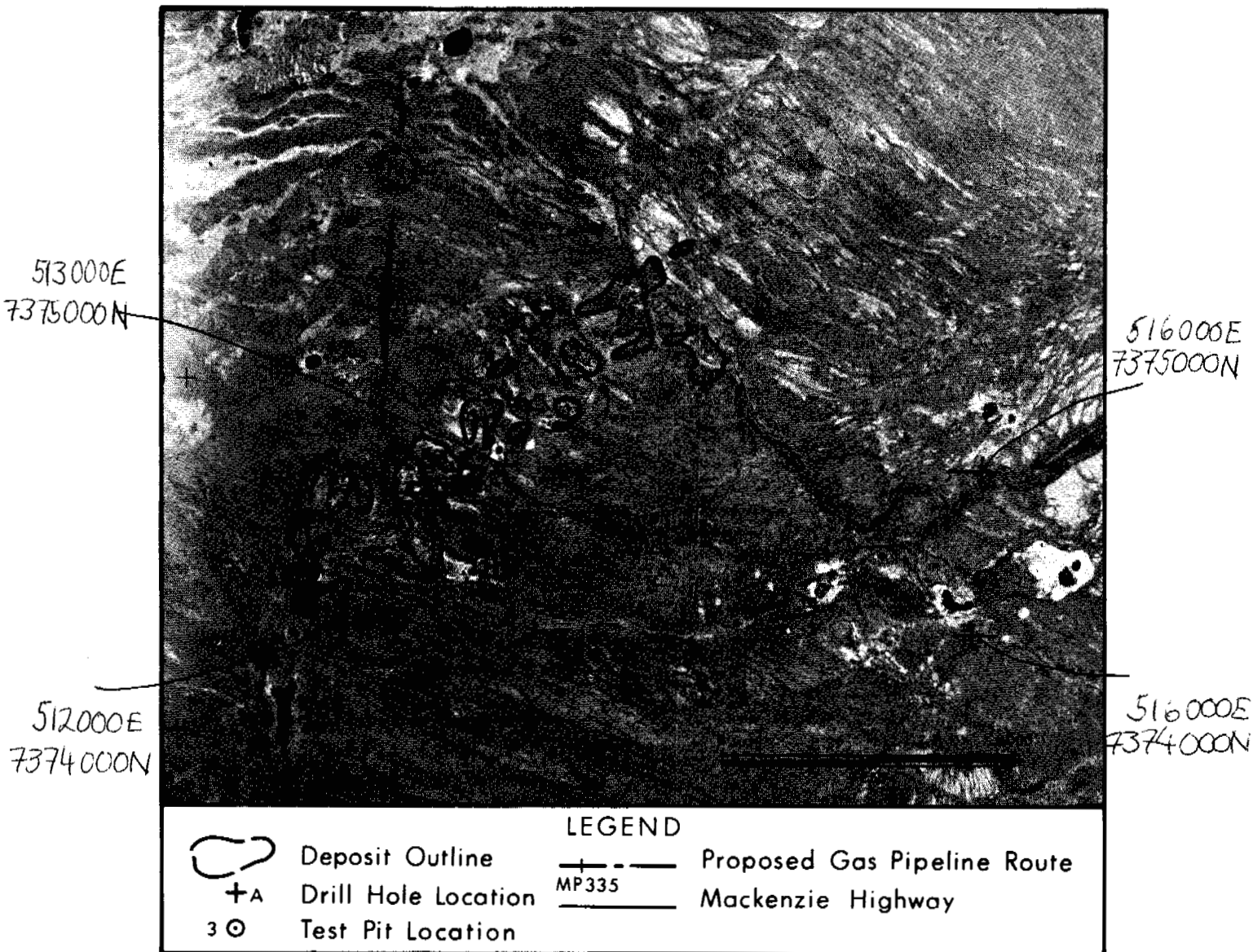
DEPOSIT 106I-B10(R)

Physical Setting: Deposit 106I-B10(R) consists of a number of kames and small eskers located 6 miles east of the Loon River mouth and 2 miles east of milepost 272 on the right of way.

Material: SAND - silty.

Volume: 1,000,000 cubic yards.

Assessment: Deposit 106I-B10(R) is a source of fair quality granular material but because other better quality deposits are closer to the right of way it will probably not require development.



Airphoto No. A12579-221
Approximate Scale: 1" = 3250'

Latitude: 66° 30'
Longitude: 128° 43'

DEPOSIT 106I-B10(R)

PHYSICAL SETTING

This deposit consists of a number of kames and small eskers located 6 miles east of the mouth of the Loon River and 2 miles east of milepost 272 on the proposed pipeline right of way.

The ridges and hills stand 5 to 30 feet, and occasionally 50 feet, above the surrounding terrain. They have gentle to moderate slopes and are well to moderately well drained. Peat cover is generally thin and thaw depths of about 12 feet can be expected.

The surrounding area is a gently sloping till plain covered by black spruce forest with occasional peat bogs and fens.

BIOLOGICAL SETTING

The site is covered by a mixed stand of spruce, aspen and birch up to 30 ft. in height with juniper and soapberry being the most common shrubs. The area provides year-round habitat for upland furbearers, caribou and moose. Potential den sites occur throughout the area. Marten sign was seen during the 1975 survey. The area is hunted and trapped by residents of Fort Good Hope. Ponds and lakes in the vicinity provide limited waterfowl habitat. Streams may support fish populations during the open-water season.

MATERIAL

Surface sampling during the field reconnaissance indicate that this deposit is silty sand, although gravel may be more common at the eastern end.

VOLUME

Based on an area of 200 acres and an average depth of 10 feet, the total estimated volume of borrow is 1,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Reconnaissance investigations indicate the material in deposit 106I-B10(R) is of fair quality. However, a detailed drilling program would be required to accurately assess its potential. Deposit 106I-B9(R) is closer to the pipeline right of way and a better source in both quality and volume than 106I-B10(R). It is therefore unlikely that further investigation and development of this site would be necessary.

DEPOSIT 106I-B11(R)

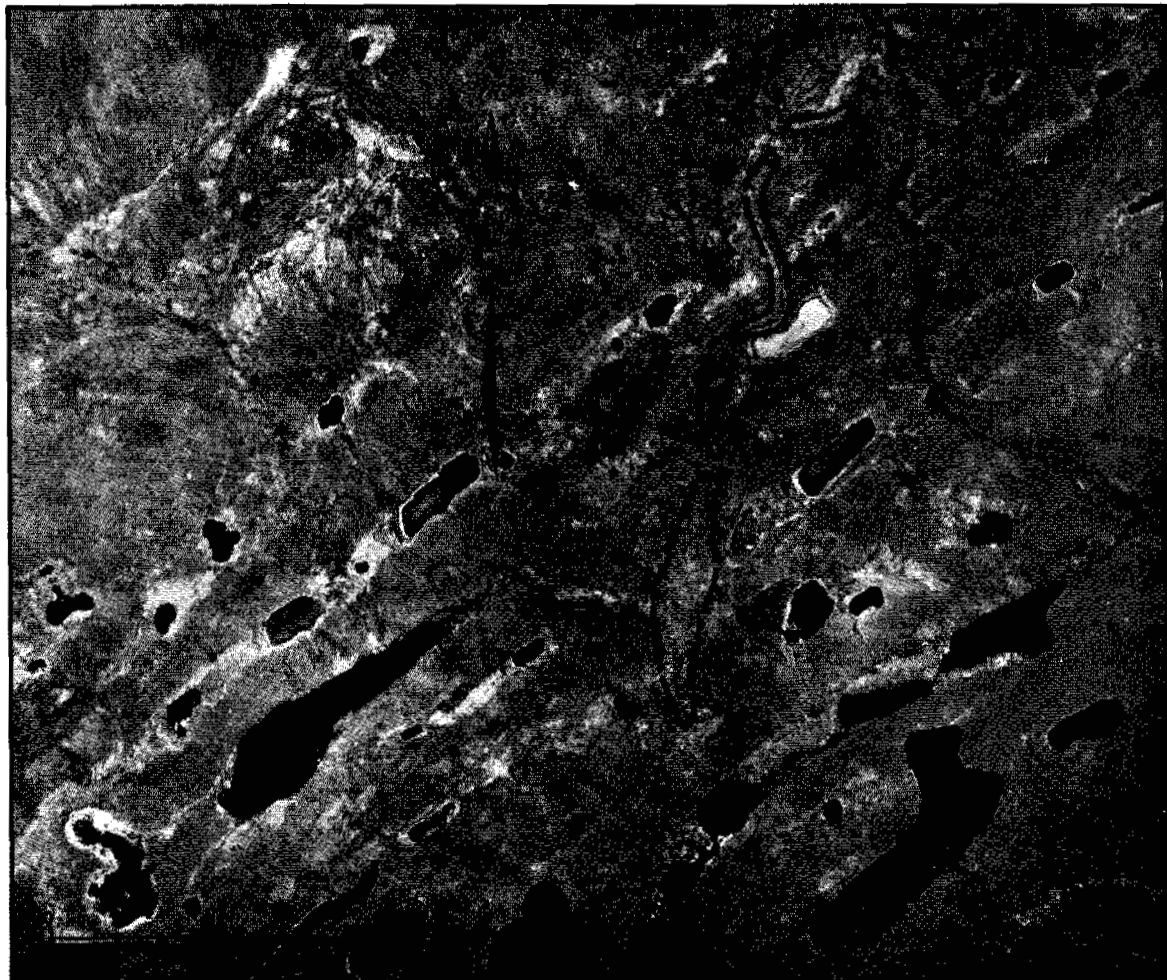
See FGH 6

Physical Setting: Deposit 106I-B11(R) is an esker located 10 miles north of Fort Good Hope and about 4 miles east of milepost 279 of the proposed pipeline right of way.

Material: SAND - poorly graded, with isolated pockets of gravel.

Volume: 1,500,000 cubic yards.

Assessment: Deposit 106I-B11(R) is a source of fair to poor quality granular material suitable for general fill but not recommended for development.



LEGEND	
	Deposit Outline
	Drill Hole Location
	Test Pit Location
	Proposed Gas Pipeline Route
	Mackenzie Highway

Airphoto No. A12607-199
Approximate Scale: 1" = 3300'

Latitude: 66° 24'
Longitude: 128° 29'

DEPOSIT 106I-B11(R)

PHYSICAL SETTING

This deposit is an esker located ten miles north of Fort Good Hope and about 4 miles east of milepost 279 on the proposed pipeline right of way. This deposit corresponds to source number 1006a in EBA DIAND Granular Materials Inventory Volume II (1974) report.

The esker has moderate to steep sided slopes and stands 30 to 80 feet above the surrounding terrain. It is a narrow ridge at its northern end, but broadens at its southern end. The deposit is well-drained and overburden is negligible. Thaw depths of 12 feet or more can be expected.

The surrounding terrain is a rolling till plain with many poorly drained, peat filled depressions.

BIOLOGICAL SETTING

This area shows evidence of an old burn. The crest of the esker is now covered by aspen with a dense understory of shrubs, while the slopes are covered by a mixed stand of birch and spruce with scattered alder. This area provides habitat for upland furbearers, moose and caribou. Residents of Fort Good Hope hunt and trap in the area. A pair of Arctic loons was observed nesting on a small adjacent pond. The small ponds and streams near the deposit do not appear to support fish populations.

MATERIAL

The DIAND report shows that the esker consists of poorly graded sand with isolated pockets of gravel. Further drilling and test pitting would be required for an accurate assessment of the deposit.

VOLUME

Volume estimates for this deposit are 1,500,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106I-B11(R) appears to be a source of fair to poor quality granular material suitable for general fill. Development of this site might be necessary if better quality material is not available closer to the pipeline route, but at this time it is not recommended for development.

DEPOSIT 106I-B12(R)

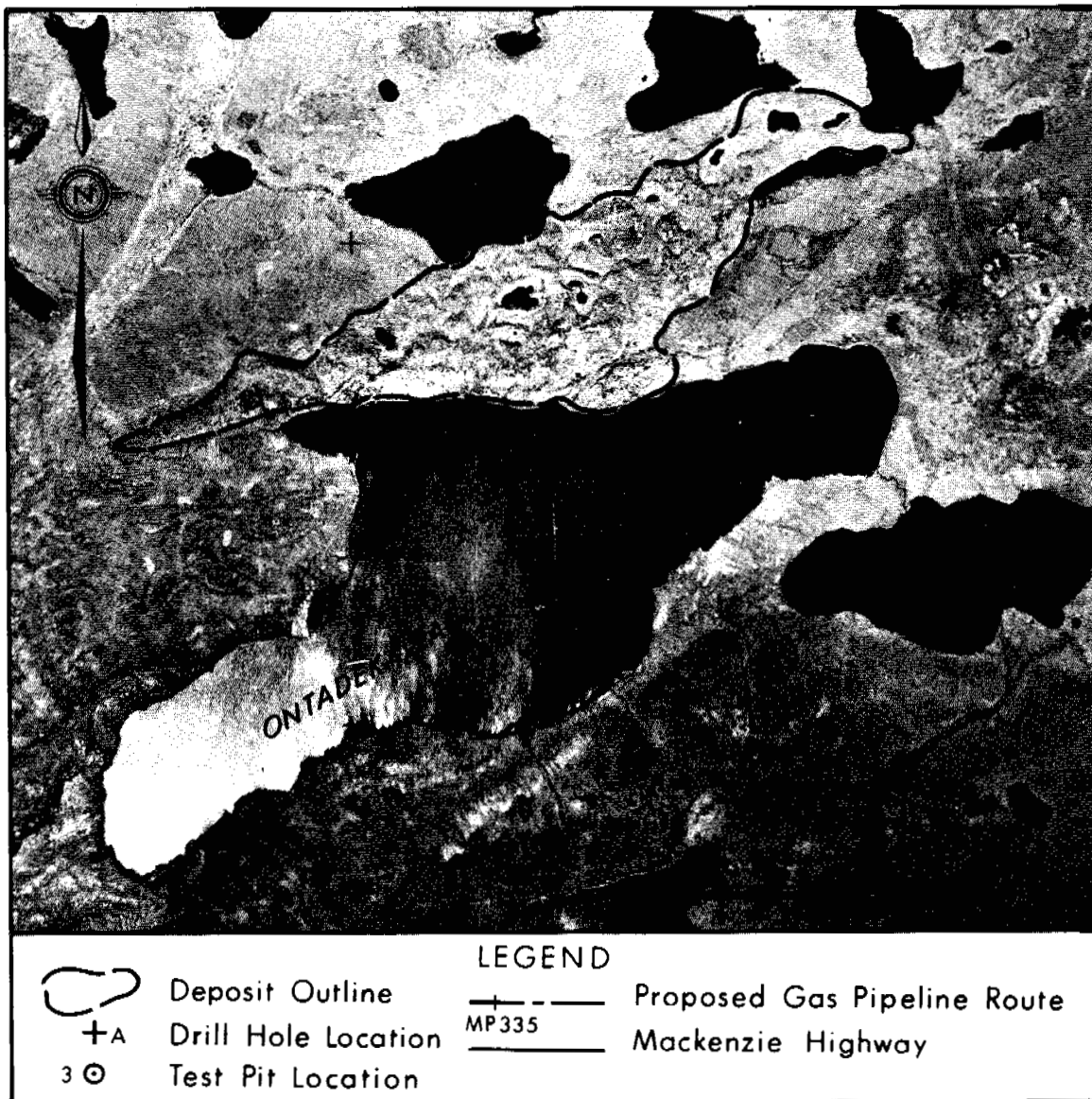
See FGH 9

Physical Setting: Deposit 106I-B12(R) is a large kame complex bordering the north edge of Ontadek Lake 9 miles east of Fort Good Hope and 5 miles east of milepost 289 of the proposed pipeline.

Material: SAND - poorly graded, fine.

Volume: 12,000,000 cubic yards.

Assessment: Deposit 106I-B12(R) is a source of fair to poor quality granular material suitable for general fill. Good quality granular material within the deposit may well be located with further exploration. Access presents very few problems.



Airphoto No. A12604-87
Approximate Scale: 1" = 3350'

Latitude: 66° 18'
Longitude: 128° 23'

DEPOSIT 106I-B12(R)

PHYSICAL SETTING

This deposit is a large kame complex which borders the north edge of Ontadek Lake. It is about 9 miles east of Fort Good Hope and 5 miles east of milepost 286 on the proposed pipeline alignment. This deposit corresponds to source number FGH-9 in Pemcan Services DIAND Granular Materials Inventory (1972) report.

The complex stands 80 to 100 feet above the surrounding terrain and most of its surface is rolling with shallow depressions. Numerous steep-sided ridges and kettles are present. Overburden is negligible except in depressions where peat may be 5 feet thick. The site is well drained except for local swales and depressions. Thaw depths of 12 feet can be expected under well drained areas.

Except for a large well drained esker complex near Fort Good Hope, most of the terrain between the deposit and the pipeline right of way is flat to rolling and moderately well to imperfectly drained.

BIOLOGICAL SETTING

Vegetation at this site consists of white spruce with occasional aspen and birch. Poorly drained areas have black spruce and tamarack with a ground cover of sedges, moss, and lichen. Sharp crested ridges have only a partial cover of shrubs and herbs. The area is adjacent to Ontadek Lake which provides good moose habitat. A cow and calf moose and moose tracks were observed during the 1975 survey. A beaver lodge was also seen on the lake. An inactive red fox den was observed as well as snowshoe hare and red squirrel sign. The area provides good marten habitat. Waterfowl utilize the lake during the open-water season. The area is actively hunted and trapped by residents of Fort Good Hope. A one-year-old camp was located in the area. Ontadek Lake is fished from May to September by residents of Fort Good Hope.

MATERIALS

The DIAND report indicates that this deposit consists mainly of poorly graded fine sand. However, many of the sharp-crested ridges superimposed on the kame complex appear to be partly gravel.

VOLUME

Based on an area of 600 acres and a conservative depth of 25 feet, total estimated volume is 12,000,000 cubic yards.

DEVELOPMENT AND REHABILITATION

Deposit 106I-B12(R) appears to be a source of fair to poor quality granular material suitable for general fill. Further drilling might locate areas of good quality gravel. This procedure is recommended so that the better sources near Fort Good Hope may be kept for local use. Access to the deposit over flat to rolling terrain presents few problems. Development could be carried out according to detailed plans to be prepared when more information is available.

12. BIBLIOGRAPHY

- Aitken, J.D., Macqueen, R.W., and Usher, J.L., 1973. Reconnaissance Studies of Proterozoic and Cambrian stratigraphy, lower Mackenzie River area, (Operation Norman), District of Mackenzie. Geol. Surv. Can. Paper 73-9.
- American Society for Testing and Materials, 1975. 1975 Annual Book of ASTM Standards, Part 14, Concrete and Mineral Aggregates (including Manual of Concrete Testing).
- Canadian Arctic Gas Pipeline Company Limited, March 1974. Applications to DIAND for Authorization to Use Land and N.E.B. for Certificate of Public Convenience and Necessity Authorizing the Construction of Pipeline Facilities.
- _____, 1974 Corridor Wildlife Map Series. Arctic Gas application exhibit.
- Canadian Standards Association, 1973. Concrete Materials and Methods of Concrete Construction, A23.1 - 1973.
- _____, 1973. Methods of Tests for Concrete, A23.2 - 1973.
- Canadian Wildlife Service. 1973. Wildlife habitat - Mackenzie Valley and Northern Yukon. Environmental Social Program, Northern Pipelines. Information Canada, 152 pp.
- Cook, D.G., and Aitken, J.D., 1969. Geology of Fort Good Hope, District of Mackenzie, NTS area 106I. Geol. Surv. Can. map 4-1969.
- _____, and _____, 1974. Surface and subsurface geology of the Ontaratie River, Travailant Lake and Canot Lake map-areas, District of Mackenzie, N.W.T., Geol. Surv. Can. Open file No. 234.
- Corns, I.G.W. 1974. Arctic plant communities east of the Mackenzie Delta. Can. J. Bot. 52: 1731-1745.
- Dennington, M.C., Johnson, B.E., and Stelfox, H.A. 1973. Beaver and muskrat *In*: Atlas of Wildlife Habitat Inventory Maps for Environmental Social Program, Northern Pipelines, Canadian Wildlife Service.
- Douglas, R.J.W., Mac Lean, B., 1963. Geology Yukon Territory and Northwest Territories. Geol. Surv. Can. Map 30-1963.

EBA Engineering Consultants Ltd. and F.F. Slaney & Co. Ltd.,
April 1974. Granular Materials Inventory - Stage III.
Vol. I - General Report
Vol. II - South Half Sites 1001 to 1053 and 1056 to 1060.
Vol. III - North Half Sites 1054, 1055 and 1061 to 1110.
Vol. IV - North Half Sites 1111 to 1156.
Reports prepared for the Department of Indian Affairs and
Northern Development.

EBA Engineering Consultants Ltd. 1975. Ya-Ya Granular Resources
Study. Vol. 1 and 2.

_____, 1976. Geotechnical Evaluation of Granular Material,
Mackenzie Delta Area. for Dept. of Indian & Northern
Affairs.

Fulton, R.J., February 1970. Surficial geology and landform maps,
scale 1:250,000, of NTS areas 96F and 106P. Geol. Surv.
Can. Open File 21.

Gabrielse, H., 1957. Geological reconnaissance in the northern
Richardson Mountains. Includes map 12-1956 (NTS area
107B, 106M). Geol. Surv. Can. Paper 56-6.

Hanley, P.T., and Hughes, O.L., May 1973. Surficial geology and
geomorphology of Mackenzie Valley transportation corridor
(central part) Map, scale 1:1,000,000. Geol. Surv. Can.
Open File 189.

Hughes, O.L., 1972. Surficial geology of Northern Yukon Territory
and N.W. District of Mackenzie. Includes map 1319A (NTS
areas 106E, F, K, L, N; 107B, C). Geol. Surv. Can.
Paper 69-36.

_____, Hodgson, D.A. and Pilon, J., June 1972. Surficial geo-
logy maps, scale 1:125,000 of NTS areas (106I, M, N).
Geol. Surv. Can. Open File 97.

_____, _____ and _____, July 1972. Surficial geology
map, scale 1:125,000, of NTS area 1060. Geol. Surv. Can.
Open File 108.

_____, Hanley, P.T., Pilon, J., and Chatwin, S.C., Sept. 1975.
Surficial geology maps, scale 1:125,000 of NTS areas
(96E, F, 106P). Geol. Surv. Can. Open File 294.

Jeletsky, J.A., 1972. Stratigraphy, facies, and paleogeography of
Mesozoic and Tertiary rocks of northern Yukon and North-
west Mackenzie District, N.W.T. Geol. Surv. Can.
Open file 82.

- Lawrence, D.E. et al., 1972 and 1973. Granular Resource Inventory - Mackenzie. NTS areas
106I - Fort Good Hope
106N - Arctic Red River
106O - Travaillant Lake
106P - Canot Lake
107B - E¹/₂ - Aklavik
107B - E¹/₂ - Aklavik Addendum
107C - Mackenzie Delta
107C - Mackenzie Delta Addendum
Geol. Surv. Can. Internal reports with maps, scale 1:125,000, prepared for the Department of Indian Affairs and Northern Development.
- McCart, P., Griffiths, W., Gossen, C. 1974. Catalogue of lakes and streams in Canada along routes of the proposed Arctic Gas pipeline from the Alaskan/Canadian border to the 60th Parallel. Arctic Gas Biol. Rep. Ser. Vol. 16.
- Mollard, J.D. and Associates Ltd., Airphoto Terrain Mapping Legend for Pipeline Route Study Report produced for Northwest Project Study Group and Mackenzie Valley Pipeline Research Limited.
- _____, October 1971. Construction materials survey along MVPLRL pipeline route - Prudhoe Bay to 60th Parallel. Prepared for Mackenzie Valley Pipe Line Research Limited.
- _____, 1972. Gravel and bedrock borrow prospects, Physiographic Division XVI (Elliot Creek to Richards Island and Travaillant Lake to the NWT/Yukon border). Unpublished report produced for CAGSL.
- Northern Engineering Services Company Limited, July 1974. Pipeline Related Borrow Studies. Report and maps prepared for Canadian Arctic Gas Study Limited.
- _____, November 1975. Pipeline Related Borrow Studies Cross Delta Alternative Route and East of Fort Simpson Realignment. Report prepared for Canadian Arctic Gas Study Ltd.
- Pemcan Services "72", 1972. Granular Materials Inventory.
Vol. I : Summary, Fort Simpson to Fort Good Hope, N.W.T.
Vol. X : Community Study Area, Ten Mile Radius of Fort Good Hope, N.W.T., site numbers FGH1 to FGH9
Reports with maps produced for the Department of Indian Affairs and Northern Development.
- Prescott, W.H., Erickson, G.L., Walton, L.E., and Smith, D.G. 1973. Moose *In*: Atlas of Wildlife Habitat Inventory Maps for Environmental Social Program, Northern Pipelines, Canadian Wildlife Service.

- Rampton, V.N., February 1970. Surficial geology maps, scale 1:250,000, of coastal areas, NTS areas 107B-W part, 117A, 117C, 117D. Geol. Surv. Can. Open File 21.
- _____, October 1972. Surficial geology map, scale 1:125,000, of NTS area 107B-E part. Geol. Surv. Can. Open File 119.
- _____, June 1972. Surficial geology maps, scale 1:125,000, of NTS areas 97F, 107C, 107D and 107E. Geol. Surv. Can. Open File 96.
- _____, March 1974. Surficial geology and landform maps, scale 1:125,000, of NTS areas 107B-W $\frac{1}{2}$, 117A, 117C, 117D. Geol. Surv. Can. Open File 191.
- _____, March 1974. Terrain Evaluation, Mackenzie Transportation Corridor Northern Part. Geol. Surv. Can. for the Environmental Social Program, Northern Pipelines, Report No. 73-74.
- _____, and Bouchard, M. 1975. Surficial Geology of Tuktoyaktuk, District of Mackenzie. Geol. Surv. Can. Paper 74-53.
- Ripley, Klohn and Leonoff International Ltd., 1972 and 1973. Granular Material Inventory
 Zone II (Mackenzie Delta - north end)
 Zone III (Mackenzie Delta - central)
 Zones IV, V, VI (Mackenzie Delta - south)
 Reports with maps produced for the Department of Indian Affairs and Northern Development.
- _____, Community Granular Material Inventory.
 Inuvik, N.W.T.
 Report with maps produced for the Department of Indian Affairs and Northern Development.
- Rowe, J.S. 1972. Forest regions of Canada. Dept. of the Environment, Canadian Forestry Service, Pub. No. 1300. Ottawa. 172p.
- Salter, R. and Davis, R.A. 1974. Snow geese disturbance by aircraft on the North Slope, September, 1972. *In*: W.W.H. Gann and J.A. Livingston (eds.), Disturbance to birds by gas compressor noise simulators, aircraft and human activity in the Mackenzie Valley and the North Slope, 1972. CAGSL Biol. Report Series, Vol. XIV, Chapt. 7.
- Slaney, F.F. and Company Ltd., 1974. Base Data Vol. 2, Wildlife Study 1972-73. Mackenzie Highway Mile 300 to 550. For Department of Public Works of Canada.

_____, 1974. Volume 5, Mammals. Environmental Program Mackenzie Delta, N.W.T., Canada. 108 pp. For Imperial Oil Ltd., Gulf Oil Canada Ltd., Shell Canada Ltd. and CAGSL.

Task Force on Northern Oil Development, Environmental - Social Committee on Northern Pipelines, 1975. Mackenzie Valley and Northern Yukon Pipelines: Regional Analysis map series.

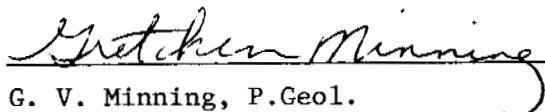
Taylor, R.S., July 1973. Geology of the pipeline routes in Canada north of 60°. Unpublished report prepared for CAGSL.

Tull, C.E. 1975. An Ornithological Comparison of the Prime Route and the Cross Delta Alternative Route of the Proposed Arctic Gas Pipeline. *In*: Preliminary Environmental Comments on the Proposed Cross Delta Route, Northern Engineering Services Company Limited.

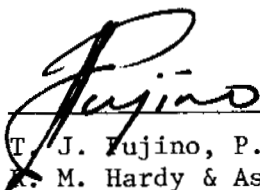
Yorath, C.J., et al, 1969. Geology of the Eastern Part of the Northern Interior and Arctic Coastal Plains, N.W.T. Geol. Surv. Can. Paper 68-27.

Zoltai, S.E. and Pettapiece, W.W., 1973. Terrain, vegetation and permafrost relationships in the northern part of the Mackenzie Valley and Northern Yukon. Environmental - Social Program, Northern Pipelines, Task Force on Northern Oil Development Rep. No. 73-4. Ottawa. 105p.

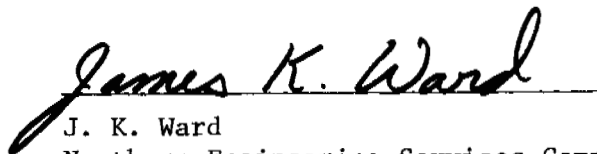
Prepared by:



G. V. Minning, P.Geol.
Northern Engineering Services Company Limited.



T. J. Fujino, P.Eng.
R. M. Hardy & Associates Limited



J. K. Ward
Northern Engineering Services Company Limited

Approved by:



P. Hoekstra, Ph.D., P.Geoph.
Manager, Geology and Geophysics
R. M. Hardy & Associates Limited

APPENDIX A
Terms and Symbols

APPENDIX A - EXPLANATION OF TERMS AND SYMBOLS1. General

The terms and symbols used on the test hole logs to summarize the results of the field investigation and of subsequent laboratory testing are described in detail below and are illustrated in the appended exhibit test hole log (Plate 1).

General information, such as test hole number, test hole location, and rig type is noted in the lower portion of the test hole log. Detailed sub-surface information observed at each test hole location and laboratory test data, are presented in columnar form on the test hole log. Each column used is described in detail below using the reference numbers shown on the appended blank test hole log (Plate 2).

It should be noted that the soil type, stratigraphic boundaries, and in situ conditions have been established only at the test hole location and that they are not necessarily representative of subsurface conditions elsewhere across the site.

Columns 1 and 13: Depth: The depth of test hole below existing ground surface is shown in these columns.

Column 2: Soil Group Symbol: A soil classification symbol in accordance with a modification of the Unified Soil Classification System¹ is noted in this column. A definition of each Group Symbol is given in Table 1 "Soil Classification System".

Column 3: Soil Graphic Log: Soil strata are depicted graphically in accordance with the "Graphic Symbol" column of Table 1 "Soil Classification System".

(1) References are listed on page A - 21.

Column 4: Description: A detailed engineering description of each soil stratum encountered is noted in this column. This description is given in accordance with the criteria outlined in Section 2.3 "Soil Description". A description of the ground ice is included in this column according to the NRC procedures² which are explained in Section 2.4 "NRC Ice Type". The depths to ground water level, seepage, and the interface between different soil strata are indicated in this column. The interface between soil strata is shown as a single continuous line. A broken line indicates a change in soil type where the location of the interface between the strata is uncertain or inferred. A double line at the bottom of the test hole log indicates "Refusal" which may be defined as "further penetration was not possible with the equipment used".

Column 5: Ice Graphic Log: The various types of ground ice are depicted graphically according to Table 2 "Ground Ice Classification".

Column 6: NRC Ice Type: (Visual Ice %): Abbreviated symbols for the forms of ground ice are noted in this column. A description of the NRC classification² is contained in Section 2.4 "NRC Ice Type", and in Table 2 "Ground Ice Classification". The volume of ground ice is estimated visually and expressed as a percentage of the total volume of soil and ice.

Column 7: Laboratory Test Data: The results of laboratory determinations of water content, Atterberg limits and density are plotted against depth. These are described in Section 2.5 "Test Data Summary".

- Column 8: Other Test Data: Test data additional to those represented in Column 7 are noted in this column at the appropriate depth. The symbols used to represent the more common engineering laboratory tests are given in Section 2.5 "Test Data Summary". The results of specialized testing are also indicated in this column using an abbreviated written form.
- Column 9: Sample Type and Number: The type and reference number of each sample attempted, whether it was recovered or lost, are recorded at the appropriate depth. The system used is described in Section 2.1 "Soil Sample Data".
- Column 10: Sample Condition: The condition of each sample whether it was recovered or lost, is recorded against depth. A description of the graphic representation and abbreviations used is given in Section 2.1 "Soil Sample Data".
- Column 11: Core Run and % Recovery: The length of core recovered is expressed as a percentage of the total length attempted. The depths to the top and bottom of the core run are recorded as described in Section 2.2 "Core Data".
- Column 12: Core Condition: The condition of the core, or segments of the core, is assessed visually and assigned a rating of I to V. The ratings and nomenclature used are given in Section 2.2 "Core Data".
- Column 14: Remarks: Additional pertinent information and comments such as in situ drilling conditions, sampling criteria, and instruments installed are noted in this column.

2. Description Details

The various terms, symbols, and abbreviations are discussed in detail to facilitate interpretation and understanding of the data presented on the test hole logs.

2.1 Soil Sample Data

(a) Sample Type and Number (Column 9)

Each sample attempted, whether it is recovered or lost, is assigned a reference number. The series of soil samples from each test hole is numbered in a sequentially increasing numerical order with increasing depth below ground surface.

The type of sample attempted is indicated using one of the following letters:

- A Auger sample
- B Bulk sample
- C Core sample
- D Drive sample (thick-walled tube, unless otherwise noted)
- P Pitcher tube sample
- R Block sample
- S Split spoon standard penetrometer sample
- U Tube sample (thin-walled unless otherwise noted)
- W Wash or Air Return sample
- X Other samples

The sample type and number are recorded at the appropriate depth on the test hole log.

Example: Sample A2: - designates the second sample attempted in the test hole. This sample was taken off an auger.

(b) Sample Condition (Column 10)

The condition of each sample attempted is designated by one of the following symbols at the appropriate depth interval:



undisturbed



disturbed



not recovered

2.2 Core Data

The details relating to length of core attempted and the percentage of core recovered are presented as follows:

(a) Core Run and % Recovery (Column 11)

The length of core attempted is shown by recording the top and bottom depth measurements for each core run. The recovered core length is expressed as a percentage of the total core run attempted.

(b) Core Condition (Column 12)

The condition of each core, or segments of core recovered, together with any unrecovered portions of the core, is recorded. The nomenclature in the following table is used to describe the conditions of the core:

<u>Condition of Soil Cores</u>			
<u>Rating</u>	<u>Recovered Condition</u>	<u>Disturbance or Remolding</u>	<u>Suitability for Testing</u>
I	Excellent	Negligible	Representative
II	Good	Slight	Representative
III	Fair	Considerable	Use Judgment
IV	Poor	Complete	Equivalent to Disturbed Samples
V	No recovery	-	-

2.3 Soil Description (Column 4)

Soils are classified and described according to their engineering properties and behaviour.

2.3.1 Soil Description System

The following properties are described for a comprehensive soil classification system:

Grain size distribution or plasticity, colour, moisture, sensitivity, structure, foreign materials, and consistency or strength.

The soil in each stratum is described on the test hole logs using the Unified Soil Classification System¹ modified slightly so that an inorganic clay of "medium plasticity" is recognized. Selected adjectives are used to define the actual or estimated percentage range by weight of the various components. The use of the modifying adjectives is similar to a system developed by D.M. Burmister³.

The identification of soil components and fractions is defined by the Modified Unified Soil Classification System which classifies soils into three major divisions:

- Coarse-grained soils - gravel and sand
- Fine-grained soils - silt and clay
- Highly organic soils - peat

Classification of soils is based on the grain size distribution of that portion of the soil smaller than the 3-inch U.S. Standard sieve size.

Soils with more than half by weight of the components coarser than the No. 200 U.S. Standard sieve size (0.074 mm) are described as COARSE-GRAINED (or granular) soils. Coarse-

grained soils (gravel and sand) are classified by grain size distribution and are subdivided into coarse and fine gravel, and coarse, medium, and fine sand.

Soils with more than half by weight of the components finer than the No. 200 sieve size are described as FINE-GRAINED soils. These may be cohesive or non-cohesive. Note that for visual classification the No. 200 sieve size is about the smallest size of particle that can be distinguished individually by the unaided eye.

Fine-grained soils (silt and clay) are classified by behaviour on the basis of the liquid limit and plasticity index of the fraction finer than the No. 40 U.S. Standard sieve size. The boundaries defining the fine-grained soil groups are shown in the Plasticity Chart in Table 1 "Soil Classification System". The Plasticity Chart is also used to determine the behaviour of the fines content of coarse-grained soils.

Particle size and shape are usually described for coarse-grained soils, and plasticity is usually described for fine-grained soils. An exception to this rule applies when describing glacial till; then plasticity, particle size, and shape are all included in the description.

The principal component of the fraction of the soil passing the 3-inch U.S. Standard sieve size is shown capitalized on the test hole logs.

The proportions by weight of the minor components are defined according to the following descriptors:

<u>Descriptor</u>	<u>Proportion</u>
"and"	50 to 35 per cent
"some"	35 to 20 per cent
"little"	20 to 10 per cent
"trace"	10 to 1 per cent

The descriptors used must not contradict the classification by the Modified Unified Soil Classification System.

The terms given above are used to define proportions by weight of granular components, but they may also be used to define the proportion of minor components of fine-grained material, according to the subdivisions of the Plasticity Chart, Table 1 "Soil Classification System". The adjectives are not used to subdivide a principal fine-grained component. The modifier "y" or "ey" (e.g., SILT, clayey) is used when the liquid limit and plasticity index plot close to the "A-line" on the Plasticity Chart.

Peat and other highly organic soils are classified under the Group Symbol "Pt". Peat may be categorized and described using the Radforth Classification System⁴.

The soil is described first by identifying the principal component, followed by the minor components in order of decreasing proportion by weight. This is followed by other significant identifying features such as plasticity, colour, moisture, structure, and strength.

2.3.2 Typical Example of a Complete Soil Description

"CLAY, silty, little medium sand, trace coarse gravel, medium plasticity, yellow-brown", describes a yellow-brown, fine-grained, silty clay soil containing 50 per cent or more of components finer than the No. 200 U.S. Standard sieve size with minor components of sand and gravel. The fraction passing the No. 40 U.S. Standard sieve size plots above, and close to the "A-line" on the Plasticity Chart. The soil contains between 10 per cent and 20 per cent of sand particles generally in the size range No. 10 to No. 40 (i.e. finer than the No. 10 Standard sieve size and larger than the No. 40 Standard sieve size) and between 1 per cent and 10 per cent of gravel in the size range 3/4-inch to 3-inch. The identifying

feature "medium plasticity" indicates that the liquid limit plots between 30 and 50 on the Plasticity Chart. Such a soil is classified as CI by the Modified Unified Soil Classification System.

2.3.3 Typical Examples of the Use of Modifiers and Descriptors

(a) Fine-grained soil with a minor coarse-grained component:

"CLAY, silty, some fine sand", describes a fine-grained soil having a fines content in excess of 50 per cent (i.e., 50% of material finer than the No. 200 U.S. Standard sieve size), which plots above the "A-line", on the Plasticity Chart, with a liquid limit less than 50 on the Plasticity Chart, and has a minor component of fine sand.

"CLAY, some silt, some fine sand", would not be used as the fines are classified by behaviour (plasticity) and not by particle size. Such a soil would be classified as CI or CL according to the Unified Soil Classification System.

(b) Coarse-grained soil with minor fine-grained component:

"GRAVEL, fine, some silty clay", describes a coarse-grained soil with a minor component of fines, which has a liquid limit and plasticity index that plot above and close to the "A-line" on the Plasticity Chart. Such a soil is classified as GC by the Unified Soil Classification System.

"SAND, some silt", is correct in that "silt" in this case is a minor component of non-plastic fines which plot below the A-line on the Plasticity Chart.

2.3.4 Glacial Till

The term "glacial till" is in widespread use in present engineering practice, however, because it is a mode of deposition, there is no provision in the Unified Soil Classification System for this term.

The term "till" is used on the test hole logs in its most general form, which has been defined by ASTM Designation D 653 as:

"A material deposited by glaciation, usually composed of a wide range of particle sizes, which has not been subjected to the sorting action of water."⁵

Glacial till is described on the test hole logs as "TILL", followed by the principal soil component also capitalized.

Example: "TILL, CLAY, silty, little fine gravel, low plastic, rust-brown--".

A loose, soft, or slightly stratified deposit believed to be transported or reworked material of glacial deposition, or of uncertain glacial origin, is described as "till-like" at the end of the soil description.

Example: "CLAY, silty, little fine gravel, low plastic, rust-brown, till-like."

2.3.5 Fill

"Fill" is material placed by artificial means, whether or not its placement was controlled.

It is described on the test hole logs as "FILL", followed by the principal soil component also capitalized.

Example: "FILL, SILT, clayey, some fine gravel".

Well-compacted fill, placed some considerable time before the test hole investigation, may be difficult to distinguish from natural material unless the history of the site is known. Such material is indicated as "FILL?" on the test hole logs.

2.4 NRC Ice Type and Estimated Visual Ice (Column 6)

Ground ice is divided by the NRC system on the basis of examination by the unaided eye into the three major categories shown below. A complete description of this system is contained in the NRC "Guide to a Field Description of Permafrost for Engineering Purposes".²

2.4.1 Ground Ice Classification Categories

Non-visible ice	N
Visible ice less than one inch thick	V
Visible ice greater than one inch thick	ICE or ICE + soil type

Table 2, "Ground Ice Classification", shows the various types of ground ice recognized by the NRC Classification System. Graphic symbols for ground ice have been devised to complement the graphic soil log.

Frozen soils in the N group may, on close examination, indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. The impression received by the unaided eye, however, is that the ice does not occupy space in excess of the original voids in the soil. Excess ice in the N group can be identified by use of a hand magnifying lens, or by placing some frozen soil in a small jar, allowing it to melt and observing the supernatant water. To the unaided eye, ice in frozen soils in the V group appears to occupy space in excess of the original voids in the soils.

The volume of ground ice can be described quantitatively in two ways. "Excess ice" is the volume of supernatant water expressed as a percentage of the total volume of the thawed soil and water. This quantity is often referred to as "excess moisture". "Visual ice" is the estimated volume of segregated ice discernible by eye in the frozen sample and is expressed as a percentage of the total volume of the frozen soil. By these definitions the quantity "excess ice" and "visual ice" are not necessarily the same for a given frozen soil. Care is taken when estimating the volume of ice coatings on granular material (V_c). The ice is usually obvious, giving the impression of "excess ice", which may not necessarily be the case.

2.4.2 Ice Description Terminology

The following terminology used in Column 4 "Description" has been generally taken from Table II of the NRC Guide².

"Ice Coatings on Particles" are discernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are associated sometimes with hoarfrost crystals that have grown into voids produced by the freezing action.

"Ice Crystal" is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in combination with other ice formations.

"Clear Ice" is transparent and contains only a moderate number of air bubbles.

"Cloudy Ice" is relatively opaque due to entrained air bubbles or other reasons, but is essentially sound and non-pervious.

"Porous Ice" contains numerous voids, usually interconnected, and generally results from melting at air bubbles or along crystal interfaces, from presence of salt or other materials in the water, or from the freezing of saturated snow; though porous, the mass retains its structural unity.

"Candled Ice" is ice that has rotted or otherwise formed into long columnar crystals very loosely bonded together.

"Granular Ice" is composed of coarse, more or less equidimensional ice crystals weakly bonded together.

"Ice Lenses" are lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.

"Ice Segregation" is the growth of ice as distinct lenses, layers, veins, and masses in soils, commonly but not always oriented normally to direction of heat loss.

"Well-bonded" signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.

"Poorly-bonded" signifies that the soil particles are weakly held together by the ice that the frozen soil possesses poor resistance to chipping or breaking.

"Friable" denotes extremely weak bonds between soil particles. The material is easily broken up.

The symbols "UF" or "F" may be used in Column 6. "UF" is added to indicate unfrozen zones in areas of generally frozen ground and also to avoid possible errors of omission. "F" is used in certain cases along with the corresponding graphic representation for "Undifferentiated" permafrost or frozen active layer soils. It may be used:

- (1) Where temperature sensors (thermistors) have been installed which indicate that the formation temperature is below 0°C, but the material in the field has the texture of unfrozen material.

- (2) Where temperature sensors have not been installed, but the soil temperature is suspected to be below 0°C. The soil is deformable because of the high unfrozen water content, but is neither "friable" nor "bonded".
- (3) Where the soil is known to be frozen, but due to circumstances beyond field control, the ice type cannot be determined because of grinding or temporary thawing of the material by the drilling operation.
- (4) Where, for reasons of economy or expediency, the hole was neither logged nor sampled, e.g., where instrumentation is installed adjacent to a previous test hole and soil stratigraphy is known to an acceptable degree.

2.5

Test Data Summary

(a) Test Data (Column 7)

The results of laboratory determinations of water content, together with Atterberg limits, and density (unit weight) are plotted symbolically against depth in this column.

Water content is determined in accordance with ASTM Designation D 2216, "Standard Method of Laboratory Determination of Moisture Content of Soil"⁵. The water content of highly organic material is determined by similar procedure, except that the material is oven-dried to constant weight at 85°C instead of 105°C⁶.

Liquid limit and plastic limit are determined in accordance with ASTM Designations D 423 and D 424, respectively⁵.

In situ density is determined from the weights and volumes of intact samples and is reported as either "dry density" which is the weight of soil solids per unit volume, or as "bulk density" which is the total weight per unit volume.

(b) Other Test Data (Column 8)

Tests and test data other than, or additional to, those shown in Column 7 are indicated in Column 8.

The more common engineering tests are denoted using the following symbols:

D ₁₀	grain size at 10% passing
D ₃₀	grain size at 30% passing
D ₆₀	grain size at 60% passing
C	consolidation
C _c	coefficient of curvature $(D_{30})^2 / D_{10} \times D_{60}$
C _u	coefficient of uniformity D_{60} / D_{10}
G _s	specific gravity of soil solids
H	hydrometer analysis
k	permeability
MA	mechanical analysis (sieve analysis)
N	the penetration resistance, i.e., the number of blows required for the second and third 6-inches of penetration during a Standard Penetration Test (SPT) in accordance with ASTM Designation D 1586 (see also SPT)
NP	non-plastic
OC	organic content
PP	pocket penetrometer
P200	per cent passing the No. 200 sieve size
Q	triaxial test
q	unconfined compressive strength
S	shear test
SO ₄	water soluble sulphate
SPT	standard penetration test (blow counts for 6-inches, 12-inches, 18-inches penetration are shown sequentially)
TC	thaw consolidation
w	water content
W _L , W _P , I _P	liquid limit, plastic limit, and plasticity index, respectively

3. Classification of Construction Materials

3.1 Granular Material Uses

The following is a description of materials that was used within the "Materials" and "Development and Rehabilitation" sections of Individual Site Reports. Material classification has been based on the potential construction usage of the granular material for each deposit.

- (1) Excellent quality material consisting of well-graded, medium-grained gravel suitable for concrete aggregate, with a minimum of processing.
- (2) Good-quality material consisting generally of fine to medium-grained well-graded sandy gravel with varying quantities of silt occurring either as narrow interbeds or dispersed throughout the material. The frequent occurrence of deleterious materials such as weathered stones or shale fragments negates its use as concrete aggregate. This material will provide good quality embankment fill for pipeline berms and building pads; base and surface course aggregates; or possible production of concrete aggregate with extensive processing.
- (3) Fair quality material consisting generally of poorly graded, silty, gravelly sand. This material will provide fair quality general fill.
- (4) Poor quality material consisting generally of fine-grained, poorly graded sandy silt with minor gravel. These deposits usually contain minimal quantities of sand and gravel, are very thin, or are overlain by extensive

thicknesses of overburden. Fine-grained dune sand is included in this category. These materials are considered unsuitable for construction except as marginal fill.

(5) Bedrock consisting of:

(a) Limestone and dolomite which would be suitable for manufacturing various types of construction aggregates.

(b) Shale and siltstone with small varying quantities of limestone and dolomite which could be exploited only for fair quality general fill useful primarily in the construction of sub-grades. This category also includes talus slopes containing a mixture of limestone, dolomite and shale blocks and fragments.

4. Soil Drainage Classes

4.1 Drainage

The Soil Drainage Classes were used in describing the drainage of each deposit that was looked at. The following set of definitions was used to determine the drainage of each site.

The following is extracted from pages 215 and 216 of National Soil Survey Committee, 1970 "The System of Soil Classification for Canada", Canada Department of Agriculture, Ottawa. The system, although devised primarily for agricultural purposes is suitable for engineering purposes and should be employed when describing soil drainage at test hole site locations. The soil drainage classes are defined in terms of:

- (i) actual moisture in excess of field moisture capacity, and
- (ii) the extent of the period during which such excess water is present in the plant-root zone.

Permeability, groundwater levels and seepage affect the moisture status but these are not easily observed in the field and therefore cannot generally be used as criteria for moisture status. The recommended definitions are as follows:

- (1) Rapidly drained - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water conditions
- (2) Well drained - The soil moisture content does not normally exceed field capacity in any horizon for a significant part of the year. ("significant" - as used in the definitions is considered in relation to plant growth)
- (3) Moderately well drained - The soil moisture in excess of field capacity remains for a small but significant period of the year
- (4) Imperfectly drained - The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year
- (5) Poorly drained - The soil moisture in excess of field capacity remains in all horizons for a large part of the year
- (6) Very poorly drained - Free water remains at or within 12 inches of the surface most of the year

Identification - commonly found morphological features associated with a particular drainage class.

Drainage Class

- (1) free of any evidence of gleying (grey color, reducing conditions)
coarse texture
steep slopes
- (2) free of mottling in upper 3 feet
may be mottled below 3 feet
- (3) commonly mottled in the B and C horizons
or below a depth of 2 feet
- (4) commonly mottled in the B and C horizons,
matrix generally has lower chroma than in the well-drained soil on similar parent material
- (5) usually strongly gleyed
matrix colors of low chroma, faint mottling may occur through out
- (6) usually strongly gleyed,
subsurface horizons are of low chroma and yellowish to blueish hues,
mottling may be present at depth in the profile

Note: "Gley" - a soil usually grey or blueish in color, generally oxygen-deficient i.e. reducing conditions prevail. Low chroma are associated with ions of lower valency eg. ferrous iron, Fe^{++} , (Fe^{+++} is associated with rusty deeper colors)

Just above the zone of contact with excess field moisture and groundwater the soil may be "mottled". This is associated with a fluctuating oxidising and reducing conditions. The soil often appears to have patchy reddish zones or concretions within a blueish grey matrix.

5. Topography5.1 Slopes

The topography of each deposit was described using the following table of terms in the Individual Site Reports.

Topography is described in the following terms:

<u>Single Slopes</u>	<u>Complex Slopes</u>	<u>Slope %</u>	<u>Slope °</u>
flat	flat depressional	0 - 2	0 - 1
gently sloping	undulating, smoothly rounded	2 - 5	1 - 3
moderately sloping	rolling ridgy, choppy	5 - 15	3 - 8
steeply sloping	kettled, knobby	15 - 60	8 - 31
precipitous	precipitous	> 60	> 31

"Region" is general area around the site location and is generally within 1500' of the test hole(s).

"Site" refers to the area within 100' of the test hole(s).

The degree of slope should be measured whenever possible by handlevel or inclinometer even if the site is to be surveyed accurately at a later date.

REFERENCES:

1. "Unified Soil Classification System" Technical Memorandum 3-357 prepared for Office, Chief of Engineering, by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S. Army. Volume I, March 1953.
2. National Research Council, Canada, "Guide to a Field Description of Permafrost for Engineering Purposes", prepared by Pihlainen, J.A. and Johnston, G.H., Technical Memorandum 79, NRC 7576, Ottawa, 1963.
3. American Society for Testing and Materials, Procedures for Testing Soils, "Suggested Methods of Testing for Identification of Soils", Fourth Ed. pp 221-233, December 1964.
4. National Research Council, Canada, "Guide to a Field Description of Muskeg", (Based on the Radforth Classification System) compiled by MacFarlane, I.C. Technical Memorandum 44 (Revised Edition) NRC 4214, Ottawa, 1958.
5. American Society for Testing and Materials, "Annual Book of Standards", (Part 19, 1974 or latest Standard) Philadelphia, Pa., U.S.A.
6. Goodman, L.J. and Lee, C.N., 1962, "Laboratory and Field Data on Engineering Characteristics of Some Peat Soils", Proc. 8th Muskeg Res. Cong. NRC ACSSM Tech. Memo 74 pp 107-129.

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	LABORATORY TEST DATA						OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS
					NRC ICE TYPE	VISUAL ICE %	▲ Dry density (pcf)	○ Water content %	Plastic limit	Liquid limit							
0.5	Pt		PEAT, black (Cat. 10)								456.8%						
2	OL		SILT, (organic) some fine sand. low to non plastic. dark brown, saturated.									C1	95	II			
4.3												C2	2.4	IV			
4.3	CL		CLAY, silty, some fine sand. low plasticity, brown.								27-17-10	C3	90	III			
7.8												C4	5.4		5.0	End coring	
7.8	ML		SILT, trace coarse sand, non plastic.									qS04					
10.0			ice layers to 1/2"									U5				Water level level indicator	
10.0												U6				8.4	
10.0	C1		TILL, CLAY, silty, little coarse sand. trace coarse gravel. medium plasticity, brown. pebbles subangular to 1 1/2" stiff.									NR	U7				
14.0												U8					
14.0												U9					
14.0	GC		GRAVEL, clayey, pebbles to 2 1/2", subangular.								32-14-18	QMA	U10				
15.4			End of hole Refusal									NR	U11			Tube damaged probable cobble	

A - 22

TEST HOLE No. 102
PLATE 1

LOGGED BY	FACILITY	PROJECT
CHKD	LAT & LONG	ELEVATION
DRWN BY	AIRPHOTO No	PIPE MILEAGE
CHKD	RIG	AIR TEMP
	METHOD	
START: D M Y TIME:	FINISH: D M Y TIME:	

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY, ALBERTA ENGINEERS LTD.	EXHIBIT LOG TEST HOLE No. 102 SHEET 1 OF 1
CANADIAN ARCTIC GAS STUDY LIMITED	

TEST HOLE LOG

DEPTH (FT.)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	ICE GRAPHIC LOG	NRC ICE TYPE	LABORATORY TEST DATA							OTHER TEST DATA	SAMPLE TYPE & No.	SAMPLE CONDITION	CORE RUN & % RECOVERY	CORE CONDITION	DEPTH (FT.)	REMARKS			
						▲ Dry density (pcf) ○ Water content % Plastic limit ———— Liquid limit																
						40	60	80	100	120	140 ▲											
						0	20	40	60	80	100 ○											
1			4																			
	2																					
		3																				
				5																		
					6																	

A - 23

TEST HOLE No.
PLATE 2

LOGGED BY	FACILITY:	PROJECT:	 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	TEST HOLE No.
CHKD	LAT. & LONG	ELEVATION:		
DRWN BY:	AIRPHOTO No	PIPE MILEAGE:		
CHKD:	RIG:	AIR TEMP		
	METHOD:			
START: D M Y TIME:	FINISH: D M Y TIME:			

SHEET OF

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISION		GROUP SYMBOL	GRAPHIC SYMBOL	TYPICAL MATERIALS	LABORATORY CLASSIFICATION CRITERIA			
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE)	GRAVELS MORE THAN HALF OF COARSE FRACTION LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (NO APPRECIABLE FINES)	GW		WELL GRADED GRAVELS, AND GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$	$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} 1 \text{ to } 3$	
			GP		POORLY GRADED GRAVELS, AND GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS		
		DIRTY GRAVELS (WITH FINES)	GM		SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE AND P I LESS THAN 4	
			GC		CLAYEY GRAVELS, GRAVEL - SAND - (SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE OR P I MORE THAN 7	
	SANDS MORE THAN HALF OF COARSE FRACTION SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (NO APPRECIABLE FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$	$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} 1 \text{ to } 3$	
			SP		POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS		
		DIRTY SANDS (WITH FINES)	SM		SILTY SANDS, SAND - SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE AND P I LESS THAN 4	
			SC		CLAYEY SANDS, SAND - (SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE OR P I MORE THAN 7	
	FINE GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE)	SILTS BELOW 'A' LINE NEGLECTIBLE ORGANIC CONTENT	$W_L < 50$	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS ACCORDING TO PLASTICITY CHART (SEE BELOW)	
			$W_L > 50$	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY, OR SILTY SOILS		
CLAYS ABOVE 'A' LINE ON PLASTICITY CHART NEGLECTIBLE ORGANIC CONTENT		$W_L < 30$	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY SANDY, OR SILTY CLAYS, LEAN CLAYS			
		$30 < W_L < 50$	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS			
		$W_L > 50$	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS			
ORGANIC SILTS & CLAYS BELOW 'A' LINE ON CHART		$W_L < 50$	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY			
		$W_L > 50$	OH		ORGANIC CLAYS OF HIGH PLASTICITY			
HIGHLY ORGANIC SOILS		Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE			

SOIL COMPONENTS			
FRACTION	U.S. STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS
	PASSING	RETAINED	PERCENT
GRAVEL	coarse	3 inch	3/4 inch
	fine	3/4 inch	No. 4
SAND	coarse	No. 4	No. 10
	medium	No. 10	No. 40
	fine	No. 40	No. 200
SILT (non plastic) or CLAY (plastic)	No. 200		
OVERSIZE MATERIAL			
Rounded or subrounded		Not rounded	
COBBLES 3 inch to 8 inch		ROCK FRAGMENTS > 3 inch	
BOULDERS > 8 inch		ROCKS > 1 cubic yard in volume	

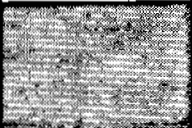

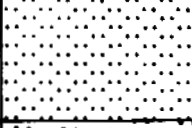
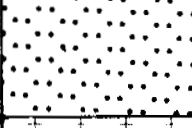
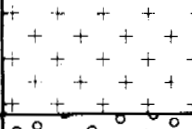
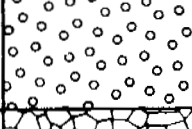
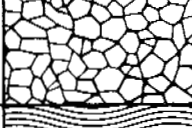



- ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD A S T M E 11
- BOUNDARY CLASSIFICATIONS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN COMBINED GROUP SYMBOLS, e.g. GW-GC IS A WELL-GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%
- TOUGHNESS AND DRY STRENGTH INCREASE WITH INCREASING PLASTICITY INDEX WHEN COMPARING SOILS AT EQUAL LIQUID LIMIT

NORTHERN ENGINEERING SERVICES COMPANY LIMITED
CALGARY ALBERTA
ENGINEERS P.E.


TABLE
1

CANADIAN ARCTIC GAS STUDY LIMITED

TABLE 2
GROUND ICE CLASSIFICATION

Category	Group Symbol	Subgroup Symbol	Graphic Symbol	Description
		F		Undifferentiated
Non-visible Ice	N	Nf		Poorly bonded or friable frozen soil
		Nbn		Well bonded frozen soil with no excess ice
		Nbe		Well bonded frozen soil with excess ice. Free water present when sample thawed
Visible Ice less than one inch thick	V	Vx		Individual ice crystals or inclusions
		Vc		Ice coatings on particles
		Vr		Random or irregularly oriented ice formations
		Vs		Stratified or distinctly oriented ice formations
Visible Ice greater than one inch thick	ICE	ICE + soil type		Ice greater than one inch thick with soil inclusions
		ICE		Ice greater than one inch thick without soil inclusions

Adapted from NRC 7576

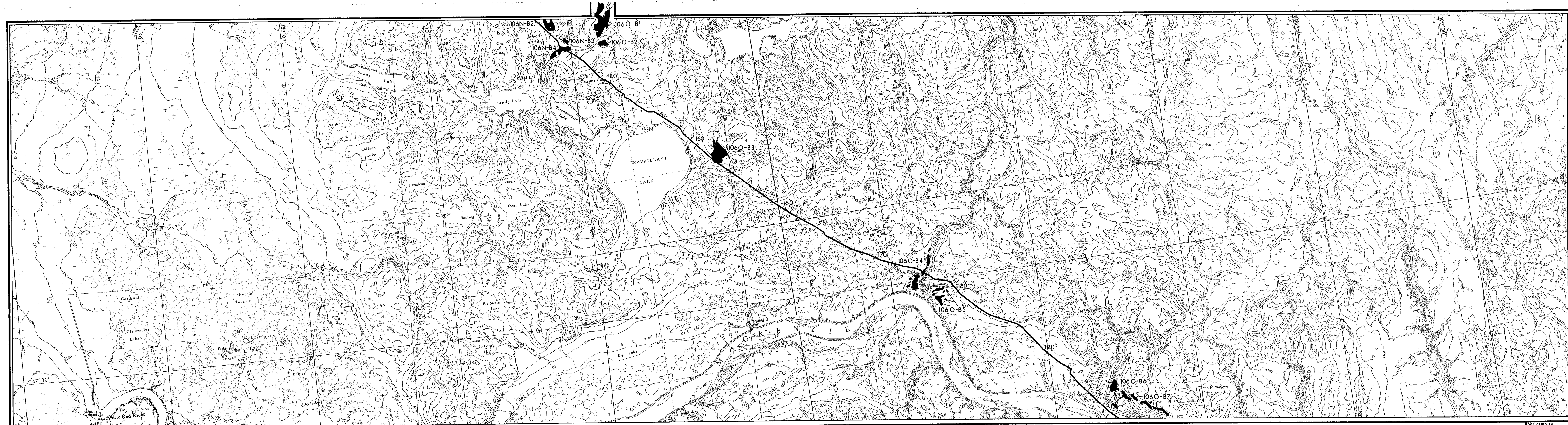


NORTHERN
Engineering Services
Company Limited


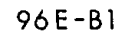
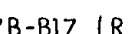

**NORTHERN ENGINEERING SERVICES
COMPANY LIMITED**
CALGARY ALBERTA
ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

APPENDIX B
Location Maps
of
1975 Summer Borrow Investigations

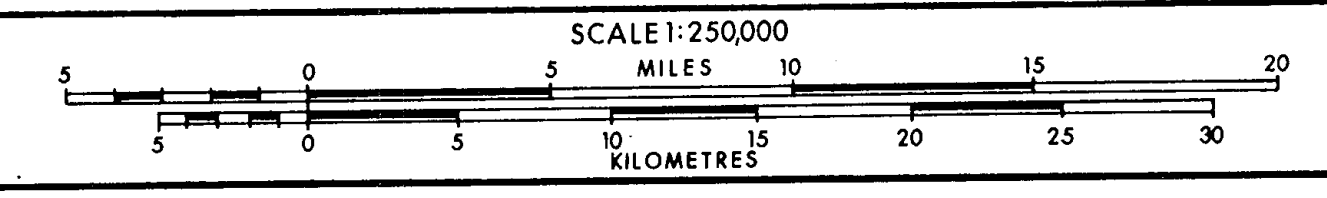


LEGEND


 DEPOSIT OUTLINE
 NESCL DEPOSIT NUMBER
 RECONNAISSANCE SITE - SOME DETAILED WORK DONE BY NESCL
 PROPOSED GAS PIPELINE ROUTE (MARCH 1976) WITH MILE POST.

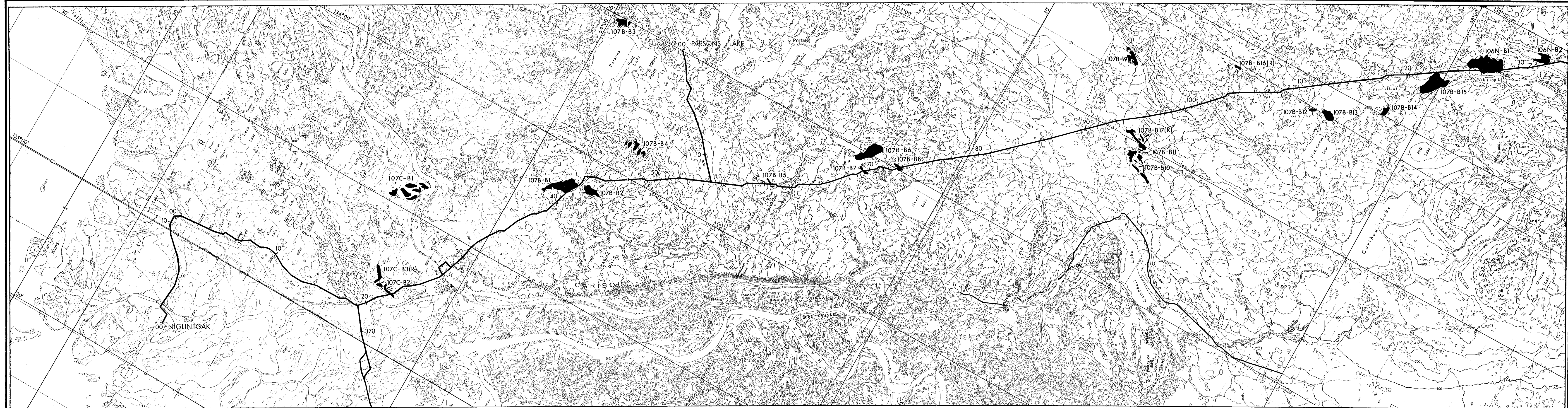
**LOCATION MAPS
1975 SUMMER BORROW INVESTIGATION**

THIS MAP HAS BEEN TAKEN FROM ORIGINAL PRINTED BASE MAPS PREPARED AND SUPPLIED BY THE DEPARTMENT OF MINES AND RESOURCES ONTO WHICH THE APPLICANT HAS SUPERIMPOSED THOSE INSTALLATIONS AND FACILITIES RELEVANT TO THIS APPLICATION.
MAY 1975





DESIGNED BY:		CHECKED BY:	
APPROVED BY:		PROJ. MANAGER:	

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	REVISED:	
	DATE:	
PROJ. NO.:	13011	
DWG. NO.:	1L-0211-1003	

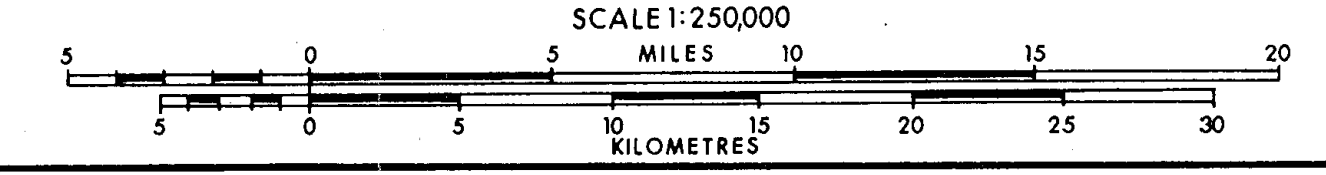


LEGEND


 DEPOSIT OUTLINE
 96E-B1 NESCL DEPOSIT NUMBER
 107B-B17 (R) RECONNAISSANCE SITE - SOME DETAILED WORK DONE BY NESCL
 200 PROPOSED GAS PIPELINE ROUTE (MARCH 1976) WITH MILE POST.

LOCATION MAPS
1975 SUMMER BORROW INVESTIGATION

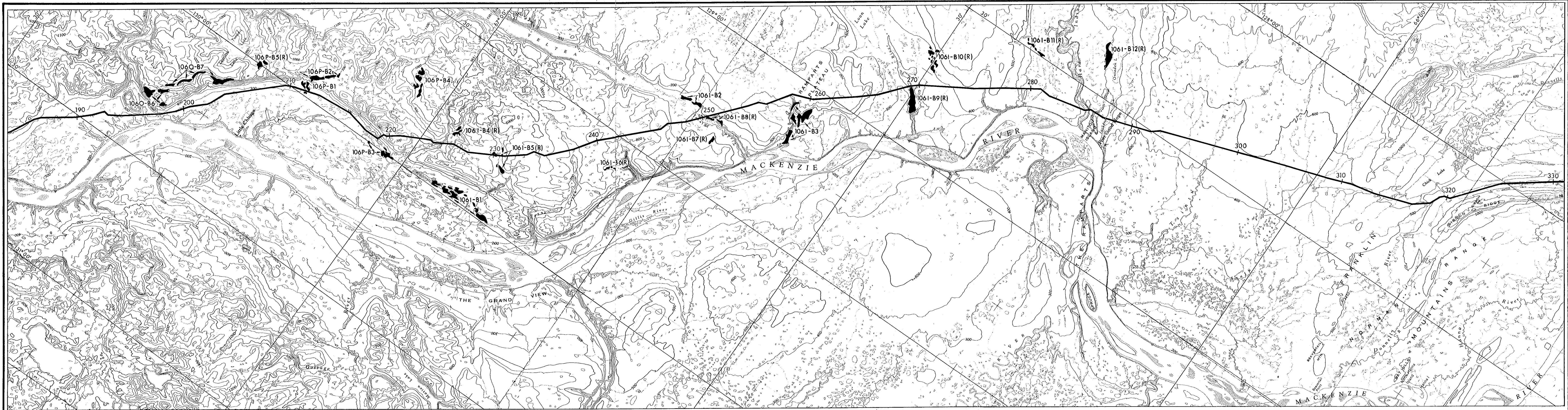
THIS MAP HAS BEEN TAKEN FROM ORIGINAL PRINTED BASE MAPS PREPARED AND SUPPLIED BY THE DEPARTMENT OF MINES AND RESOURCES ONTO WHICH THE APPLICANT HAS SUPERIMPOSED THOSE INSTALLATIONS AND FACILITIES RELEVANT TO THIS APPLICATION.
 MAY 1975



DESIGNED BY: _____
 CHECKED BY: _____
 APPROVED BY: _____
 PROJ. MANAGER: _____

 NORTHERN ENGINEERING SERVICES COMPANY LIMITED CALGARY ALBERTA ENGINEERS FOR CANADIAN ARCTIC GAS STUDY LIMITED	REVISED: _____
	DATE: _____
	PROJ. NO.: 13011
	DWG. NO.: 1L-0211-1001

94
 8
 4
 142

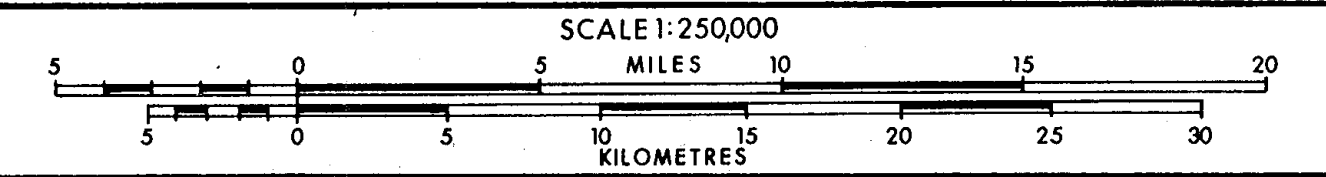


LEGEND

- DEPOSIT OUTLINE
- 96E-B1 NESCL DEPOSIT NUMBER
- 107B-B17 (R) RECONNAISSANCE SITE - SOME DETAILED WORK DONE BY NESCL
- PROPOSED GAS PIPELINE ROUTE (MARCH 1976) WITH MILE POST.

LOCATION MAPS
1975 SUMMER BORROW INVESTIGATION

THIS MAP HAS BEEN TAKEN FROM ORIGINAL PRINTED BASE MAPS PREPARED AND SUPPLIED BY THE DEPARTMENT OF MINES AND RESOURCES ONTO WHICH THE APPLICANT HAS SUPERIMPOSED THOSE INSTALLATIONS AND FACILITIES RELEVANT TO THIS APPLICATION.
 MAY 1975



DESIGNED BY: _____
 CHECKED BY: _____
 APPROVED BY: _____
 PROJ. MANAGER: _____



REVISED: _____
 DATE: _____
 PROJ. NO.: 13011
 DWG. NO.: 1B-0211-1006

APPENDIX C

Resistivity Measurement
with
Inductive Coupling Equipment
at
Several Gravel Pits in the Calgary Area

APPENDIX C - Resistivity Measurements with Inductive Coupling
Equipment at Several Gravel Pits in the
Calgary Area

1. Introduction

Borrow material is required for construction of the proposed gas pipeline and associated facilities. Sources of borrow material have been identified by photo methods and some of the deposits have been probed by drilling and conventional geophysical methods.

In general the conventional geophysical measurements have added little information about the nature, depth or extent of the deposits. For geophysical measurements to be of value in reconnaissance exploration for granular material deposits a rapid method of resistivity mapping is required that can quickly scan the deposit and the surrounding areas. Also, the depth of exploration in most instances should be limited to 20-30 ft.

A dipole-dipole system was designed for shallow exploration, but was not available in time for the 1975 borrow program along the pipeline route. In December, the instrument was tested at several active gravel pits in the Calgary area. This appendix gives the results of these tests.

2. The Inductive Coupling System

Soil types can often be distinguished by their electrical resistivity. The resistivity ranges encountered for certain soil types vary from area to area, but invariably gravel deposits are found to have higher resistivities than glacial tills or lacustrine deposits. Sands and gravels can often not be separated on the basis of electrical resistivity.

To establish the relation between soil types and resistivity, in a region, requires substantial amounts of data. The recent development of non-contact methods has made it possible to acquire area coverage and large amounts of data at a low cost. The method that appears particularly attractive measures the mutual coupling between two loop antennas carried above the ground.

In the inductive coupling system two small antenna loops (magnetic dipoles) are separated by a fixed distance. In the instrument, shown in Figure 1, the loops are in the horizontal plane and the separation distance between the loops is 3.6 m. One dipole transmits electromagnetic waves at a frequency of 39 kilohertz. The transmitted waves induce current flow in the ground; the magnetic field of that current flow is measured by the receiving dipole. The received signal can be related to the resistivity of the ground.

The instrument is light weight (15 lbs.) and is carried by a shoulder strap approximately 0.8 m above the ground. No contact with the ground is required for a measurement, so that readings can be taken continuously along a traverse.

The frequency and separation of the system are chosen so that the depth of exploration depends mainly on the separation distance of the dipoles. The depth of exploration on gravel

deposits is approximately $2\frac{1}{2}$ times the separation distance or about 9 m (30 ft). Similar instruments with larger depth of exploration are also available.

Over ground uniform with depth the instrument would measure the true resistivity of the ground. Over layered ground the resistivity measured is influenced by the resistivities of all the layers within the depth of exploration. Computer models are required to derive the layered structure from the measurements.

3. Results

Five gravel deposits were investigated in the Calgary area.

In all these pits traverses were made:

- (1) right above the face of the cut (on the gravel),
- (2) in the bottom of the pit, where presumably most gravel was excavated, and
- (3) when possible, at locations near the pit, outside the gravel deposit.

Table I lists the gravel pits and the range of apparent resistivities observed in each of the three categories listed above. The conclusion that can be drawn from Table I is that in Pit 1, 2, 4 and 5, the difference in resistivity between gravel and surrounding material is at least a factor 2. The gravel in Pit #3 contained a large amount of fines.

In order to calculate the depth of gravel from resistivity data, one would in general make, for a specific site, a few independent measurements of resistivity with other methods. Since this was not done, the calibration curve (shown in Figure 2) relating the apparent resistivity to depth of gravel is tentative. Normally, one would make a separate calibration curve for each pit. There are also other factors that could obscure the simple picture shown in Figure 2, such as substantial changes in the quality of gravel with depth. Nevertheless, for illustrating the use of geophysics in this appendix this curve is used for all five pits.

Next, the results of measurements at each quarry are discussed:

No. 1, Standard General, Ogden Pit, North Wall

Figure 3 shows a layout of some of the traverses made near the North Wall of the pit, and Figure 4 and 5 show resistivity profiles along the traverses. The resistivity profile along line 4 has been interpreted in terms of depth of gravel with the aid of Figure 2; the data show that the granular deposit terminates at the northeast corner of the property indicated by a rapid decrease in resistivity. The gravel is more extensive on the western side (line 6), since the resistivity remains high on line 6. Also on line 5 (Figure 5) the resistivity can be seen to increase gradually towards the west. From Figure 2 one estimates the gravel deposit to be more than 10 m (30 ft) thick on line 6; and, as shown on Figure 4 for example less than 2 m (6 ft) at station 400 on line 4.

These data clearly show the advantage of continuous resistivity readings. Boundaries can be delineated and drill holes can be planned at selected points, and the information can be extrapolated between the holes.

No. 2, Standard General, Ogden Pits, East Wall

Figure 6 shows the layout of some of the traverses near the East Wall of the Standard General, Ogden Pit. Of interest are the resistivity profiles perpendicular to the pit face (10, 11, 12) shown in Figure 7. These lines clearly show a decreasing resistivity towards the hill, indicating that the gravel deposit terminates near the base of the hill as is shown by the interpretation in Figure 7. Figure 8 shows the profiles of some of the lines parallel to the face of the cut. These lines also show the substantial difference in resistivity between gravel (line 7), and surrounding material (line 9). Figure 2 can be used to relate the decrease in resistivity to depth of gravel.

No. 3, Burnco, Ogden Pit

Figure 9 shows the layout of some of the lines at the Burnco, Ogden Pit. The values of the resistivities along these lines are listed in Talbe II. The resistivities measured above the face of the cut are the lowest found in the gravel pits investigated in the Calgary area. From Figure 2 one would estimate less than 4 m (12 ft) of gravel. However, this gravel had a high content of fines, and probably needs a separate calibration curve.

The ground water table in the bottom of the pit was within a few feet from the surface.

No. 4, Burnco, Canyon Meadows

Short lines were measured on top of the faces of the Burnco, Canyon Meadows Pit. The layout of the lines is shown in Figure 10. The data are listed in Talbe III. The data show resistivities greater than 100 ohm-meters on the lines on top of the pit. At the bottom of the pit most values are less than 100 ohm-meters, although there are apparent substantial pockets of gravel left locally in the bottom of the pit. The depth of gravel on top of the cut faces is estimated from Figure 2 to be about 20 feet on line 2, and more than 30 feet on line 3.

No. 5, Consolidated Concrete, Bearspaw Pit

Several traverses were run on the Bearspaw Pit. The approximate layout of the lines is shown in Figure 11.

The data on the line at the North South Road Allowance is listed in Talbe IV. The resistivity values found along this traverse were the highest found on gravel deposits in the Calgary area. These resistivities are indicative of thick high quality gravel.

The location of the lines run near the fence of the property from the South East Corner are shown in Figure 11. The resistivity profiles for line 1 and line 6 are given in Figure 12. The data show a rapid decrease in resistivity at station 400 of both lines; this decrease is no doubt due to thinning of the gravel beds.

Table V lists the values measured along the lines of the top and the bottom of the Bearspaw Pit, East-West Section.

4. Conclusion

The resistivity data obtained on the gravel pits in the Calgary area showed that gravel deposits can be delineated from the surrounding materials by non-contact inductive coupling methods. The depth of gravel can be estimated from computer model curves, but independent measurements of the resistivity of gravel would be necessary to arrive at an acceptable accuracy.

TABLE I
 Range of Apparent Resistivities in ohm-meters
 Measured On and Off Gravel Deposits
 In Active Quarries in the Calgary Area

No.	Quarry Name	On Gravel, Above Face of Cut	At Bottom of Pit	Out of Gravel in Surrounding Material
1	Standard General, Ogden Pit North Wall	140-160	30-70	20-50
2	Standard General, Ogden Pit East Wall	140-160	20-50	20-50
3	Burnco, Ogden Pit South Gravel Base	60-80	20-30	60-80
4	Burnco, Canyon Meadows	110-160	-	50-30
5	Consolidated Concrete Bearspaw	130-250	90-50	50-70

TABLE II

Apparent Resistivities Measured Along the Top
And Bottom of Burnco, Ogden Pit. The Approximate
Locations of the Line are Shown in Figure 8

<u>Station, meters</u>	Top of Pit Line 1	<u>Apparent Resistivity ohm-meters</u>
0		80
25		-
50		-
75		70
100		70
125		65
150		70
175		80
200		80
225		80
250		80
275		60
300		55
325		60
350		65
375		70
400		65
425		85
450		70
475		70
500		65
525		70
550		65
575		65
600		80

Table II, continued

<u>Station, meters</u>	<u>Line 3 Top of Pit</u>	<u>Apparent Resistivity ohm-meters</u>
0		80
25		75
50		55
75		65
100		60
125		60
150		60
175		55
200		50
225		55
250		65
275		70
300		60
325		55
350		50
375		55
400		60
425		65
450		70
475		70
500		65
525		70
550		80
575		65
600		70

Table II, continued

<u>Station, meters</u>	<u>Bottom of Pit Line 4</u>	<u>Apparent Resistivity ohm-meters</u>
0		25
25		20
50		20
75		20
100		25
125		25
150		20
175		20
200		20
225		20
250		20
275		20
300		25
325		25
350		20
375		20
400		25
425		25
450		25
475		25
500		25
525		25
550		25
575		25
600		25

TABLE III

List of Apparent Resistivities Measured On
Survey Lines at Burnco Pit, Canyon Meadows

<u>Stations, meters</u>	<u>On Top of Pit Walls</u> <u>Line 2</u>	<u>Apparent Resistivity</u> <u>ohm-meters</u>
0		130
25		115
50		120
75		110
100		110
125		115
150		100
175		100
200		100
225		100
250		110
275		120
300		150
Line 3		
0		150
25		150
50		150
75		150
100		155
125		150
150		140
175		135
200		135

Table III, continued

<u>Station, meters</u>	Line 4	<u>Apparent Resistivity ohm-meters</u>
0		115
25		130
50		140
75		160
100		160
125		150
150		150
175		150
200		155
225		150
250		155
275		160
300		160

Bottom of Pit

Line 5

0	65
25	80
50	95
75	110
100	110
125	130
150	100
200	95
225	65

Table III, continued

<u>Station, meters</u>	Line 7	<u>Apparent Resistivity ohm-meters</u>
0		130
25		90
50		70
75		70
100		60
125		65
150		70
175		80
200		85
225		95
250		85
275		65
300		65

Line 6

0	120
25	130
50	125
75	55
100	60
125	70
150	80
175	85
200	110
225	110
250	100
275	100
300	90

TABLE IV

Apparent Resistivities Measured Along a
Traverse Near the North-South Road
Allowance in the Bearspaw Pit

<u>Station, meters</u>	<u>Apparent Resistivity ohm-meters</u>
0	170
25	220
50	200
75	220
100	240
125	210
150	220
175	250
200	220
225	220
250	250
275	220
300	250
325	200
350	200
375	200
400	200
425	200
450	200
475	200
500	100
525	200
550	220
575	220
600	200
625	190
650	140

INDUCTIVE COUPLING SYSTEM

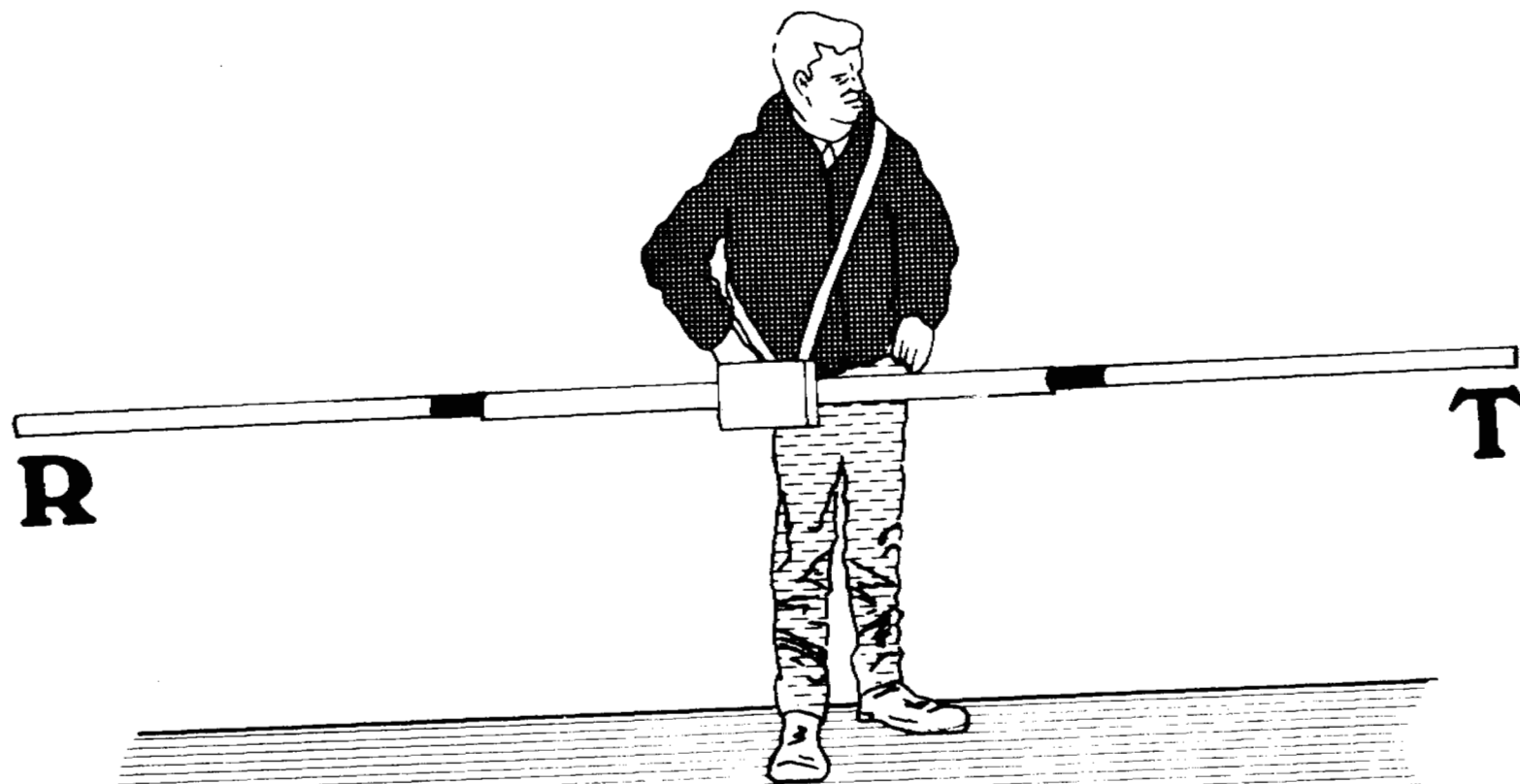


FIGURE 1

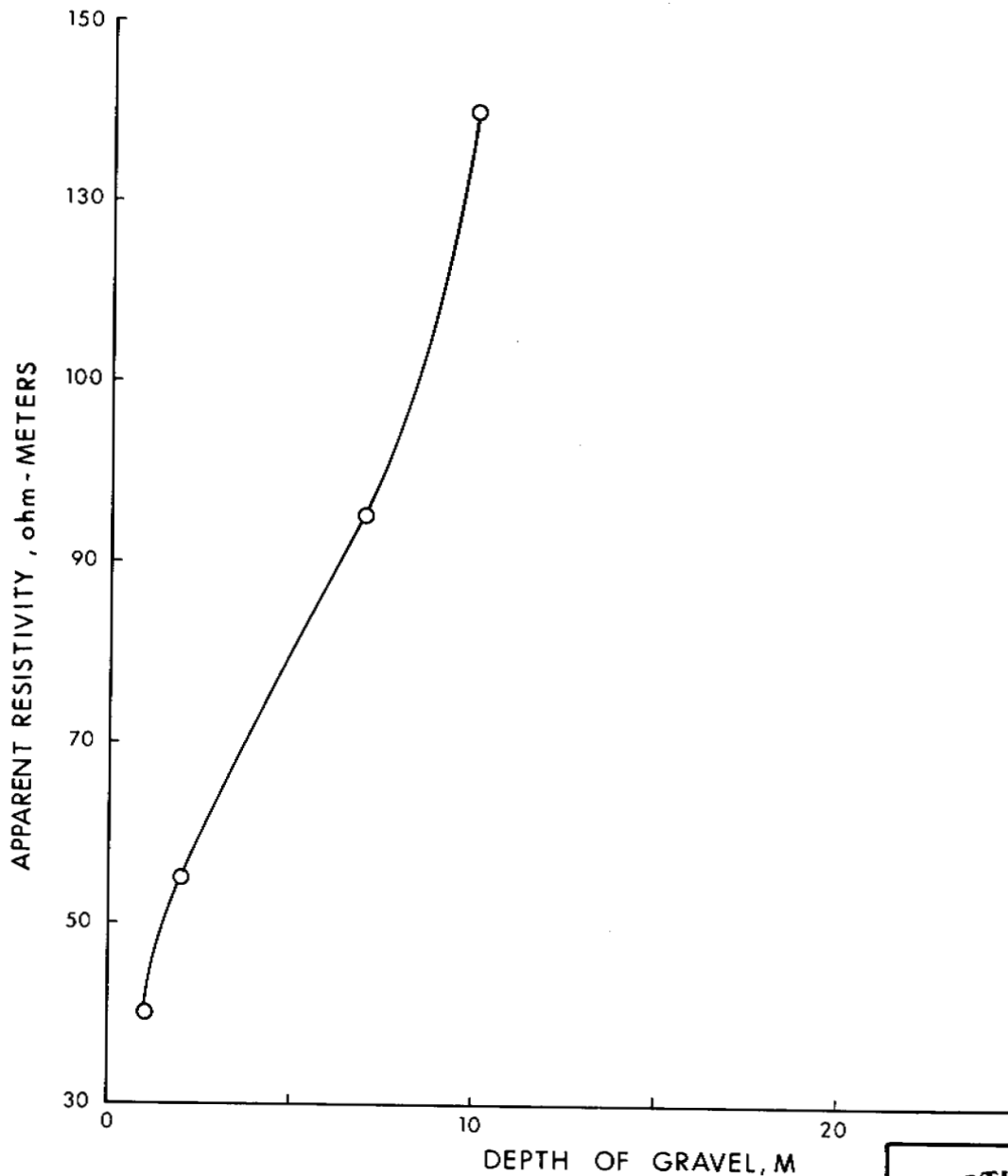


NORTHERN ENGINEERING SERVICES
COMPANY LIMITED

CALGARY ALBERTA

ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED



CALIBRATION CURVE :
APPARENT RESISTIVITY Vs DEPTH OF GRAVEL

FIGURE 2

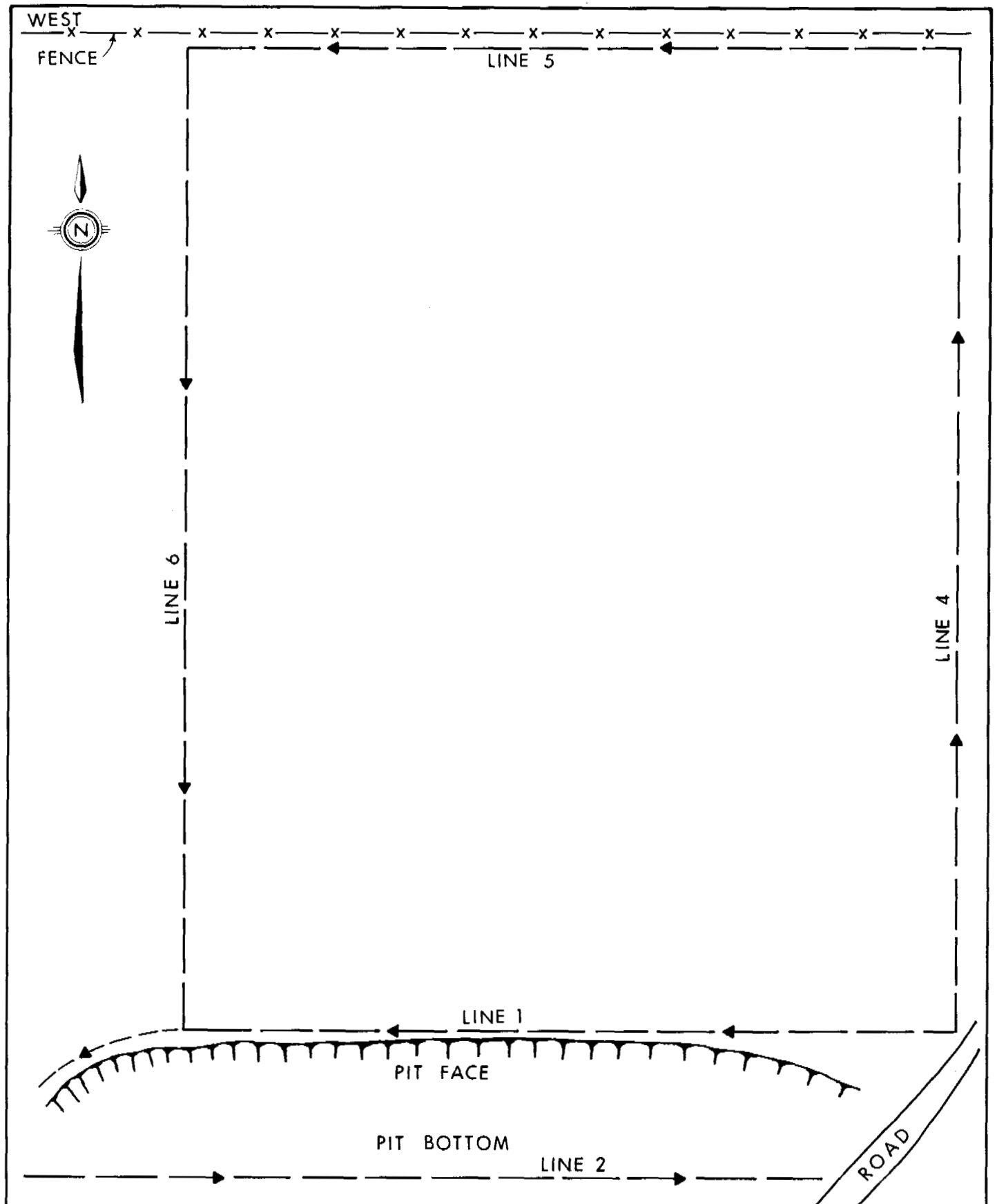


NORTHERN ENGINEERING SERVICES
COMPANY LIMITED

CALGARY ALBERTA

ENGINEERS FOR


CANADIAN ARCTIC GAS STUDY LIMITED



PIT No.1 - GEOPHYSICS-INDUCTIVE COUPLING
 STANDARD GENERAL: OGDEN GRAVEL PIT
 NORTH WALL

SCALE: VERTICAL 1" = 50 M
 HORIZONTAL 1" = 40 M

FIGURE 3

 <p>NORTHERN Engineering Services Company Limited</p>	<p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED</p> <p>CALGARY ALBERTA</p> <p>ENGINEERS FOR</p>
	<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>

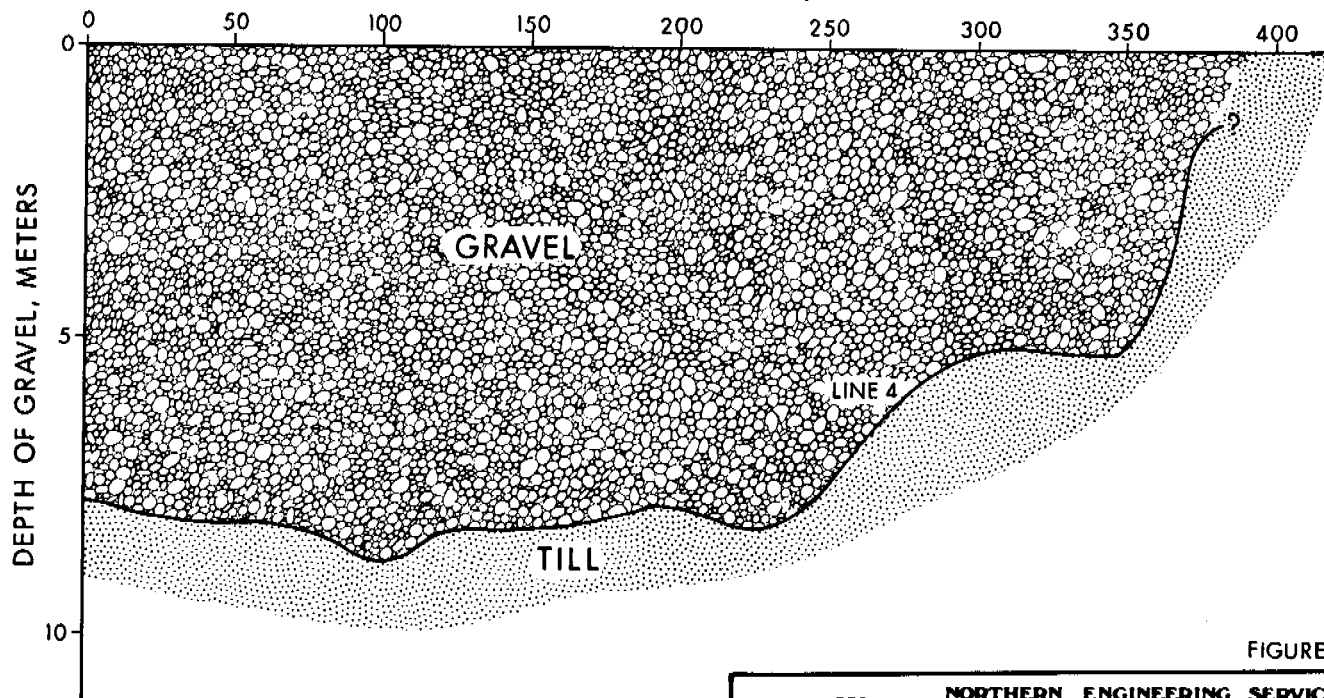
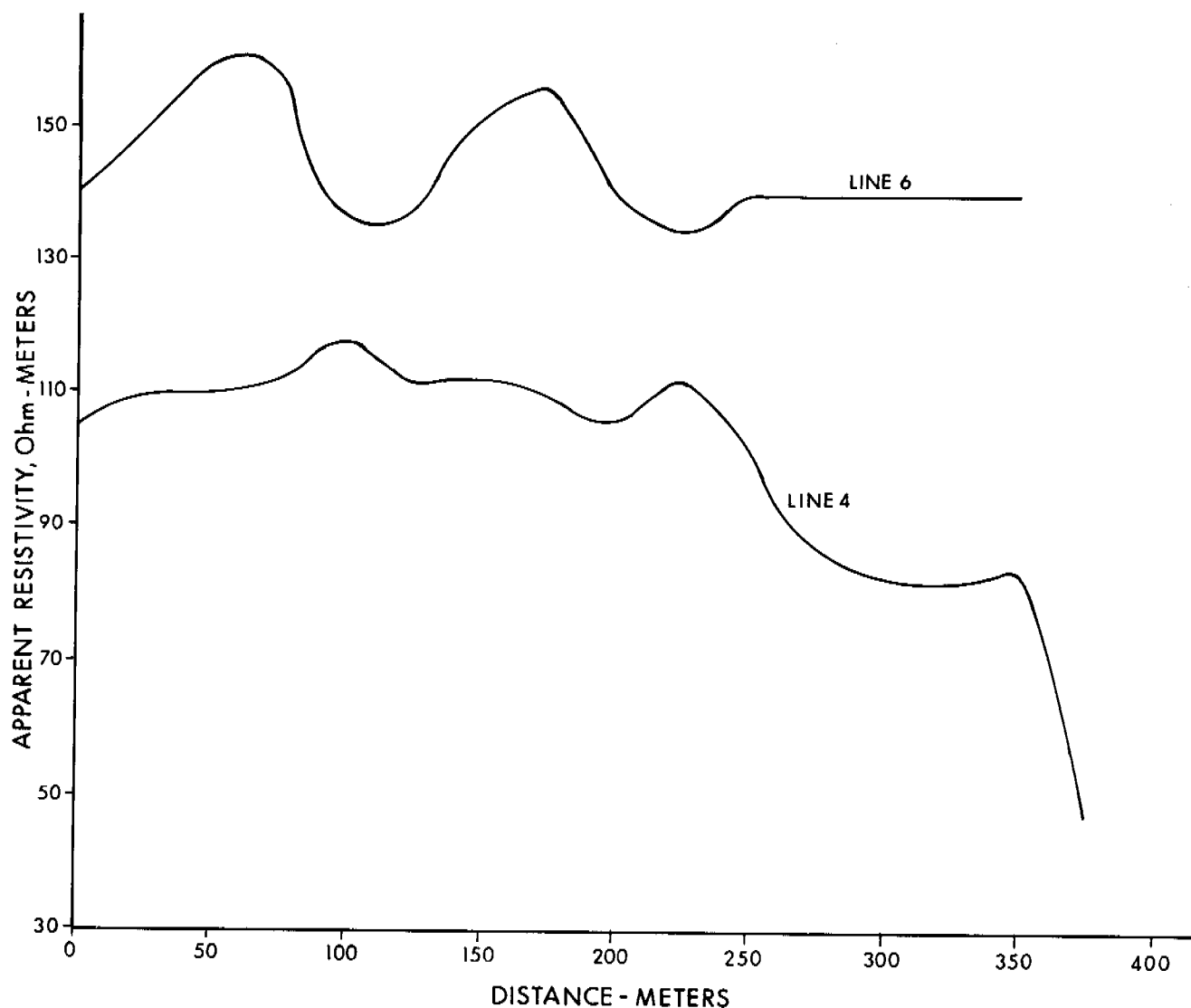
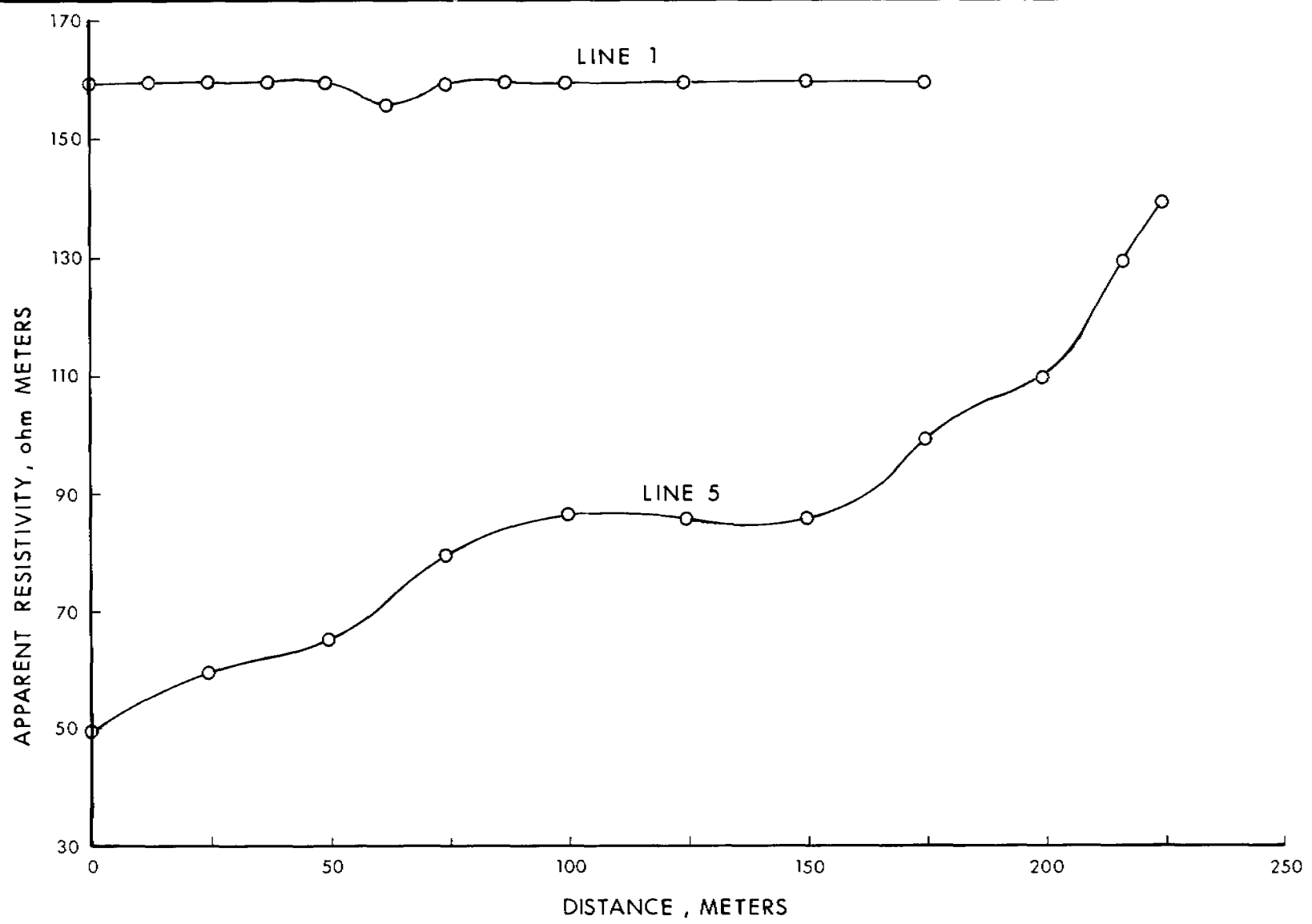


FIGURE 4

PIT No. 2
 STANDARD GENERAL
 OGDEN PIT, NORTH WALL


**NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED**
 CALGARY ALBERTA
 ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED

C - 21

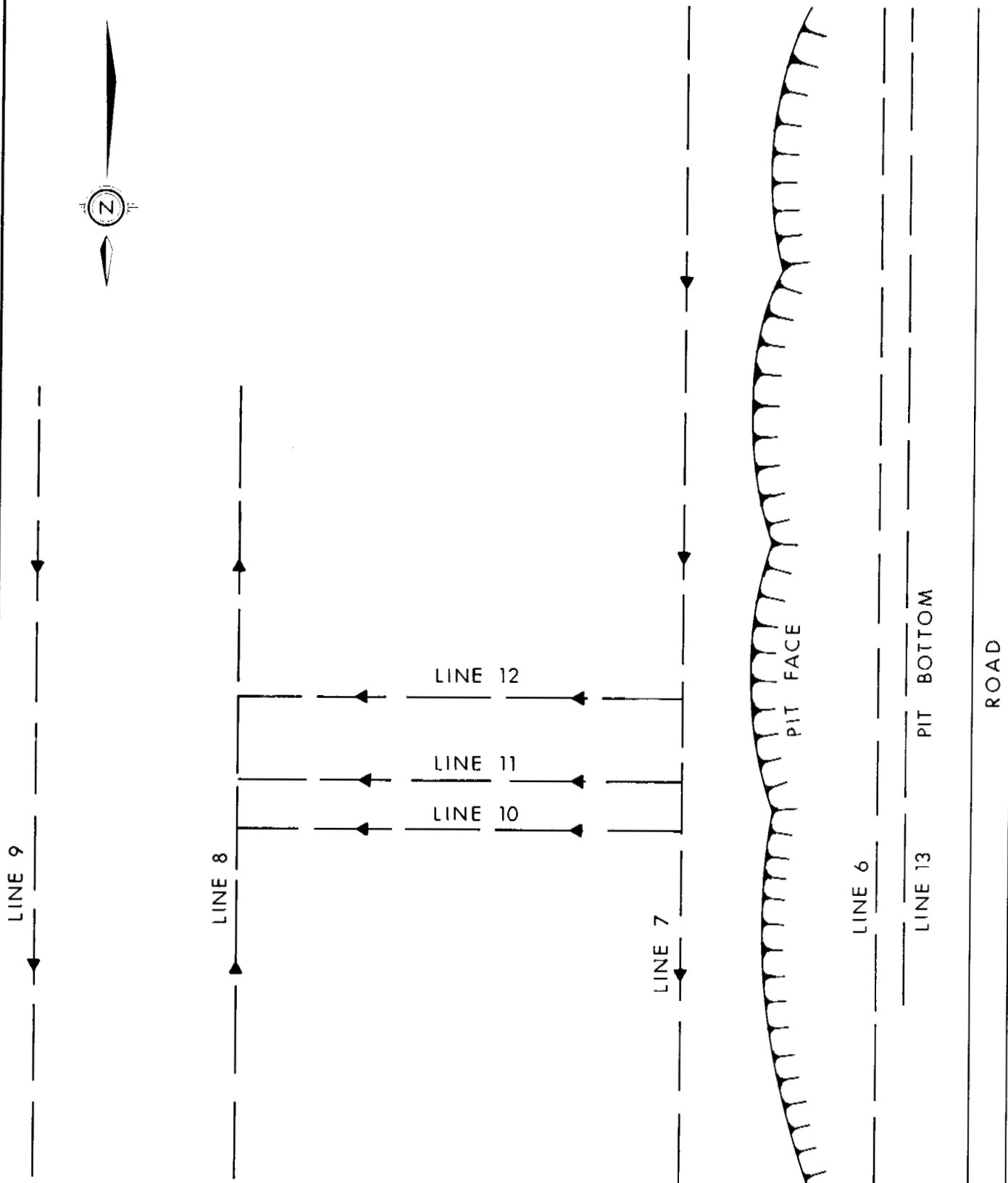


PIT No. 2
STANDARD GENERAL
OGDEN PIT, NORTH WALL

FIGURE 5

NORTHERN
Engineering Services
Company Limited

**NORTHERN ENGINEERING SERVICES
COMPANY LIMITED**
CALGARY ALBERTA
ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED

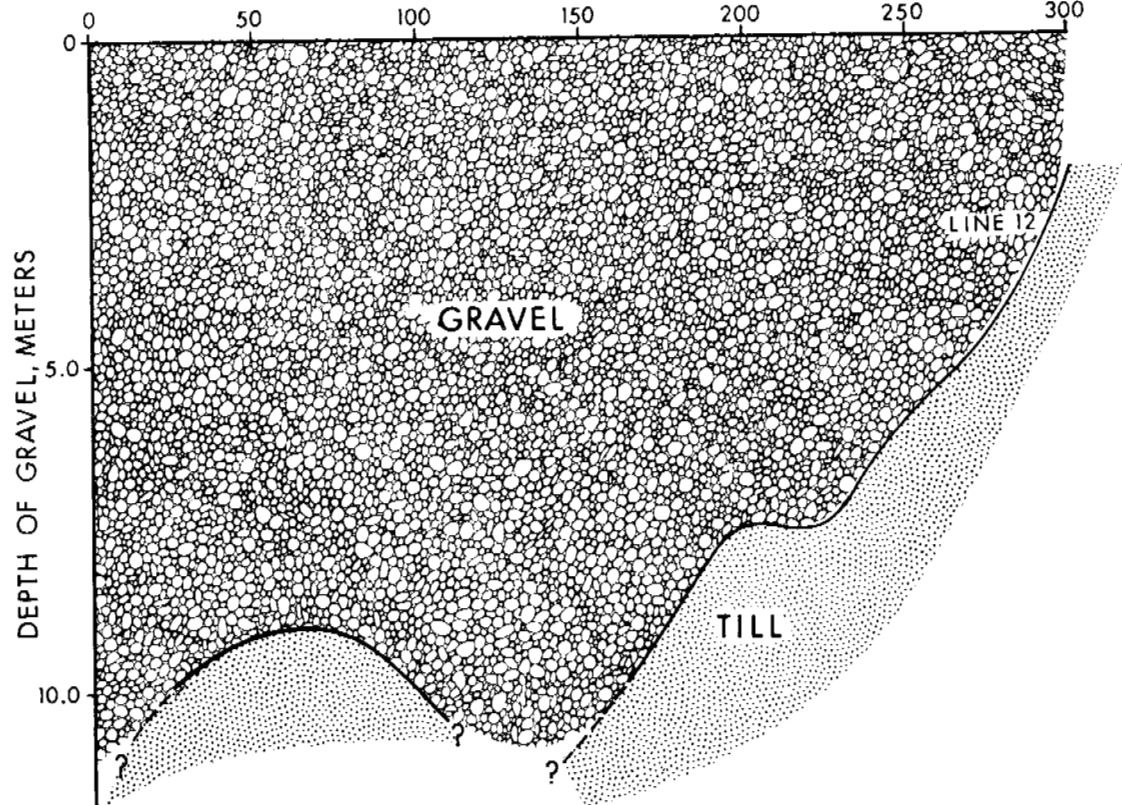
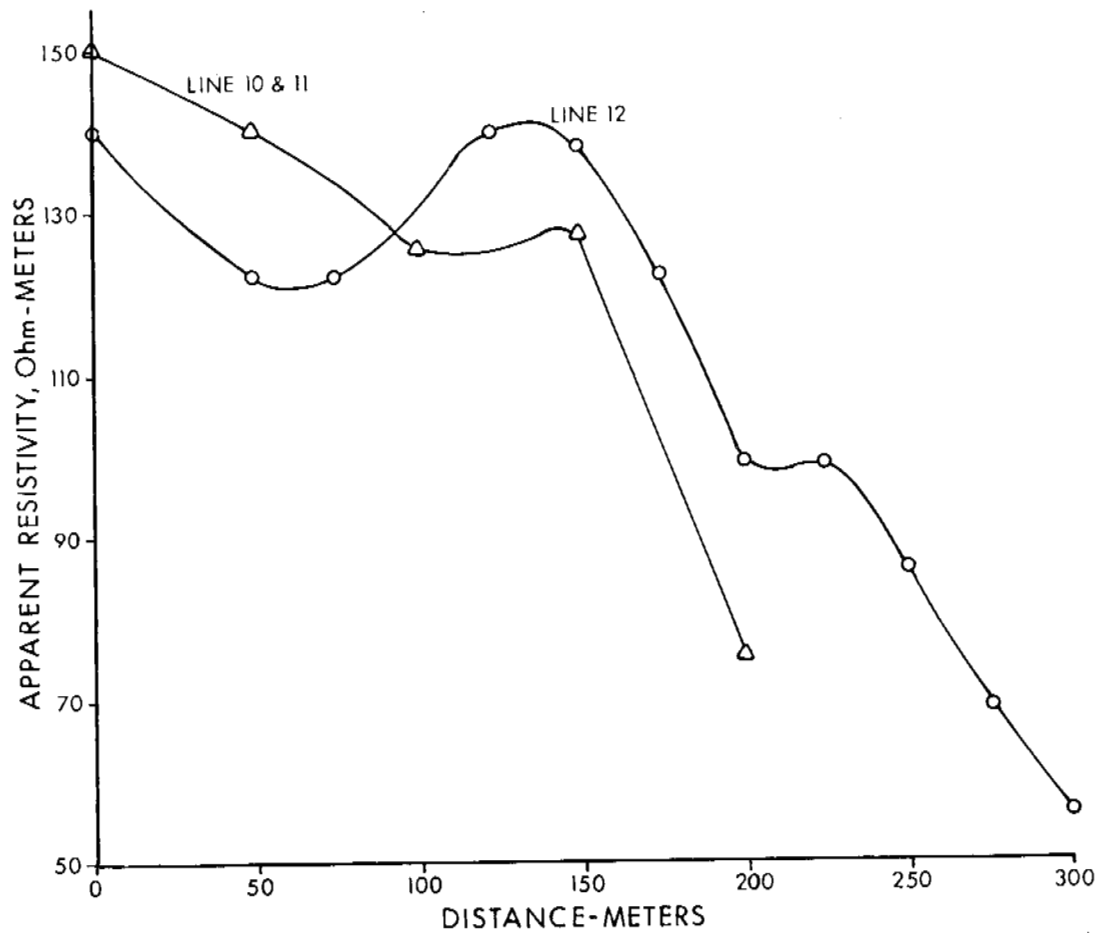


SCALE :
VERTICAL 1" - 70 M
HORIZONTAL 1" - 70 M

PIT No. 2
GEOPHYSICS - INDUCTIVE COUPLING
STANDARD GENERAL: OGDEN GRAVEL PIT
EAST WALL

FIGURE 6

	NORTHERN ENGINEERING SERVICES COMPANY LIMITED
	CALGARY ALBERTA
	ENGINEERS FOR
	CANADIAN ARCTIC GAS STUDY LIMITED



PIT No. 2
 STANDARD GENERAL
 OGDEN PIT, EAST WALL

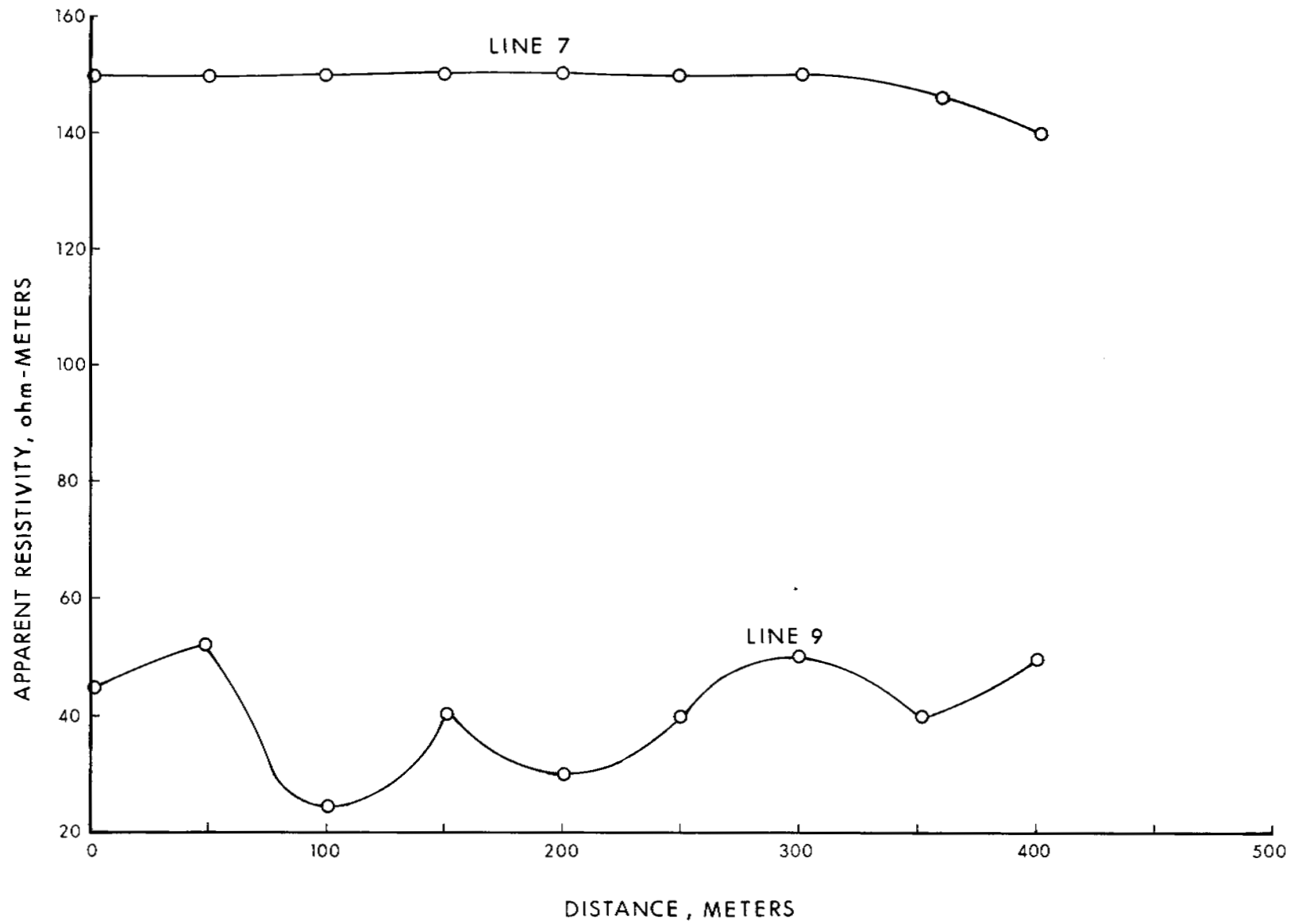


**NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED**
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED

FIGURE 7

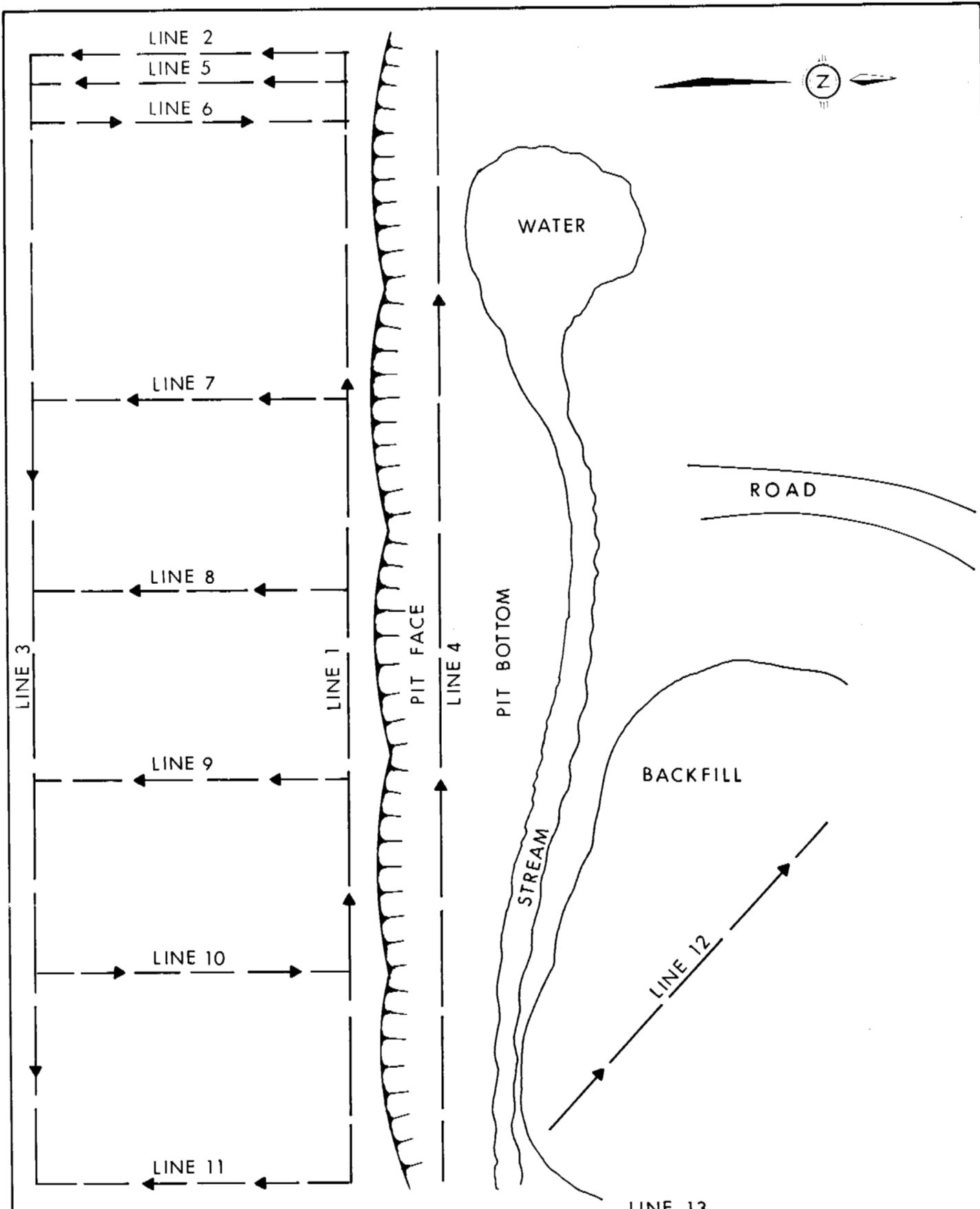
C - 24



PIT No. 2
STANDARD GENERAL
OGDEN PIT, EAST WALL

FIGURE 8

**NORTHERN ENGINEERING SERVICES
COMPANY LIMITED**
CALGARY ALBERTA
ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED

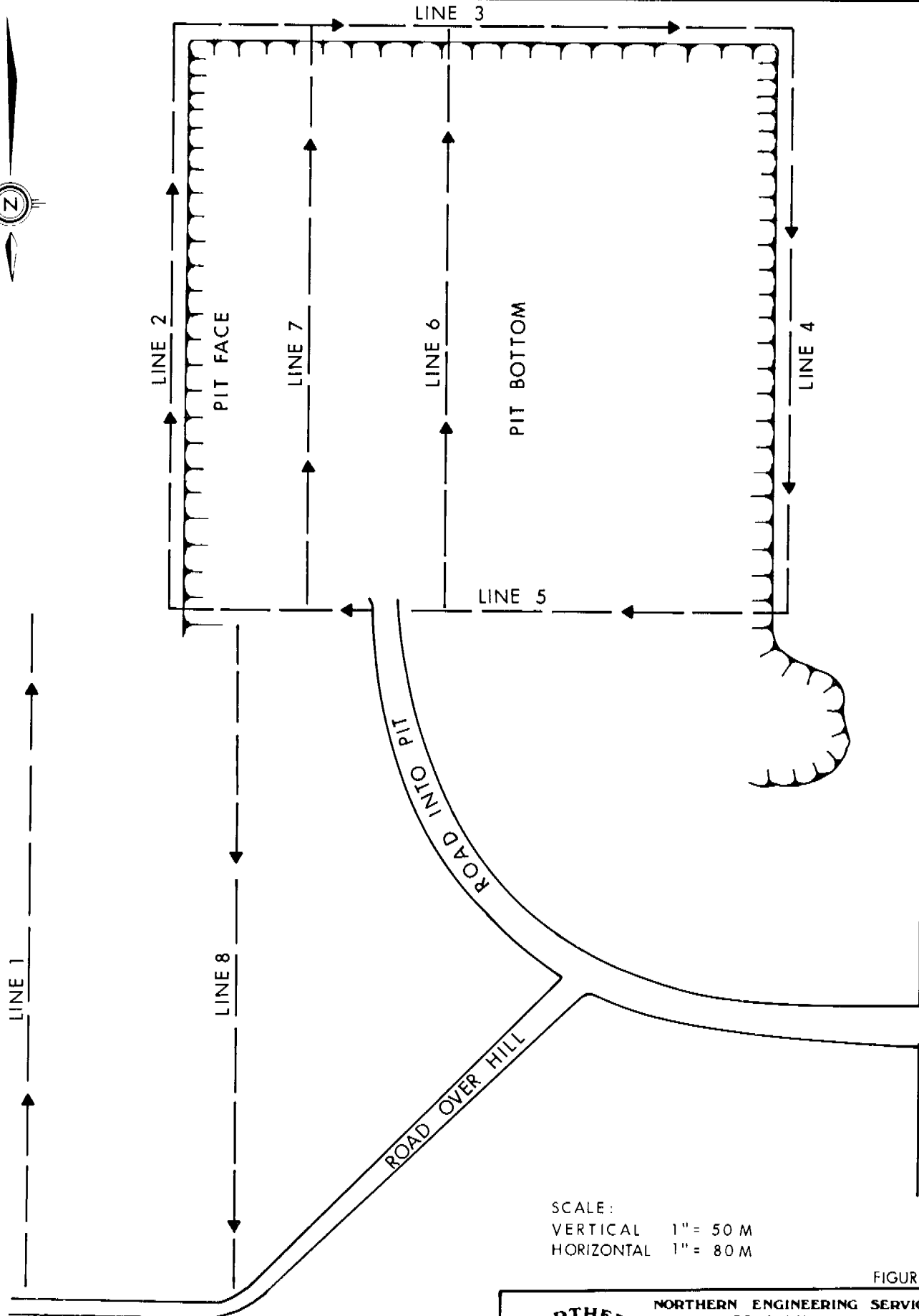


PIT No. 3
 GEOPHYSICS INDUCTIVE COUPLING
 BURNCO: OGDEN GRAVEL PIT

SCALE: VERTICAL 1" = 70 M
 HORIZONTAL 1" = 80 M

FIGURE 9


<p>NORTHERN Engineering Services Company Limited</p>	<p>NORTHERN ENGINEERING SERVICES COMPANY LIMITED</p>
	<p>CALGARY ALBERTA</p>
	<p>ENGINEERS FOR</p>
<p>CANADIAN ARCTIC GAS STUDY LIMITED</p>	

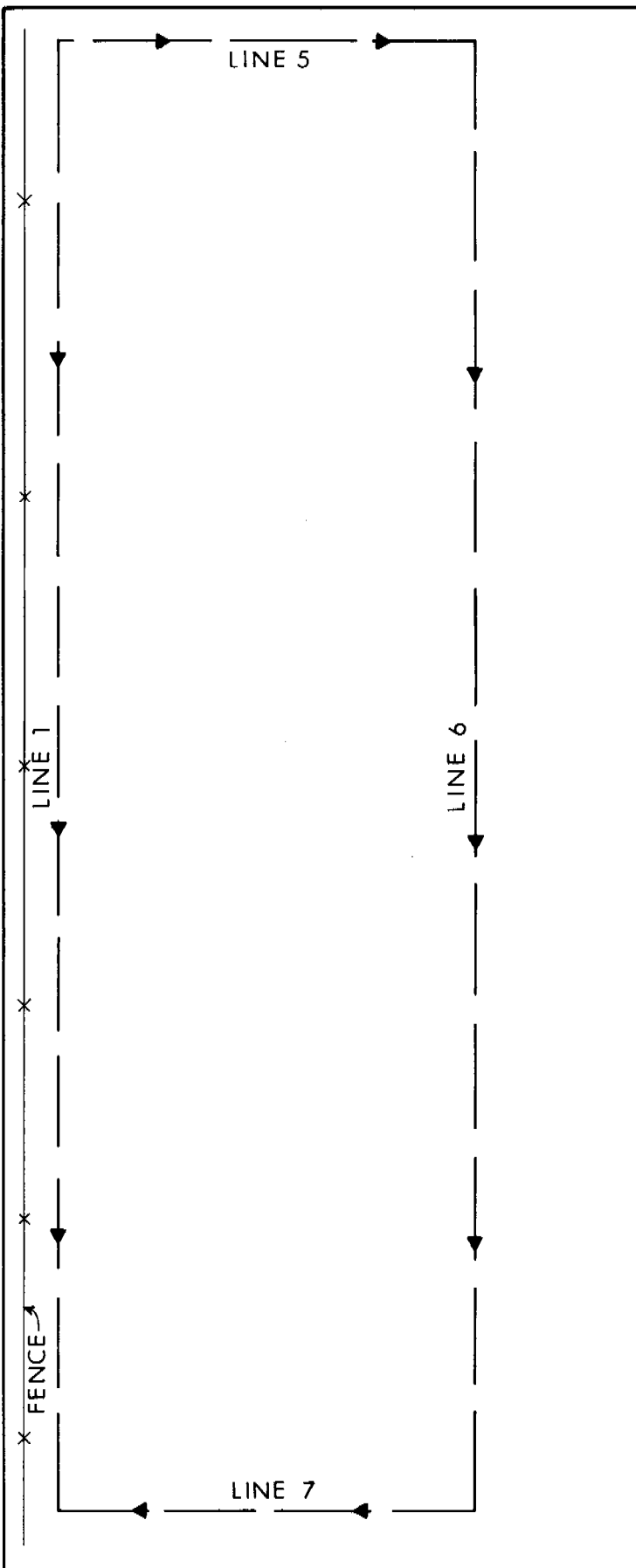


PIT No. 4
GEOPHYSICS INDUCTIVE COUPLING
BURNCO: CANYON MEADOWS

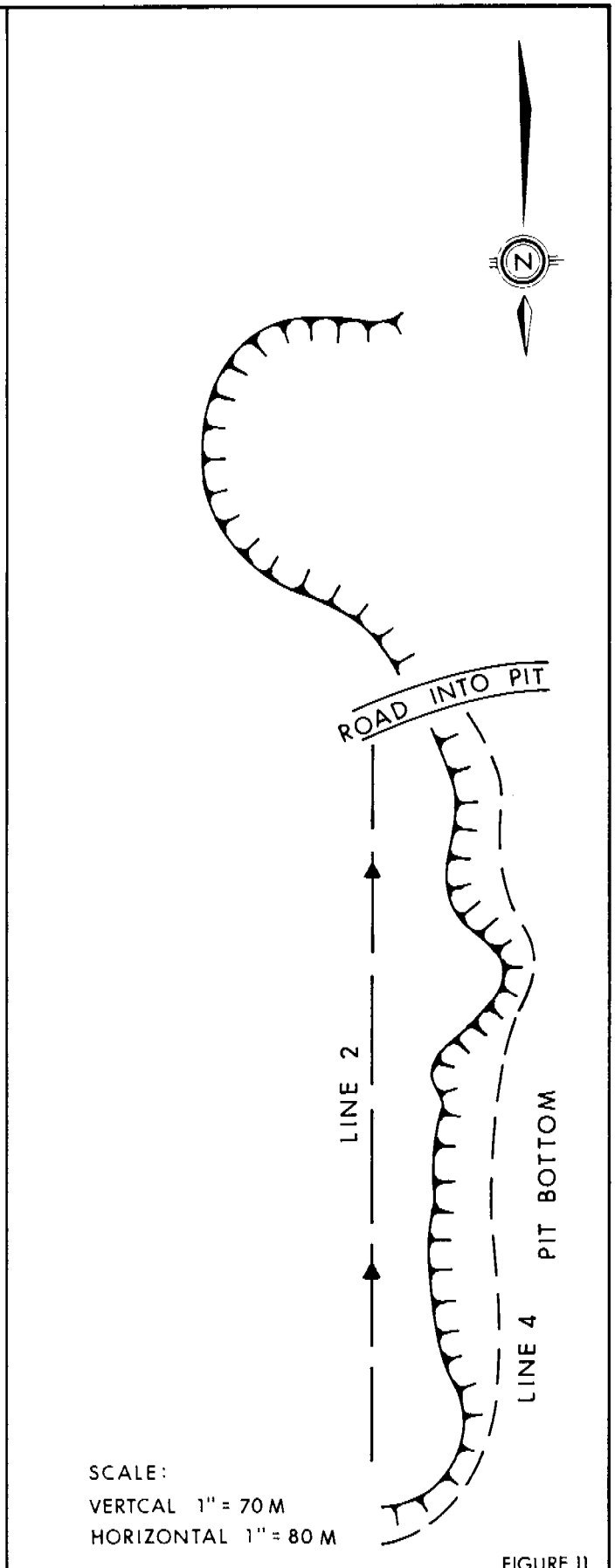
SCALE:
VERTICAL 1" = 50 M
HORIZONTAL 1" = 80 M

FIGURE 10

**NORTHERN ENGINEERING SERVICES
COMPANY LIMITED**
CALGARY ALBERTA
ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED



PIT No. 5
 GEOPHYSICS INDUCTIVE COUPLING
 CONSOLIDATED CONCRETE; BEARSPAW PIT



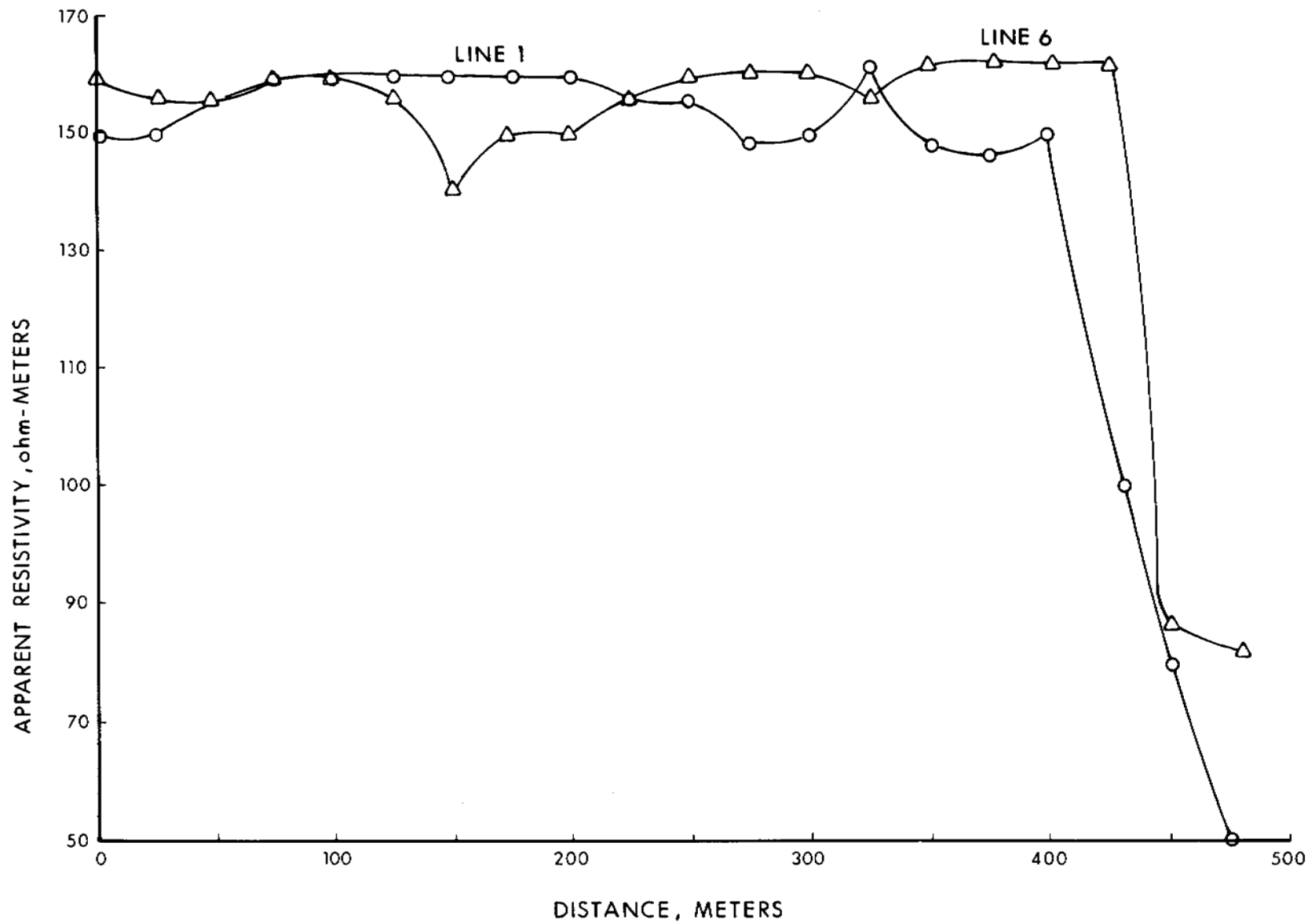
SCALE:
 VERTICAL 1" = 70 M
 HORIZONTAL 1" = 80 M

FIGURE 11

NORTHERN
 Engineering Services
 Company Limited

**NORTHERN ENGINEERING SERVICES
 COMPANY LIMITED**
 CALGARY ALBERTA
 ENGINEERS FOR

CANADIAN ARCTIC GAS STUDY LIMITED



C - 28

PIT No. 5
 CONSOLIDATED CONCRETE
 BEARSPAW PIT

FIGURE 12


NORTHERN ENGINEERING SERVICES COMPANY LIMITED
 CALGARY ALBERTA
 ENGINEERS FOR
CANADIAN ARCTIC GAS STUDY LIMITED