ULAR MATERIAL SOU

INVESTIGATION

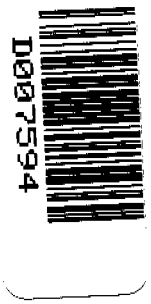
RAE/EDZO, N.W.T.

Granular Program

Northwest
Territories
Engineering Division

GRANULAR MATERIAL SOURCES INVESTIGATION A

RAE/EDZO, N.W.T.



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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The Hamlet of Rae/Edzo, which was incorporated on April 1, 1975, is a mature and growing community of approximately 1,443 people that needs a reliable and convenient source of all types of granular material.

This report presents the results of a geotechnical study, conducted under the objectives and guidelines of the Community Granular Program, to determine the 20-year demand for granular materials and the best means of satisfying that demand.

In summary, the 20-year demand for granular materials in the community is nearly 360,000 cubic meters. This demand is primarily related to the development of a large residential area adjacent to Fort Rae and the maintenance of community facilities.

In general, pitrun granular materials of sufficient quality and quantity to meet the 5-year forecast demand are NOT available in the vicinity of Rae/Edzo.

An examination of supply and demand will indicate that during the 1991/92 fiscal year, there will be a deficit of all grades of granular material from existing sources. Development of potential sources will satisfy the community's foreseen needs to 1994/95 and beyond through the implementation of a large scale "blast and crush" quarry operation. A quarry and stockpile operation, for both select and embankment material, should be implemented during the 1991/92 fiscal year and then continue on an "as and when needed" basis.

Implementation of a Granular Source Management Plan by the Hamlet of Rae/Edzo, based on the technical recommendations of this report and local concerns, is recommended at the earliest possible date.

1. INTRODUCTION

The geotechnical studies undertaken by the Community Granular Section are an integral part of the Community Granular Program. The goals, principles, definitions and methodology of these reports are discussed in this section.

1.1 General

The Community Granular Program, Engineering Division, D.P.W., provides the capital resources for identifying, laboratory testing, developing, and restoring granular sources for all non-taxed based communities in the N.W.T. The objective is to process, stockpile, and manage granular supplies to ensure materials are available for planned community development projects, ongoing maintenance, and private use, at a reasonable cost.

To meet this objective, geotechnical investigations are planned for various communities throughout the N.W.T. and are priorized on the basis of the granular needs in the communities. These needs are derived through an analysis of the 5 year capital plans and the 20 year capital needs assessment of every GNWT Department, the N.W.T. Housing Corporation, the Federal Government and where available, the private sector, as of November, 1989. Highly speculative needs such as resource development projects (i.e. oil and gas) are beyond the scope of these studies.

The intent of this report is to precisely define the community's available granular resources and its granular needs over a 20 year horizon and develop options for the management of those resources that ensure the community's long term needs are met. The report and recommendations will enable the community, through the consultative process, to develop a comprehensive Granular Resource Development and Management Plan that will provide control of the extraction, development, use and restoration of granular resource areas.

1.2 Geotechnical Investigation Procedure

This granular materials study is a multi-phased investigative and assessment process that may be broken down as follows:

Terrain Analysis
- regional setting
- geology and geomorphology
- drainage
- permafrost distribution

Resource Description and Assessment
- review of pertinent information
- air photograph interpretation
- ground reconnaissance and sampling
- material quantity assessment
- material quality assessment
- ground ice and permafrost assessment
- evaluation of all sources
- access routes
- source summary

Granular Needs Assessment
- granular material breakdown
- 5 year needs assessment
- 20 year needs projections
- needs summary

Recommendations
- comparison of resources and needs
- development of options
- development of estimates
- selection of options

1.3 Specifications and Terminology

A number of systems have been devised for classifying granular materials that are based on soil characteristics and engineering properties of the material. The Community Granular Section uses the following standards, criteria and specifications to describe the material in the granular sources discussed in this report. In addition, a Glossary of Terms is to be found following Section 8.

1.3.1 Classification of Soils

The Unified Soil Classification System (USC) is used to identify various types of soils through visual description in situ and in the laboratory and through tests such as Atterburgh Limits and sieve analysis. The USC system is shown on the following page.

1.3.2 Engineering Properties of Materials

Granular materials have been separated into various "types" for the purposes of this report. Each type is based on the intended end use of the material and conforms to the American Association of State Highways and Transportation Officials (AASHTO) specifications, as follows:

Type	Specification
Embankment	AASHTO M 57-80
Sub-base	AASHTO M 57-80
Base	AASHTO M 147-65(80)
Surface	AASHTO M 147-65(80)
Concrete Aggregate - fine	AASHTO M 6-81
- coarse	AASHTO M 80-77(92)

All granular material samples are subjected to standard laboratory tests to ensure conformance with these specifications. The tests are:

- **Washed Sieve Analysis: AASHTO T11-82:**
  Report grain size analysis on standard form showing all calculations, eg. original dry, dry after washing amount retained per sieve and percent error. Use following sieve nest.

100 mm	4 in.	4.75 mm	No. 4
75 mm	3 in.	2.36 mm	No. 8
67.5 mm	2 1/2 in.	2.00 mm	No. 10
50 mm	2 in.	1.18 mm	No. 16
37.5 m	1 1/2 in.	0.60 mm	No. 30
25 mm	1 in.	0.425 mm	No. 40
19 mm	3/4 in.	0.300 mm	No. 50
16.5 mm	5/8 in.	0.150 mm	No. 100
12.5 mm	1/2 in.	0.075 mm	No. 200
9.5 mm	3.8 in.		

- **Dry Sieve Analysis: AASHTO T27-82:**
  Sieve down to No. 4 (4.75 mm) using sieve nest indicated in specification. Prepare grain size curve on standard form.

- **Lab Crushing:**
  Crush to required maximum size using laboratory jaw crusher. Size will be given on sample information.

- **Atterberg Limits: AASHTO T89-81 Method A. T90-81:**
  Report summary list of sample numbers with liquid limit, plastic limit, and plasticity index. Report on standard form.

- **Visual Description and Classification:**
  Give a brief visual description of sample content as per example. Classify the material as per Unified Soils system and AASHTO system including group index. Report on standard form.

- **Natural Moisture Content: AASHTO T265-79:**
  Supply summary list showing sample number and moisture content. Also complete lab data copies.

- **Magnesium Sulphate Soundness, AASHTO T104-77 (1982):**
  Report the loss on each coarse fraction and the total loss by the weighted average based on the grading of the original sample.

- **Los Angeles Abrasion, AASHTO T96-77:**
  Depending on the sample, use the appropriate grading, and report the loss as a percentage.

- **Modified Proctor Standard Proctor, AASHTO T99-81:**
  Report results of five (5) points and prepare proctor curve on standard form.

- **Petrographic Analysis, MTC LS-609:**
  Using coarse aggregate report PN number and flakiness index.

- **Fractured Face Count, MTC LS-607:**
  Report as percentage of original sample mass.
  Refer to AASHTO T4-35, Section 2.

- **Flat and Elongated Particle Count, MTC LS 608:**
  Report as percentage of original sample mass.

- **Hydrometer Analysis: AASHTO T88-81:**
  Supply all lab data and grain size curve. Plot results of grain size on Contractor's standard grain size distribution curve.

- **Washed Sieve Analysis:**
  Minus 0.075 mm: AASHTO T11-82.
  Organic Content: AASHTO T267.

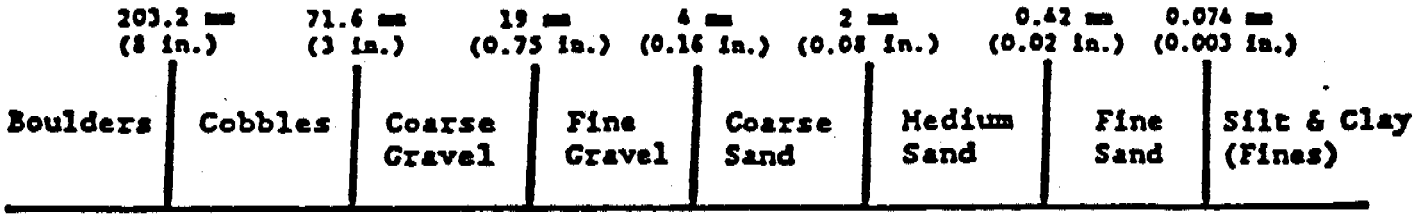
It is important to note that all samples may not have to be subjected to the full range of test procedures.

It should be noted also that ground thermal analysis and the engineering properties of permafrost unique to northern periglacial environments are taken into consideration in all situations.

1.3.3 Environments of Deposition

The properties of any granular material vary with its gradation, moisture content, vertical position in relation to the surface of the ground, and geographic location. Time and climate influence the weathering process of mechanical and chemical disintegration that breaks the material down into progressively smaller particles. The term gradation refers to the relative size of these particles in a deposit.

Size distribution is related to environments of deposition that indicate the texture and composition of a granular deposit. The amount of each size grouping in a deposit is one of the major tools used in judging, analyzing, and classifying a source for use as a construction material. Granular deposits contain particles ranging in size from boulders through clay, as indicated below.



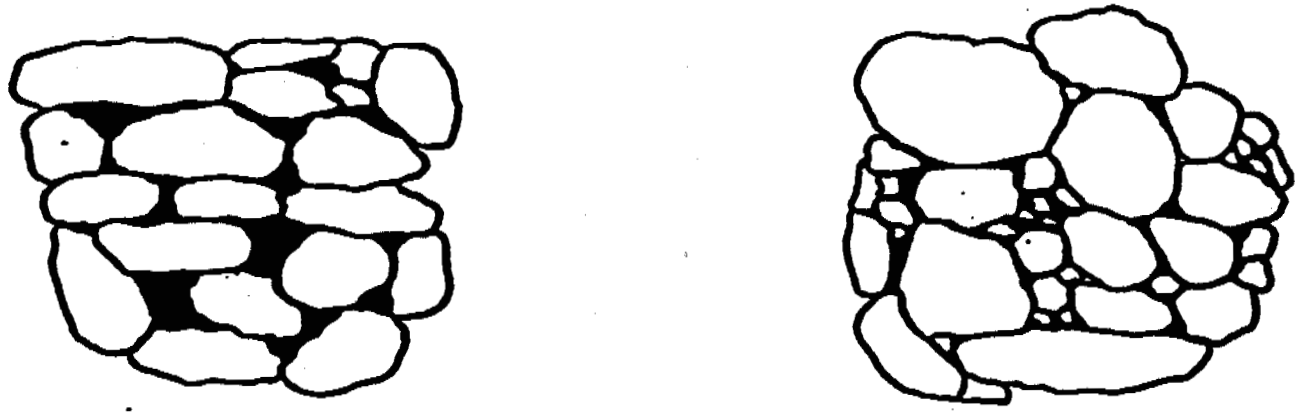
Gravel and sand particles are the most desireable and are found in glacio-fluvial deposits and post glacial beaches. Silt and clay particles, called 'fines', are undesirable over 15 percent because they tend to hold water which in periglacial environments, as in the N.W.T., results in high ice content and greater frost susceptibility. However, a lower limit of 5% is often acceptable to aid in compaction. Fines are often found in deltaic and lacrustine deposits, some fluvial sediments, and tidal flats. Post glacial/fluvial processes during the Quarternary period have also influenced the type of gradation in granular sources in the N.W.T.

Mechanical weathering is the dominant process acting on the rock strata of the precambrian outcrops throughout the N.W.T. Since the regolith produced from the weathering process occur "in situ", most granular deposits in the N.W.T. are "poorly graded" with a high percentage of "oversized" particles.

The suitability of a deposit for construction purposes is directly related to the particle distribution or grain-size curve. This curve indicates if a deposit is "well-graded" or "poorly graded", two terms that are used extensively in this report.

A "well graded" granular deposit has an equal amount of each gravel and sand size and little or no fines. These deposits are referred to as "clean" and are excellent quality materials for "pitrun" construction purposes. Eskers and raised beaches are prime examples of "clean" deposits.

A "poorly graded" granular source has an excess of some particle sizes, a shortage or lack of others, or has nearly all particles the same size. These sources need processing to improve and upgrade their quality. Screening and washing can be used to remove undesirable particle sizes. Talus slopes, alluvial fans, and varved clays are prime examples of this type of deposit found in the N.W.T.



Poorly-graded materials with all particles the same size or with a lack of certain particle sizes (left drawing) have more voids and are less stable than well-graded materials where the voids are filled by the smaller particle (right drawing).

1.4 Volume Estimates

Volumes of granular material sources as described in this study are classified as being proven, probable, or prospective.

A **proven** volume is one where existence, extent, thickness and quality is supported by ground truth information such as a test-pitting, exposed stratigraphic sections, bore hole drilling, and aggressive sampling and ground truth reconnaissance.

A **probable** volume is one whose existence, extent, thickness and quality is inferred on the basis of direct and indirect evidence such as airphoto interpretation, geophysical data, terrain analysis, and limited sampling and ground truth reconnaissance.

A **prospective** volume is one whose existence, extent, thickness and quality is suspected on the basis of limited direct evidence, such as airphoto interpretation, remote sensing information, or imaging radar techniques. There is no sampling or ground truth reconnaissance.

1.5 Restoration and Regulations

Pit planning, design, and restoration are important aspects of granular resource development. Environmentally, the development of any granular sources offers the potential for drainage and erosion problems, habitat destruction, and the disturbance of wildlife. In many communities in the N.W.T., excessive scarring of the surrounding terrain is a major concern. These reports take into account the economic and environmental factors of pit abandonment and reclamation. Guidelines to minimize the impact of pit development and quarry operations are available in the INAC (1982) publication "Environmental Guidelines Pits and Quarries". At all stages of pit planning, design and operation, methods that ensure final pit restoration are stressed.

Permafrost can be expected throughout the N.W.T. and results in a variety of environmentally sensitive problems related to pit abandonment and restoration; thus pit development in permafrost environments must be planned well in advance and special techniques used during the extraction of material.

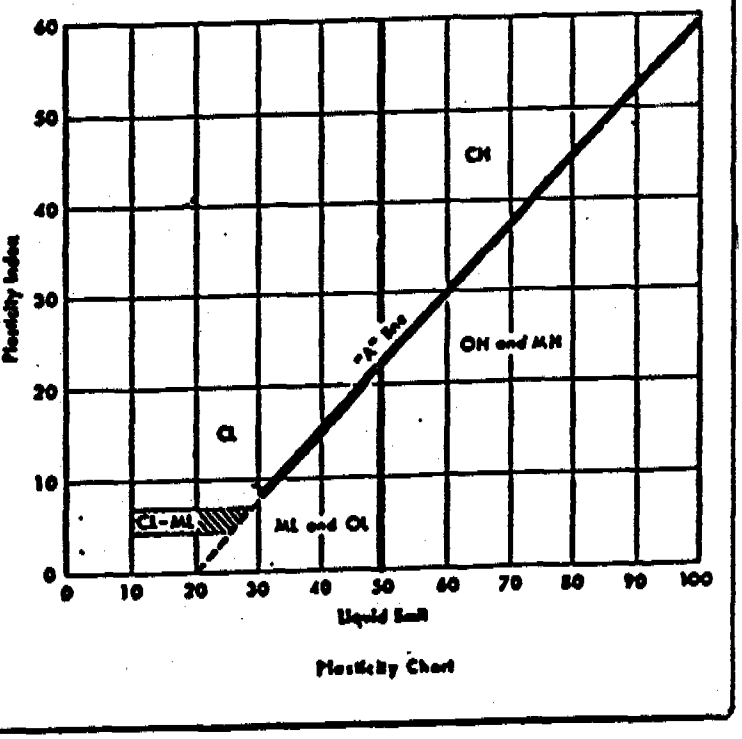
Territorial land use regulations are to be followed in all development plans, without exception, especially in the areas of land use permits, explosives, and pit abandonment.

Unified Soil Classification System

Major divisions			Group symbols		Typical names	Laboratory classification criteria
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$ between 1 and 3
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravels with fines (Appreciable amount of fines)	GM*	d	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 — Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u		
			GC		Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$ between 1 and 3
			SP		Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM*	d	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 — Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u		
			SC		Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL		Organic silts and organic silty clays of low plasticity	
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
			CH		Inorganic clays of high plasticity, fat clays	
			OH		Organic clays of medium to high plasticity, organic silts	
	Highly organic soils		Pt		Peat and other highly organic soils	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 per cent	GW, GP, SW, SP
More than 12 per cent	GM, GC, SM, SC
5 to 12 per cent	Borderline cases requiring dual symbols

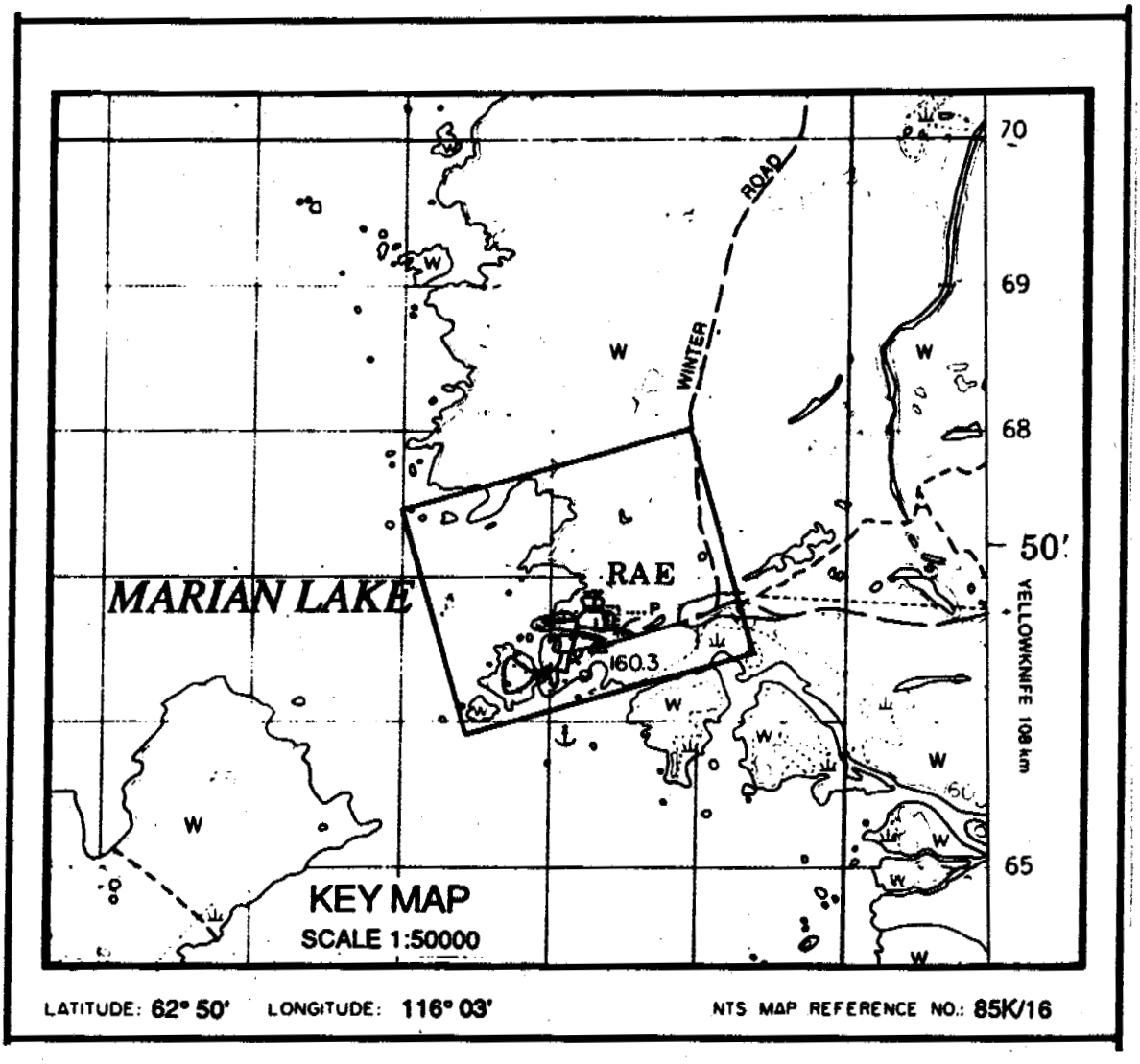


Plasticity Chart

2. TERRAIN ANALYSIS

2.1 Regional Setting

The community of Rae/Edzo is located within the Fort Smith Region of the N.W.T. Rae is 113 air km. northwest of Yellowknife on a rocky peninsula on the southeast shore of Marion Lake. Edzo is located on the east shore of the West Channel which flows between Marion and the North Arm of Great Slave Lake. The Rae/Edzo community is easily accessible via Highway #3 of the MacKenzie Highway System. A site location map is displayed below with geographical co-ordinates and N.T.S. reference as noted.



The community of 1,443 people (June, 1988) is considered the largest Dene community in the Northwest Territories.

2.2 Geology and Geomorphology

Rae/Edzo is located on the boundary between the Slave Structural Province of the Canadian Shield and the extensive Interior Plains physiographic region. Rae is located on a peninsula of hilly rock outcrops and lowlands. Edzo is located on a large plain that exhibits little relief. Elevation at Marion Lake is 156m.

The bedrock of the study area is situated within the Bear Slave Upland Subprovince (Rae) and the Great Slave Plain Subprovince (Edzo) respectively. The Rae area consists of a massive rock ridge complex with a distinct north-south structural trend as viewed below.

The bedrock consists mostly of granites, granitic-gneiss, quartz and diorite. The carbonate bedrock of the Edzo area is overlain by thick Paleozoic strata of sandstone and shale. The age of the rock strata around Rae is Archean whereas around Edzo it is of Cambrian age. Two stratigraphic formations are found around the Edzo area: the La Martre Falls Formation, a green and red soft shale, and the Old Fort Island Formation, a white to grey fine grained quartz sandstone.

The geomorphology of the Rae area consists of massive linear, rock outcrops and large areas of lowlands and marsh. The lowlands are predominantly silty clay lake sediments with the water table near or at the surface, as viewed below.

Edzo is situated on a post glacial lake bottom which is mostly flat to rolling. Glacial drift associated with the most recent Wisconsin glaciation cover the bedrock and rock formations of the study area. The ice sheet advanced across the area from the northeast. Glacial drift includes moraine venner, rolling moraine, drumlinoid moraine, glaciofluvial ridges, and glaciolacustrine deposits. More recent alluvial, colluvial, and organic deposits have developed since the glacier's retreat.

Vegetation within the study area is typical of the boreal forest. Organic peat and fen deposits are situated in low-lying, poorly drained areas. Trees and shrub are found on well drained sites.

The community of Rae/Edzo lies within the discontinuous permafrost zone (note Fig. 1); however, permafrost is widespread within this part of the discontinuous zone.

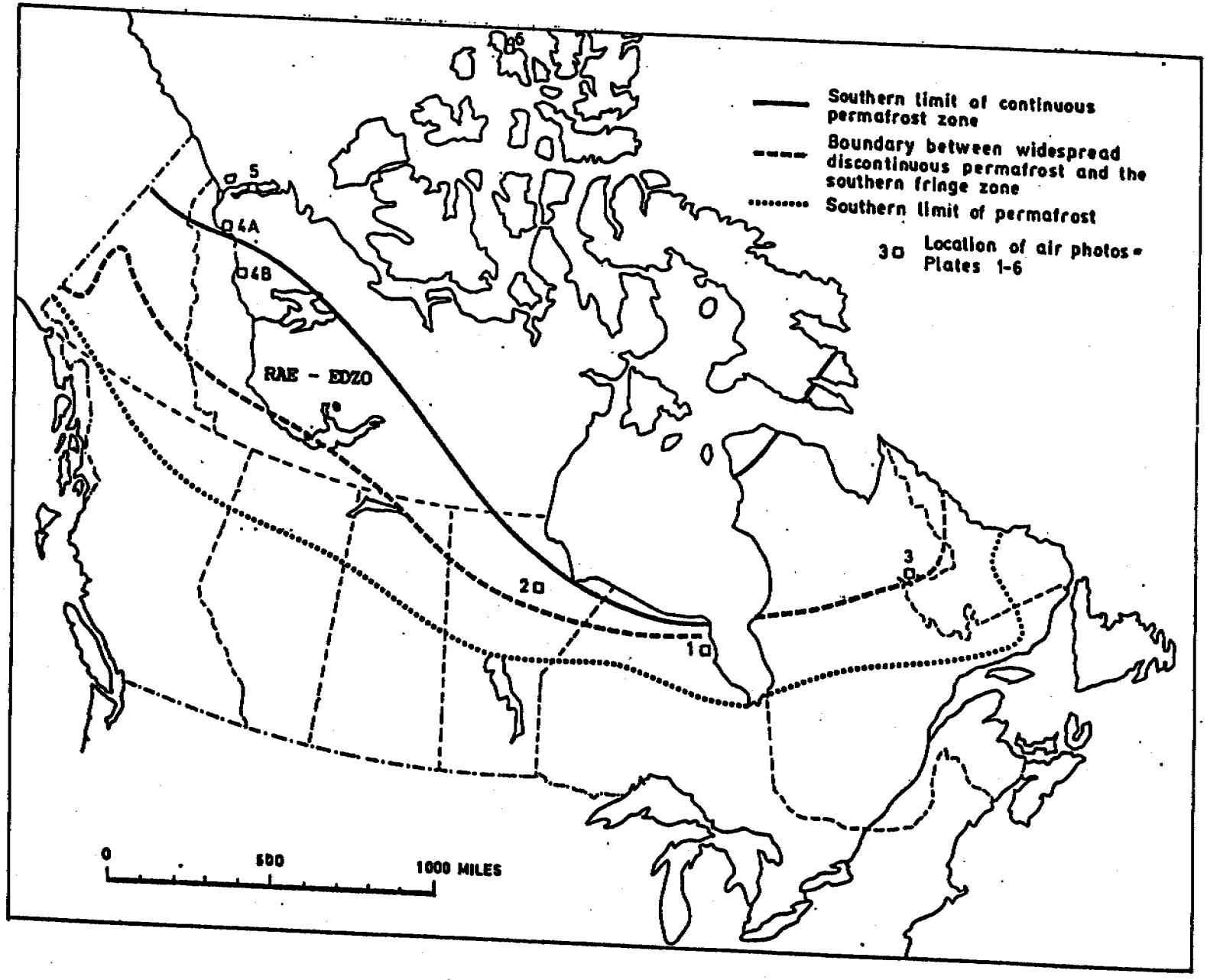


FIGURE 1 PERMAFROST DISTRIBUTION

2.3 Drainage

The proximity of Great Slave Lake and Marian Lake affect the drainage pattern of the Rae/Edzo area. Drainage is mostly north to south or southeast following the structural lineation of the region. Numerous small lakes and ponds are formed in closed bedrock depressions. A combination of lowlands, a high water table, and thick organic deposits produce extensive areas of muskeg and peatlands creating a "blocked drainage" pattern.

2.4 Environments of Deposition

To explain the existing borrow and potential sources of granular material in the vicinity of Rae/Edzo, the processes that have resulted in the accumulation of surficial deposits in the region need to be addressed. With respect to Rae/Edzo, there are two ways in which surficial granular material are formed.

The most widespread type of granular source found in the region is related to glacial materials deposited directly from glacier ice to form glacial drift and morainal deposits. Silty clay till is the sediment most commonly associated with these deposits around the Edzo area and a stoney sandy till is found around Rae. The till is often less than one meter thick within the Rae area and overlie bedrock whereas around Edzo the till is from 1 to 10 meters thick and overlie thick Cambrian rock strata.

A second type of granular source are the glaciolacustrine sands, silts and clay formed in glacial lakes associated with the ice sheet. There sediments can range in thickness from 1 to 10 meters and are found at ground surface throughout a large part of the study area. Where silt and clay are abundant, drainage is poor and thick organic deposits have developed forming large areas of peatland.

3. GRANULAR SOURCES AND ASSESSMENT

This section provides an overview of the various existing and potential granular sources within the study area. Each source is described in terms of location, genesis, volume, engineering properties, and development considerations. Test results are found in **Appendix 2.**

3.1 Existing Sources

There are two borrow sources presently in use in the vicinity of Rae/Edzo. The Russell Lake pit is located approximately 6.5 km. north of Rae. The community has used this large sand and gravel source for a number of years. The Edzo sand pit is located adjacent to Highway #3 approximately one kilometre from Edzo. A crushed stockpile of 19mm material is located at the Frank Channel, 16 km. from Rae.

3.1.1 Crushed Stockpile

At the Frank Channel, just west of the Rae Access and Highway #3 intersection, approximately 4,500 m^3 of crushed 19mm material remains for use by the community. The stockpile is about 16 kilometres from the Hamlet of Rae/Edzo.

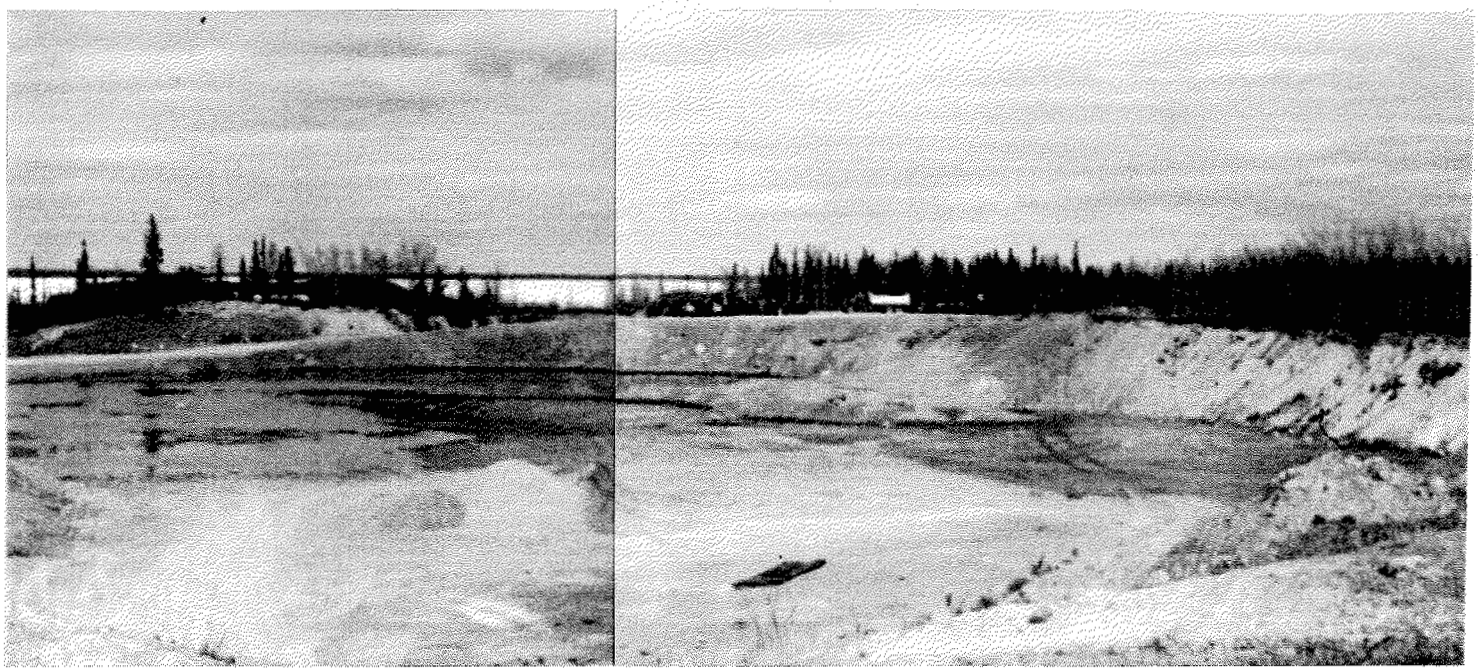
3.1.2 Russell Lake Pit

Description/Genesis:

This source represents a large glaciolacustrine sand and silt deposit adjacent to Marian Lake. Recent post glacial accumulations of organic and colluvial sediments have covered the deposit. The source is located 6.5 kilometres north of Rae along a good, all season, access road. Continual excavation has resulted in a large spreading pit. Material composition and texture changes with depth and geographic location. The pit is well drained in northwest and southern areas but ponding has developed in the central and eastern sections of the pit as seen in the photograph on the following page.

Quantity:

The pit is large - over 500 meters in length and 200 meters in width; however, the deposit is mostly depleted in the south and central sections, with excavation occurring in the north and northwest corner of the pit. It is estimated that approximately 8,000 m^3 of sand and gravel remain in this area of the pit.



Russell Lake Pit view looking directly north - note ponding.

Russell Lake Pit view looking directly west. Q_1 in background.

Test Results:

The estimated volume of 8,000 m^3 was based in part on numerous test pits that were dug throughout the northwest corner as viewed below. Sample 2-106-90 was obtained from the test pit seen below; sample 1-106-90 was obtained from the central area of the pit. Sample 02-106-90 contained 62% gravel, 37% sand and 1% sand. Sample 01-106-90 was taken from an area of the pit only 150 meters from sample 02-106-90, yet contained only 5.5% gravel, with 90.5% sand and 4.0% fines. The material to the northwest is a well graded gravel whereas the rest of the pit contains a poorly graded fine grained sand. Note cross section #2-106-90, Appendix 2.

Development Considerations:

This site should be used until depletion as a source of embankment and subbase material owing to its proximity to the community, available access, and proven volume. Excavation should continue in the northwest corner. The community has used this site for a number of years and it would seem logical to continue to excavate this source till depletion. Eventually, development will be restricted in the west because of a large continuous rock ridge and in the north because of Marian Lake. The area to the east has potential but the community has restricted land development in this area.

3.1.3 Edzo Sand Pit

Description/Genesis:

This source represents a large glaciolacustrine sand deposit overlain by a thin layer of silty clay till. The sand was reworked by modern post glacial beach processes related to the erosional and depositional phases of Great Slave Lake.

Quantity:

The pit is mostly depleted to the east and north but has been re-opened to the west. Approximately 6,000 m^3 of sand exists in various small stockpiles throughout the pit. One such stockpile can be viewed below. The view is from the middle of the pit looking northeast.

Test Results:

Sample 7-106-90 was removed from one of the numerous small stockpiles located randomly throughout the pit. Sample 7-106-90 consisted of 13.5% gravel, 85.0% sand, and 1.5% fines. The material is a poorly graded sand with little binding or compaction properties. Approximately 50% passed the No. 4 sieve (fine sand).

Development Consideration:

Even as a general fill, the Edzo sand pit has little value as a granular source. The material could be used as a "blend" source for crushing or in combination with another "pitrun" source for construction purposes.

3.2 Potential Sources

Potential sources of "pitrun" granular material in the vicinity of Rae/Edzo are limited with respect to quality and quantity. However, access to sources is fair to good along winter or all season roads or existing cut-lines.

3.2.1 Site 1 / Site 2

Description/Genesis:

Sites 1 and 2 are located approximately 3.2 kilometres and 1.8 kilometres along a cutline trail north and slightly east of Rae. They are part of a ridge complex that is covered by thick glacial till (note Source Location Map). Site 1 is over 2 meters higher than the surrounding terrain which is highly saturated with water. Thick vegetation covers the ridge. The material is mostly a stoney, sandy till. Boulders and cobbles cover the ridge and were found throughout the test holes. Site 1 is seen below. The view is northeast.

Site 2 is about 3 meters higher than the surrounding terrain and covered with boulders up to 100 centimeters. Vegetation on the ridge is dense. Again the material consists mostly of a stoney, sandy, till. A view of Site 2 is seen below. The view is directly west from the junction of two cutlines (note Source Location Map). Note cross-section #8-106-90, Appendix 2.

Quantity:

Several test holes were dug along both Sites 1 and 2. There is approximately 30,000 m^3 of material along Site 1 and 35,000 m^3 at Site 2. Unproven volumes are probably much higher.

Test Results:

Sample 8-106-90 was extracted from Site 2. Results indicated a poorly graded sand with cobbles and boulders. Numerous test holes were dug on both ridges in December, 1979 and results indicated that the material consisted of poor to well graded sands with large pebbles and cobbles. Generally, test results indicate that this material would be suited as "pit-run" embankment or sub-grade fill.

Development Considerations:

These sources of potential borrow would only be accessible in winter along a winter road. Material would have to be hauled to the community and stockpiled. Further processing would be necessary to produce select grades; however, the material could be used directly as embankment and general fill. However, the material is not suitable for direct placement on the silty clay terrain that surrounds the community of Fort Rae. An environmental consideration is that an average thickness of the deposit is less than 2 meters before bedrock was encountered. This would indicate that to remove a substantial quantity of material, the size of the quarry would be large and extensive. Site restoration should be an important factor with respect to the development of these sources.

3.2.2 Mosquito Creek Pit

Description/Genesis:

This source is located at kilometer 223 adjacent to Highway #3, north ride, and is approximately 30 kilometers from Rae. This is an abandoned pit that was active ten to fifteen years ago, and represents a large area of rolling moraine and glaciofluvial ridges. The pit is split in two by a small ridge. The western sector of the pit is seen below; it is extensive and shallow with numerous small stockpiles. Note cross-section #5-106-90, Appendix 2.

The eastern area of the pit is seen below and consists mostly of a large ridge covered by glacial till and fluvial deposits. The entire pit is well drained and terraced.

Quantity:

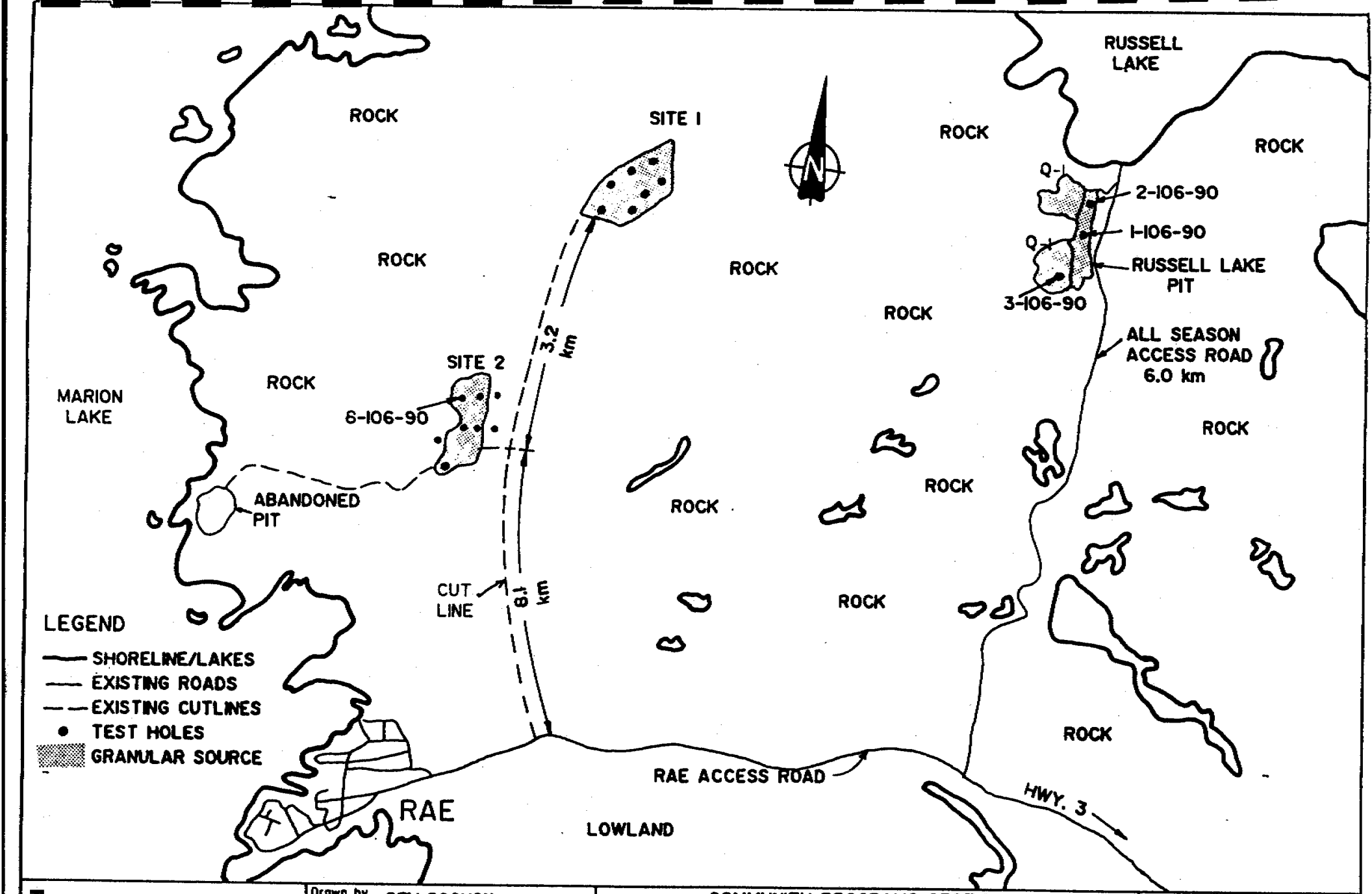
The eastern area of the pit contains approximately 6,000 m^3 of coarse granular material. The western sector has about 5,400 m^3 of material. However, the total of 11,400 m^3 should be considered conservative as unproven estimates indicate the total volume would be much higher.

Test Results:

Sample 5-106-90 was extracted from the western area of the pit. The sample contained 43.0% gravel, 55.0% coarse sand, and 2.0% fines. The western area of the pit contained a great deal more oversize material of cobbles and boulders. This area would be an excellent site/source for "crushing".

Development Consideration:

The major consideration is distance. This source is 30 kilometers from Rae and 14 kilometers from Edzo. However, there is excellent access to the pit, and Highway #3 provides an all season route to both Rae and Edzo. The pit can provide suitable "pit-run" embankment and sub-base material, and would be an excellent source for a crushing or screening operation to produce select grades. Also, the pit can be expanded beyond its present boundries with minimal cost and effort.



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Northwest Territories Public Works

Drawn by	BEV ROCHON
Checked by	
Approved by	
Date	OCT. 1990
Scale	1:25000

COMMUNITY PROGRAMS SECTION
ENGINEERING DIVISION

SOURCE LOCATION MAP
RAE, N.W.T.

REVISIONS	
Date	By
Drawing No.	Fig 1

3.3 Quarries / Bedrock Sources

There are a number of excellent quarry locations within the vicinity of Rae due to the extensive outcropping of bedrock throughout the study area. The report will concentrate on three specific locations that would be suitable for a major blasting / crushing / quarry operation.

3.3.1 Site Q_1

The entire western boundary of the Russell Lake Pit consists of a massive, exposed, bedrock complex that would be ideal for a proposed rock quarry operation. Q_1 is viewed below. Q_1 is actually a series of large bedrock outcrops that extend along the length of the western boundary of the Russell Lake Pit (note Source Location Map).

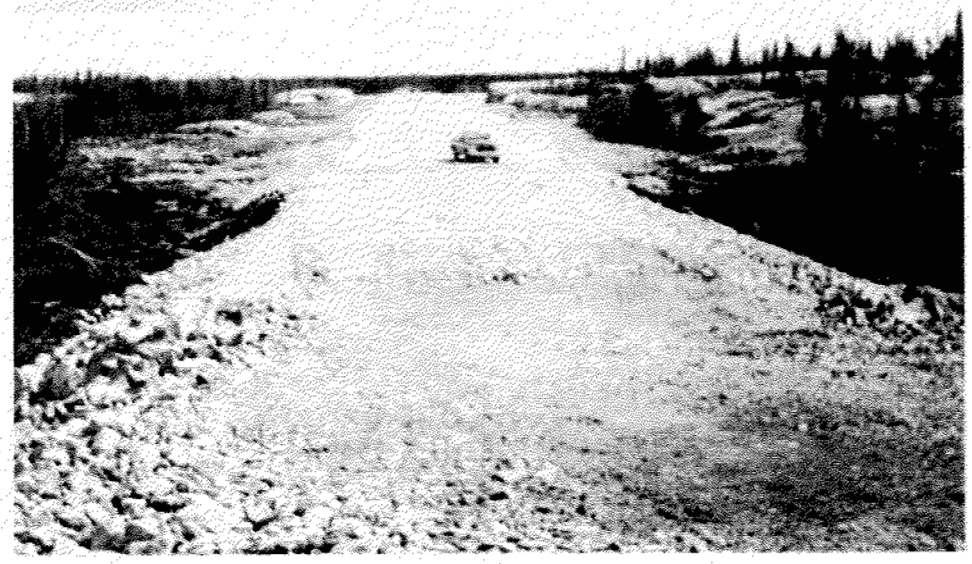
The southern area of Q_1 consists of a large rock outcrop as seen in the photo above approximately 70 meters x 60 meters, if just an average lift of 5 meters is considered, this area would provide approximately 21,000 m^3 of material.

The northern sector of Q_1 is seen below and lies directly behind the area of the pit presently under excavation. This area is over 200 meters x 80 meters and with an average lift of 5 meters would provide approximately 80,000 m^3 of material. This estimate should be considered conservative.

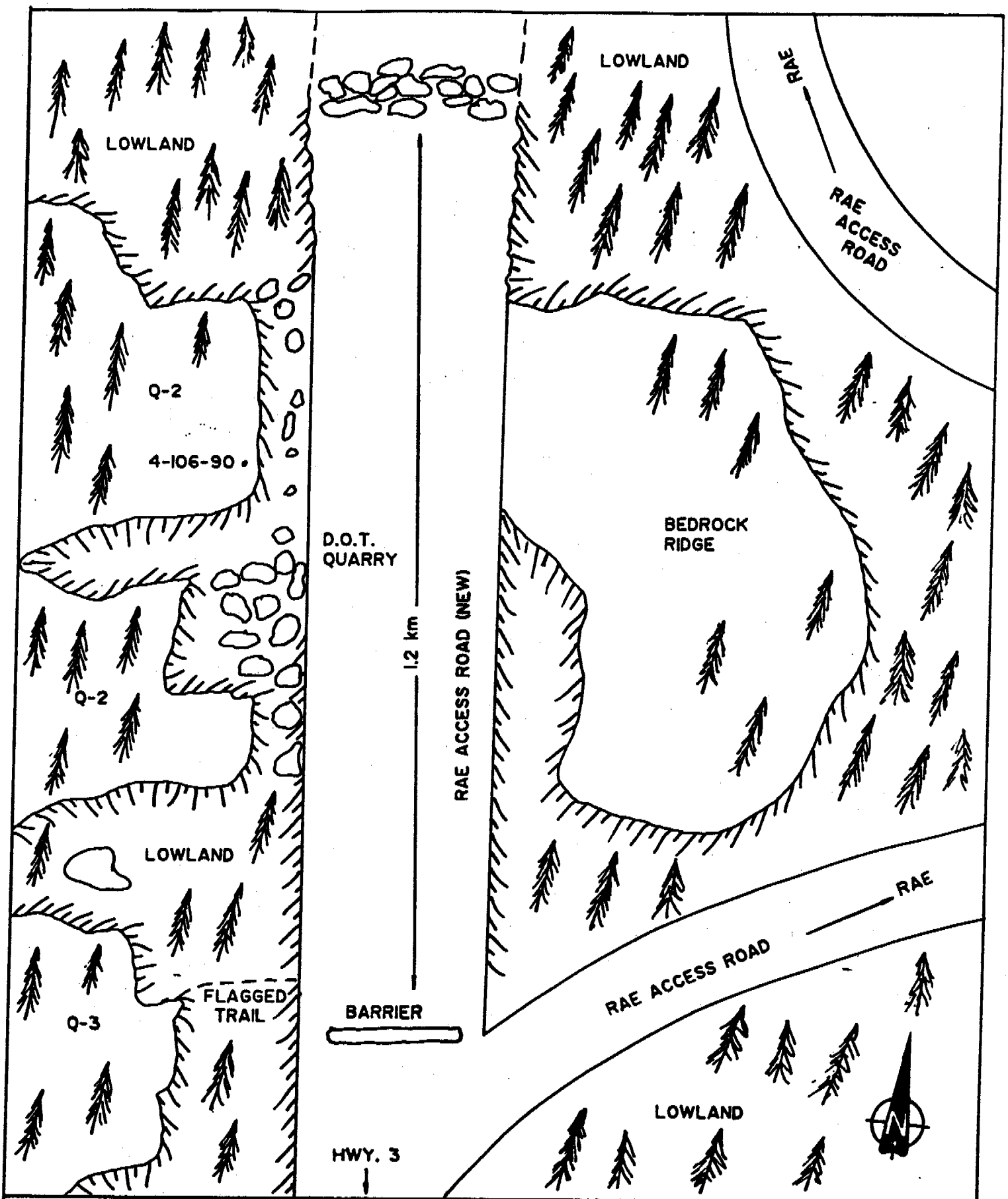
Rock samples taken from Q_1 indicate an abrasion rate of only 11.2% and a soundness percentage weight loss of 0.6%. This indicates an excellent blasting and crushing material. Once crushed to 19mm, the material produced a well-graded gravel.

3.3.2 Site Q_2

An overview of the newly constructed Rae access road is seen below. The road was built using blasted rock from local quarries along it's length as seen in Fig. 2.



The Q_2 area is approximately 0.6 kilometers along the new access road; just directly to the right of the truck in the above photo. The ridge outcrop is massive, extending over 140 meters to the south and over 90 meters in width. A close-up of Q_2 is viewed below. (Note Fig. 2.)



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Date	By

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ENGINEERING DIVISION

RAE ACCESS ROAD Q-2, Q-3
RAE, N.W.T.

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Drawn by	Date	Scale	Drawing No.
BEV ROCHON	OCT. 1990	N.T.S.	FIG. 2

With an average 5 meter lift, this location would produce over 63,000 m^3 of material (140m x 90m x 5m).

This area was previously quarried to produce the material for the construction of the new access road as viewed in the two photographs on the proceeding page.

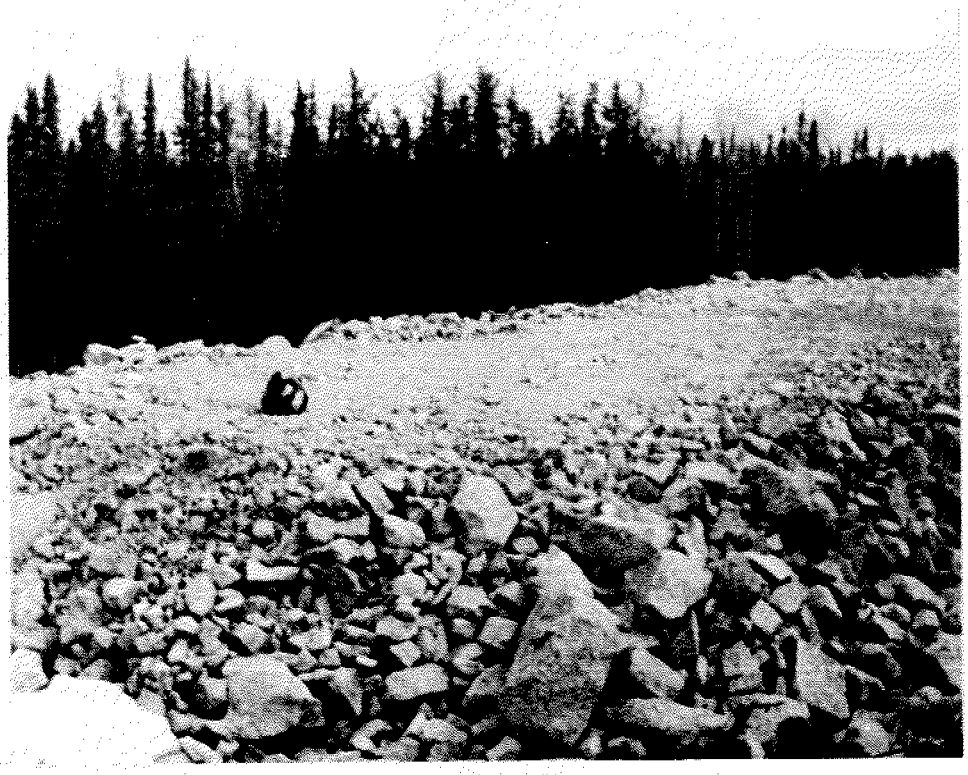
Sample 4-106-90 indicates that the rock of Q_2 has a low abrasion rate, 11.8%, and a soundness percentage weight loss of only 0.5%. This represents an excellent blasting and crushing rock. Once crushed to 19mm, the material produced a well graded material of 80% gravel, 18.5% sand, and 1.5% fines.

3.3.3 Site Q_3

This source is similar to Q_2 as it is part of the same bedrock outcrop complex. However, it is located at the junction of the old and new access routes to Rae and provides an alternate site to Q_2. A view of Q_3 is seen below. (Note Fig. 2)

This large ridge is approximately 50 meters west from the junction, on the same side as Q_2, and is approximately 100m x 100m in area. With an average lift of 5 meters, Q_3 can provide approximately 50,000 m^3 of material.

Q_2 = 0.6 kilometers, west side, new Rae Access Road



Blasted material from Q_2 was used in the construction of the Rae Access Road

4. SITE INFORMATION SUMMARY

The following table is an inventory of all existing and potential granular resources in the vicinity of Rae/Edzo. Associated with each site is the U.S.C., distribution, volume, grade, and processing required. Samples were taken when and where possible; test results are available for viewing in Appendix 2.

4.0 TABLE 1: GRANULAR INVENTORY, RAE/EDZO 1990

SOURCE	USC	DESCRIPTION	VOLUME (m3)	GRADE	PROCESSING
Franklin Channel	GW	Crushed 19mm	4,500	Select Grades	Nil
Russell Lake Pit	SP-GW	Poorly to well graded gravels and sand	8,000 (proven)	Embankment & Subbase	Pitrun
Edzo Sand Pit	SP	Poorly graded coarse - fine sands	6,000 (proven)	Blend	Blend Source for Pitrun
Site 1	SP	Poorly graded sands & gravels	30,000 probable	Embankment (marginal)	Pitrun
Site 2	SP	Poorly graded sand, large percentage oversize	35,000 probable	Embankment (marginal)	Pitrun
Mosquito Creek	SP	Poorly graded sand and gravel, high percentage oversize	11,400	Embankment & Select Grades	Pitrun / Screen / Crush
Q1	GW	Bedrock Quarry	100,000+	Embankment & Select Grades	Blast and Quarry Operation
Q2 & Q3	GW	Bedrock Quarry	113,000+	Embankment & Select Grades	Blast and Quarry Operation

5. GRANULAR RESOURCE EVALUATION

5.1 Supply and Demand (Note Appendix 1)

As shown in Table 1, the total amount of granular material from all EXISTING sources is approximately 15,500 m^3 of which 10,000 m^3 (1990 data) is considered embankment and subbase and 4,500 m^3 (1989 survey) select. Material from the Edzo sand pit was partially included as this deposit should only be considered as a source of "blend".

TABLE 1

AVAILABLE MATERIAL / EXISTING SOURCES

Existing Source	Grades (m^3)		Totals (m)
	Embankment/Subbase	Select	
Frank Channel		4,500	
Russell Lake Pit	8,000		
Edzo Sand Pit	3,000		
Total cu. m.	11,000	4,500	**15,500**

Of a total ten year forecast demand of approximately 242,990 m^3 of granular material between 1990 and 1999, there is available approximately 15,500 m^3 of material within the vicinity of Rae/Edzo for use in local capital projects, at the beginning of 1990/91 fiscal year. Please note Appendix 1 for granular needs assessment data/information.

Table 2 is a summary of the material requirements (from needs assessment tables - Appendix 1) for all proposed capital projects from 1990 through 1999.

TABLE 2

MATERIAL REQUIREMENTS (m^3)

YEAR	EMBANKMENT/SUBBASE		SELECT	
	Increment	Cumulative	Increment	Cumulative
1991/92	18,400	18,400	7,750	7,750
1992/93	10,900	29,800	6,175	13,925
1993/94	9,800	39,100	4,800	18,725
1994/95	5,300	**44,400**	5,175	23,900
1995/99	69,720	114,120	57,770	81,670

An examination of supply and demand will indicate that during the 1991/92 fiscal year, there will be a deficit of all grades of granular material from existing sources.

91/92 Embankment/Subbase (m^3)	91/92 Select Grades (m^3)
11,000 (existing) - 18,400 (required)	4,500 (existing) - 7,750 (required)
= -7,400	= -3,250

It is obvious that even if the material needs for granular materials are not 100% realized, there will exist a major deficit of embankment/subbase material during the 91/92 fiscal year. Select grades will also be depleted but not to the same degree. Future requirements of all grades of granular material during 91/92 in part, and definitely beyond 91/92, will certainly have to be met by the development of potential sources. These sources will have to be adequate to provide for over 44,000m^3 of embankment and subbase and 24,000 m^3 of select material between the years 1991 and 1995 just to satisfy the short term granular needs of the community, if the total material needs are 100% realized.

5.2 Rae Access Road

The Department of Transportation will continue to re-construct the Rae Access Road from the present position just north of Q_2. The route has been surveyed, as viewed below.

Construction will begin during the 1991 field season. A number of large rock outcrops will be "blasted" to provide material for the road and for "right-of-way".

It is recommended that the development of any quarry related to the production of granular material along the access route - including Q_2 and Q_3 - should be discussed with representatives of DOT as the projects are closely connected.

5.3 Assessment

Development of identified potential sources will be required to satisfy the long term granular needs of the community. The study indicates that potential sources of "pitrun" within the vicinity of Rae/Edzo will not satisfy the volume demand for embankment/subbase material. As well, identified sources lack the quantity and quality necessary for the cost-effective production of select grades.

The present study concludes that a "drill/blast/crushing" operation is necessary to produce and stockpile the required grades of granular material for use in local capital projects.

Approximately 25,000 m^3 of material should be produced and stockpiled to satisfy the immediate needs of the community. A "quarry blast" operation can then be continued on an as-needed basis to satisfy the high volume demand for embankment/subbase material.

6. COST ESTIMATES

The following preliminary cost estimates are related to the production of granular material from bedrock and "pitrun" sources in the vicinity of Rae/Edzo. The estimates involve the mobilization, hauling, site development, and/or drilling, blasting, crushing, and blending to generate specific volumes of various grades of granular material. Unit price bid summaries from the Hamlet of Rae/Edzo, Stan Dean and Sons, Robinson's Trucking and Curry Construction were AVERAGED to achieve a production cost per meter.

6.1 Mosquito Creek - Load, Haul and Stockpile

A preliminary cost estimate to haul and stockpile 11,000 m^3 of embankment and subbase material the 30 kilometers from the Mosquito Creek Pit to Rae, is approximately $300,630 or **$27.33 m^3**. This material could be stockpiled in Rae as a source of embankment and subbase or as an ideal source for "crushing" to produce a select grade. By extending the pit boundaries, upwards of 15,000 m^3 could be excavated. The haul could be completed during the summer or fall months and is based on the use of 6 twelve metric trucks, a haul time of 83 minutes, and a 12 hour shift. A haul to Edzo would be one-half the price but the majority of future capital projects are centered around the Rae community.

6.2. Site 1 / Site 2 - Winter Load, Haul and Stockpile

A preliminary cost estimate to winter excavate, haul and stockpile 50,000 m^3 of embankment material from Site 1 and Site 2 is approximately $378,500 or **$7.60 m^3**. However, this material is not suited for direct placement on the silty clay sediments of the lowland areas that surround Rae. Blasted rock greater than 30 centimeters (12") should be used as a base similar to the construction profile of the new Rae Access Road. The haul would have to take place in winter and is based on the use of 6 twelve metric trucks, a haul time of 6 minutes, and a 12 hour shift. At best, the material could only be used as general fill over bedrock or wherever ground conditions allow direct placement.

6.3 Russell Lake Pit - Load, Haul, Place and Compact

Historically, the unit price averages between **$7.00 - $12.00/cubic metre** depending on the size of the project and volume of material needed.

6.4 Drill, Blast, Crush and Stockpile

A preliminary cost estimate to quarry and crush the bedrock outcrops in the vicinity of Rae/Edzo to produce 25,000 m^3 of all grades of granular material is approximately $587,000 or **$23.48 m^3**. The work would involve drilling and blasting the bedrock in a 4 ft. x 4 ft. x 10 ft. deep pattern (1.82m x 1.82m x 3m) to produce different sized material. The granular material would be "sized" to produce three stockpiles. All material greater than 6" (150mm) would be used for embankment and subbase. Material less than 6" (150mm) would be crushed to produce 2" (50mm) and 3/4" (19mm) select grades. A "drill and blast" operation could produce large quantities of embankment material, depending on the hole pattern and type of explosive used, on an as-and-when needed bases.

7. RECOMMENDATIONS

It is recommended that, as soon as possible, the Municipality of Rae/Edzo implement a Granular Resource Development and Management Plan based on this report and modified as is appropriate by legitimate local concerns that are properly beyond the scope of this report.

The specific technical recommendations of this report are:

1. Continue to use the existing sources (NW corner, Russell Lake Pit) until depletion which is expected to be in 1990/91, for all grades of granular material.

2. Develop a "quarry and crushing" operation during the 91/92 fiscal year to produce 25,000 m^3 of all grades of granular material. A quarry location should be localized and restricted to either the western side (Q_1) of the Russell Lake Pit or along the newly constructed Rae Access Road (Q_2, Q_3). The material should be "sized" to produce embankment, as well as 25mm and 19mm grades.

3. Once a stockpile of material has been established, a quarry operation should be continued on an as-and-when needed basis to supply the long term granular volume for embankment material required for future capital projects.

4. The Mosquito Creek Pit can provide upwards of 11,000 m^3 of embankment/subbase material or provide an excellent granular source for crushing. This deposit should be used as a sole source for a major capital project in the vicinity of Edzo, as the cost/m^3 to haul to Rae is considerably higher.

5. It is not recommend to develop Site 1 or Site 2 at this time. These sources would not provide an adequate quality of material; however, it may be necessary to consider these deposits in future years of fiscal restraints.

6. Since the requirements beyond 1995/96 are uncertain, review and reconsider source potential and requirements in 1994/95.

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GLOSSARY OF TERMS

Active layer:	the layer of ground in permafrost which thaws each summer and refreezes each fall.
Alluvial fan:	fan shaped mass of alluvial deposits shed by fluvial activity from mountain streams.
AASHTO:	American Association of State Highways and Transportation Officials, used almost exclusively by the several state Departments of Transportation and the Federal Highway Administration in earthwork specifications for transportation lines.
Archean:	a Precambrian time-strategraphic classification; the oldest eon within the Precambrian, 2,480 million years.
Blocked-drainage:	a distinct beaded or feathered drainage pattern due to the presence of poorly drained soils in permafrost regions.
Colluvial sediments:	sediments transported and deposited through the process of mass wasting (i.e. by gravity).
Continuous permafrost zone:	an area underlain by permanently frozen subsoil.
Crushed Rock:	is produced by passing blasted bedrock or pitrun through a mechanical crusher to produce angular fragments.
Deltaic deposits:	deposition of sediments by rivers in low energy environments, characterized by well-developed cross-bedding and sands, silts and clays.
Detritus:	the accumulation of non-stratified rock fragments through the weathering of large rock outcrops in situ.

Lacrustine deposits:	silts and clays deposited in lake water and later exposed either by the lowering of the water level or by the elevation of the land.
Mass Movement:	surface movements of earth materials caused primarily by gravity; known also as Mass Wasting.
Mechanical weathering:	relates to the physical breakdown of rocks, at or near the earth's surface, by external processes (such as wind and water).
Metamorphism:	extensive change of rocks or mineral due to great changes in temperature, pressure, and chemical environment.
Organic Layer:	that portion of the soil which contains decomposed or partially decomposed vegetation.
Outwash Plan:	a broad, gently sloping sheet of outwash deposited by melt water streams flowing in front of or beyond a glacier.
Oversize Material:	this refers to rock particle size as gravel particles larger than 75 mm (3") in diameter are usually considered to be too large to be used for most geotechnical uses.
Peat:	unconsolidated compressible material consisting of partially decomposed remains of plants.
Periglacial environment:	depositional and erosional environments modified by cold climates (subglacial).
Permafrost:	the thermal condition in soil or rock where temperatures below 0° C persist over at least two consecutive winters and the intervening summer.
Permafrost Table:	the interface between the active layer and permafrost zone.

Drumlin:	rounded streamline mounds of till.
Environment of deposition:	the lithology, composition, and diversity of all granular deposits are directly related to part and modern depositional and erosional environments.
Eskers:	a long narrow, winding ridge composed of stratified accumulations of sand and gravel produced from subglacial streams; eskers are aligned with the flow of retreating glaciers or ice sheets.
Frost Susceptible Soil:	soil in which significant ice-segregation will occur, resulting in frost heave, or heaving pressures, when requisite and freezing conditions exist.
Frost wedging:	water expanding as it freezes widens crevices in well-bedded or well-jointed rock and shatters it.
Glacial Till:	unstratified glacial drift deposited directly by the ice.
Ground-truth reconnaissance:	the physical act of acquiring data on the ground to prove geological assumptions.
In-situ:	the natural undisturbed soil or strata of weathered material in place.
Isostatic Rebound:	the upward movement of the earth's crust to achieve a general equilibrium as the great weight of the continental ice sheets decrease.
Kame Terrace:	a steep-side, constructional terrace consisting of stratified sand and gravel formed as a glacio-fluvial deposit between a melting glacier or a stagnant ice lobe and a higher valley wall or lateral moraine.

Pitrun:	unprocessed gravel containing a minimum of 35% coarse aggregate larger than #4 sieve.
Raised beaches:	beaches formed during times of high water level and then stranded by the lowering of the water level or by the elevation of the land.
Regolith:	unconsolidated mantle of weathered rock and soil material on the earth's surface.
Solifluction:	in subarctic regions, fine rock fragments when saturated with water, spread slowly down slope and along valley floors.
Syncline:	a trough or downfold in the rocks.
Talus slope:	the accumulation of small fragments (scree) in the millimeter-to-meter range from cliffs or steep walls that maintain a uniform slope (commonly about 30°) as it grows.
Territory Land Use Regulations:	provides regulatory control for maintaining sound environmental practice for any land use activity on all lands under Federal control in the territories.
USC:	United Soil Classification System, used for foundation engineering such as dams, buildings, road earthwork specifications, and airfield design.
Varved sediments:	distinct band representing the annual deposit in sedimentary materials.
Wisconsin glaciation:	the latest of the various ice sheets of the Pleistocene epoch, approximately 10,000 years ago.

APPENDIX 1

Granular Needs Assessment Tables
Tables 2 - 9

Appendix 1

GRANULAR NEEDS ASSESSMENT

As previously indicated, the granular requirements for Rae/Edzo have been developed from each G.N.W.T. Department's 5 year capital plan and 20 year capital needs assessment, as well as information from the NWTHC, Federal Agencies and the private sector. The various projects were analyzed for their granular requirements and this information was used as the basis for establishing a 20 year granular needs projection by the type of materials required.

The information upon which this report is based is as accurate as could be found in November, 1989. To revise it and the conclusions drawn from it to keep them up to date has been impossible. Therefore, comparison with the approved capital plan for 90/91 will certainly show differences. However, the objective has been to make a reasonable assessment of needs for granular materials in Rae/Edzo for the period noted. Since the changes brought about each year by the capital planning process will tend to reduce the quantities required and, to some extent the substitution of one project for another will probably have a relatively small effect on the totals, this approach is considered fair and reasonable. Furthermore, continual surveillance of the sources and the quantities extracted will show when additional sources must be developed.

The analysis shows that Rae/Edzo requires approximately 243,000 m^3 of granular materials for fiscal years 1990/91 through 1998/99. This information is shown in part on the following pages, as is a summary of the projected requirements for fiscal years 1998/99 through 2000/2009. Detailed information for this later period is available from office files. If consulted, the data should be considered rather speculative at best.

For the purpose of this report, granular materials have been separated into five major types: embankment, subbase, base, surfacing and concrete aggregate. However, base, surfacing, and concrete aggregate are often referred to collectively as "select grades". The reason for this is that embankment and subbase materials are often used directly from a source as "pitrun" while select grades are obtained through the processing of the material by washing, screening or crushing.

Table 2 represents the granular material breakdown of capital projects that was used to develop this section of the report. This information was then used to derive the granular needs assessment tables for individual fiscal years displayed in Table 3.

TABLE 2: CAPITAL PROJECTS

Granular Material Breakdown
(in cubic metres)

Description	Embankment	Sub Base	Base	Surface Material	Concrete Aggregate	Riprap
Warehouse		900	450	300		
Group Home		500	175	300		
Solid Waste Facility	9000		3750	2250		
Solid Waste Facility/ Access (1 km.)	13900		1300	200		10
Solid Waste Improvements	6000		2500	1500		
Water Supply Improvements	6000		2500	1500		
Water Supply - Reservoir	30000	10000	10000			
WS-Facility Access	10000		5000	3000		
R/S/L - Lot Development (1 lot)		180	80	100		
R/S/L - New Road (1 km.)	4900		1300	1200		100
R/S/L - Resurfacing (1 km.)	600		200	1200		50
R/S/L - Road Upgrade (1 km.)				1000		
Staff Housing		400	175	200		
Single Unit (Satellite base)		300	100	200		
Duplex		500	175	200		
4-plex		675	225	200		

Description	Embankment	Sub Base	Base	Surface Material	Concrete Aggregate	Riprap
In town gas station		600	200	200	50	
Garage x 2 Bay x 3 Bay		600	200	200	50	
Firehall		350	100	200	50	
New School		400	100	200	200	
School Addition		200	50	100	100	
Museum - Low$		200	50	100	100	
Small Community Hall (250m²)		300	100	200		
Medium Community Hall (390m²)		500	175	200		
Large Community Hall (440m²)		675	225	200		
Hamlet Office		500	175	200		
Small Gym (250m²)		300	100	200		
Medium Gym (390m²)		500	175	200		
Large Gym (440m²)		675	225	200		
Medium Arena		675	225	200		
Trade Shop		300	100	200		
Small Arena		500	175	200	100	
Skating Rink		500	175	200	100	
Airstrip - New 60 x 900	81000		16200	5400		
Airstrip - Upgrade Maint/year				1700		
Airstrip - Resurface 60 x 900				5400		

Description	Embankment	Sub Base	Base	Surface Material	Concrete Aggregate	Riprap
Tankfarm - new facility	3000		2000	3000		
Tankfarm - upgrade	300	300	300			
Tankfarm - facility & access	6000		2000	6000		
Increase capacities	6000		2000	6000		
Shoreline Protection				600		4000
Sewage Lagoon	100,000m^3					
Office - small	Duplex	500	175	200	(visitor centre)	
Office - large	4-plex	675	225	200		
Arena - large		850	275	200		
Park Development (Low$)	600		200	1200		50
(High$)	4900		1300	1200		100

TABLE 3
GRANULAR NEEDS ASSESSMENT
RAE/EDZO CAPITAL PROJECTS ESTIMATED MATERIAL REQUIREMENTS
SUMMARY
(Volumes in cubic metres)

FISCAL YEAR	EMBANKMENT	SUBBASE	BASE	SURFACING MATERIAL	CONCRETE AGG.	RIPRAP	ANNUAL TOTAL
1990 - 1991	← 42,100 →		1,700	3,400			47,200
1991 - 1992	← 18,400 →		3,000	4,750			26,150
1992 - 1993	← 10,900 →		1,975	4,200			17,075
1993 - 1994	← 9,800 →		1,600	3,200			14,600
1994 - 1995	← 5,300 →		1,775	3,400			10,475
1995 - 1999	31,870	37,850	26,340	30,600	100	730	127,490
1999 - 2009	20,700	43,430	25,055	27,800	100	300	117,385
20-YEAR TOTAL	**← 215,250 →**		**61,445**	**77,350**	**200**	**1,030**	**360,375**

TABLE 4
GRANULAR NEEDS ASSESSMENT
RAE/EDZO CAPITAL PROJECTS ESTIMATED MATERIAL REQUIREMENTS
1990 - 1991
(Volumes in cubic metres)

PROJECT	EMBANKMENT	SUBBASE	BASE	SURFACING MATERIAL	CONCRETE AGG.	RIPRAP
MACA						
Phase 3/School Site	← 37,000 →					
HOUSING						
Social		3,900	1,300	2,600		
Replacement		1,200	400	800		
TOTAL REQUIREMENTS	← 42,100 →		**1,700**	**3,400**		

TABLE 5
GRANULAR NEEDS ASSESSMENT
RAE/EDZO CAPITAL PROJECTS ESTIMATED MATERIAL REQUIREMENTS
1991 - 1992
(Volumes in cubic metres)

PROJECT	EMBANKMENT	SUBBASE	BASE	SURFACING MATERIAL	CONCRETE AGG.	RIPRAP
MACA Phase 4	← 10,000 →					
Water Improvement (Edzo)	3,000		1,200	750		
HOUSING						
Social		3,900	1,300	2,600		
Replacement		1,200	400	800		
ECONOMIC DEVELOPMENT						
Old Fort Rae	300		100	600		
TOTAL REQUIREMENTS	← 18,400 →		**3,000**	**4,750**		

TABLE 6
GRANULAR NEEDS ASSESSMENT
RAE/EDZO CAPITAL PROJECTS ESTIMATED MATERIAL REQUIREMENTS
1992 - 1993
(Volumes in cubic metres)

PROJECT	EMBANKMENT	SUBBASE	BASE	SURFACING MATERIAL	CONCRETE AGG.	RIPRAP
MACA						
Phase 4	3,000	2,000				
TRANSPORTATION						
Storage Building		500	175	200		
HOUSING						
Social		3,900	1,300	2,600		
Replacement		1,200	400	800		
ECONOMIC DEVELOPMENT						
Old Fort Rae	300		100	600		
TOTAL REQUIREMENTS	**3,300**	**7,600**	**1,975**	**4,200**		

TABLE 7
GRANULAR NEEDS ASSESSMENT
RAE/EDZO CAPITAL PROJECTS ESTIMATED MATERIAL REQUIREMENTS
1993 - 1994
(Volumes in cubic metres)

PROJECT	EMBANKMENT	SUBBASE	BASE	SURFACING MATERIAL	CONCRETE AGG.	RIPRAP
MACA						
Phase 4	2,500	2,500				
HOUSING						
Social		3,600	1,200	2,400		
Replacement		1,200	400	800		
TOTAL REQUIREMENTS	**2,500**	**7,300**	**1,600**	**3,200**		

TABLE 8
GRANULAR NEEDS ASSESSMENT
RAE/EDZO CAPITAL PROJECTS ESTIMATED MATERIAL REQUIREMENTS
1994 - 1995
(Volumes in cubic metres)

PROJECT	EMBANKMENT	SUBBASE	BASE	SURFACING MATERIAL	CONCRETE AGG.	RIPRAP
MACA						
Medium Community Hall (Edzo)		500	175	200		
HOUSING						
Social		3,600	1,200	2,400		
Replacement		1,200	400	800		
TOTAL REQUIREMENTS		**5,300**	**1,775**	**3,400**		

TABLE 9
GRANULAR NEEDS ASSESSMENT
RAE/EDZO CAPITAL PROJECTS ESTIMATED MATERIAL REQUIREMENTS
1995 - 1996
(Volumes in cubic metres)

PROJECT	EMBANKMENT	SUBBASE	BASE	SURFACING MATERIAL	CONCRETE AGG.	RIPRAP
HOUSING						
Social		3,900	1,300	2,600		
Replacement		1,200	400	800		
TOTAL REQUIREMENTS		**5,100**	**1,700**	**3,400**		

APPENDIX 2

Geotechnical Data 1990

Laboratory Test Results
Grain Size Curves
Cross Sections

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT	PROJECT NUMBER
RAE/EDZO GRANULAR INVESTIGATION	90-9170-106

PART 1 – COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION	1-106-90	METHOD OF SAMPLING	Hand Shovel
LOCATION	North End - Russell Lake Pit		
TEST HOLE NUMBER	#1	DEPTH	1.5 meters
FIELD DESCRIPTION	Sample taken from north terminus of existing pit		
LAB TESTS REQUIRED	Visual, W.S.A., U.S.C.		
SAMPLED BY	Fred Collins	DATE D/M/Y	16/05/90
SAMPLE DISCARDED	X	RETAINED	

PART 2 – COMPLETED IN THE LABORATORY

DATE RECEIVED	RECEIVED BY
REQUESTED COMPLETION DATE D/M/Y	RESULTS SUBMITTED TO

PART 3 – LABORATORY TEST RESULTS AND COMMENTS

Visual Description

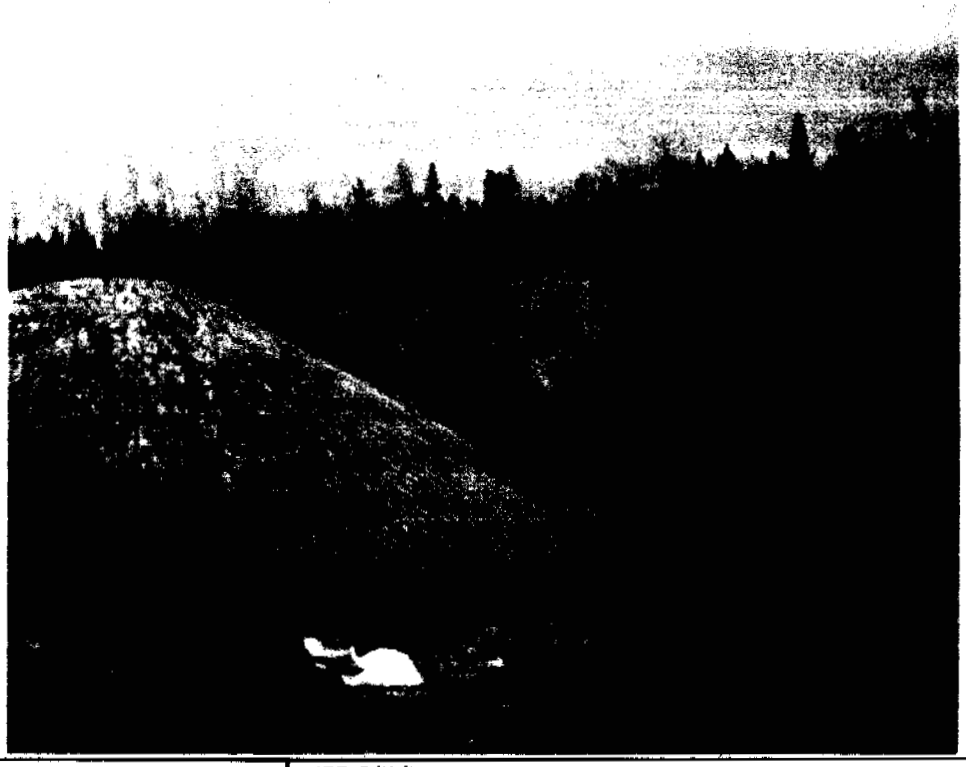
Sand, trace of gravel, subangular, trace non-plastic fines, light brown.

Wash Sieve Analysis

Gravel > 5.5%
Sand > 90.5%
Fines > 4.0%

U.S.C.

SP



COMPILED BY		DATE D/M/Y
REVIEWED BY	DATE D/M/Y	ATTACHMENTS _____ PAGES

NWT 2601/0886

F-0486 - 016

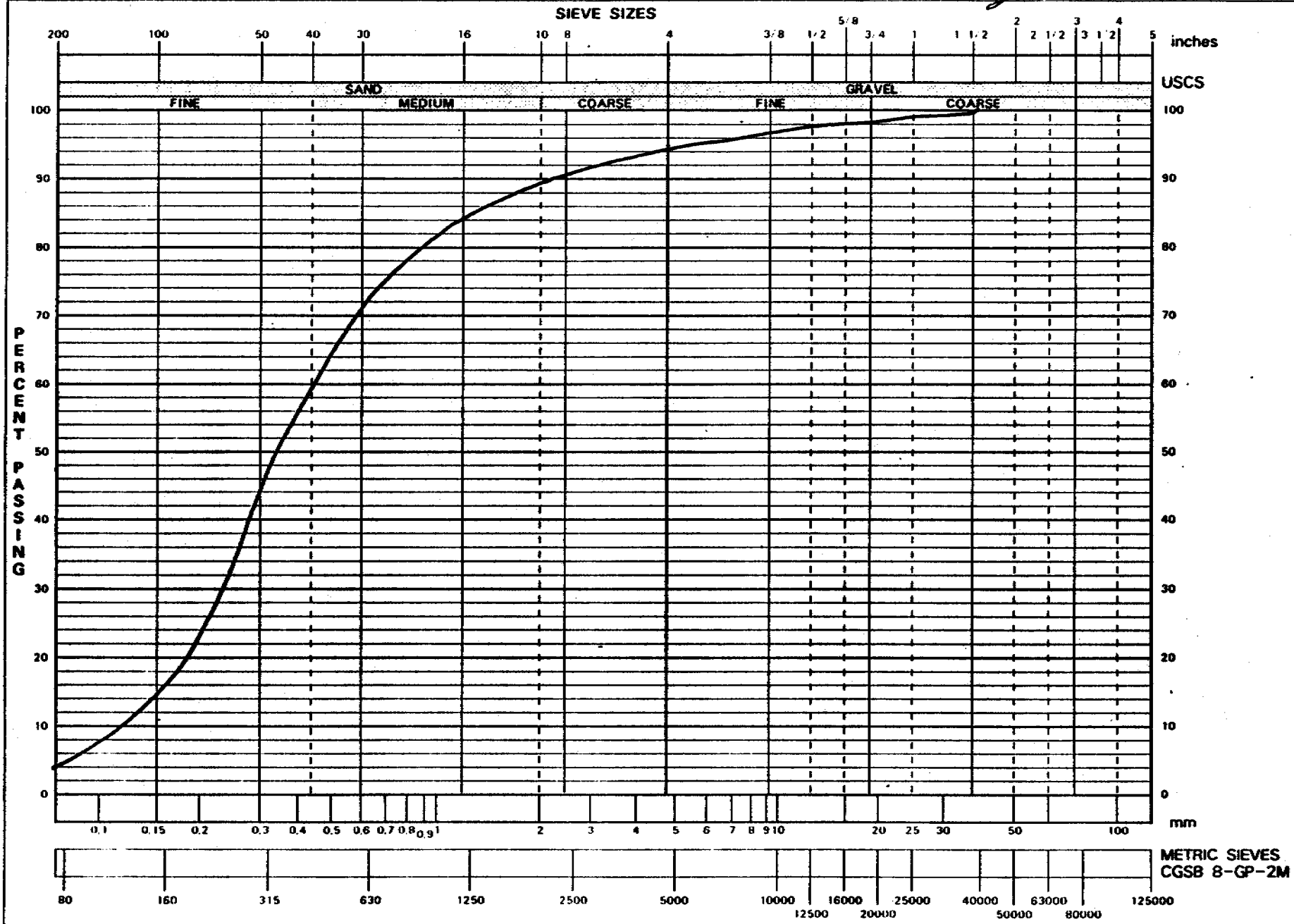
Northwest Territories

RAE - ED20

GRAIN SIZE CURVES

DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION	LAB NUMBER	TESTED BY
1-106-90		



D_{10}	D_{30}	D_{60}	C_u	C_c
0.12	0.23	0.44	3.7	1.0

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT	RAE/EDZO GRANULAR INVESTIGATION	PROJECT NUMBER	90-9170-106

PART 1 – COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION	2-106-90	METHOD OF SAMPLING	Hand Shovel
LOCATION	Northwest corner of Russell Lake Pit		
TEST HOLE NUMBER	#2	DEPTH	2.0 meters
FIELD DESCRIPTION	Adjacent to old test pits above area of present excavation		
LAB TESTS REQUIRED	W.S.A., Visual, U.S.C.		
SAMPLED BY	Fred Collins	DATE D/M/Y	16/05/90
SAMPLE DISCARDED	X	RETAINED	

PART 2 – COMPLETED IN THE LABORATORY

DATE RECEIVED	RECEIVED BY
REQUESTED COMPLETION DATE D/M/Y	RESULTS SUBMITTED TO

PART 3 – LABORATORY TEST RESULTS AND COMMENTS

Visual

Gravel and sand, subangular, trace non-plastic fines, light brown, maximum size 20 cm.

Wash Sieve Analysis

Gravel > 62.0%
Sand > 37.0%
Fines > 1.0%

U.S.C.

GW

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REVIEWED BY	DATE D/M/Y	ATTACHMENTS _____ PAGES

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F-0486 - 016

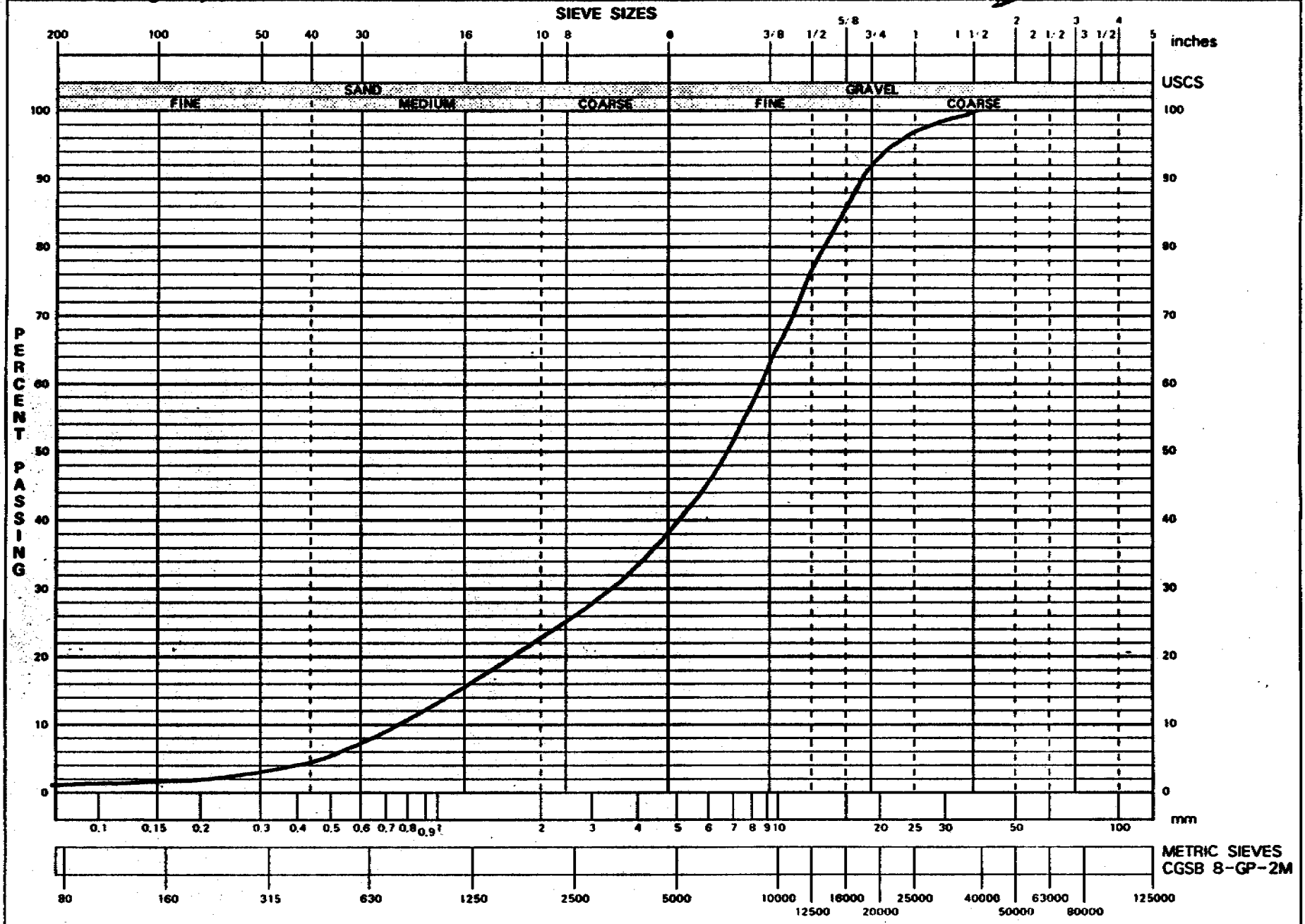
Northwest Territories

RAE-ED20

GRAIN SIZE CURVES

DEPARTMENT OF TRANSPORTATION

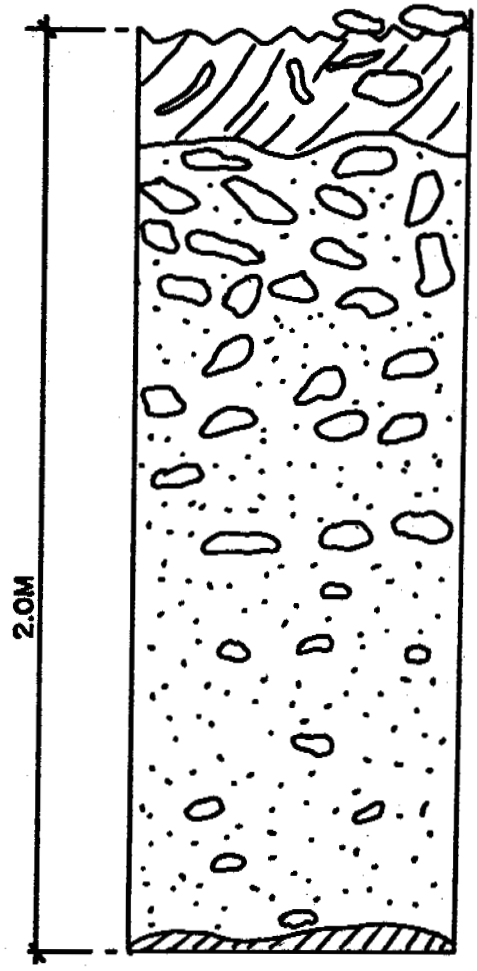
SAMPLE IDENTIFICATION	LAB NUMBER	TESTED BY
2-106-90		PQ.



D_{10}	D_{30}	D_{60}	C_u	C_c
0.75	3.3	8.5	11.3	1.7

RUSSELL LKE PIT - RAE, N.W.T.

TEST HOLE PROFILE # 2-106-90



0.3M ORGANIC,BLACK, ROOTS, MOSS.

0.92M COARSE GRAVEL AND SAND, COBBLES UP TO 15cm, SUBROUNDED NON-STRATIFIED, LITTLE FINES, APPROXIMATELY 60% GRAVEL, 40% SAND.

0.8M COARSE SAND WITH 30% FINE GRAVEL, SUBROUNDED, TRACE OF FINES, GRAVEL 2-3cm.

LARGE BOULDERS.

Northwest Territories Public Works

Checked by		COMMUNITY PROGRAMS SECTION ENGINEERING DIVISION
Approved by		RUSSELL LAKE PIT, RAE, N.W.T. SAMPLE # 2-106-90 CROSS SECTION
REVISIONS		
Date	By	
		Drawn by B. ROCHON | Date OCT. 1990 | Scale N.T.S. | Dwg. No.

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT	RAE/EDZO GRANULAR INVESTIGATION	PROJECT NUMBER	90-9170-106

PART 1 - COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION	3-106-90	METHOD OF SAMPLING	Rock Fragments
LOCATION	Proposed Quarry - Q2		
TEST HOLE NUMBER	#3	DEPTH	Surface / Pit Wall
FIELD DESCRIPTION	Rock Fragments from present Quarry Site along Rae Access Road		
LAB TESTS REQUIRED	W.S.A., Lab Crush, L.A.A., Soundness		
SAMPLED BY	Fred Collins	DATE D/M/Y	17/05/90
SAMPLE DISCARDED		RETAINED	

PART 2 - COMPLETED IN THE LABORATORY

DATE RECEIVED	RECEIVED BY
REQUESTED COMPLETION DATE D/M/Y	RESULTS SUBMITTED TO

PART 3 - LABORATORY TEST RESULTS AND COMMENTS

Visual

Rock Fragments - granitic gneiss

Wash Sieve Analysis (after crush to 19mm)

Gravel > 80.5%
Sand > 18.0%
Fines > 1.5%

U.S.C.

GW

L.A.A. (%)

11.2

Soundness (% Loss)

0.6

COMPILED BY	DATE D/M/Y	
REVIEWED BY	DATE D/M/Y	ATTACHMENTS _____ PAGES

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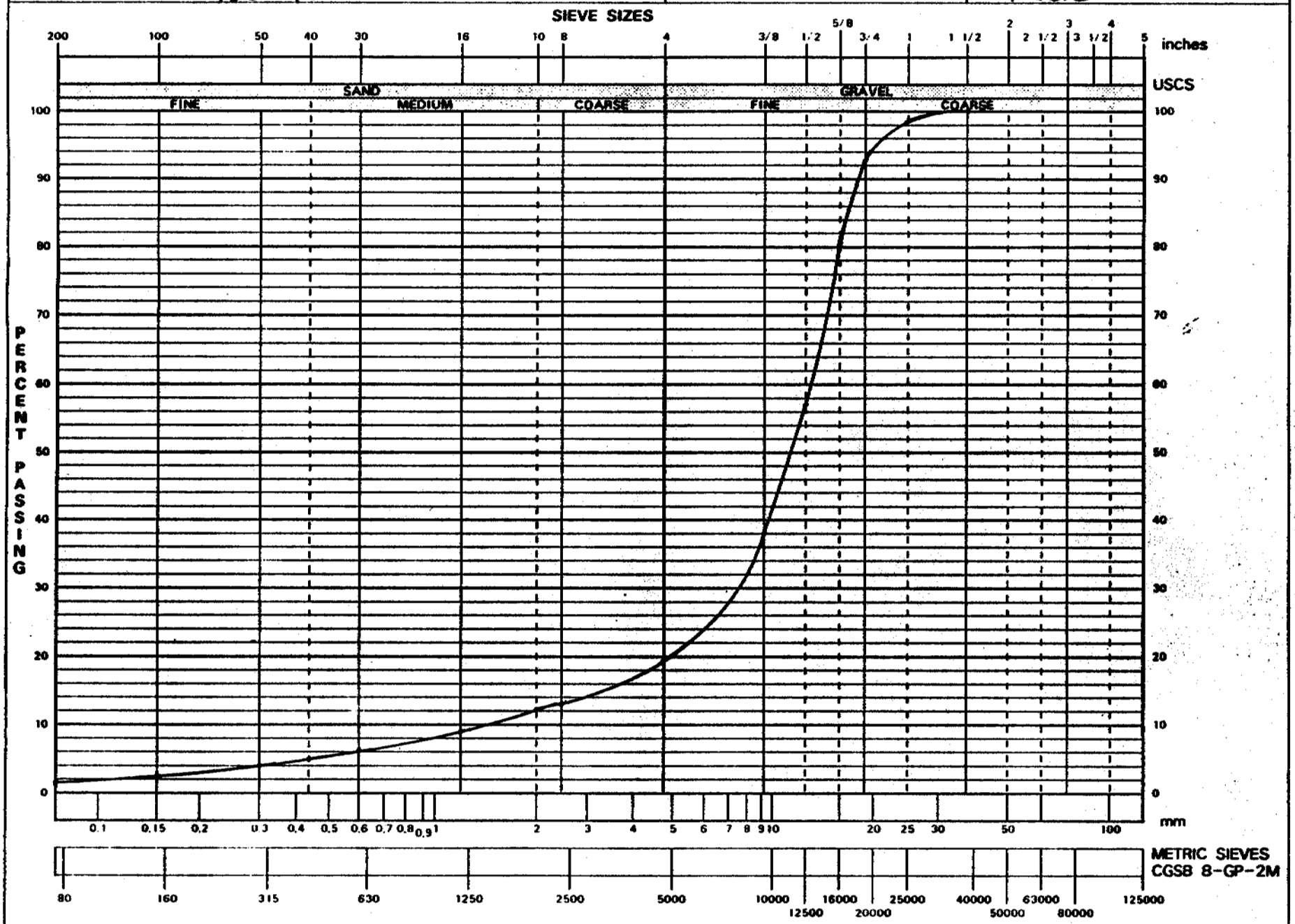
Northwest Territories

RAE-EDZO

GRAIN SIZE CURVES

DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION	LAB NUMBER	TESTED BY
3-106-90		M.E.B.



D_{10}	D_{30}	D_{60}	C_u	C_c
1.40	7.04	12.89	9.2	2.7

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT	PROJECT NUMBER
RAE/EDZO GRANULAR INVESTIGATION	90-9170-106

PART 1 – COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION: 4-106-90	METHOD OF SAMPLING: Rock Fragments	
LOCATION: Ray Access Quarry - Russell Lake Pit SW corner Q1		
TEST HOLE NUMBER: #4	DEPTH: Surface	
FIELD DESCRIPTION: Area at SW corner of Russell Lake Pit, continuous ridge complex		
LAB TESTS REQUIRED: W.S.A., crush 19mm, LAA, soundness		
SAMPLED BY: Fred Collins	DATE D/M/Y: 17/05/90	SAMPLE DISCARDED RETAINED

PART 2 – COMPLETED IN THE LABORATORY

DATE RECEIVED	RECEIVED BY
REQUESTED COMPLETION DATE D/M/Y	RESULTS SUBMITTED TO

PART 3 – LABORATORY TEST RESULTS AND COMMENTS

Visual

Rock Fragments, granitic gneiss

Wash Sieve Analysis

Gravel > 80.0%
Sand > 18.5%
Fines > 1.5%

U.S.C.

GW

LAA

11.8%

Soundness (% Loss)

0.5%

COMPILED BY	DATE D/M/Y	
REVIEWED BY	DATE D/M/Y	ATTACHMENTS _____ PAGES

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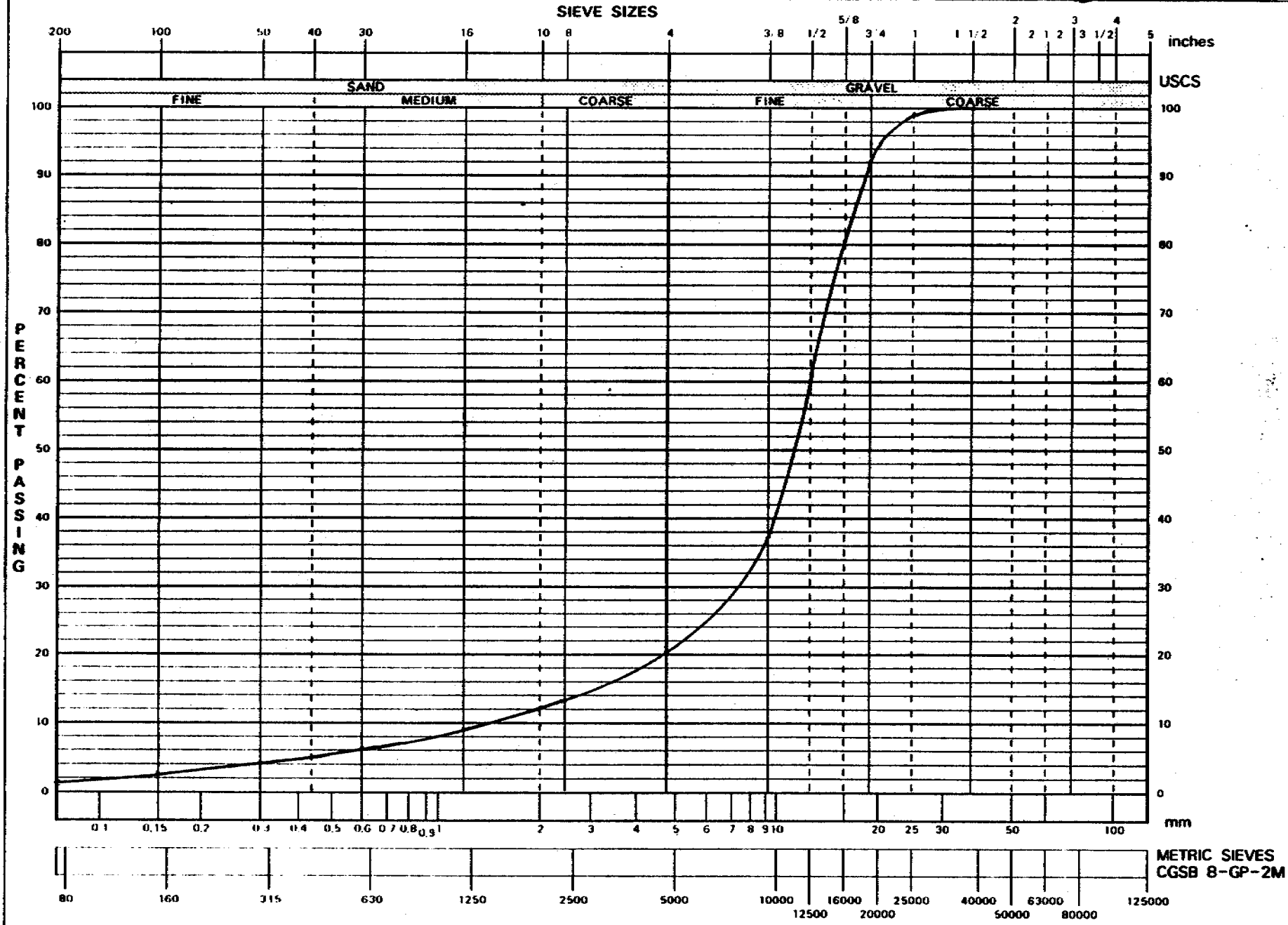
Northwest Territories

RAE-ED20

GRAIN SIZE CURVES

DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION	LAB NUMBER	TESTED BY
4-106-90		M.E.B.



D_{10}	D_{30}	D_{60}	C_u	C_c
1.37	7.05	12.49	9.1	2.9

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT	RAE/EDZO GRANULAR INVESTIGATION	PROJECT NUMBER	90-9170-106

PART 1 - COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION	5-106-90	METHOD OF SAMPLING	Hand Shovel
LOCATION	Mosquito Creek Pit - 30 km. from Rae		
TEST HOLE NUMBER	#5	DEPTH	1.0 meters
FIELD DESCRIPTION	Test Hole in center of pit towards south access route; great deal of oversize		
LAB TESTS REQUIRED	W.S.A., U.S.C., Visual		
SAMPLED BY	Fred Collins	DATE D/M/Y	19/05/90
SAMPLE DISCARDED		RETAINED	

PART 2 - COMPLETED IN THE LABORATORY

DATE RECEIVED	RECEIVED BY
REQUESTED COMPLETION DATE D/M/Y	RESULTS SUBMITTED TO

PART 3 - LABORATORY TEST RESULTS AND COMMENTS

Visual

Sand and gravels, subangular, trace of slightly plastic fines, dark brown, dry.

Wash Sieve Analysis

Gravel > 43.0%
Sand > 55.0%
Fines > 2.0%

U.S.C.

SP

COMPILED BY		DATE D/M/Y
REVIEWED BY	DATE D/M/Y	ATTACHMENTS _____ PAGES

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F-0486 - 016

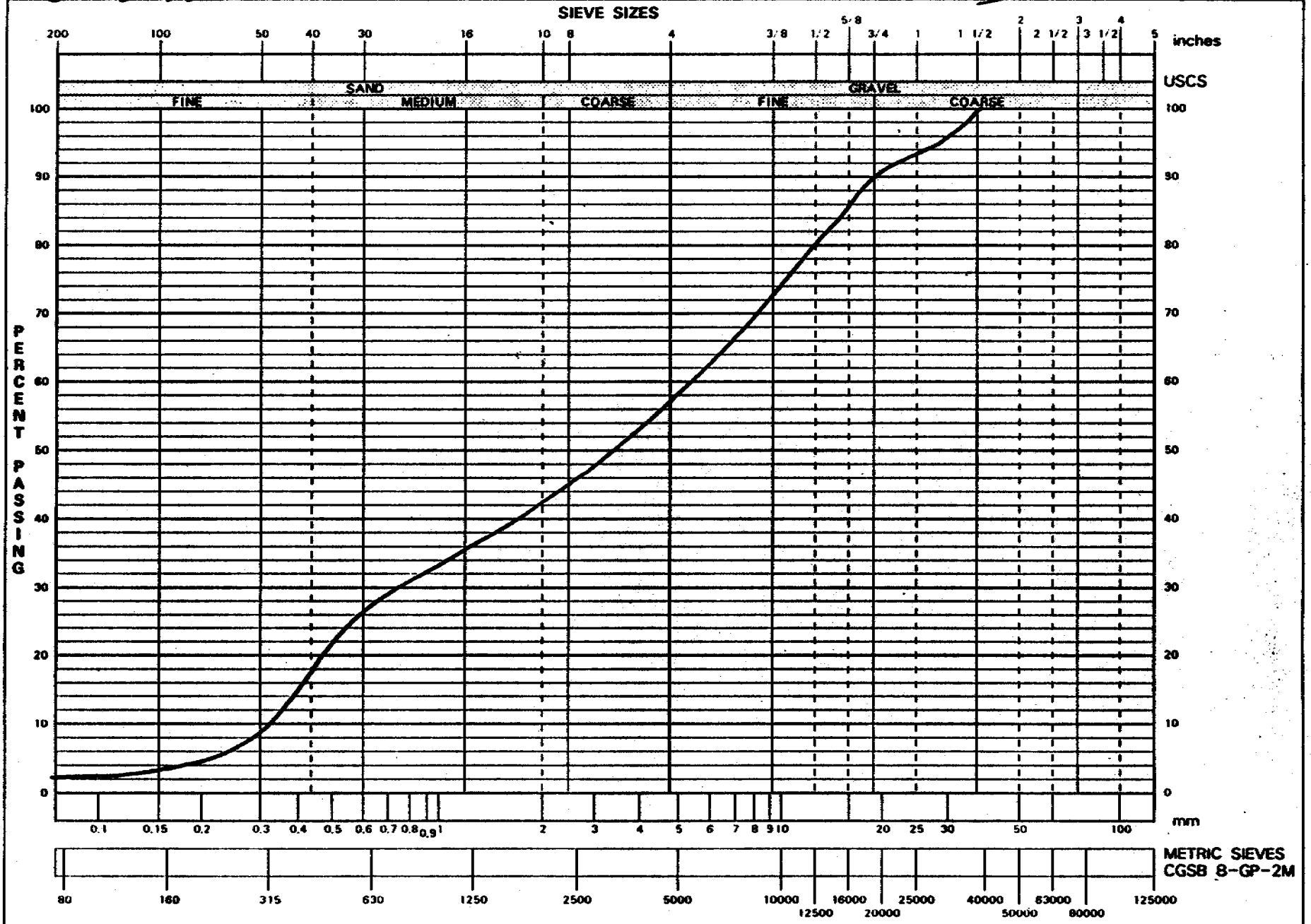
Northwest Territories

RAE-ED20

GRAIN SIZE CURVES

DEPARTMENT OF TRANSPORTATION

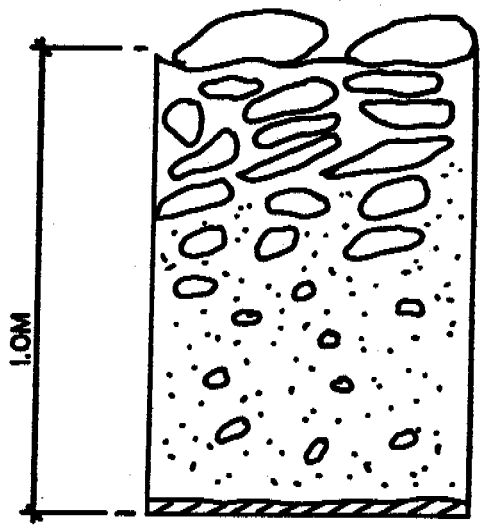
SAMPLE IDENTIFICATION	LAB NUMBER	TESTED BY
S-106-90		



D_{10}	D_{30}	D_{60}	C_u	C_c
0.31	0.74	5.5	17.7	0.4

MOSQUITO CREEK PIT
km 223 HWY. 3

TEST HOLE PROFILE # 5-106-90



NO ORGANIC ACCUMULATION
LARGE BOULDERS LESS THAN 60cm.

0.5M LARGE COBBLES LESS THAN 30cm, VERY COARSE GRAVEL, SUBANGULAR, SOME SAND.

0.5M COARSE SAND WITH 20% FINE GRAVEL.

BEDROCK

Northwest Territories Public Works

Checked by		COMMUNITY PROGRAMS SECTION ENGINEERING DIVISION			
Approved by		MOSQUITO CREEK PIT SAMPLE # 5-106-90 CROSS SECTION			
REVISIONS					
Date	By				
		Drawn by B. ROCHON	Date OCT. 1990	Scale N.T.S.	Dwg. No.

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT	RAE/EDZO GRANULAR INVESTIGATION	PROJECT NUMBER	90-9170-106

PART 1 - COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION	6-106-90	METHOD OF SAMPLING	Hand Shovel
LOCATION	Side Borrow, north side km. 227.4		
TEST HOLE NUMBER	#6	DEPTH	1.5 meters
FIELD DESCRIPTION	Large side borrow on North side of Hwy. #3 at km. 227.4 - shale		
LAB TESTS REQUIRED	W.S.A., U.S.C., Visual, Atterberg Limits		
SAMPLED BY	Fred Collins	DATE D/M/Y	19/05/90
SAMPLE DISCARDED		RETAINED	

PART 2 - COMPLETED IN THE LABORATORY

DATE RECEIVED	June 8, 1990	RECEIVED BY	EBA Engineering
REQUESTED COMPLETION DATE D/M/Y		RESULTS SUBMITTED TO	

PART 3 - LABORATORY TEST RESULTS AND COMMENTS

Visual

Gravel and sands, flat pieces of shale, trace slightly pastic fines, dark brown to black, subangular to angular, friable, moist.

Wash Sieve Analysis

Gravel > 58.0%
Sand > 33.0%
Fines > 9.0%

Atterberg Limits

LL > 32
PL > 24
PI > 8

COMPILED BY		DATE D/M/Y	
REVIEWED BY		DATE D/M/Y	ATTACHMENTS _____ PAGES

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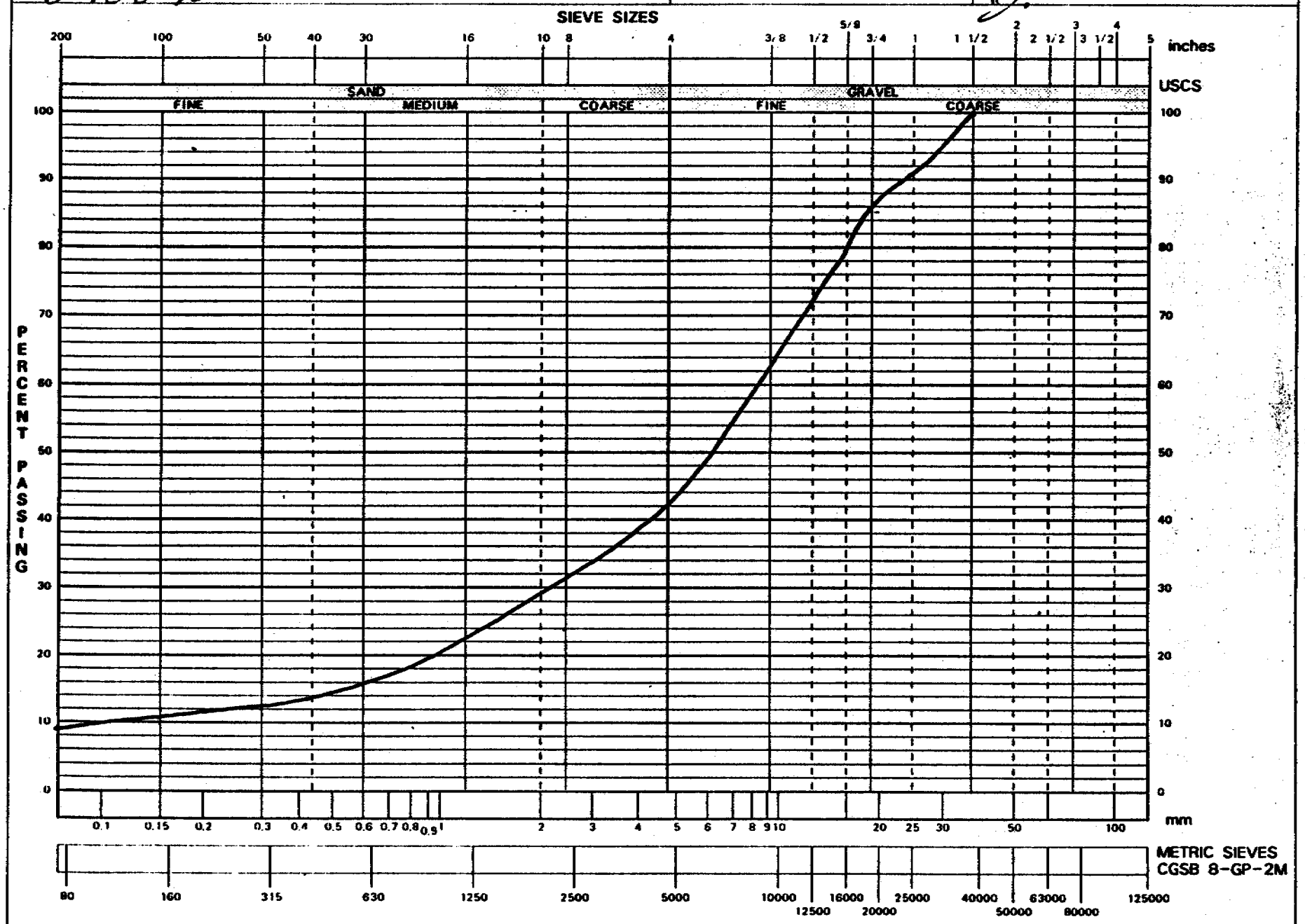
Northwest Territories

RAE-ED20

GRAIN SIZE CURVES

DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION	LAB NUMBER	TESTED BY
6-106-90		D.

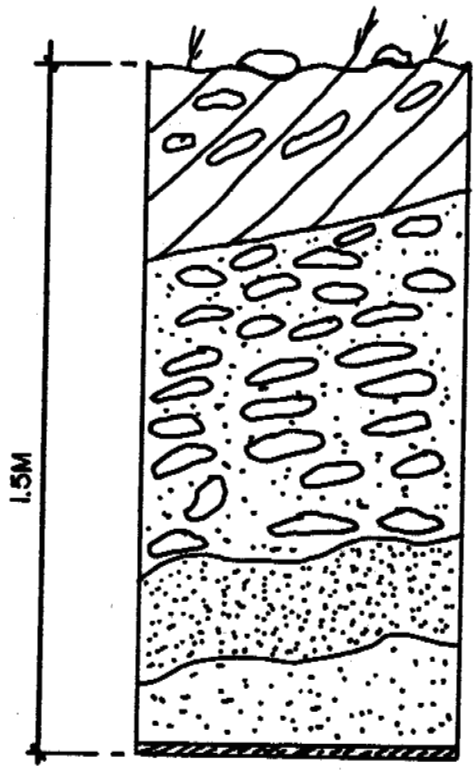


D_{10}	D_{30}	D_{60}	C_u	C_c
0.11	2.1	8.2	74.5	4.9

NWT 1785-0590

SIDE BORROW km 227.4 HWY. 3

TEST HOLE PROFILE # 6-106-90



0.4M THICK, DENSE ORGANIC LAYER, BLACK, ROOTS

0.6M ELONGATED FLAT SHALE, SOME COARSE SAND, SHALE DETRITUS IS FRIABLE, BLACK, LAYERED.

0.3M, FINE SAND, HIGH CLAY CONTENT, DENSE.

0.2M, COARSE SAND, POORLY GRADED, TRACE FINES.

FROZEN GROUND.

Northwest Territories Public Works

Checked by		COMMUNITY PROGRAMS SECTION ENGINEERING DIVISION
Approved by		SIDE BORROW km 227.4 HWY. 3 SAMPLE # 6-106-90 CROSS SECTION
REVISIONS Date	By	
		Drawn by B. ROCHON / Date OCT. 1990 / Scale N.T.S. / Dwg. No.

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT: RAE/EDZO GRANULAR INVESTIGATION	PROJECT NUMBER: 90-9170-106

PART 1 - COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION: 7-107-90	METHOD OF SAMPLING: Hand Shovel
LOCATION: Old Sand Pit at Edzo	
TEST HOLE NUMBER: #7	DEPTH: 0.8 meters - encountered permafrost
FIELD DESCRIPTION: Large sand pit at Edzo - numerous small sand stockpiles	
LAB TESTS REQUIRED: W.S.A., U.S.C., Visual	
SAMPLED BY	DATE D/M/Y
SAMPLE DISCARDED	RETAINED

PART 2 - COMPLETED IN THE LABORATORY

DATE RECEIVED: June 8, 1990	RECEIVED BY: EBA Engineering
REQUESTED COMPLETION DATE D/M/Y	RESULTS SUBMITTED TO

PART 3 - LABORATORY TEST RESULTS AND COMMENTS

Visual

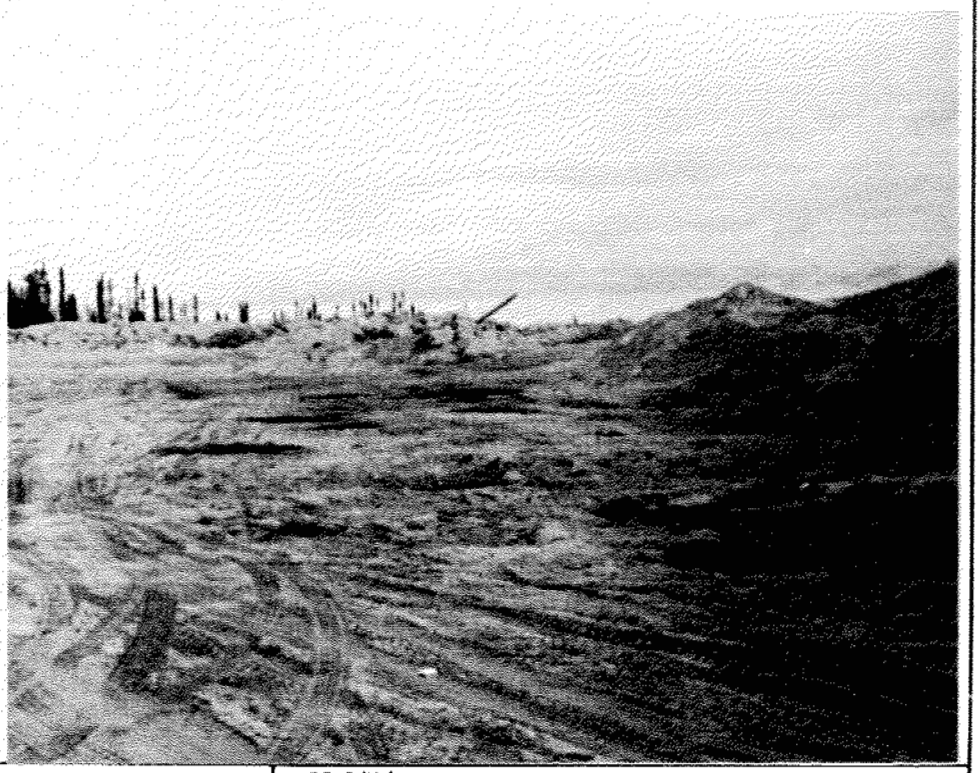
Poorly graded sand, subrounded, yellow-brown

Wash Sieve Analysis

Gravel > 13.5%
Sand > 85.0%
Fines > 1.5%

U.S.C.

SP



COMPILED BY	DATE D/M/Y
REVIEWED BY	DATE D/M/Y
ATTACHMENTS _____ PAGES	

NWT 2601/0886

F-0486 - 016

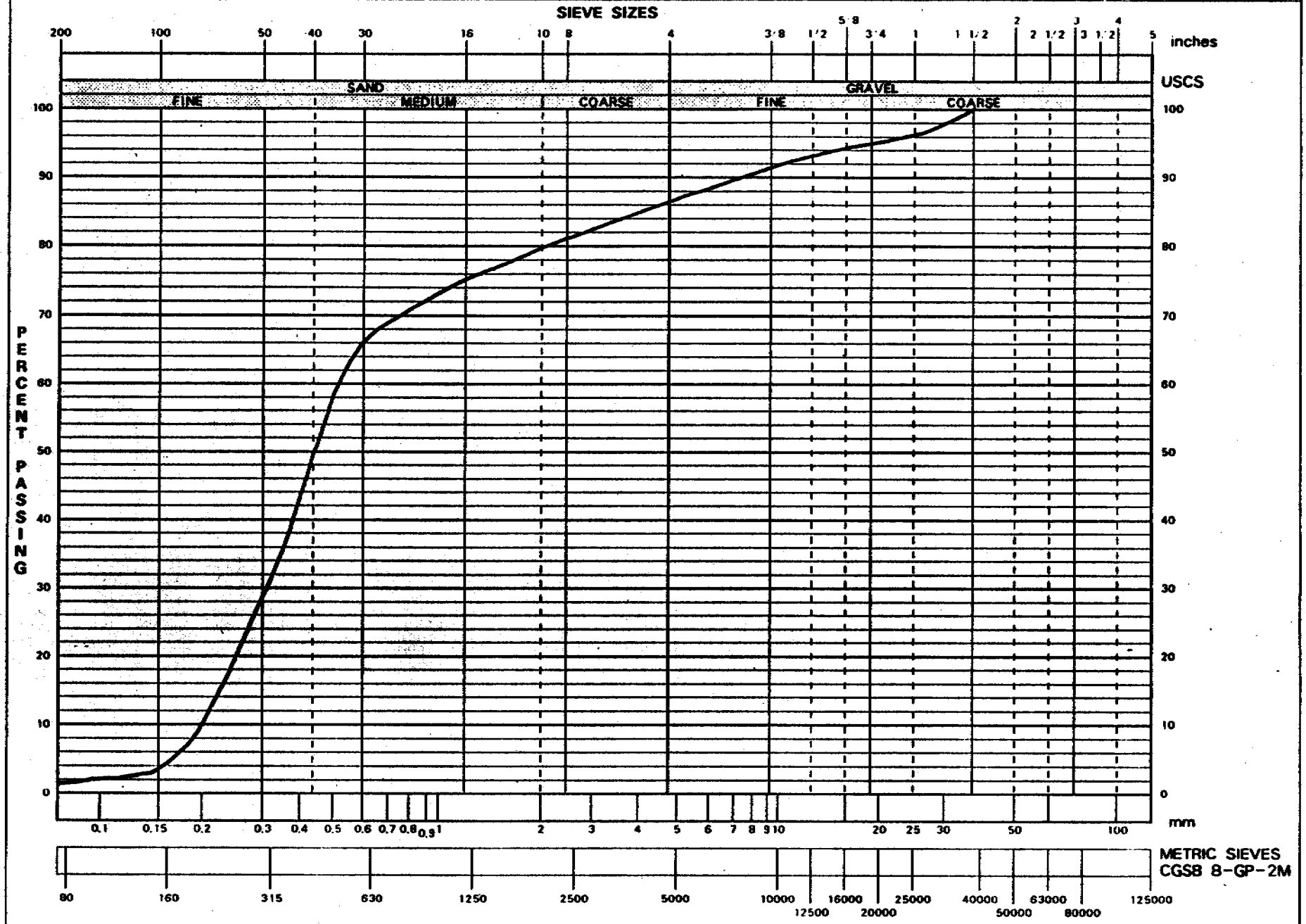
Northwest Territories

RAE-ED20

GRAIN SIZE CURVES

DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION	LAB NUMBER	TESTED BY
7-106-90		PJ



D_{10}	D_{30}	D_{60}	C_u	C_c
0.2	0.31	0.51	2.6	0.9

Northwest Territories Public Works and Highways

SAMPLE DATA SHEET

PROJECT	RAE/EDZO GRANULAR INVESTIGATION	PROJECT NUMBER	90-9170-106

PART 1 – COMPLETED IN THE FIELD

SAMPLE IDENTIFICATION	8-106-90	METHOD OF SAMPLING	Hand Shovel
LOCATION	Site 2 - 1.8 km. north of Rae		
TEST HOLE NUMBER	#8	DEPTH	1.8 meters - encountered bedrock
FIELD DESCRIPTION	Large area north of Rae of poorlyg raded shands and gravels		
LAB TESTS REQUIRED	Visual, U.S.C., W.S.A.		
SAMPLED BY	Fred Collins	DATE D/M/Y	19/05/90
SAMPLE DISCARDED		RETAINED	

PART 2 – COMPLETED IN THE LABORATORY

DATE RECEIVED	June 8, 1990	RECEIVED BY	HARDY BBT
REQUESTED COMPLETION DATE D/M/Y		RESULTS SUBMITTED TO	

PART 3 – LABORATORY TEST RESULTS AND COMMENTS

Visual

Sand and gravels, light brown, subrounded

Wash Sieve Analysis

Gravel > 44%
Sand > 51%
Fines > 5%

U.S.C.

SP - GP

COMPILED BY		DATE D/M/Y	
REVIEWED BY	DATE D/M/Y	ATTACHMENTS	PAGES

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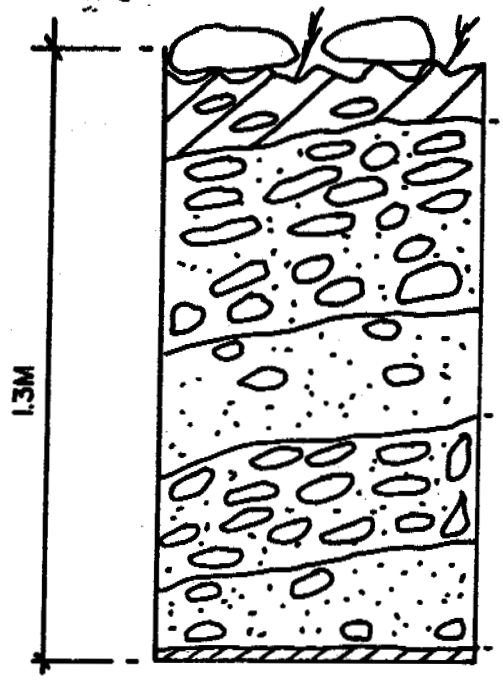
F-0486 - 016

SITE 2 / RAE, N.W.T.

TEST HOLE PROFILE # 8-106-90



LARGE BOULDERS ON SURFACE
MORE THAN 100 cm
0.2M ORGANIC LAYER

0.3M LARGE COBBLES AND PEBBLES
20-50cm, 40% COARSE SAND,
POORLY GRADED.

0.8M POORLY GRADED STRATIFIED
LAYERS OF SAND AND GRAVEL,
TRACE OF FINES.

BEDROCK

Northwest Territories Public Works	Checked by		COMMUNITY PROGRAMS SECTION ENGINEERING DIVISION		
	Approved by		SITE 2, RAE, N.W.T. SAMPLE # 8-106-90 CROSS SECTION		
	REVISIONS				
	Date	By			
			Drawn by B. ROCHON	Date OCT. 1990	Scale N.T.S.	Dwg. No.