GRANULAR RESOURCE INVENTORY

SOUTHERN MACKENZIE VALLEY

MILLS LAKE (85E)

GEOLOGICAL SURVEY OF CANADA

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DEPARTMENT OF ENERGY, MINES AND RESOURCES

GRANULAR RESOURCE INVENTORY - SOUTHERN MACKENZIE VALLEY MILLS LAKE (85E) (1:125,000)

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October 1972

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SUMMARY

Natural granular material is abundant in the Mills Lake map-area. Unconsolidated deposits with considerable sand and gravel are concentrated northwest of Mills Lake and south of the Mackenzie River. At these localities wave action in Glacial Lake McConnell built beaches along bedrock controlled topographic highs.

Other coarse granular material is found in scattered glaciolacustrine beach ridges, in minor glaciofluvial outwash deposits, and in alluvial plain and terrace deposits of Mackenzie River tributaries.

Alluvial deposits along the Mackenzie River give no evidence of containing significant amounts of sand and gravel. However, these alluvial deposits and the ground moraine which mantles the bedrock throughout the map-sheet could supply silt and clay for fill.

Competent bedrock at or near the surface is limited. It does occur in river gorges along the northwest trending escarpment south of the Mackenzie River. Shot hole records also show that bedrock is close to the surface north and west of Mills Lake.

Although natural granular material is abundant in most of the map-area, it is not readily available north of the Mackenzie River in the western half of the map-sheet.

INTRODUCTION

Granular material for construction purposes can be obtained from unconsolidated deposits or competent bedrock. This report will discuss the distribution and physical characteristics of these sources of granular material and will also present an estimate of the quantity of material available in unconsolidated deposits.

Unconsolidated deposits resulting from various geologic processes, i.e. glacier activity, river deposition, wind action, and mass wasting, are a source of natural granular material of gravel (> 2 mm), sand (1/16-2 mm), silt (1/16-1/256 mm), and clay (< 1/256 mm) sizes.

Good natural granular material for construction uses is generally larger than silt size (1/16 mm)[1]. In the southern Mackenzie Valley good granular material comes primarily from deposits of glaciofluvial and glaciolacustrine origin, and secondarily from morainal, eolian, alluvial, and colluvial deposits.

Bedrock that can be crushed by mechanical means can also supply granular material. Competent bedrock suitable for crushing includes limestone, dolomite, sandstone, and certain igneous and metamorphic rock types. Other less resistant rock types, i.e. shale, can be used for fill material but will not be included here as a bedrock source of granular material. In the southern Mackenzie

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[1] Silt and clay size material < 1/16 mm can be used for fill. This material is unlimited in the unconsolidated deposits of this map-sheet and will not be included in the numerical estimate of the quantity of granular material available.

Valley limestone and dolomite are the best sources of rippable bedrock.

Published and unpublished Geological Survey of Canada maps and reports, personal communication with officers of the Geological Survey, and field investigation have provided the basic data for this report. Supplementary information on distribution, thicknesses, and textures of unconsolidated deposits was obtained from unpublished oil and pipeline company shot hole and drilling records (see sources of information, Appendix A).

A Geological Survey surficial geology map at a scale of 1:125,000 (Rutter, N.W., Minning G.V., and Netterville, J.A., 1972) provided data on location and areal extent of unconsolidated deposits containing good granular material. This map is indexed as GSC Open File 93 and may be viewed at the Geological Survey of Canada offices in Ottawa, Calgary and Vancouver. Copies may be obtained at a nominal cost from Riley's DataShare International, 631 - 8 Avenue South West, Calgary, Alberta.

Quantities of natural granular material in unconsolidated deposits have been computed using data on areal extent and thicknesses obtained from the surficial geology map, drilling results, and field observations. Variables such as ground ice and height of water table were considered when deriving final volumes of material available in each deposit[2]. The tabular summary at the end of this report contains detailed volumetric data.

Information on bedrock that can supply granular material comes mainly

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[2]The area of each deposit was measured on the surficial geology map with a planimeter. The average thickness of the deposit was multiplied by the area to get the total volume of the deposit. Variables, i.e. water table, type of deposit, were assessed to obtain the final percentage of the total volume that is listed in the table as material available for exploitation.

from Geological Survey of Canada Paper 58-11. Map 28-1958, which accompanies this paper, has been used as a base for indicating competent bedrock that is available at or near the surface.

GENERAL GEOLOGY AND PHYSIOGRAPHY

Except for the Horn Plateau at its northern edge, the Mills Lake map-area falls entirely in the Great Slave Plain physiographic region (see location map, Figure 1).

Bedrock geology was mapped by the Geological Survey on Operation Mackenzie in 1957 (Douglas, 1959). A reconnaissance surficial geology investigation was undertaken by B. G. Craig as part of this operation (Douglas, 1959; Craig, 1965). A detailed surficial geology map based on airphoto interpretation and field investigations was compiled by the Geological Survey in 1971 (Rutter, Minning, and Netterville, 1972).

Bedrock formations[3] are mostly Upper Devonian shales and limestones with minor sandstones and siltstones. Cretaceous shale is also present in the Horn Plateau.

The Upper Devonian shales and siltstones which occur in the lowland north and south of the Mackenzie River and the Cretaceous shale of the Horn Plateau are poor sources of granular material.

Competent limestone formations, good for construction materials, are found at or near the surface in the northwest trending escarpment south of the Mackenzie River.

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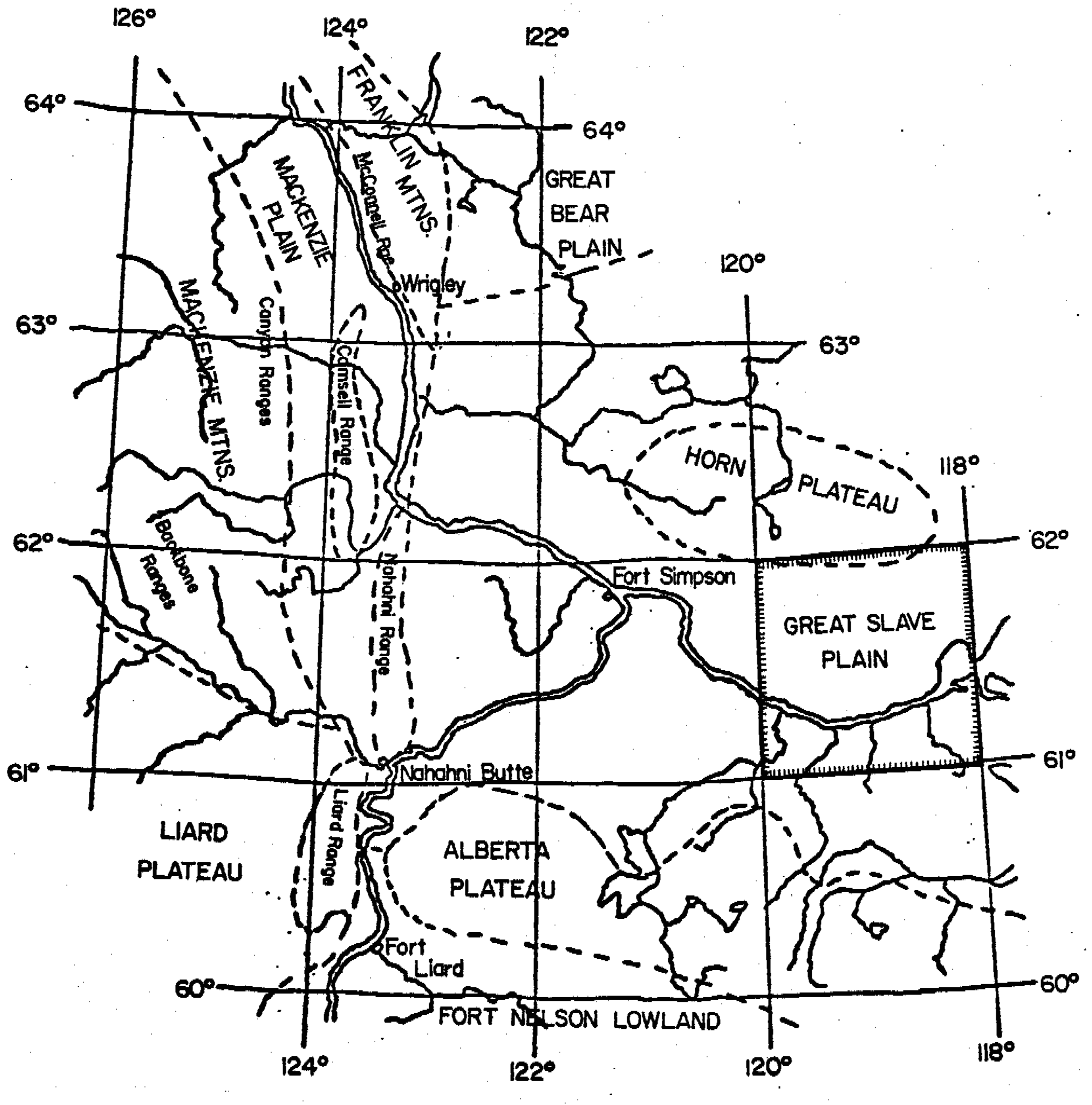
[3] A formation is a bed (of rocks) or assemblage of beds with well-marked upper and lower boundaries that can be traced and mapped over a considerable tract of country (Holmes, 1965).



PHYSIOGRAPHIC REGIONS – MILLS LAKE 85E

miles 50 Scale

Figure I

after Bostock 1969

Morainal deposits mantle the bedrock throughout the map-area. In addition to this ground moraine cover, glacier activity has produced minor glaciofluvial channel deposits, and numerous glaciolacustrine beach ridge and plain deposits. Rivers, especially tributaries which flow into the Mackenzie along its south shore, have reworked unconsolidated material into alluvial plain and terrace deposits. All of these unconsolidated deposits, except for the ground moraine, contain significant coarse natural granular material.

GEOLOGIC DESCRIPTION OF EXPLOITABLE MAP UNITS

Unconsolidated deposits and bedrock that can supply granular material appear on Figures 2 and 3.

Figure 2 is adapted from a Geological Survey of Canada surficial geology map. Unconsolidated deposits with good natural granular material are labelled with the appropriate map-unit name and assigned a pattern designation (see Figure 2, 2b). Pattern designations are based on geologic origin and texture of material in the deposit. Where map-unit names are used without pattern designations, i.e. Mackenzie River alluvial terrace deposits, the deposits consist almost entirely of material $< 1/16$ mm.

Figure 3 is a Geological Survey of Canada bedrock geology map. Bedrock at or near the surface is indicated by solid lines or an x. Bedrock formations preceded by an asterisk (*) could be crushed to obtain granular material (see legend, Figure 3).

Unconsolidated Deposits

Glacial Deposits

Glaciofluvial outwash deposits contain high quality granular material of gravel and sand size. Glaciolacustrine plain and beach deposits in this map-area consist mainly of gravel and coarse sand. Till of morainal deposits is primarily fine material unsuitable as a granular resource.

Glaciofluvial Deposits
(Gt, Gh, Ghr, $\frac{\text{Gpv}}{\text{R}}$)

Glaciofluvial deposits are minor and are confined to the southwestern corner of the map-sheet. Although these deposits do not cover large areas they are composed of good quality gravel and sand. They have been indicated by a dot and circle pattern on the natural granular materials map (see Figure 2).

The capital G in the unit mapped indicates the glaciofluvial origin of the deposit, and the lower case prefix denotes the principal types of material, e.g. silt (si), sand (s), and gravel and/or sand (g). It should be noted that if two letters are used the first refers to the most abundant constituent (see legend for surficial geology maps, Figure 2b).

Topographic expression of the unit is indicated by the suffix attached, e.g. terrace (t), ridge (r), hummocky (h), veneer (pv). Glaciofluvial units vary from flat and gently sloping (Gt, $\frac{\text{Gpv}}{\text{R}}$) to hummocky (Gh, Ghr). Thicknesses have been estimated at 50 feet for these deposits.

Glaciolacustrine Deposits
(Lpbx, Lpb, $\frac{\text{Lpbxv}}{\text{tMorR}}$, $\frac{\text{Lpbv}}{\text{tMorR}}$,)

Most of the natural granular material in this map-area comes from glaciolacustrine beach ridge and beach plain deposits. On the natural granular materials map glaciolacustrine deposits have been assigned one of several striped patterns (see Figure 2).

The capital L in each map-unit indicates its glaciolacustrine origin and the lower case prefixes and suffixes give textural and morphologic information respectively.

Glaciolacustrine beach plain and beach plain veneer deposits are generally flat or gently sloping (Lpb, $\frac{\text{Lpbv}}{\text{tMorR}}$, $\frac{\text{Lpbxv}}{\text{tMorR}}$). Individual beach ridges and beach ridge complexes (Lpbx,) consist of ridges which rise 5 to 20 feet above the surrounding plain.

Average thicknesses of 9 and 15 feet and widths of 40 feet were used when computing amounts of material in beach deposits north of the Mackenzie River and in area IV south of Mills Lake. These same deposits along the northwest trending escarpment south of the Mackenzie River are thicker and 27 feet was used in estimating volume of material.

Ground ice, organic cover, and high water table may make a few of the glaciolacustrine beach deposits, especially those with a high percentage of fine sand and silt, difficult to exploit.

Morainal Deposits

Morainal deposits do not contain sufficient percentages of sand and gravel to be classified as a potential source of granular material. In the southeastern part of the map sheet till of morainal deposits has been used as fill in construction of the Mackenzie Highway.

Alluvial Deposits
(Ap, At)

Alluvial (fluvial) deposits are composed of silt, sand, and gravel left by rivers and streams. Only those with significant coarse material have been assigned a pattern designation on the accompanying natural granular materials map (see Figure 2). All alluvial deposits are mapped as A with textural and morphologic prefixes and suffixes.

Alluvial deposits along the Mackenzie River are mainly silt, but the tributary rivers have alluvial deposits with considerable gravel and coarse sand.

Alluvial deposits form plains with little relief along present river and stream channels and terraces (flat surfaces) above present channels.

Alluvial plain deposits are approximately 8 feet thick. Alluvial terrace deposits are thicker and an average figure of 40 feet was assumed for volumetric calculations.

Bedrock

Devonian limestone of three geologic formations can be used to supply granular material. Outcrop areas of these formations are indicated on Figure 3 with solid lines or an x symbol.

The northern two-thirds of the map-sheet is underlain by soft Devonian and Cretaceous shales, siltstones, and mudstones which are not good construction materials. Shot hole records and field investigation of glaciolacustrine beach areas north of the Mackenzie River indicate that Devonian limestone may be close to the surface in some localities.

Competent limestone units occur at the surface in the southern third of the map-sheet. In most places they are covered by thick surficial deposits. These formations will be described in detail with the best listed first.

High Quality Bedrock for Construction Materials

Unit 21 is an Upper Devonian sandy, silty limestone. It is a tough, well-jointed formation and is a good source of crushable rock. Exposures occur in river gorges (Trout, Bouvier, and Redknife Rivers) along the northwest trending escarpment in the southern third of the map-sheet.

Unit 22, a sandy limestone with shale and siltstone interbeds, is a good source of construction material. Throughout most of its extent in the southern third of the map-sheet, it is covered by till and organic deposits. This limestone unit does appear in sections along the Trout and Redknife Rivers.

Secondary Bedrock Construction Materials

Unit 21 is considered a good source for construction material in the Fort Simpson map-area (95H). However, in the Mills Lake map-area the formation is composed of soft calcareous, silty mudstone with interbeds of resistant sandstone and limestone. Only the more competent interbeds could be used to supply granular material. Exposures are found along the Trout, Bouvier, and Redknife Rivers.

GEOGRAPHIC DISTRIBUTION OF EXPLOITABLE MATERIALS

All natural granular deposits have been assigned an identification number, i.e. E-1, for use in assembling data. Roman numerals I to VI and geographic names designate groups of natural granular deposits discussed in this report. The lowest Roman numeral applies to the best area of natural granular deposits (see Figure 2). The same system of Roman numerals and geographic names has been used to assemble bedrock information for different localities on the map-sheet (see figure 3).

Further details on volumetric estimates of natural granular material and types of bedrock available in each Roman numeral area are found in the tabular summary of this report.

I. Redknife - Bouvier Beach Area

Natural granular material in the form of glaciolacustrine beach sand and gravel is extensive in this area. Some of the thicker gravel beach deposits have already been exploited for construction of the Mackenzie Highway. Beach deposits are up to 50 feet thick, but an average thickness of 27 feet was used in volumetric computations. Thicknesses of 9 feet have been determined as the average in areas mapped as beach veneer over bedrock. In some localities organic cover may make exploitation of glaciolacustrine deposits difficult.

Secondary sources for granular material include one glaciofluvial deposit and competent limestone of formations 21, 22 and 20.

II. Laferte River Beach Area

This area is similar to area I, but shot hole data and field investigations show that gravelly glaciolacustrine beach deposits are probably not as thick. Volumes of material in these deposits have been computed using a 15 foot average. The individual ridges (⤡) outside beach complex deposits are usually composed of coarse sand and varying amounts of gravel. A thickness of 9 feet was used for volumetric estimates of material in each ridge.

Shot hole records indicate that limestone is approximately 10-15 feet beneath the surface at some localities. However, this rock is not close enough to the surface to provide construction material. It should be noted that the bedrock geology map does not show any limestone outcrops in this area.

III. Rabbitskin River Beach Area

Only a few glaciolacustrine beach ridge and beach complex deposits protrude above the surrounding till plain and are unaffected by organic cover and high water table. For volumetric calculations individual ridges have been estimated to be 40 feet wide and 9 feet thick. Gravel and sand volumes in the beach complex areas are calculated using 15 foot thicknesses.

Once again shot hole data shows that competent bedrock is 10-15 feet below the surface. However, it is not shown on the attached bedrock map and is not a readily available source for crushable bedrock.

IV. Winter Road Beach Area

This area is similar to area III and contains mostly individual beach ridges composed of coarse sand and some gravel. These ridges rise above the surrounding till plain and widths of 40 feet and a thickness of 9 feet have been used in volumetric computations. No competent bedrock is near the surface here.

V. Mackenzie River and Tributaries

This area includes alluvial sand and gravel deposits of the Mackenzie River tributaries. Mackenzie River deposits, mostly in the form of silty alluvial terraces are not considered a good source of granular material. Also included in this grouping are the limestones of units 20, 21 and 22 which are exposed along the Redknife and Bouvier Rivers, and another unnamed creek.

VI. Trout River Complex

A few small glaciofluvial deposits composed of gravel, sand and silt are found in this area. Also competent limestone of units 22, 21 and 20 occur along the Trout River.

TABULAR SUMMARY

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yds.^{3}) Available
	I. Redknife - Bouvier Beach Area				
E - 1	gravelly glaciolacustrine beach ridges with gravel and sand between ridges	27	12.33	343.98	240.78
E - 10		27	1.32	36.90	25.83
E - 12		27	3.26	91.17	63.81
E - 17		27	0.81	22.77	15.93
E - 9	gravelly, silty glaciolacustrine beach ridges with gravel, sand and silt between ridges, some areas have high water table and organic cover	9	2.13	59,67	23.86
E - 13		27	12.48	348.30	139.32
E - 18		27	22.83	636.93	254.77
E - 22	gravelly glaciolacustrine beach ridges with gravel and sand between ridges, some areas have high water table and organic cover	27	24.81	692.28	276,91
E - 11	flat glaciolacustrine gravel and sand plain	27	2.21	61.83	43.28
E - 11a	limestone bedrock with uneven fairly thin cover of glaciolacustrine beach gravel	27	2.29	63.90	12.79
E - 21	flat glaciolacustrine gravel and sand plain, some frozen ground and organic cover	27	6.92	193.14	57.94

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes (Million yds.^{3}) Total	Available
E - 2	thin cover of gravel, sand and silt	9	1.71	15.60	6.24
E - 15	beach deposits over till	9	1.43	13.38	5.35
E - 7	veneer of beach gravel, sand and silt over till. High water table, some organic cover	9	3.61	33.63	10.08
E - 3	thin cover of gravel, sand and silt beach deposits over limestone bedrock	9	4.70	43.77	17.50
E - 14	thin cover of gravel, sand and silt beach deposits over limestone. Fair amount of ground water and organic cover	9	11.20	104.16	31.24
E - 4	thin cover of gravel, sand and silt deposits over till, some limestone bedrock at surface	9	3.92	31.83	9.54
E - 5	50% limestone, 50% gravel, sand, silt beach veneer over limestone	9	4.78	44.49	13.34
E - 6	thin cover of glaciolacustrine beach gravel, sand and silt over limestone	9	3.50	32.55	13.02
E - 8	> 50% limestone lesser % of glaciolacustrine gravel, sand and silt veneer over limestone	9	2.33	21.69	4.33

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	Million yds.^{3}) Available
E - 16	> 50% gravelly beach veneer over limestone, lower % of bare limestone	9	4.47	41.58	12.47
E - 19	thin layer of beach gravel, sand and silt over limestone, some areas with thin cover of till over limestone	9	2.33	21.66	8.66
E - 20	veneer of glaciolacustrine deposits and/or till over limestone	9	6.84	63.66	12.73
	Bedrock - limestone of Unit 20, 21 and 22 is at or near the surface				
				I Total	1299.72
	II. Laferte River Beach Area				
E - 29	gravelly glaciolacustrine beach	15	6.84	106.10	74.27
E - 30	ridges with gravel and sand	15	10.34	160.35	112.24
E - 35	between beach ridges	15	29.75	461.15	322.80
E - 37	gravelly glaciolacustrine beach	15	2.13	33.15	13.26
E - 39	ridges with gravel between ridges,	15	6.65	103.10	41.24
E - 41	organic cover and high water table	15	22.79	353.25	141.30
E - 34	gravelly glaciolacustrine beach	15	5.87	91.00	36.40
E - 36	ridges with gravel between ridges, organic cover and possible frozen ground	15	15.28	236.90	94.76

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes (Million yds.^{3}) Total	Available
E - 33	gravelly glaciolacustrine beach ridges with organic cover, frozen ground and high water table	15	9.99	154.90	61.96
E - 43	silt, gravel and sand glaciolacustrine beach ridges with gravel, silt and sand between ridges. Some organic cover and high water table	15	18.90	292.95	117.18
E - 44		15	1.82	28.35	19.84
E - 32	thin cover of glaciolacustrine beach gravel and sand over till	9	4.94	45.93	18.37
E - 38	thin silty glaciolacustrine beach plain deposits over till, some organic cover and high water table	9	3.22	30.30	12.01
E - 40		9	4.97	46.29	18.51
E - 42	glaciolacustrine silt, gravel and sand veneer over till	9	2.76	25.68	10.27
Individual beach ridges of gravel and sand		9		1.24	.87
Bedrock -	Competent limestone approximately 10 feet below surface deposits - Not really good source for construction material				
				II Total	1095.28

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yds.^{3}) Available
	III. Rabbitskin River Beach Area				
E - 25	glaciolacustrine gravel and sand	15	4.74	73.55	51.48
E - 26	beach deposits	15	1.32	20.50	14.35
E - 27		15	0.70	10.85	7.59
E - 28		15	0.38	6.05	4.23
Individual beach ridges of gravel and sand		9		7.55	5.28
Bedrock -	Competent limestone approximately 10 feet below surface deposits - Not really good source for construction material			III Total	82.93
	IV. Winter Road Beach Area				
Individual beach ridges of sand		9		7.28	5.09
Bedrock -	None				
				IV Total	5.09
	V. Mackenzie River and Tributaries				
E - 50	gravel, sand and silt in alluvial	39	5.60	225.68	45.13
E - 51	terrace deposits	39	2.76	111.28	22.25

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yds.^{3}) Available
E - 53	gravel and sand in both alluvial plain	24	6.10	151.44	60.57
E - 54	and terrace deposits	24	2.21	54.96	21.98
E - 52	gravel, sand and silt in alluvial plain deposits	9	3.65	33.99	6.79
Bedrock -	Competent limestone of Units 20, 21, 22 exposed along smaller rivers				
				V Total	156.72
	VI. Trout River Complex				
E - 45	gravel, sand and silt in hummocky glaciofluvial deposits	51	0.62	32.81	22.96
E - 46	gravel, sand and silt in hummocky	51	1.05	55.42	38.79
E - 48	ridged glaciofluvial deposits	51	0.58	30.77	21.53
E - 55	gravel, sand and silt in glaciofluvial terrace deposit	51	2.76	145.52	58.20
E - 47	thin cover of glaciofluvial gravel, sand over limestone	6	1.43	8.92	3.56
Bedrock -	Competent limestone of Units 22, 21, 20				
				VI Total	145.04

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yds.^{3}) Available
	Miscellaneous				
E - 23	glaciolacustrine gravel and sand	15	1.08	16.90	11.83
E - 24	beach ridges with gravel and sand between ridges	15	0.97	15.05	10.53
E - 49	eolian sand	33	1.05	35.86	8.96
E - 31	sandy glaciolacustrine beach veneer over till	9	1.05	9.78	3.91
Individual beach ridges of sand and gravel		9		2.75	1.92
				Misc. Total	37.15

Total Natural Granular Resources for Mills Lake (85E) **2821.93** million yds.^{3}

Appendix A

Sources of Information

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