Ontario Geological Survey

Northern Ontario
Engineering Geology Terrain Study 53

RAINY LAKE AREA

(NTS 52C/NW)

District of Rainy River

by

M.A. Roed

1980

Ontario

Ministry of
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1.0 INTRODUCTION

This report and the accompanying map present the results of an engineering geology terrain study for the Rainy Lake area, District of Rainy River. The area, which covers NTS block 52C/NW, lies between Latitudes 48°30'N and 49°00'N and Longitudes 93°00'W and 94°00'W. The report and map form part of a series of publications which provide similar terrain data for approximately 370 000 km^2 of northern Ontario.

The purpose of this study is to provide an inventory of engineering geology terrain conditions that will serve as a basic data framework for engineering and resource planning activities, at a level of detail consistent with a scale of 1:100 000. The terrain information is contained on the Data Base Map (OGS Map 5069, accompanying this report).

Interpretation of 1974 black and white aerial photographs, at a scale of approximately 1:38 000, formed the basis of the terrain mapping process.

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The interpretation was compared to relevant published information for the study area. The main roads in the area were traversed during the summer of 1978 to provide spot checks of the office studies. Thus, the Data Base Map represents a reconnaissance overview of the engineering conditions of the terrain.

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2.0 GEOLOGIC SETTING

The Rainy Lake area is underlain by crystalline bedrock of Precambrian age, which is covered by a discontinuous mantle of Quaternary surficial deposits. The northern part of the area is dominated by rugged bedrock terrain. Toward the southwest, this passes gradually into an extensive, flat to undulating, bouldery clay plain interspersed with extensive peat bogs.

2.1 BEDROCK GEOLOGY

The Rainy Lake area lies within the Wabigoon Belt of the Superior Structural Province, near the western edge of the Canadian Shield. The oldest rocks are supracrustal and consist of highly folded Early Precambrian metavolcanics and metasediments in small curvilinear belts and broad lowlands (Davies and Pryslak 1967).

These are surrounded by Early Precambrian granite and granitic gneiss in foliated batholiths and plutons which dominate the northern part of the map-area; included are several quartz monzonite stocks (Blackburn

1976). Ultramafic intrusive rocks underlie large parts of the Rainy Lake lowland and remarkably continuous diabase dikes of Proterozoic age occur throughout the area (Davies 1973; Blackburn 1976).

Numerous past-producing mines occur in the area, including the Olive Mine (silver), Port Arthur Copper Mine (copper, zinc), Cone Mine (gold, silver, lead, zinc), and Foley Mine (gold, silver). Areas of high mineral potential, particularly for base metals and all coincident with metavolcanic-metasedimentary rocks or ultramafic intrusions, are located in the northwest, southwest, and southeast corners of the area. The remainder of the map-area has medium to low mineral potential (Springer 1978).

2.2 QUATERNARY GEOLOGY

Northwestern Ontario was affected by several stages of continental glaciation during the Pleistocene. However, only deposits of the last glaciation, the Laurentide of Wisconsinan age, are preserved in the Rainy Lake area. The ice began to advance approximately 100 000 years ago and travelled as far south as central Wisconsin before receding. The ice disappeared from the Rainy Lake area approximately 15 000 years ago (Prest 1970). Zoltai (1961) gives a more complete account of the glacial history of the region.

Widespread stagnation of the ice mass resulted in the deposition of a variety of surficial materials. Till was deposited directly by the ice in the form of ground moraine and hummocky moraine. Meltwater from the glacier formed glaciofluvial outwash deposits and kames, and accumulated in lowlands to form glacial lakes. These grew in size and eventually coalesced to form an enormous body of water called Glacial Lake Agassiz. Widespread deposits of glaciolacustrine silt and clay occur wherever this lake covered the land in the Rainy River lowland. Johnston (1915) recognized two phases of this glacial lake in the Rainy River district. In some localities, bedrock hills were swept clean of unconsolidated material during the high water stage of Glacial Lake Agassiz, as evidenced by numerous bare bedrock knobs. In other parts of the area, the bedrock topography has been completely covered by the lake deposits. In the rugged rocky uplands characteristic of the northern part of the map-area, the glacier overdeepened valleys, rounded off bedrock outcrops, and left scattered patches of moraine and boulders. Glacial lake water did not inundate large parts of these uplands.

The complete disappearance of glacial ice and the gradual draining or drying up of glacial lakes marked the end of the Pleistocene Stage of the Quaternary Period in the area. Since that time, approximately 9 000 years ago (Prest 1970), the Rainy River has carved a channel in the plain, other streams have developed alluvial flood plains, and organic deposits have accumulated in wet depressions. These deposits are non-glacial in origin and, together with the various glacial materials, comprise the variety of Quaternary unconsolidated deposits that forms a discontinuous mantle over the bedrock in the Rainy Lake area.

2.3 PHYSIOGRAPHY

Rocky uplands of low to moderate relief occupy the northern part of the map-area. Elevations range from 335 m along the archipelago and shores of Rainy Lake to about 427 m near Jackfish Lake. The southwestern part of the area is a low, undulating plain referred to as the Rainy Lake lowland. Elevations here range from about 335 to 381 m. Rainy River forms the International Boundary along much of the southern margin of the area. The river lacks a defined flood plain but has become incised 10 to 15 m below the elevation of the surrounding lowland.

3.0 ENGINEERING TERRAIN UNITS

Engineering terrain units are composed of a combination of various materials (unconsolidated and/or bedrock) which form recognizable landforms with certain engineering characteristics. Major terrain unit groups, and the engineering significance of each, are discussed in detail. These include bedrock terrain (RN, RR), moraine (MG, MH), glaciofluvial outwash (GO), glaciolacustrine plains (LP), and organic terrain (OT). Less significant terrain units include alluvial plains (AP) and an eolian deposit (ED). A diagrammatic sketch of a typical terrain setting is given in Figure 1. Table 1 summarizes the characteristics and engineering significance of the major terrain units in the Rainy Lake area.

3.1 BEDROCK

Examples: $\frac{\text{RN(tsMG)(pOT)}}{\text{Mnj-D(M)}}$ $\frac{\text{RR(tsMG)(pOT)}}{\text{Mjr-D(M)}}$

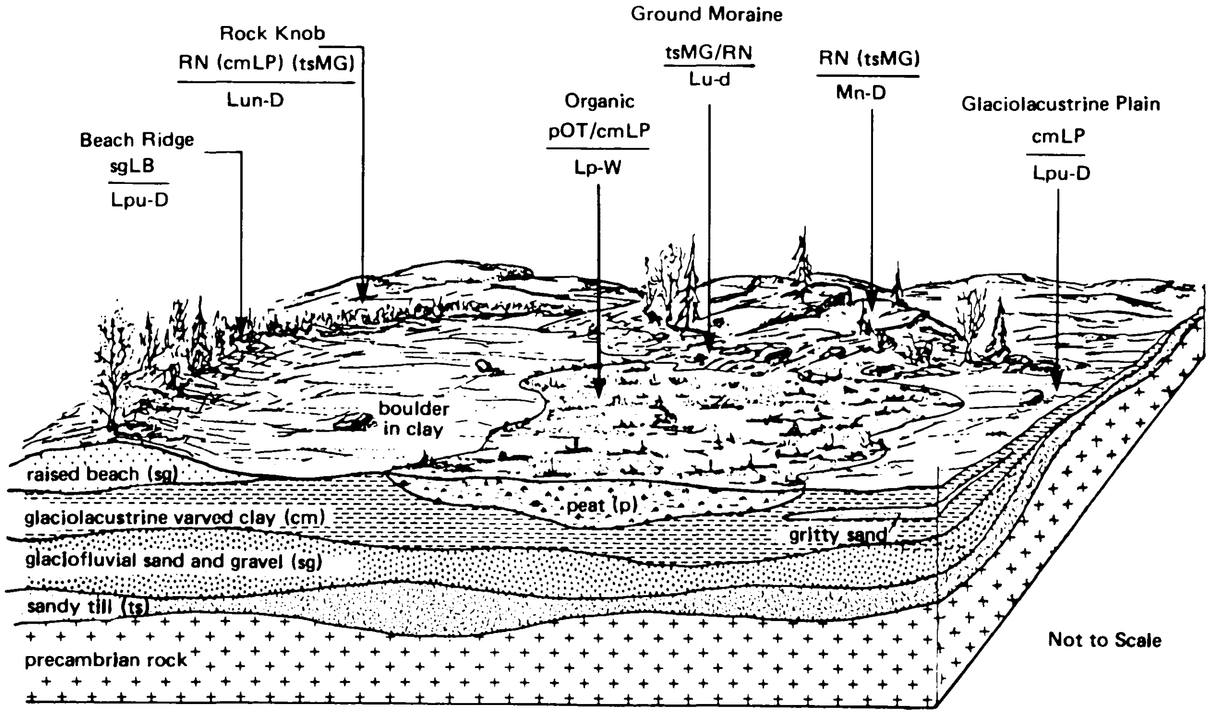

FIGURE 1 – DIAGRAMMATIC SKETCH SHOWING TYPICAL TERRAIN TYPES AND THEIR REPRESENTATIVE LETTER SYMBOLS.

TABLE 1 SUMMARY OF TERRAIN UNIT CHARACTERISTICS AND ENGINEERING SIGNIFICANCE, RAINY LAKE AREA

CLASSIFICATION		ENGINEERING USE				
Terrain Unit and Location	**Material; Relief; Topography; Drainage**	**General Construction**	**Transportation Routes**	**Waste Disposal**	**Groundwater Supply**	**Major Constraints**
BEDROCK TERRAIN (RN), throughout northwestern part of area	rock; relief varies from 0 to 30 m; undulating to rugged; drainage good	excavations and fill are necessary for most types of construction; blasting	expensive excavations and fill required; aggregate in small pockets	pollution potential is high	domestic supply from deep wells	rugged terrain; lack of aggregate; blasting required for roads
GROUND MORAINE (MG), in northwest and northeast corners of area and as a subordinate landform throughout bedrock terrain	sandy, bouldery, till; relief from 15 to 30 m; knobby; drainage good	excavation and fill for some types of construction	excavations and fill are easier than in bedrock terrain; aggregate in small pockets	suitable for septic systems where till is at least 1.5 m thick	poor to fair	deposits are thin; aggregate must be imported
HUMMOCKY MORAINE (MH), southwest of Lake Despair in central part of area	sandy, bouldery till; relief from 15 to 30 m; knobby and kettled; drainage good	good conditions where material is thick	good; aggregate may be abundant	suitable for waste disposal where deposit is thick	fair to good	deposit is not widespread; large boulders; irregular topography
GLACIOFLUVIAL DEPOSITS (GO, GK), as pockets in bedrock and moraine terrain, and beneath some glaciolacustrine deposits	sand and gravel (sg); low relief; flat; drainage good	excellent conditions	aggregate readily available	pollution potential high	excellent yields possible where deposits are thick	surface deposits small; subsurface deposits mainly unexplored

GLACIOLACUSTRINE PLAIN (LP), underlies Rainy Lake lowland	clay, silt (cm), gritty sand; low relief; planar; drainage good	excavation easy; construction materials must be imported	low relief; routes are constructed easily; aggregate must be imported	good potential	poor	slope instability; frost susceptibility; low bearing capacity for large structures
ORGANIC TERRAIN (OT), in Rainy River lowland and in depressions throughout area	peat (p); low relief; planar; drainage poor	low bearing capacity; high frost susceptibility; high compressibility	unsuitable subgrade except for light vehicle roads	pollution potential high	poor quantity and quality	low strength; high frost susceptibility; poor drainage
ALLUVIAL PLAINS (AP), throughout area	sand and peat (sp); low relief; planar; drainage poor	low bearing capacity; frost susceptibility; flood hazard	unsuitable subgrade; poor drainage	pollution potential high	poor	frost susceptibility; low bearing capacity; poor drainage; flood hazard

Comments: Glaciolacustrine beach deposits (LB) of sand and gravel (sg) may occur in places in the Rainy River lowland. Eolian dunes occur in one locality close to Alysworth.

Bedrock terrain (RN), which dominates the northern and eastern parts of the map-area, is generally of moderate relief (M), hilly (n), and rugged (j). Ridged bedrock terrain (RR) occupies a large area to the northwest of Manitou Sound in the north-central part of the map-area. A common physiographic feature in this unit is steep, rock-buttressed scarps, some of which are shown on the map. Bedrock terrain is generally dry (D), but depressions and associated organic terrain (pOT) are occasionally wet (M). Although bare bedrock is characteristic, ground moraine composed of sandy till (tsMG) occurs in patches and as a thin veneer throughout the unit. Glaciolacustrine silty clay (cmLP) occurs in association with bedrock terrain in the northwestern part of the area and in the lowland adjacent to Rainy Lake in the eastern part of the area.

The principal engineering significance of bedrock terrain is that it is difficult and expensive to excavate. Blasting is required for all subsurface excavations. Due to the rugged topography, extensive cuts that require blasting are necessary for transportation route construction in order to eliminate extreme horizontal and vertical alignments. High rugged slopes pose additional problems for general construction activities. Although there are many small sand and gravel deposits in bedrock terrain that provide sufficient construction material for low-grade access roads, major transportation routes may require importation of suitable granular material.

Groundwater potential is generally poor, except in fault zones where it may be possible to obtain substantial quantities of water. Bedrock terrain is not suitable for the installation and operation of septic drain tile fields, except where there is a thick (at least 1.5 m) layer of associated till, clay, or sand. The unit is not suitable for near-surface solid or hazardous waste disposal.

3.2 MORAINE

Examples: $\dfrac{\text{tsMG/RN(RN)(pOT)}}{\text{Mn-D(M)}}$ $\qquad$ $\dfrac{\text{tsMH(RN)(cmLP)}}{\text{Mnk-D(M)}}$

Extensive deposits of moraine occur in the northeast and northwest corners of the area and southwest of Lake Despair in the central part of the area. Around Weller Lake and Big Sawbill Lake in the northeast corner, sandy bouldery till occurs in a ground moraine unit overlying bedrock (tsMG/RN). Bedrock knobs (RN) are common and the unit is hilly, of moderate relief (Mn), and well drained (D) except where organic deposits are present (W or M).

Southwest of Lake Despair, the moraine is hummocky (tsMH), with associated bedrock knobs (RN) and pockets of glaciolacustrine silty clay (cmLP). The hummocky moraine is of moderate relief, hilly, and characterized by kettles. The material is sandy bouldery till, but probably includes local gravel deposits.

The ground moraine in the northwest corner of the area is associated with bedrock knobs and kame deposits consisting of sand and gravel. This terrain unit and the hummocky moraine southwest of Lake Despair may represent parts of a band of moraine mapped by Zoltai (1961, 1965) that was considered to extend between Lake of the Woods and Rainy Lake. Blackburn (1976) did not confirm the existence of this band of moraine, nor were significant linear moraine features observed during the present study, other than those noted above.

The engineering significance of the sandy bouldery till is limited because of the thin, discontinuous nature of the deposits. It provides good foundation conditions, but bedrock may be close to the surface and rock knobs can occur. The till is used as a construction material for forest access roads. In Menary Township, gravel deposits may occur in the associated kames. Groundwater potential is poor to fair and the unit may be suitable for waste disposal where the till is thick (at least 1.5 m).

3.3 GLACIOLACUSTRINE

Examples: $\frac{\text{cmLP(RN)}}{\text{Lp-D}}$ $\frac{\text{cmLP}}{\text{Lpu-D}}$ $\frac{\text{cmbLP}}{\text{Lp-D}}$ $\frac{\text{cmsLP}}{\text{Lp-D}}$

The Rainy Lake lowland, which occupies the southwestern part of the map-area, is mantled by a thin layer of gritty and varved clay (cmLP) of glaciolacustrine origin. The glaciolacustrine plain is well drained and has flat to undulating topography. Common subordinate landforms include low, undulating, bedrock plains and knobs and extensive poorly drained peat bogs. Conspicuous boulders (cmbLP) occur throughout the clay plain, but rarely form noticeable concentrations except near bedrock outcrops. Sandy phases of the clay (cmsLP) occur around Fort

Frances and probably elsewhere (Hills and Morwick 1944). The glaciolacustrine gritty clay unit overlies thick glaciofluvial sand and gravel in places, notably in the Armstrong Pit immediately west of Fort Frances. The unit has been described by Johnston (1915) and Zoltai (1961, 1965) as a calcareous till and a clayey till respectively, but wherever exposures occur in the map-area, the unit was observed to consist of up to 3 m of varved or banded clay with thin discontinuous layers of coarse gritty sand and scattered boulders. Bouldery till (tsMG) was only observed near bedrock outcrops. Much more stratigraphic work is required to further define this glaciolacustrine unit.

Beach deposits (cmLP/sgLB) composed of sand and gravel underlie the clay or occur adjacent to bedrock hills along the irregular northern boundary of the clay plain. These are particularly common in northeastern Mather Township. Wave-washed deposits of local extent are found adjacent to or atop low bedrock knobs in other parts of the plain, but cannot be identified on the airphotos.

Although the gritty layers characteristic of the glaciolacustrine deposits in this area improve the strength parameters, these fine-grained sediments still have low bearing capacity and shearing resistance. Small landslides have occurred along the Rainy River, and minor slumping and erosion are evident along most streams. These are important considerations in the design and construction of bridges and buildings on or near steep slopes.

Transportation route construction and general near-surface construction are inexpensive due to the low relief and ease of excavation. The unit is a poor construction material because of the high percentage of silt and its susceptibility to frost action. Aggregate may have to be imported.

Although the moisture content of the silt and clay is very high, groundwater potential is poor due to the low effective porosity and permeability of the unit. The terrain is suitable for construction of oversized septic drain tile fields and for near-surface waste disposal. The soil is difficult to work when frozen.

Sand and gravel beach deposits have potential as local sources of aggregate for the Rainy Lake area. Groundwater potential in the beach deposits is poor, as most occur above the water table; where the water table is high, the potential is excellent. The beach ridges may be suitable for near-surface waste disposal where they are underlain and surrounded by silt and clay.

3.4 GLACIOFLUVIAL

Examples: $\frac{\text{sgGO}}{\text{Lp-m}}$ $\frac{\text{gsGO}}{\text{Lp-w}}$ $\frac{\text{cmLP/sgGO(RN)}}{\text{Ln-D(M)}}$ $\frac{\text{csLP/sgGO/RN}}{\text{Lp-D}}$

Surface glaciofluvial deposits (GO) are rare in this map-area, but a number of large subsurface deposits have been identified. The most common unit consists of stratified and cross-stratified sand and gravel (sgGO), from 5 to 20 m thick, which is completely or partially overlain by the glaciolacustrine (cmLP) deposits described in Section 3.3. Examples include (1) the Armstrong Pit in flat, low relief topography (Lup or Lp) west of Fort Frances, and (2) the Labelle Pit in the hummocky topography of Mather Township. The two deposits are not necessarily of the same origin. Water well information and field observation suggest that extensive buried channels of glaciofluvial sand and gravel, similar to the deposit exposed in the Armstrong Pit, may occur in other parts of the Rainy Lake lowland. Substantial glaciofluvial terrain may also occur in the poorly defined moraine belt between Dance and Menary Townships in the northwestern part of the area (Blackburn 1976). Glaciofluvial deposits around Burditt Lake in Senn Township underlie clay and beach gravel in places and are confined in narrow bedrock valleys. Kame (sgGK) deposits are suspected to occur in Menary Township.

Glaciofluvial terrain is generally well drained; however, some deposits, such as the one near Big Sawbill Lake in the northeast corner of the area, occur in depressions and may be wet for part of the year.

The major engineering significance of the glaciofluvial sand and gravel is its potential for use as a construction material. Surface deposits occur in areas of moraine and extensive buried deposits are suspected. Subsurface investigation and detailed mapping to outline possible reserves is probably warranted in an aggregate poor area. Groundwater potential is excellent in these deposits and a number of existing wells tap subsurface glaciofluvial aquifers. The unit is not suitable for waste disposal.

3.5 ALLUVIAL

Examples: $\frac{\text{smAP}}{\text{Lt-D}}$ $\frac{\text{smAP}}{\text{Lp-M}}$ $\frac{\text{psAP}}{\text{Lp-W}}$

Alluvial terrain consists of terraces along the Rainy River, and flood plain deposits along small streams, such as the La Vallée River in the southern part of the area and the Sturgeon River in the southwest corner. Terraces (Lt) along the Rainy River are well above the present river level, and are composed of silty sand with occasional thin layers of gravel. This unit is dry, flat, and difficult to outline on airphotos.

Flood plain deposits of the small, poorly developed streams in the area are composed mainly of peat (pAP) with interbeds of silt and sand (psAP). This terrain is at or near stream level, is commonly wet during parts of the year, and is subject to flooding. The Rainy River has a very narrow flood plain which was not recognized on the airphotos.

Alluvial plains offer poor foundation conditions and do not contain good quality aggregate. They are not suitable for waste disposal of any kind and groundwater potential is poor.

The possibility of slumps and landslides exists along slopes of stream valleys that have exposed glaciolacustrine clay. Much of this terrain appears stable and dry, but minor slumps were mapped southwest of Fort Frances and 4 km southeast of Emo. Both are located along steep valley slopes of the Rainy River. Bank erosion along the Rainy River is active, thus increasing the possibility of periodic slumps, especially in poorly drained localities.

3.6 ORGANIC

Examples: $\frac{\text{pOT}}{\text{Lp-M}}$ $\frac{\text{pOT/cmLP}}{\text{Lp-M}}$

Organic deposits form a particularly common terrain unit in the Rainy Lake lowland. They occur in nearly flat, dish-shaped depressions in the glaciolacustrine plain (pOT/cmLP) and are estimated to be in excess of 1 m thick in most localities. The terrain is wet (W) or seasonally wet (M), probably due to a perched water table and a poorly developed drainage system. Graham and Tibbetts (1965) carried out a preliminary study of the peat in the area and some production occurred during the period 1941 to 1952 (Davies 1973).

Construction is difficult and expensive in organic terrain due to the poor drainage conditions and the low strength, low bearing capacity, high compressibility, and extremely high frost susceptibility of the soil materials. The unit is generally poor for engineering or construction use, but, light vehicle roads have been built with some success across drier parts of the deposits.

Groundwater potential is low and any water is likely to have a high content of organic iron. The terrain is not suitable for any type of waste disposal or for the installation of septic drain tile fields.

Some peat deposits, especially near the edges of bogs, have been reclaimed for agriculture through extensive ditching. Turf industries have utilized the organic deposits in the past. Perhaps the greatest potential for the unit is as a fossil fuel source, since reserves may be large.

3.7 EOLIAN

Example: $\frac{\text{sED(cmLP)}}{\text{Lp-D}}$

A small patch of poorly defined eolian sand dunes (sED) was mapped near Aylsworth on the southern margin of the area. The unit is composed of fine-grained sand which is inferred to overlie clay. The dunes are stabilized by vegetation. The topography is essentially planar (Lp) and the unit is dry (D).

This sand deposit was not examined in the field, but may have local potential for use as back fill or in tile field construction.

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Numerous past-producing mines occur in the area, including the Olive Mine (silver), Port Arthur Copper Mine (copper, zinc), Cone Mine (gold, silver, lead, zinc), and Foley Mine (gold, silver). Areas of high mineral potential, particularly for base metals and all coincident with metavolcanic-metasedimentary rocks or ultramafic intrusions, are located in the northwest, southwest, and southeast corners of the area. The remainder of the map-area has medium to low mineral potential (Springer 1978).

2.2 QUATERNARY GEOLOGY

Northwestern Ontario was affected by several stages of continental glaciation during the Pleistocene. However, only deposits of the last glaciation, the Laurentide of Wisconsinan age, are preserved in the Rainy Lake area. The ice began to advance approximately 100 000 years ago and travelled as far south as central Wisconsin before receding. The ice disappeared from the Rainy Lake area approximately 15 000 years ago (Prest 1970). Zoltai (1961) gives a more complete account of the glacial history of the region.

Widespread stagnation of the ice mass resulted in the deposition of a variety of surficial materials. Till was deposited directly by the ice in the form of ground moraine and hummocky moraine. Meltwater from the glacier formed glaciofluvial outwash deposits and kames, and accumulated in lowlands to form glacial lakes. These grew in size and eventually coalesced to form an enormous body of water called Glacial Lake Agassiz. Widespread deposits of glaciolacustrine silt and clay occur wherever this lake covered the land in the Rainy River lowland. Johnston (1915) recognized two phases of this glacial lake in the Rainy River district. In some localities, bedrock hills were swept clean of unconsolidated material during the high water stage of Glacial Lake Agassiz, as evidenced by numerous bare bedrock knobs. In other parts of the area, the bedrock topography has been completely covered by the lake deposits. In the rugged rocky uplands characteristic of the northern part of the map-area, the glacier overdeepened valleys, rounded off bedrock outcrops, and left scattered patches of moraine and boulders. Glacial lake water did not inundate large parts of these uplands.

The complete disappearance of glacial ice and the gradual draining or drying up of glacial lakes marked the end of the Pleistocene Stage of the Quaternary Period in the area. Since that time, approximately 9 000 years ago (Prest 1970), the Rainy River has carved a channel in the plain, other streams have developed alluvial flood plains, and organic deposits have accumulated in wet depressions. These deposits are non-glacial in origin and, together with the various glacial materials, comprise the variety of Quaternary unconsolidated deposits that forms a discontinuous mantle over the bedrock in the Rainy Lake area.

2.3 PHYSIOGRAPHY

Rocky uplands of low to moderate relief occupy the northern part of the map-area. Elevations range from 335 m along the archipelago and shores of Rainy Lake to about 427 m near Jackfish Lake. The southwestern part of the area is a low, undulating plain referred to as the Rainy Lake lowland. Elevations here range from about 335 to 381 m. Rainy River forms the International Boundary along much of the southern margin of the area. The river lacks a defined flood plain but has become incised 10 to 15 m below the elevation of the surrounding lowland.

3.0 ENGINEERING TERRAIN UNITS

Engineering terrain units are composed of a combination of various materials (unconsolidated and/or bedrock) which form recognizable landforms with certain engineering characteristics. Major terrain unit groups, and the engineering significance of each, are discussed in detail. These include bedrock terrain (RN, RR), moraine (MG, MH), glaciofluvial outwash (GO), glaciolacustrine plains (LP), and organic terrain (OT). Less significant terrain units include alluvial plains (AP) and an eolian deposit (ED). A diagrammatic sketch of a typical terrain setting is given in Figure 1. Table 1 summarizes the characteristics and engineering significance of the major terrain units in the Rainy Lake area.

3.1 BEDROCK

Examples: $\frac{\text{RN(tsMG)(pOT)}}{\text{Mnj-D(M)}}$ $\frac{\text{RR(tsMG)(pOT)}}{\text{Mjr-D(M)}}$

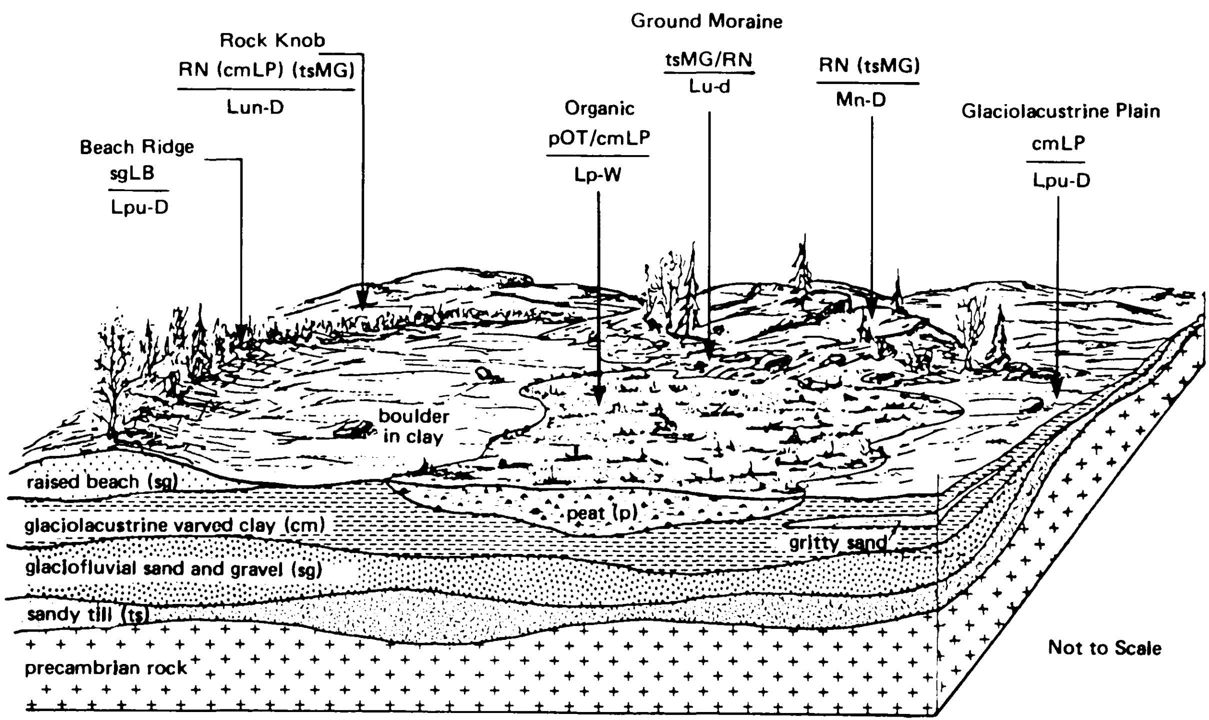

FIGURE 1 – DIAGRAMMATIC SKETCH SHOWING TYPICAL TERRAIN TYPES AND THEIR REPRESENTATIVE LETTER SYMBOLS.

TABLE 1 SUMMARY OF TERRAIN UNIT CHARACTERISTICS AND ENGINEERING SIGNIFICANCE, RAINY LAKE AREA

CLASSIFICATION		ENGINEERING USE				
Terrain Unit and Location	Material; Relief; Topography; Drainage	General Construction	Transportation Routes	Waste Disposal	Groundwater Supply	Major Constraints
BEDROCK TERRAIN (RN), throughout northwestern part of area	rock; relief varies from 0 to 30 m; undulating to rugged; drainage good	excavations and fill are necessary for most types of construction; blasting	expensive excavations and fill required; aggregate in small pockets	pollution potential is high	domestic supply from deep wells	rugged terrain; lack of aggregate; blasting required for roads
GROUND MORAINE (MG), in northwest and northeast corners of area and as a subordinate landform throughout bedrock terrain	sandy, bouldery, till; relief from 15 to 30 m; knobby; drainage good	excavation and fill for some types of construction	excavations and fill are easier than in bedrock terrain; aggregate in small pockets	suitable for septic systems where till is at least 1.5 m thick	poor to fair	deposits are thin; aggregate must be imported
HUMMOCKY MORAINE (MH), southwest of Lake Despair in central part of area	sandy, bouldery till; relief from 15 to 30 m; knobby and kettled; drainage good	good conditions where material is thick	good; aggregate may be abundant	suitable for waste disposal where deposit is thick	fair to good	deposit is not widespread; large boulders; irregular topography
GLACIOFLUVIAL DEPOSITS (GO, GK), as pockets in bedrock and moraine terrain, and beneath some glaciolacustrine deposits	sand and gravel (sg); low relief; flat; drainage good	excellent conditions	aggregate readily available	pollution potential high	excellent yields possible where deposits are thick	surface deposits small; subsurface deposits mainly unexplored

GLACIOLACUSTRINE PLAIN (LP), underlies Rainy Lake lowland	clay, silt (cm), gritty sand; low relief; planar; drainage good	excavation easy; construction materials must be imported	low relief; routes are constructed easily; aggregate must be imported	good potential	poor	slope instability; frost susceptibility; low bearing capacity for large structures
ORGANIC TERRAIN (OT), in Rainy River lowland and in depressions throughout area	peat (p); low relief; planar; drainage poor	low bearing capacity; high frost susceptibility; high compressibility	unsuitable subgrade except for light vehicle roads	pollution potential high	poor quantity and quality	low strength; high frost susceptibility; poor drainage
ALLUVIAL PLAINS (AP), throughout area	sand and peat (sp); low relief; planar; drainage poor	low bearing capacity; frost susceptibility; flood hazard	unsuitable subgrade; poor drainage	pollution potential high	poor	frost susceptibility; low bearing capacity; poor drainage; flood hazard

Comments: Glaciolacustrine beach deposits (LB) of sand and gravel (sg) may occur in places in the Rainy River lowland. Eolian dunes occur in one locality close to Alysworth.

Bedrock terrain (RN), which dominates the northern and eastern parts of the map-area, is generally of moderate relief (M), hilly (n), and rugged (j). Ridged bedrock terrain (RR) occupies a large area to the northwest of Manitou Sound in the north-central part of the map-area. A common physiographic feature in this unit is steep, rock-buttressed scarps, some of which are shown on the map. Bedrock terrain is generally dry (D), but depressions and associated organic terrain (pOT) are occasionally wet (M). Although bare bedrock is characteristic, ground moraine composed of sandy till (tsMG) occurs in patches and as a thin veneer throughout the unit. Glaciolacustrine silty clay (cmLP) occurs in association with bedrock terrain in the northwestern part of the area and in the lowland adjacent to Rainy Lake in the eastern part of the area.

The principal engineering significance of bedrock terrain is that it is difficult and expensive to excavate. Blasting is required for all subsurface excavations. Due to the rugged topography, extensive cuts that require blasting are necessary for transportation route construction in order to eliminate extreme horizontal and vertical alignments. High rugged slopes pose additional problems for general construction activities. Although there are many small sand and gravel deposits in bedrock terrain that provide sufficient construction material for low-grade access roads, major transportation routes may require importation of suitable granular material.

Groundwater potential is generally poor, except in fault zones where it may be possible to obtain substantial quantities of water. Bedrock terrain is not suitable for the installation and operation of septic drain tile fields, except where there is a thick (at least 1.5 m) layer of associated till, clay, or sand. The unit is not suitable for near-surface solid or hazardous waste disposal.

3.2 MORAINE

Examples: $\frac{\text{tsMG/RN(RN)(pOT)}}{\text{Mn-D(M)}}$ $\frac{\text{tsMH(RN)(cmLP)}}{\text{Mnk-D(M)}}$

Extensive deposits of moraine occur in the northeast and northwest corners of the area and southwest of Lake Despair in the central part of the area. Around Weller Lake and Big Sawbill Lake in the northeast corner, sandy bouldery till occurs in a ground moraine unit overlying bedrock (tsMG/RN). Bedrock knobs (RN) are common and the unit is hilly, of moderate relief (Mn), and well drained (D) except where organic deposits are present (W or M).

Southwest of Lake Despair, the moraine is hummocky (tsMH), with associated bedrock knobs (RN) and pockets of glaciolacustrine silty clay (cmLP). The hummocky moraine is of moderate relief, hilly, and characterized by kettles. The material is sandy bouldery till, but probably includes local gravel deposits.

The ground moraine in the northwest corner of the area is associated with bedrock knobs and kame deposits consisting of sand and gravel. This terrain unit and the hummocky moraine southwest of Lake Despair may represent parts of a band of moraine mapped by Zoltai (1961, 1965) that was considered to extend between Lake of the Woods and Rainy Lake. Blackburn (1976) did not confirm the existence of this band of moraine, nor were significant linear moraine features observed during the present study, other than those noted above.

The engineering significance of the sandy bouldery till is limited because of the thin, discontinuous nature of the deposits. It provides good foundation conditions, but bedrock may be close to the surface and rock knobs can occur. The till is used as a construction material for forest access roads. In Menary Township, gravel deposits may occur in the associated kames. Groundwater potential is poor to fair and the unit may be suitable for waste disposal where the till is thick (at least 1.5 m).

3.3 GLACIOLACUSTRINE

Examples: $\frac{\text{cmLP(RN)}}{\text{Lp-D}}$ $\frac{\text{cmLP}}{\text{Lpu-D}}$ $\frac{\text{cmbLP}}{\text{Lp-D}}$ $\frac{\text{cmsLP}}{\text{Lp-D}}$

The Rainy Lake lowland, which occupies the southwestern part of the map-area, is mantled by a thin layer of gritty and varved clay (cmLP) of glaciolacustrine origin. The glaciolacustrine plain is well drained and has flat to undulating topography. Common subordinate landforms include low, undulating, bedrock plains and knobs and extensive poorly drained peat bogs. Conspicuous boulders (cmbLP) occur throughout the clay plain, but rarely form noticeable concentrations except near bedrock outcrops. Sandy phases of the clay (cmsLP) occur around Fort

Frances and probably elsewhere (Hills and Morwick 1944). The glaciolacustrine gritty clay unit overlies thick glaciofluvial sand and gravel in places, notably in the Armstrong Pit immediately west of Fort Frances. The unit has been described by Johnston (1915) and Zoltai (1961, 1965) as a calcareous till and a clayey till respectively, but wherever exposures occur in the map-area, the unit was observed to consist of up to 3 m of varved or banded clay with thin discontinuous layers of coarse gritty sand and scattered boulders. Bouldery till (tsMG) was only observed near bedrock outcrops. Much more stratigraphic work is required to further define this glaciolacustrine unit.

Beach deposits (cmLP/sgLB) composed of sand and gravel underlie the clay or occur adjacent to bedrock hills along the irregular northern boundary of the clay plain. These are particularly common in northeastern Mather Township. Wave-washed deposits of local extent are found adjacent to or atop low bedrock knobs in other parts of the plain, but cannot be identified on the airphotos.

Although the gritty layers characteristic of the glaciolacustrine deposits in this area improve the strength parameters, these fine-grained sediments still have low bearing capacity and shearing resistance. Small landslides have occurred along the Rainy River, and minor slumping and erosion are evident along most streams. These are important considerations in the design and construction of bridges and buildings on or near steep slopes.

Transportation route construction and general near-surface construction are inexpensive due to the low relief and ease of excavation. The unit is a poor construction material because of the high percentage of silt and its susceptibility to frost action. Aggregate may have to be imported.

Although the moisture content of the silt and clay is very high, groundwater potential is poor due to the low effective porosity and permeability of the unit. The terrain is suitable for construction of oversized septic drain tile fields and for near-surface waste disposal. The soil is difficult to work when frozen.

Sand and gravel beach deposits have potential as local sources of aggregate for the Rainy Lake area. Groundwater potential in the beach deposits is poor, as most occur above the water table; where the water table is high, the potential is excellent. The beach ridges may be suitable for near-surface waste disposal where they are underlain and surrounded by silt and clay.

3.4 GLACIOFLUVIAL

Examples: $\frac{\text{sgGO}}{\text{Lp-m}}$ $\frac{\text{gsGO}}{\text{Lp-w}}$ $\frac{\text{cmLP/sgGO(RN)}}{\text{Ln-D(M)}}$ $\frac{\text{csLP/sgGO/RN}}{\text{Lp-D}}$

Surface glaciofluvial deposits (GO) are rare in this map-area, but a number of large subsurface deposits have been identified. The most common unit consists of stratified and cross-stratified sand and gravel (sgGO), from 5 to 20 m thick, which is completely or partially overlain by the glaciolacustrine (cmLP) deposits described in Section 3.3. Examples include (1) the Armstrong Pit in flat, low relief topography (Lup or Lp) west of Fort Frances, and (2) the Labelle Pit in the hummocky topography of Mather Township. The two deposits are not necessarily of the same origin. Water well information and field observation suggest that extensive buried channels of glaciofluvial sand and gravel, similar to the deposit exposed in the Armstrong Pit, may occur in other parts of the Rainy Lake lowland. Substantial glaciofluvial terrain may also occur in the poorly defined moraine belt between Dance and Menary Townships in the northwestern part of the area (Blackburn 1976). Glaciofluvial deposits around Burditt Lake in Senn Township underlie clay and beach gravel in places and are confined in narrow bedrock valleys. Kame (sgGK) deposits are suspected to occur in Menary Township.

Glaciofluvial terrain is generally well drained; however, some deposits, such as the one near Big Sawbill Lake in the northeast corner of the area, occur in depressions and may be wet for part of the year.

The major engineering significance of the glaciofluvial sand and gravel is its potential for use as a construction material. Surface deposits occur in areas of moraine and extensive buried deposits are suspected. Subsurface investigation and detailed mapping to outline possible reserves is probably warranted in an aggregate poor area. Groundwater potential is excellent in these deposits and a number of existing wells tap subsurface glaciofluvial aquifers. The unit is not suitable for waste disposal.

3.5 ALLUVIAL

Examples: $\frac{\text{smAP}}{\text{Lt-D}}$ $\frac{\text{smAP}}{\text{Lp-M}}$ $\frac{\text{psAP}}{\text{Lp-W}}$

Alluvial terrain consists of terraces along the Rainy River, and flood plain deposits along small streams, such as the La Vallée River in the southern part of the area and the Sturgeon River in the southwest corner. Terraces (Lt) along the Rainy River are well above the present river level, and are composed of silty sand with occasional thin layers of gravel. This unit is dry, flat, and difficult to outline on airphotos.

Flood plain deposits of the small, poorly developed streams in the area are composed mainly of peat (pAP) with interbeds of silt and sand (psAP). This terrain is at or near stream level, is commonly wet during parts of the year, and is subject to flooding. The Rainy River has a very narrow flood plain which was not recognized on the airphotos.

Alluvial plains offer poor foundation conditions and do not contain good quality aggregate. They are not suitable for waste disposal of any kind and groundwater potential is poor.

The possibility of slumps and landslides exists along slopes of stream valleys that have exposed glaciolacustrine clay. Much of this terrain appears stable and dry, but minor slumps were mapped southwest of Fort Frances and 4 km southeast of Emo. Both are located along steep valley slopes of the Rainy River. Bank erosion along the Rainy River is active, thus increasing the possibility of periodic slumps, especially in poorly drained localities.

3.6 ORGANIC

Examples: $\frac{\text{pOT}}{\text{Lp-M}}$ $\frac{\text{pOT/cmLP}}{\text{Lp-M}}$

Organic deposits form a particularly common terrain unit in the Rainy Lake lowland. They occur in nearly flat, dish-shaped depressions in the glaciolacustrine plain (pOT/cmLP) and are estimated to be in excess of 1 m thick in most localities. The terrain is wet (W) or seasonally wet (M), probably due to a perched water table and a poorly developed drainage system. Graham and Tibbetts (1965) carried out a preliminary study of the peat in the area and some production occurred during the period 1941 to 1952 (Davies 1973).

Construction is difficult and expensive in organic terrain due to the poor drainage conditions and the low strength, low bearing capacity, high compressibility, and extremely high frost susceptibility of the soil materials. The unit is generally poor for engineering or construction use, but, light vehicle roads have been built with some success across drier parts of the deposits.

Groundwater potential is low and any water is likely to have a high content of organic iron. The terrain is not suitable for any type of waste disposal or for the installation of septic drain tile fields.

Some peat deposits, especially near the edges of bogs, have been reclaimed for agriculture through extensive ditching. Turf industries have utilized the organic deposits in the past. Perhaps the greatest potential for the unit is as a fossil fuel source, since reserves may be large.

3.7 EOLIAN

Example: $\frac{\text{sED(cmLP)}}{\text{Lp-D}}$

A small patch of poorly defined eolian sand dunes (sED) was mapped near Aylsworth on the southern margin of the area. The unit is composed of fine-grained sand which is inferred to overlie clay. The dunes are stabilized by vegetation. The topography is essentially planar (Lp) and the unit is dry (D).

This sand deposit was not examined in the field, but may have local potential for use as back fill or in tile field construction.

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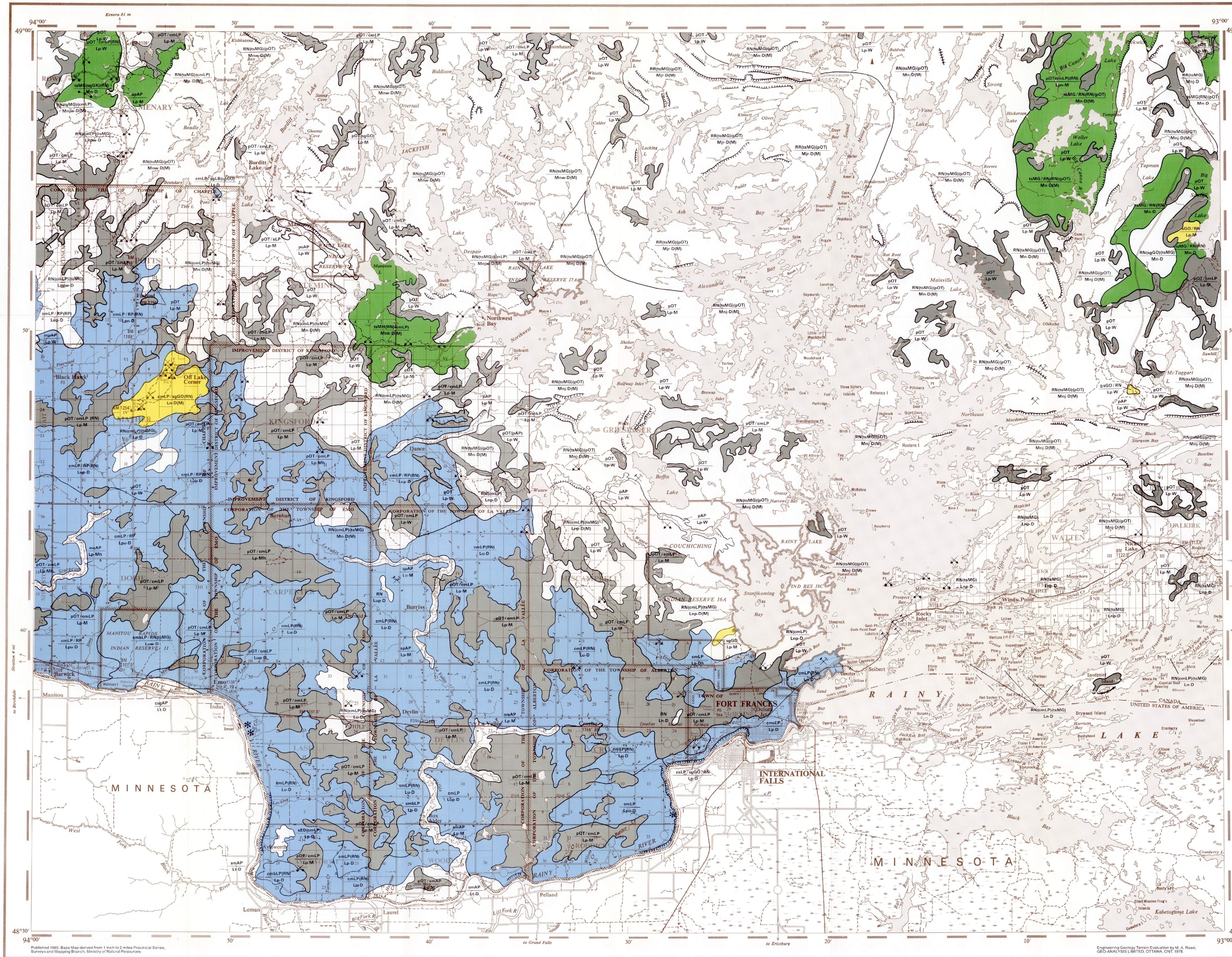

Published 1980. Base Map derived from 1 inch to 2 miles Provincial Series, Surveys and Mapping Branch, Ministry of Natural Resources.

Engineering Geology Terrain Evaluation by M. A. Roed, GEO-ANALYSIS LIMITED, OTTAWA, ONT. 1978.

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Minister
Dr. J. K. Reynolds
Deputy Minister

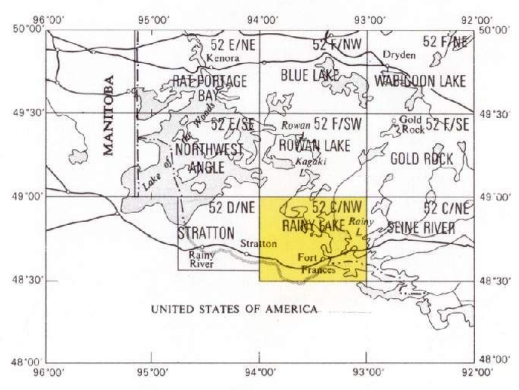
Ontario Geological Survey

Map 5069
RAINY LAKE

NTS 52 C/NW

Data Base Map

Northern Ontario Engineering Geology Terrain Study



INDEX TO ADJOINING SHEETS

1:100 000

2 1 0 2 4 6

One centimetre represents one kilometre

LEGEND

LANDFORM

MORAINAL

- **ME** *End moraine*
- **MG** *Ground moraine*
- **MH** *Hummocky moraine*

GLACIOFLUVIAL

- **GD** *Ice contact delta, esker delta, kame delta, delta moraine*
- **GE** *Esker, esker complex, crevasse filling*
- **GK** *Kame, kame field, kame terrace, kame moraine*
- **GO** *Outwash plain, valley train*

GLACIOLACUSTRINE

- **LB** *Raised (abandoned) beach form*
- **LD** *Glaciolacustrine delta*
- **LP** *Glaciolacustrine plain*

ALLUVIAL

- **AP** *Alluvial plain*

COLLUVIAL

- **CS** *Slope failure*
- **CT** *Talus pile*
- **CW** *Slopewash and debris creep sheet; minor talus*

EOLIAN

- **ED** *Sand dunes*

ORGANIC

- **OT** *Organic terrain*

BEDROCK

- **RL** *Bedrock plateau*
- **RN** *Bedrock knob*
- **RP** *Bedrock plain*
- **RR** *Bedrock ridge*
- **/R** *Bedrock below a drift veneer*

MATERIAL

- **b** *boulders, bouldery*
- **c** *clay, clayey*
- **g** *gravel, gravelly*
- **p** *peat, muck*
- **r** *rubble*
- **s** *sand, sandy*
- **m** *silt, silty*
- **t** *till*

TOPOGRAPHY

LOCAL RELIEF

- **H** *Mainly high local relief*
- **M** *Mainly moderate local relief*
- **L** *Mainly low local relief*

VARIETY

- **c** *channelled*
- **d** *dissected, gullied*
- **j** *jagged, rugged, cliffed*
- **j*** *cliffed volcanic rock signature*
- **k** *kettled, pitted*
- **n** *knobby, hummocky*
- **p** *plain*
- **r** *ridged*
- **s** *sloping*
- **t** *terraced*
- **u** *undulating to rolling*
- **w** *washed, reworked*

DRAINAGE

SURFACE CONDITION

- **W** *Wet*
- **D** *Dry*
- **M** *Mixed wet and dry*
- **h** *Suspected high water table*

The letter codes describing the terrain units are made up of four components arranged as follows:–

MATERIAL	**LANDFORM**
TOPOGRAPHY	**DRAINAGE**

Examples:

1\. **tMG(RN)** / **Mu(Hj)-D** — material; dominant landform; subordinate landform; drainage; relief of subordinate landform; topographic variety of dominant landform; local relief

2\. **pOT/sGO** / **Lp-W** — slash indicates a veneer of one landform overlying a second landform

SYMBOLS

- *Significant end moraine or linear moraine-like feature*
- *Well expressed drumlins and drumlinoid ridges*
- *All other linear ice-flow features*
- *Esker ridge (continuous, discontinuous; the symbol does not indicate direction of flow)*
- *Abandoned shoreline (continuous, discontinuous)*
- *Local dune area (type and location of individual dunes not indicated)*
- *Abandoned river channel, spillway, or ice marginal channels*
- *Escarpment*
- ●10 *Sample location*
- *Small landslide scar*
- *Sand or gravel pit*
- *Quarry or mine workings evident from airphotos or field observation (crossed picks are shown in the area of open excavation)*
- *Other man-made features (rock dumps, tailings, lagoons, landfills, etc.: type of feature mentioned where identifiable)*
- *Steep-walled valleys, often bedrock-controlled features*
- *Talus (defined, inferred; base of talus triangle indicates downslope side of escarpment)*
- *Line joining the same terrain units*

NOTE 1:

This map is intended to be an inventory of regional engineering terrain conditions, as determined largely by airphoto interpretation. Its purpose is to provide a guide for engineering and resource planning functions. The boundaries of the terrain units shown on the map are approximate only, consistent with a 1:100 000 scale. Site specific investigations are required in order to obtain detailed information for a particular area. The map user should refer to the accompanying report for a fuller description of terrain in the study area.

NOTE 2:

Colour is used to enhance what is considered to be the dominant engineering condition in simple, complex or layered terrain units.

NOTE 3:

Not all letter and graphic symbols shown in the legend necessarily appear on this map sheet.

Reference to this map is recommended as follows:

Roed M. A.
1980: Northern Ontario Engineering Geology Terrain Study, Data Base Map, Rainy Lake
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