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SURFICIAL GEOLOGY OF THE EDMONTON DISTRICT, ALBERTA

by

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CONTENTS

	Page
Abstract	5
Introduction	5
Location of district	5
Previous work	7
Field work	7
Acknowledgments	7
Physiography	8
North Saskatchewan River valley	8
Sturgeon River valley	8
Gwynne outlet	10
Ground moraine area	11
Hummocky dead-ice moraine area	11
Lake Edmonton area	13
Pitted deltas	13
Early North Saskatchewan River area	14
Dune areas	15
Description of materials	16
Bedrock	16
Saskatchewan sands and gravels	16
Till	17
Superglacial and impounded glacial lake sediments	19
Lake Edmonton deposits	20
Normal deposits	20
Modified Lake Edmonton deposits	22
Pitted deltas	23
Early North Saskatchewan River alluvium	24
"Sturgeon Valley" fluvial sand	25
Crevasse fillings and kames	25
Sand and gravel outwash	26
Aeolian sand	26
Glacial and recent history	28
Preglacial topography	28
Glacial advance	28
Deglaciation	29
Lake Edmonton	29
Recent modifications	30
References cited	31
Appendix - Commercial deposits of sand and gravel	34

ILLUSTRATIONS

		Page
Figure 1.	Location of the Edmonton district	6
Figure 2.	Physiographic units of the Edmonton district	9
Figure 3.	Distribution of mechanical composition of till samples .	18
Figure 4.	Locations of sand and gravel deposits of probable commercial value	35
Figure 5.	Locations of sand and gravel deposits of probable commercial value	36
Maps 62 - 6A, 62 - 6B, 62 - 6C, 62 - 6D.	Preliminary maps, surficial geology of the Edmonton district	in pocket
Table 1.	Mechanical composition of the till samples	18

SURFICIAL GEOLOGY OF THE EDMONTON DISTRICT, ALBERTA

Abstract

The Edmonton district was glaciated during Wisconsin time by a continental glacier which advanced over the area from the central region of Keewatin. This glacier at the time of maximum extension covered most of Alberta and attained a thickness of about one mile over the map area. The retreat of the glacier from central Alberta was largely by stagnation. As the natural drainage of central Alberta is northeasterly and as the glacier retreated in that same direction, meltwaters were impounded in front of the glacier producing large, relatively short-lived lakes many hundreds of square miles in area. The rapid recession of the stagnating glacier allowed these proglacial lakes to find constantly new and lower outlets. As a result of this, the proglacial lakes in Alberta as a rule have no beaches associated with them.

One such proglacial lake - Lake Edmonton - at one time covered most of the Edmonton district and extended far to the west. Only the very eastern part of the district and a small area in the northwest were not covered by Lake Edmonton; these areas are devoid of lacustrine sediments, the surface deposit being till.

The surface of the lacustrine deposits is for the most part flat, but in places has a very rough topography, a function both of conditions of sedimentation in the lake and of the topography of the underlying materials.

Lake Edmonton was drained finally by the North Saskatchewan River in post-glacial time.

During the Altithermal period, the climate of the area was much warmer and drier than at present. At this time most of the sand dunes in the area were probably formed.

INTRODUCTION

This report presents the preliminary results of the mapping of surficial deposits of the Edmonton district. The distribution of these deposits is shown on four contiguous map sheets reproduced herein on a scale of one inch to one mile.

Location of District

The Edmonton district is located in central Alberta between longitudes 113° 00' and 114° 00' W., and latitudes 53° 15' and 53° 45' N.

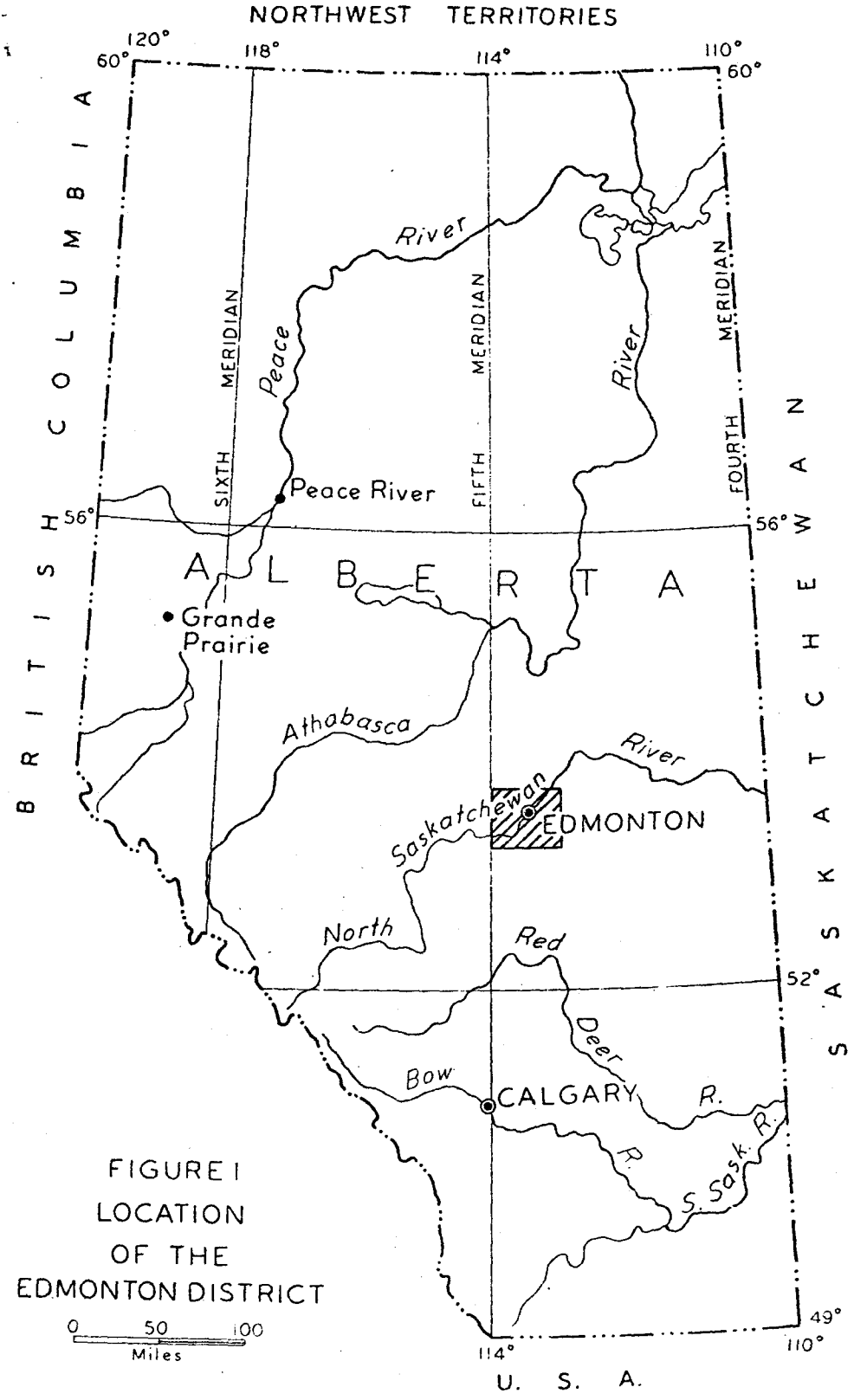

FIGURE 1
LOCATION
OF THE
EDMONTON DISTRICT

(Fig. 1). The total area of the district is about 1,390 square miles. The City of Edmonton is situated in the central part of the district. All locations given in the text, unless otherwise stated, are west of the Fourth Meridian.

Previous Work

Lake deposits in the vicinity of Edmonton were noticed as early as 1886 by Tyrrell (1887, p. 143E), who attributed them to proglacial lakes or remnants of a retreating glacial sea. Dawson (1899, p. 14A), Coleman (1910, p. 7), Taylor (1934, p. 52), Rutherford (1937, p. 86), and Warren (1937, p. 301) were aware of these lake deposits but no examination was made until relatively recently, when Warren (1954, p. 80-81) and Duff (1955) studied these sediments in moderate detail.

The term "Lake Edmonton" was first used in print in 1956 by Gravenor and Bayrock (1956, p. 10) in referring to the lake that drained through the Gwynne outlet.

Field Work

The mapping was carried out by both authors during the summer of 1958 and mainly by G. M. Hughes in 1959. Aerial photographs from the Alberta Department of Lands and Forests were used extensively as an aid in the interpretation and mapping of surficial deposits. Field information was collected by the examination of roadcuts and river cut-banks, and by shallow digging. Some additional information was gathered from holes bored with a 60-foot Euger power drill.

Spacing was one mile on the north-south traverses and two miles on the east-west traverses. Additional traverses were made at closer intervals wherever necessary. Transportation in the field was accomplished by jeep or passenger car. In areas of rough terrain many traverses were carried out on foot.

Acknowledgments

Helpful suggestions by Dr. C. P. Gravenor, Research Council of Alberta, and Dr. R. S. Taylor proved to be very valuable in the interpretation of glacial geology and history of the area.

The Soils Division, Research Council of Alberta, provided the writers with the results of mechanical analyses performed on many samples of soil parent material collected in the map area.

S. J. Groot, map production officer, Research Council of Alberta, prepared the accompanying maps. Excellent field assistance in 1959 was provided by K. Shutt.

A part of this report was used as material for an M. Sc. thesis at the University of Alberta by G. M. Hughes in 1958.

PHYSIOGRAPHY

The Edmonton district has nine important physiographic units (Fig. 2):

1) North Saskatchewan River valley
2) Sturgeon River valley
3) Gwynne outlet
4) Ground moraine area
5) Hummocky dead-ice moraine area
6) Lake Edmonton area
7) Pitted deltas
8) Early North Saskatchewan River area
9) Dune areas

North Saskatchewan River Valley

The North Saskatchewan River is the main drainage channel of the area. It enters the Edmonton district in the southwest and leaves it in the northeast after passing diagonally through the City of Edmonton. On the basis of morphology of the banks, the valley can be divided into two parts, the dividing line lying close to the railway bridge west of Clover Bar (Sec. 18, Tp. 53, R. 23). Upstream from the bridge the valley seldom exceeds one mile in width. On the average the walls are about 200 feet high and in places form unclimbable cliffs. Downstream from the Clover Bar railway bridge the valley widens abruptly, is generally more than one and one-half miles in width, and is greater than two miles wide in places. The valley walls in this area are usually less than 125 feet in height while farther downstream at Fort Saskatchewan the valley walls are again close together, about one-half to three-quarters of a mile apart, and only about 50 feet high.

The reason for this difference in morphology of the valley is that the North Saskatchewan River between the Clover Bar bridge and Fort Saskatchewan follows a preglacial valley or a preglacial topographic low.

Sturgeon River Valley

The Sturgeon River enters the Edmonton district in the northwest corner and then flows east and south to enter Big Lake. From Big Lake the Sturgeon River flows northeastward to leave the district north of Edmonton. The valley of the Sturgeon River upstream from Big Lake is less than 20 feet deep and 200 feet wide. From Big Lake downstream the valley takes on an entirely different character, being about 100 feet deep and one and one-half miles wide with the underfit Sturgeon River meandering through it. This section of the valley appears to be an extension of the valley containing Big Lake and Atim Creek to the west, rather than of the valley containing the Sturgeon River north of Big Lake.

The morphology of the Sturgeon River valley is related to bedrock topography and to glacial or possibly interglacial drainage systems. The

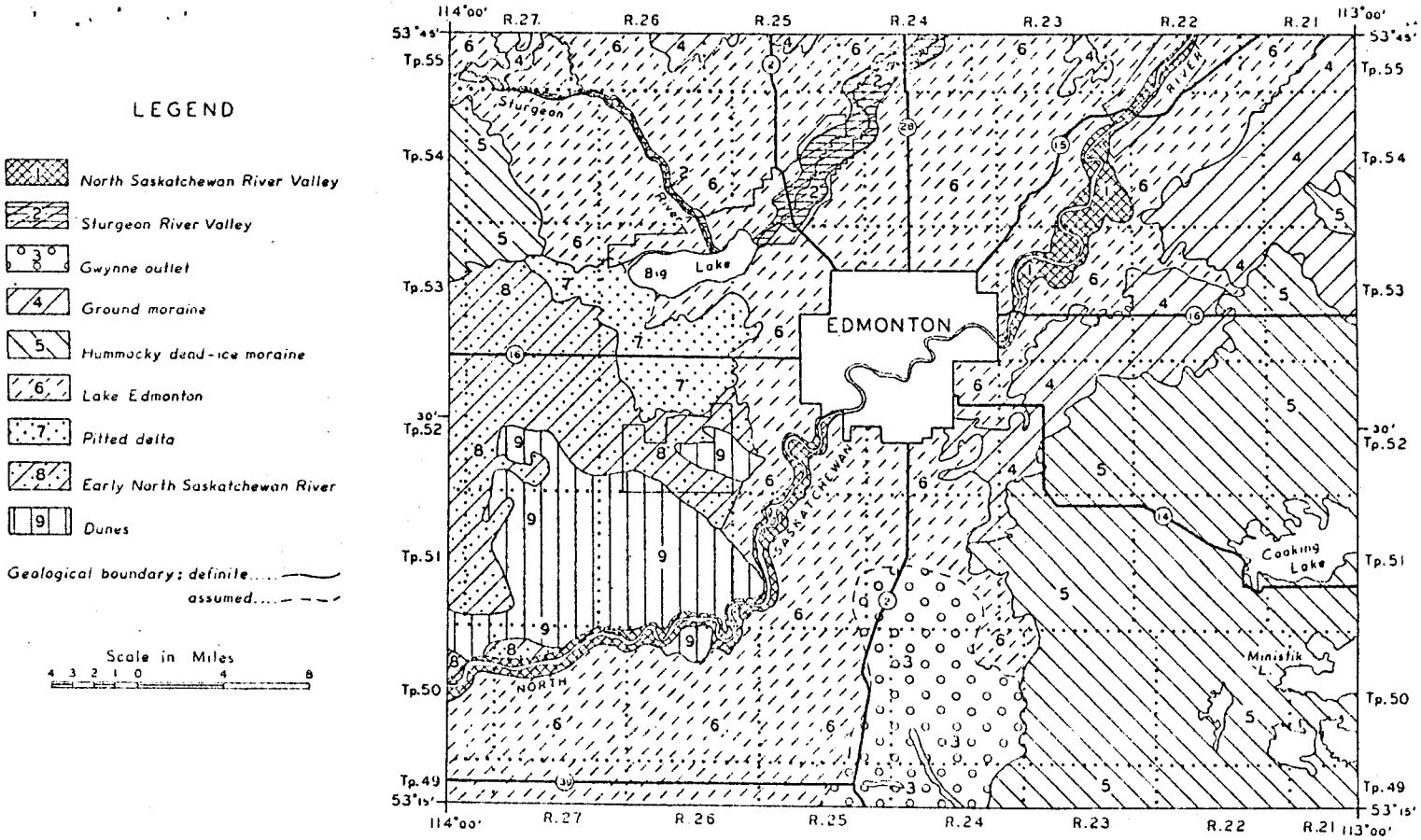

Figure 2. Physiographic units of the Edmonton district

Sturgeon River has many puzzling features and its history has not yet been deciphered.

Gwynne Outlet

The Gwynne outlet was originally defined by Gravenor and Bayrock (1956, p. 9) as the outlet of Lake Edmonton. Only that part of the Gwynne outlet channel lying within the area mapped is discussed here. This channel is located in the south-central section of the Edmonton district and is at present in part occupied by Saunders Lake in the south and Blackmud Creek in the north. East of Leduc the valley of the outlet channel is 125 to 150 feet deep and one-half mile wide, with steep walls and a flat floor. To the north, the valley becomes broader and shallower and disappears at a point about four miles north of Nisku (Sec. 7, Tp. 51, R. 24). A number of subsidiary anastomosing channels are associated with the Gwynne outlet in the Edmonton area, but with the exception of one that lies about two miles to the east and joins the outlet channel just south of the southern boundary of the map area they are poorly defined. Downstream, outside the Edmonton district, the Gwynne outlet valley is essentially one deep and broad valley which at the town of Gwynne becomes occupied by the Battle River. The Battle River follows the Gwynne outlet eastwards and joins the North Saskatchewan River at Battleford, Saskatchewan. Throughout its course the Battle River is a misfit stream in the Gwynne outlet valley. Inasmuch as the North Saskatchewan River came into existence after the Gwynne outlet incision, it can be said that the North Saskatchewan River joins the Battle River, rather than the converse, in spite of the relative sizes of the two rivers.

The Gwynne outlet probably drained Lake Edmonton at its highest level in the Edmonton district; this highest level is named the Gwynne stage in this report. During this stage Lake Edmonton did not drain to the east and it is believed that in that direction ice formed the lake boundary. The Gwynne outlet was entirely cut during the time it was used as an outlet.

As the outlet valley became incised it could drain Lake Edmonton at lower levels. With this progressive incision the level of Lake Edmonton was being constantly lowered and the escaping lake waters eroded the headwater region of the Gwynne outlet. The sediments of Lake Edmonton deposited during higher lake level stages were consequently partly or in places wholly eroded in the headwater region of the outlet. In some places not only lacustrine sediments but also till and bedrock were eroded. Extensive boulder pavement bears witness to this.

The term "channeled scabland", as first used by Bretz (1923), was applied to a terrain cut and eroded by an anastomosing system of glacial river courses in the State of Washington. Later, retaining the same term Bretz et al. (1956) proved that this scabland was produced by escaping glacial-lake waters. The term "channeled scabland" consequently is a very appropriate term to describe the headwater region of the Gwynne outlet.

Ground Moraine Area

Ground moraine is defined as a level to gently undulating till plain. A large area of ground moraine lies east of the City of Edmonton and extends to the northeast beyond the map limit. Small patches of similar ground moraine are also present in the northwestern portion of the Edmonton district.

The surface of ground moraine in the map area is gently undulating with a local relief up to 20 feet. The large area of ground moraine east of the City of Edmonton (Tps. 52 to 55, Rs. 21 to 23) grades into a hummocky dead-ice moraine to the east. To the west the ground moraine is covered by the lacustrine deposits of Lake Edmonton.

The main topographic expression of ground moraine in the district is as small knobs about 100 to 300 feet in diameter and about 2 to 10 feet high. Some of the larger knobs have a central depression and resemble prairie mounds (Gravenor, 1955). Kettles are common on the ground moraine; these are usually small, up to 100 feet in diameter and 3 to 5 feet deep. Although most of the kettles are dry or contain water only in the springtime, they can be readily seen on aerial photographs.

Hummocky Dead-Ice Moraine Area

The hummocky dead-ice moraine that exists in the east portion of the Edmonton district (Tps. 49 to 55, Rs. 21 to 24) is a part of the Buffalo Lake moraine of Warren (1937, 1954), who interpreted it as a recessional moraine. Later studies of similar features in Western Canada and Europe revealed that moraines of similar topographies are the product of deposition of till from stagnant ice (Hoppe, 1952; Christiansen, 1956; Gravenor and Bayrock, 1956; Bayrock, 1958a, 1958b; Stalker, 1960; and others) and they are now called hummocky dead-ice moraines (Bayrock, 1958a, 1958b).

The main topographic features of hummocky dead-ice moraines are knobs, kettles, prairie mounds, till ridges, moraine plateaus, and stream-trenches.

Knobs are hills and hillocks circular to oval in plan outline. They are composed almost entirely of till. Knobs range in size from a few tens of feet to several hundred feet in diameter. They average about 15 feet in height but range from a few feet to about 50 feet. Kettles are small closed depressions produced by melting of residual glacial ice either wholly or partially buried in the drift. Knobs and kettles are the most common features of the hummocky dead-ice moraine in the area.

Prairie mounds are very similar to knobs except they have a small depression in the centre giving them the appearance of gigantic doughnuts. The origin of prairie mounds has been disputed for several years and diverse hypotheses have been offered to explain their formation. Prest (1957) assumed that prairie mounds were formed under a proglacial environment,

but does not give any process for their formation. Stalker (1957, 1960) accepted Hoppe's (1952) ideas about the formation of hummocky dead-ice moraine and interpreted prairie mounds in a similar fashion, although Hoppe has not found any prairie mounds in Sweden. Hoppe (1952) postulated that the till beneath the stagnant ice was wet and not frozen and that large residual blocks of ice while resting upon it pressed the till from under them into spaces between the blocks, thus forming the rough topography of the hummocky dead-ice moraine. Gravenor (1955) postulated that the mounds were formed on stagnant ice by slumping of debris into holes or moulins in the ice. The origin of knobs is very similar to that of prairie mounds. All gradations may be found within the map area between the two.

In the Edmonton district till ridges generally are short, being on the average about one-quarter of a mile in length; they range from one-eighth of a mile to over one mile. Most are irregular in outline, although some are straight and some are sinuous. The best developed till ridges have even crests, the more poorly developed ones undulating crests, and they grade to rows of hummocks or rows of prairie mounds. Hoppe (1952) called similar ridges "moraine ridges" and Gravenor and Ellwood (1957) used the term "morainic ridges". Hoppe (1952) explained them as having been formed by pressing up of wet, unfrozen till from under stagnant ice blocks into spaces between the ice blocks. Gravenor and Ellwood (1957) explained till ridges ("till crevasse fillings") as having been formed by debris slumping into open fissures from the top. The authors favor the second explanation because the till ridges are found in very close association with prairie mounds, for which a superglacial origin is accepted.

Moraine plateaus, first recognized and named by Hoppe (1952), are small areas with a level to undulating surface within the hummocky dead-ice moraine. Hoppe (1952) explained them as part of the original basal till that was not distorted by stagnant ice blocks. The authors' concepts of the origin of moraine plateaus are in general in accordance with those of the formation of the surrounding hummocky dead-ice moraine: that is, they were formed superglacially rather than subglacially. Because most of the moraine plateaus are covered with glacio-lacustrine materials of small thickness (5 to 10 feet), moraine plateaus are believed to have been sites of former superglacial lakes. These superglacial lakes are believed to have mantled the underlying debris-loaded ice uniformly and thus induced uniform melting without much slumping. A second possible explanation is that moraine plateaus represent areas into which large mud flows moved from the surrounding stagnant and debris-covered ice.

Stream trenches (Gravenor and Bayrock, 1956) are channels which vary in width from a few hundred feet to over one mile and from only a few feet to over 100 feet in depth. Commonly, the stream trenches are filled with hummocky dead-ice moraine and contain many ponds and lakes. Locally, small sections of a stream trench are not covered by till. At such places either glacio-fluvial gravel or exposed bedrock may be found. In plan view the stream trenches form a sub-parallel pattern with intersecting channels of varying width.

Lake Edmonton Area

Glacial Lake Edmonton, which covered most of the Edmonton district, was in some respects a unique lake; it bordered against the ice in many places and its level was rapidly lowered in response to new outlet levels and to the melting rate of the glacier. Lacustrine conditions persisted longest in the centre of the basin and as a rule the thickest Lake Edmonton sediments are found there. Also, because of the rapid lowering of the lake level no beaches are found on Lake Edmonton. The sediments become thinner from the centre of the basin towards the border; close to the border it is very difficult to define the lake limit because the thickness of deposits may become less than 6 inches and thus they become obscured by the soil profile.

The topography of the Lake Edmonton area in the Edmonton district is smooth throughout most of its extent, but pre-lake topography is reflected through the overlying lacustrine sediments near the lake borders. At the border, where lacustrine sediments are thin, the pre-lake topography has such a marked influence that as a rule it is very difficult to define the limit of Lake Edmonton by topography alone. At such places only examination of surface deposits may indicate the former extent of the lake. In many places where the border of the lake could not be defined precisely, it is shown on the accompanying maps by an indefinite geological boundary or by a transition zone.

The pre-lake topography was not wholly smooth. The deepest part of Lake Edmonton basin follows more or less the course of the present North Saskatchewan River in the Edmonton district, except where a broad high area -- believed to be a reflection of bedrock topography - extends through Calmar northward to the North Saskatchewan River. East of this high area is a broad shallow valley containing Whitemud Creek, and farther eastward the country rises gently until the Gwynne outlet is reached.

In some places where the pre-lake surface was rough, it reflects through considerable thicknesses of lake sediments, such as in township 51, range 25, southwest of the City of Edmonton. Other similar but smaller areas are present along the borders of Lake Edmonton.

Pitted Deltas*

Pitted deltas are composite deltas of many streams that flowed on the surface of the glacier and terminated in a lake. The pitted deltas were deposited partly over ice and partly around large ice blocks standing in water of Lake Edmonton. As the front of the glacier receded, the deltas were built at different localities close to the ice edge. Later melting of the ice blocks covered or surrounded by sediments produced the characteristic pits and kettles of the pitted deltas.

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* G. M. Hughes (1958) used the term "inwash" to designate these deltas.

Two large pitted deltas of Lake Edmonton are present in the area. These deltas have a rough topography resembling that of hummocky dead-ice moraine in general appearance but in detail they differ markedly from both the moraine and from each other. One delta is located in the Winterburn-Acheson area west of the City of Edmonton; it is bounded by a poorly defined channel on the west and by a well defined, scoured channel on the east. As seen from the ground, the pitted delta bears some resemblance to the knob and kettle topography of the hummocky dead-ice moraine, but aerial photographs show it to be composed of a relatively flat surface broken by distinct pits up to 40 feet deep. These pits tend to become smaller towards the periphery of the delta. In general appearance the pitted delta resembles a highly pitted outwash plain.

The second pitted delta is located in the valley of Atim Creek northwest of, but adjacent to, the first pitted delta and is partially separated from it by an area of marsh. This marshy area is an extension of the poorly defined, scoured channel lying to the west of the first pitted delta area.

The second pitted delta differs from the first in that it consists of a number of small knobs 10 to 15 feet in height separated by flat areas of recent sediments and bog. Some of these knobs have small central depressions and are very similar in surface expression to the prairie mounds described by Gravenor (1955).

Early North Saskatchewan River Area

After the final draining of Lake Edmonton, the North Saskatchewan River flowed as a braided stream over the surface of the area west of the City of Edmonton. Later, one of the channels was incised to become the present-day North Saskatchewan River valley. East of the City of Edmonton the river incised itself directly without a braiding stage. The area covered by the braided and anastomosing channels is called the Early North Saskatchewan River area. The western limit of this area is a few miles west of the map area; in the Edmonton district the area attains a width of many miles, extending from the Town of Devon to that of Spruce Grove.

Most of the channels are very shallow, poorly defined, and difficult to detect from the ground, although on aerial photographs they can be seen with ease. At present most of the channels contain bogs and marshes. The banks of the more prominent channels seldom exceed 20 feet in height, and are on the average only about 10 feet.

A number of the better defined channels are outlined on the maps, but many very poorly defined and small channels have been omitted. The channels become less pronounced from west to east and are indistinguishable in the dune area.

Dune Areas

Sand dunes were produced in areas where loose sand was available. Two sources of such sands were present in the Edmonton area: lacustrine sands and early North Saskatchewan River alluvium, the latter having less silt and clay to act as a binding medium for sand grains than had the lake sands.

Three large areas are covered by dunes at present. The largest area lies due east of the distributaries found in township 51, range 27, and extends from the distributaries eastward to the North Saskatchewan River. The dunes are widely spaced in the west and are more closely spaced in the east in township 51, range 26, with small lakes and swamps commonly occupying the inter-dune areas. The dunes are longitudinal (linear) and parabolic (U-shaped); the parabolic dunes are concentrated near the central part of the dune area and the longitudinal dunes along the northeast boundary. Few of the dunes exceed 40 feet in height; some longitudinal dunes attain a length of over two miles.

Immediately north of the main dune area, in the southeast corner of township 52, range 26, lies a smaller dune area also composed of longitudinal and parabolic dunes. One longitudinal dune in this area has a length of over three miles, but in all other respects the two areas are similar. The dunes in the area west and south of the Town of Devon in the north-central part of township 50, range 26, are also similar to those in the main dune area.

As indicated by the long axes, the dunes were produced by northwesterly (43° north of west) winds. This is in agreement with the findings of Odynsky (1958).

DESCRIPTION OF MATERIALS

Bedrock

The bedrock of the Edmonton area is composed of Upper Cretaceous shales, shaly sandstones and sandstones belonging to three formations, all dipping at about 20 feet per mile to the southwest:

Edmonton formation
Bearpaw formation
Belly River formation

The Edmonton formation underlies most of the Edmonton district. It is composed of interbedded bentonitic shales and sandstones with some coal seams.

There is some doubt as to the existence of the Bearpaw formation below the Edmonton formation in the area. Map 1002A (Geol. Surv. Can., 1951) shows the Bearpaw formation as being present in Sec. 23, Tp. 54, R. 23, but neither Ower (1958, p. 7) nor the authors could find outcrops at this locality. Apparently this formation, which is composed predominantly of shales elsewhere, pinches out in the map area. The Belly River formation outcrops in the extreme northeast corner of the Edmonton district. Strata of these formations are all poorly consolidated to unconsolidated.

Saskatchewan Sands and Gravels

The Saskatchewan sands and gravels occur sporadically throughout the area. They are present below the till and unconformably overlie the Edmonton formation in the hills north of the town of Spruce Grove and west of Gladu Lake. The sands and gravels also occur near the City of Edmonton, forming the Mount Pleasant cemetery hill on the southern outskirts of the City, as well as other similar hills in that vicinity. Also, the Saskatchewan sands and gravels are found as channel fill in preglacial valleys in the area, and can be observed at many localities on the North Saskatchewan River.

The origin of the Saskatchewan sands and gravels in the Edmonton district is complex, as doubtless more than one depositional cycle is involved.

The sands and gravels can be separated into three groups on the basis of elevations of occurrence. The topographically lowest group is found as a preglacial valley fill in the Edmonton district, in valleys incised into the underlying bedrock. Exposures of these sands and gravels are found in many places along the North Saskatchewan River valley. At one location, Lsd. 9, Sec. 14, Tp. 52, R. 25, bones referable to a species of Equus have been found and these resemble three distinct species: E. scotti (Gidley), E. pacificus (Leidy), E. midlandensis (Quinn). The first two species are Kansan in age, the last Sangamon or Wisconsin.

The topographically highest group of Saskatchewan sands and gravels is located as cappings on hills north of the town of Spruce Grove (Tp. 53, R. 27) and they are overlain by till. These sands and gravels and the upper part of the Edmonton formation at this location have been severely contorted by the overriding glacier. At location Lsd. 1, Sec. 31, Tp. 53, R. 27, fossils were found in this group of sands and gravels; preliminary information indicates that these fossils are of early Pleistocene age.

The group of Saskatchewan sands and gravels at intermediate elevations is found forming cores of hills on the Lake Edmonton plain near the City of Edmonton, forming the Mount Pleasant cemetery hill on the southern outskirts of the City, as well as other hills in that vicinity. Many hills between Highway No. 16 and Fort Saskatchewan east of Edmonton are similarly composed of this group of Saskatchewan sands and gravels.

In lithology the three groups of Saskatchewan sands and gravels are very similar. The gravels are mainly composed of quartzites and cherts with occasional arkose pebbles, all of which were derived from the Rocky Mountains. No igneous or metamorphic rocks are found in the gravels. On this basis they can be easily differentiated from glacial gravels, which contain appreciable quantities of materials derived from the Canadian Shield, such as igneous and metamorphic rocks.

Till

Till is unsorted, unstratified sediment deposited by a glacier. In the Edmonton area till makes up most of the ground moraine and the hummocky dead-ice moraine, and underlies most of the other glacial deposits of the area.

The color of the till usually is brown near the surface. Between 10 and 30 feet below the surface the brown oxidized till grades into unoxidized till of a grey to dark grey color.

In mechanical composition the surface tills of Edmonton area and adjacent districts have the following average composition: sand 41.1 per cent, silt 31.4 per cent, and clay 27.5 per cent (average of 14 samples) (Table 1, Fig. 3). This is similar to the average composition of till from the Alliance-Hardisty district, east-central Alberta (Bayrock, 1960) which is: sand 40.1 per cent, silt 31.9 per cent, and clay 28.0 per cent (average of 42 samples). This similarity was to be expected because of the similarity of bedrock composition throughout central Alberta.

Although surface tills of the Edmonton area are more or less uniform in size and are similar in composition to tills of central Alberta, there exist marked local deviations. Sandy till can be found near lake borders and, as the name implies, this till contains a smaller percentage of clay and silt than the "average" till. All gradations between "average" till, sandy till and poorly washed gravel have been found.

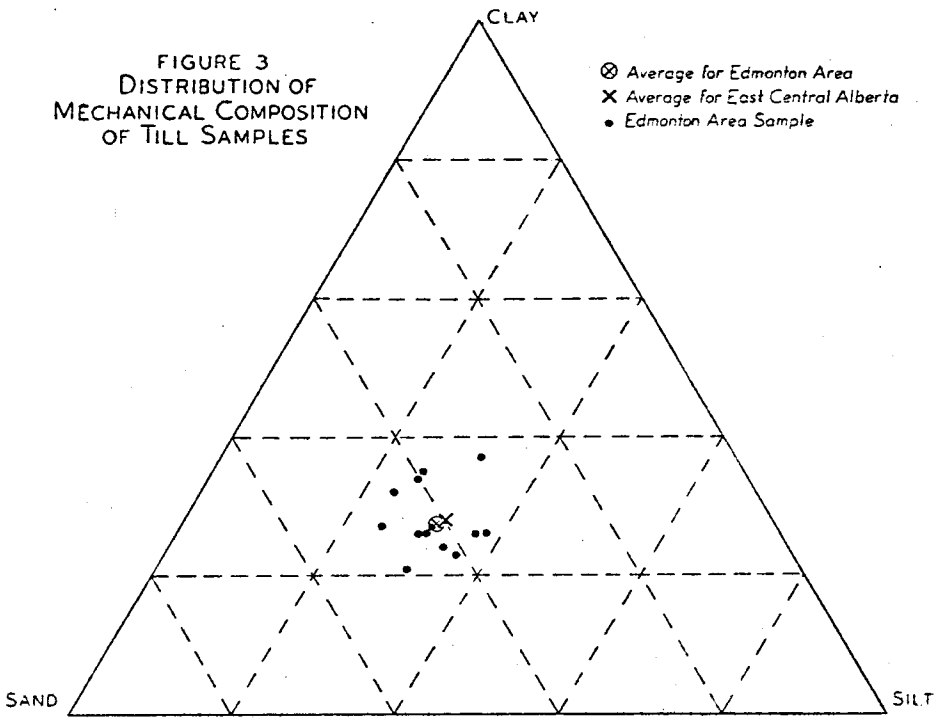

Figure 3. Distribution of mechanical composition of till samples

Table 1. Mechanical composition of till samples*

Sample No.	Location				Depth (feet)	Composition (per cent)		
	Sec.	Tp.	R.	Mer.		Sand	Silt	Clay
1	SW 6	47	19	4	58 - 62	36	38	26
2	SW 12	60	27	4	32 - 44	44	30	26
3	NW 14	52	23	4	47 - 65	48	25	27
4	NW 32	48	1	5	40	42	31	27
5	NW 10	60	27	4	72	39	26	35
6	NE 12	53	21	4	50	40	29	31
7	NW 23	46	27	4	36	41	36	23
8	SW 2	53	23	4	62 - 83	44	24	32
9	33	48	1	5	48	42	34	24
10	34	57	27	4	34 - 50	48	31	21
11	23	60	27	4	29 - 48	40	26	34
12	13	51	24	4	48	31	42	27
13	19	55	20	4	50 - 62	43	31	26
14	29	56	29	4	60	37	37	26
			Average			41.1	31.4	27.5

* Data supplied by Soils Division, Research Council of Alberta

The amount of stone present in the till is variable. "Stone-poor" till is usually present near lake borders. It is believed that this till had some sorting prior to deposition, as had the sandy till.

The clay-size fraction of the till contains a large percentage of montmorillonite derived from the local Cretaceous bedrock. This high content of montmorillonite imparts to the till a gumbo-like consistency.

The till underlying Lake Edmonton deposits is very similar in mechanical composition to surface till beyond the limits of Lake Edmonton, as judged by examination in the field.

Superglacial and Impounded Glacial Lake Sediments

Superglacial lakes are bodies of water that existed on top of the ice. Impounded glacial lakes were surrounded by ice on all sides but had no ice underneath them. All gradations between the two kinds of lakes exist. Some of the lakes were partly over ice and partly over ground. In the majority of cases it is difficult to distinguish the one from the other without detailed studies.

Sediments deposited in superglacial and impounded glacial lakes are encountered in many places throughout the area of the hummocky dead-ice moraine. As a rule these lacustrine sediments are not thick, ranging from less than one foot to over 10 feet, and being on the average about 5 feet. Individual deposits vary in length from less than 100 feet to over 6 miles.

Bedding of these lacustrine deposits, for the most part, is little disturbed and can be easily recognized. In some places, however, where the sediments were deposited over ice or over till with ice underlying it, they have been disturbed considerably by slumping following later melting of the ice. In extreme cases originally horizontal bedding may now have a vertical attitude.

In mechanical composition the superglacial and impounded glacial lacustrine deposits range from clay to fine gravel. The smaller deposits consist usually of clay and silt, but larger ones grade to fine sand. Near lake borders these deposits are commonly interlayered with till. The till in such cases is present in separate beds, ranging in thickness from a few inches to several feet. Although no petrofabric studies have been carried out on the till beds, it is evident that they represent mudflows of wet till from the surrounding ice. In some places mudflows were so numerous that it is difficult to differentiate lake deposits from till. Subsequent slumping of the deposits due to melting out of buried ice has further complicated the structure. Such slumping, as a rule, is most common near lake borders.

Occasionally fossils are found in superglacial lake deposits. In the hummocky dead-ice moraine region near Ardrossan, some 15 miles east of the City of Edmonton, fresh-water faunas were found in lake sediments

covered by till in the central depressions of prairie mounds. The faunas vary in qualitative composition and relative abundance from one locality to the next, but overall the same rather limited number of species were found. In general ostracodes predominate, with Candona sp. cf. C. subtriangularis Swain, Candona swaini Staplin, Cyclocypris forbesi Sharpe, Cypridopsis vidua (Muller), Cyprinotus incongruens (Ramdohr) and Limnocythere spp. being the common forms. Species of the pelecypod Pisidium are not uncommon and Stagnicola palustris Müller, Stagnicola sp. cf. S. lanceata (Gould), Promenetus exacuous (Say) and Gyraulus hornensis Baker are typical of the gastropod fauna. All of these also are constituents of the present faunas of Alberta. Chara spp. are typically found associated with the fossils*.

The gross aspect of the fauna and flora is that of a shallow pool or pond with marshy borders, probably permanent in character. The molluscs at maturity typically are of somewhat smaller size than are living species, and it is suggested that the dwarfing is a function of cold-water conditions.

Topographically, superglacial and impounded glacial lacustrine deposits may be found anywhere from tops of till knobs and bedrock highs to topographic lows. Commonly the smaller deposits are found buried by up to 20 feet of till and only deep road cuts reveal them.

Lake Edmonton Deposits

In mechanical composition the Lake Edmonton sediments range from pure sand to pure clay. In thickness they range from about 100 feet to less than one foot.

Lake Edmonton deposits are classified under three main headings which are as follows:

(a) Normal deposits, which are the most common type of sediment of the lake not modified by later action, consist of bedded fine sands, silts and clays.
(b) Modified deposits, which are deposits of "normal" type that were subsequently partly or wholly eroded, or had additional materials deposited over them, or both.
(c) Pitted deltas, consisting of fine to medium grained sand and silt.

Normal Deposits

Under this heading are classified Lake Edmonton deposits which were laid down under quiet-water conditions and were not modified by later action.

The basin of Lake Edmonton in the area has a trough shape, the axis of which lies more or less parallel to the North Saskatchewan River. The lake

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* The fossils were identified by R. Green, Research Council of Alberta.

sediments are thickest at the centre of the trough and thin towards the shores. At the boundaries the lake sediments are so thin (less than one foot) that quite commonly it is impossible to tell where they end; soil-forming processes have mixed and altered these thin beds beyond recognition. Areas which have such a problematic lake boundary have been designated by a separate symbol on the map, called "Lake Edmonton deposits and ground moraine, undifferentiated". The transition zone exists along all of the boundary of Lake Edmonton, even where the boundary is shown as a definite one.

A typical section through Lake Edmonton sediments near the centre of the basin (Lsd. 12, Sec. 36, Tp. 20, R. 26) is as follows:

Thickness (feet)	
	TOP
3.5	fine to medium grained sand and silt
19.5	bedded silt and clay (partly varved), becoming more clayey towards top
11	fine to medium grained sand and silt, bedded, partly cross-bedded, some till inclusions in places
10+	till
	BOTTOM

The upper 3.5 feet of sand in this section represent later deposition. In some places there are large bodies of till in the lower sand that are believed to have been dumped onto the lake floor from melting ice rafts in the lake. Also, locally, ice-rafted pebbles and boulders are found throughout the section. At some localities, especially west of the Town of St. Albert, ice-rafted pebbles and boulders are so numerous that on a cursory examination one may confuse these lacustrine sediments with till. Ice-rafted material, however, has disrupted varves or bedding planes underlying it and has continuous varves above.

There is usually a wide transition zone between the lower sand and silt and the overlying bedded and varved silt and clay. Commonly a single basal bed of the bedded sand and silt, about 1 to 2 feet thick, is overlain by a layer of pure clay, about one-quarter to one-half inch thick, which has sharp contacts above and below. Towards the top of the sand and silt individual beds are thinner and grade into proper varves in the last 5 to 10 feet of the section; these varves are about 4 inches thick with a gradational contact between the silt and overlying clay and with a sharp contact at the top of the clay. In the upper part of the section the silt beds become thin and in many cases are absent, leaving only clay present.

As a general rule, the normal Lake Edmonton deposits contain the lowermost sand unit only in thick sections. Where the deposits are thinner,

only varved silts and clays together with the uppermost clayey layer are present. In places where the lacustrine deposits are very thin, in the order of 3 to 5 feet, only the uppermost clayey deposits are present. Till underlies most of the Lake Edmonton deposits, except in very small areas where it was eroded away before deposition of lake sediments.

Ice-rafted till and pebbles found throughout the section of Lake Edmonton signify that the lake was in contact with the retreating glacier for the greater part of its existence.

Modified Lake Edmonton Deposits

Normal Lake Edmonton deposits as described in the previous section were in places modified after deposition by erosion, subsequent deposition, or by both.

The scabland area (Tps. 49 to 51, Rs. 24 to 26) which was produced by the erosive action of escaping Lake Edmonton waters through the Gwynne outlet has many shallow channels which show up on aerial photographs, but which are very difficult to detect in the field. Lacustrine deposits were quite thin before erosion - a maximum of 10 feet - and now, especially in channels, only a thin boulder pavement on top of till is left. In certain places the erosion removed not only the lake deposits but also the underlying till down to bedrock. In such places the boulder pavement is found on top of bedrock.

The boulder pavement is usually discontinuous and only one pebble or boulder thick, but exceptionally it assumes the proportions of small pockets of gravel not over 3 feet thick.

The whole of the scabland area as well as some adjacent country is covered with fluvial sand, which is on the average about 3 feet thick, ranging from less than one foot to about 5 feet. The fluvial sand is from fine to medium grained with occasional gravel and coarse sand pockets. In some places, especially those distant from the channels of the scabland, the sand is impure containing silt and clay up to the amount of 15 per cent.

The fluvial sand mantles different types of deposits: till, superglacial lake sediment, and normal Lake Edmonton sediments. In the field it was found difficult, if not impossible in some instances, to determine the type of material underlying the fluvial sands and thus some types of materials were grouped together. Consequently, on the accompanying maps the fluvial sands are shown by four different symbols which represent (a) fluvial sands overlying till, (b) fluvial sands overlying Lake Edmonton deposits, (c) fluvial sands overlying superglacial lake deposits and till, and (d) fluvial sands overlying Lake Edmonton deposits and till.

The fluvial sand represents deposition from the outflowing waters of Lake Edmonton.

There are three areas where lacustrine sands overlie Lake Edmonton deposits. The first is located around the town of Oliver and extends along the North Saskatchewan River to the Town of Fort Saskatchewan. The second area is located along the North Saskatchewan River southwest of Edmonton and the third is in the northwest portion of the area along the Sturgeon River.

These sands overlie Lake Edmonton deposits in places where those deposits are thickest, or in other words, they are present along the axis of the Lake Edmonton basin. In thickness these sands exceed 5 feet only locally, such as where they have been modified into dunes by later aeolian action.

In mechanical composition the sand may be described as fine to medium grained with up to 45 per cent of silt and clay, usually around 30 per cent, but in places as low as 10 per cent. In one exposure adjacent to the valley of the North Saskatchewan River (Lsd. 12, Sec. 17, Tp. 53, R. 23), a gravel channel infill was encountered associated with this sand. Sorting becomes poorer away from the river valley and bedding is generally poorly developed.

The material found along the Sturgeon River is generally thinner and less well sorted than that adjacent to the North Saskatchewan River, and is transitional into outwash close to Gladu Lake.

The origin of these sands is not known in detail, but because they are present mainly where normal Lake Edmonton deposits are thickest they are believed to represent deposition in small bodies of water of the final stages of Lake Edmonton, after the activity of the Gwynne outlet ceased. It is considered that after most of Lake Edmonton was drained there remained some closed depressions containing water wherein sedimentation continued even after the disappearance of the glacier from the district. Later these small lakes were drained by the North Saskatchewan River with the exception of one - Big Lake. The Big Lake depression has been only partially drained by the Sturgeon River.

Pitted Deltas

Pitted deltas of Lake Edmonton are composed mainly of fine sand and silt; thin clay and clayey beds or both are encountered in places. Till inclusions are not common, but a few have been observed in recent roadcuts.

The sands and silts are well bedded with good cross-bedding developed in coarser materials. Individual beds are 1 to 6 inches thick. In some places the bedding is contorted severely, the contortions in places being so severe that originally horizontal beds now occupy vertical positions. Many individual beds were found to be continuous without major disruptions through the contortions for distances of over 100 feet.

In some places the pitted deltas contain many pebbles and cobbles, coarse materials that are believed to have been either ice rafted into place or to have come from the surrounding or covered residual ice blocks.

The changes of attitude of a single bed are not depositional, but postdepositional. It is believed that these contortions were produced by melting of buried ice blocks or blocks surrounded by the delta materials. Subsurface melting of residual ice blocks, of course, should produce similar structures to those of the hummocky dead-ice moraine and this in fact is what was found in the field: the internal structure of prairie mounds resembles closely that of hummocks of the pitted deltas.

Previously, these pitted deltas have been called "silt till" (Warren, 1954). Other deposits of similar appearance and lithology may have had a different genesis and consequently all may not necessarily be pitted deltas.

Two holes were augered in this material. Hole No. 1 (Lsd. 9, Sec. 34, Tp. 52, R. 26) was drilled in the bottom of a pit and penetrated 68 feet of sand and silt. Hole No. 2 (Lsd. 8, Sec. 34, Tp. 52, R. 26) penetrated 93 feet of the same material. Samples were poor but it seemed that less clay was encountered at depth in both holes.

Fresh-water fossils were found in two localities in the pitted deltas.

Early North Saskatchewan River Alluvium

The North Saskatchewan River must have cut its valley in the Edmonton area entirely in post-Pleistocene time, for Lake Edmonton deposits are continuous on both sides of the river valley. Before the valley was established the river flowed in a braided channel over a large area north of the Town of Devon. Initially some of the water from this anastomosing channel complex drained through the Sturgeon River to the northeast and some through the North Saskatchewan River, but later, when the North Saskatchewan River valley was established, all of the water became confined to the North Saskatchewan River.

The Early North Saskatchewan River alluvium overlies normal Lake Edmonton deposits. Varved clay beneath the alluvium can be seen in many places, such as deep roadcuts and the river banks. The alluvium is variable in thickness, usually around 5 feet, but in places up to 20 feet.

In composition the alluvium is fine to medium grained sand with some silt and clay. Coarse sand and gravel is present in many places, especially in or close to channels.

Some of the alluvium was subjected after deposition to aeolian action which produced the extensive areas of sand dunes found in townships 51 and 52, ranges 25 to 27.

In some places the alluvium resembles very closely the sandy deposits of the last stage of Lake Edmonton, so much so that a definite distinction between the two could not be made in some localities. The two kinds of deposits are very similar in lithology, mechanical composition, and thickness.

"Sturgeon Valley" Fluvial Sand

The Sturgeon Valley fluvial sand outcrops along the valley of the Sturgeon River downstream from Big Lake, and on higher areas in the valley. A discontinuous low ridge on top of the valley wall of the Sturgeon River was found to contain the sand under Lake Edmonton sediments.

The deposit is a clean, fine to medium grained sand with some silt. Cross-bedding and channel infilling is evident in many outcrops. Occasional pebbles are present in the deposit. From the cross-bedding and channel infilling structures it is deduced that this sand was deposited mainly from flowing water and on this basis it is easily separated from Lake Edmonton deposits which overlie it. One poor exposure of the sand seemed to indicate that the sand overlies till. The thickness of the Sturgeon River fluvial sand is from 2 to over 30 feet.

The Sturgeon River fluvial sand was deposited from flowing glacial meltwaters prior to the establishment of Lake Edmonton.

Crevasse Fillings and Kames

A group of kames is present in the southeast corner of township 52, range 25, and the northeast corner of township 51, range 25. The kames are composed predominantly of well washed sand, silt, and fine gravel, with numerous till inclusions. Individual beds are generally less than 10 inches thick and cross-bedding is not uncommon. Lacustrine clay and silt overlies the flanks of these kames.

A number of small linear ridges have been found which are probably crevasse fillings. With the exception of those in the vicinity of Fort Saskatchewan, which will be discussed later, and two in township 55, range 24, these features are associated with the eastern hummocky dead-ice moraine, and commonly with the glacial stream channels in this moraine. Sand and gravel is found in these features but it is commonly poorly sorted and often mixed with varying amounts of till.

Crevasse fillings are found in Secs. 7 and 8, Tp. 55, R. 24, Sec. 35, Tp. 52, R. 23, Secs. 13 and 14, Tp. 51, R. 24, Sec. 36, Tp. 49, R. 24, and Secs. 4 and 5, Tp. 52, R. 21. The first-mentioned is composed of poorly sorted and washed gravel with numerous till inclusions, the second and third of till, and the fourth and fifth, while not examined closely, seem to contain gravel or sand.

A number of kames and crevasse fillings too small to be shown on the map were found in hummocky dead-ice moraine areas.

Sand and Gravel Outwash

Sand and gravel outwash deposits are found along the east shore of Lake Edmonton. Well sorted sand is the dominant fraction in these deposits, and fine gravel is present only in minor amounts. Well developed cross-bedding and channel infill structures are commonly discernible in these deposits. Outwash in township 54, range 27, in the Gladu Lake area is a poorly sorted fine to medium grained, sandy gravel with many sand lenses. No sections through this gravel were found, and thickness and attitude of bedding were not examined.

Detailed descriptions of the individual outwash deposits are given in the appendix at the end of this report.

Aeolian Sand

Five deposits of aeolian sand occur in the map area. Three lie southwest of Edmonton in the Devon-Woodbend area, the fourth in the Oliver area, and the fifth in Sec. 7, Tp. 55, R. 22. These deposits consist of fine to medium grained sands and silt with very little clay. In areas where recent aeolian action has concentrated the coarser fractions, pebbles of 1 cm. diameter are common and pebbles up to 2 cm. diameter are found together with arrowheads and other artifacts.

In order to determine the origin of pebbles on the sand dunes the authors collected all pebbles on the surface from five small sand dunes in township 51, range 26; 639 pebbles were collected (some 12 lbs.). The following list shows the classification of the pebbles as to their possible use by Indians*:

1.	Definite artifacts (arrow and spear heads, one tomahawk, scrapers, knives, etc.)	48
2.	Cooking stones (rocks fractured by fire, used for cooking or around camp fires)	50
3.	Angular flakes, chips and broken stones (discarded materials from stone working; all of very fine grained materials)	454
4.	Very well rounded pebbles 1 to 3 cm. in diameter	21
5.	Very well rounded pebbles 3 to 8 cm. in diameter	60
6.	Shell fragments (used as ornaments)	6
		639

All materials except those listed under 4 and 5 have been definitely used by Indians. The very well rounded stones present a problem because they might have been used by Indians and consequently transported by man from distant localities to the sand dunes. The larger ones (over 3 cm. in diameter) could have been used as throwing stones for hunting, or they may be

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* The authors are not sufficiently qualified to identify all the artifacts in fine detail.

"cooking stones" not extensively used. The smaller ones could have been used by Indian children in games. Thus most, if not all, of the rocks in the sand dunes are Indian artifacts and have been brought into the area.

The aeolian sand varies in thickness from less than one foot to over 60 feet. Bedding is poorly defined near the surface, where soil-forming processes and slumping have partially obliterated it, but is visible in the deeper sections.

The sands composing the dunes were not transported any appreciable distance and in most places the wind-driven sand is overlying original undisturbed source sand. The source sand for the sand dunes south of the town of Spruce Grove and north of the North Saskatchewan River was the early North Saskatchewan River alluvium. All other sand dunes in the map area are composed of Lake Edmonton lacustrine sands.

GLACIAL AND RECENT HISTORY

Preglacial Topography

In many places where the Cretaceous shales are exposed they are found to be overlain by the Saskatchewan sands and gravels which, in the higher regions of the area, must have protected these soft shales from erosion in preglacial times. In general, the preglacial topography over much of the area is similar to that of today. Areas of exception to this statement are probably the Sturgeon River valley east of Big Lake, the valley of Atim Creek, and the area to the south of this valley. Drill hole information seems to indicate that the surface elevation in these areas was much lower in preglacial times than today. Also, parts of the North Saskatchewan River valley were not present in preglacial times.

The amount of glacial drift cover in the Edmonton district varies in thickness from less than 10 feet on top of highlands to over 80 feet, as in the hummocky dead-ice moraine and over buried valleys. The over-all effect of the glacial drift on topography is small when compared with the size of the large preglacial topographic features, such as the hills north of Spruce Grove which rise about 300 feet above the surrounding lake plain.

Preglacial stream channels are fairly common in the Edmonton area. Generally, the smaller channels have no surface expression, but the larger ones show up as gentle troughs. All of these channels contain Saskatchewan sands and gravels.

Glacial Advance

No signs of multiple glaciation were found in the area. The last ice to cover the district was of Wisconsin age, as judged by the young topography, shallow soil profiles and continuity of surface deposits with others of known Wisconsin age.

One radiocarbon date (McCallum and Dyck, 1960) obtained from a log found in a well by a farmer in the Smoky River district, Alberta (about 50 miles northeast of Edmonton) gave a date of over 31,000 years B.P. This log in till of the last glaciation is assumed to have been incorporated by the last glacier and deposited shortly afterwards. The time of the onset of the last glaciation in the Edmonton area is probably of the same general date because of the proximity of the two districts.

Flutings mapped in Secs. 8, 9 and 10, Tp. 54, R. 24, and previously mentioned by Gravenor and Ellwood (1957, p. 26) indicate that the last ice advanced over the Edmonton area from a northeasterly direction. This agrees with the results of investigations by Gravenor and Bayrock (1955, p. 1325) postulating a general direction of ice advance in northern and central Alberta of south 30 degrees west.

An approximate ice thickness of 5,000 feet has been suggested by Bayrock (1960) in the Alliance-Brownfield district of Alberta, one hundred miles southeast of Edmonton, and the ice in the Edmonton area is presumed to have reached about the same thickness.

The glacier advancing over the area extensively eroded local bedrock. According to Bayrock (1962) till of central Alberta contains 81 $\pm$ 8 per cent of local bedrock. Besides eroding, the glacier also severely contorted the underlying bedrock in places into tight folds.

Deglaciation

Hummocky dead-ice moraines in the Edmonton area are very similar to those elsewhere in the Province (Bayrock, 1958a; Bayrock, 1958b; Gravenor and Ellwood, 1957; Stalker, 1960). These moraines were produced by stagnant ice and as such do not signify a definite position of the receding glacier front, but rather a wide zone of uncertain width that became stagnant and wasted away in place.

The stagnation of the last ice sheet was apparently simultaneous over the whole of the Edmonton district. During this phase of deglaciation most of the ice disappeared, but some was left in the hummocky dead-ice moraine areas covered by till.

Most land covered by Lake Edmonton in the district was deglaciated before the establishment of the lake. In certain places, as for example in township 52, range 26, south of Edmonton, the till topography that is reflected through the lacustrine sediments is essentially hummocky dead-ice moraine topography. A similar relationship of lacustrine materials overlying hummocky dead-ice moraine is found in western parts of Lake Edmonton in the vicinity of Lake Wabamun. This hummocky dead-ice moraine of very rough topography is overlain by a near uniform thickness of 3 to 5 feet of lacustrine silty clays and lacustrine clays which were deposited after the development of the hummocky dead-ice moraine.

Buried ice was present, of course, in the pitted delta areas and later this ice upon melting produced the rough topography there.

If the above discussion is correct, then there was a period during which most of the land in the Edmonton district was deglaciated and free of ice before establishment of Lake Edmonton.

Lake Edmonton

As it is known that till underlies lake deposits in the Edmonton district, it follows that the ice must have wasted away before Lake Edmonton developed.

At present it is still problematical as to how Lake Edmonton developed. It could have been due to two causes: (1) blockage of normal drainage to

the east by an ice advance in that area - possibly the Lloydminster lobe of Ellwood (1960); (2) deleveling of the land due to the removal of the ice load or orogenic readjustment of the Canadian Rocky Mountains. As evidenced by sands underlying the silts and clays, there was some current sorting action in the initial stages of Lake Edmonton, thus indicating relatively free water movement. Presumably, as the lake level was raised the rate of current movement became less and clays and silts were deposited or settled out of the water. This would then account for the bedded silts and clays overlying the basal sands; in quiet bays away from the incoming streams, mainly clays were deposited.

The dammed-up meltwaters filled the available basin of Lake Edmonton until an outlet was found. Four outlets to Lake Edmonton have been found. From examination of aerial photographs, air photo mosaics, topographic maps and soil maps, it has been deduced that the Gwynne outlet located in the Nisku area was the major outlet for Lake Edmonton and that the others did not differ more than 25 feet in elevation from each other before any post-glacial deleveling. Because of the lack of accurate topographical and geological maps, it is not possible at present to correlate the different outlets with the various stages of the history of the lake.

For the present discussion it is assumed that the Gwynne outlet was the only significant outlet of Lake Edmonton in the Edmonton district as the other outlets are of small size by comparison. Once Lake Edmonton reached its maximum extent - and this probably took only a short time - the Gwynne outlet came into operation. At first the lake could not have drained too rapidly, as lacustrine sediments were deposited in the vicinity of the outlet. Later, however, when erosion of the outlet lowered the headwater region, the lake waters escaped through the outlet with a considerable velocity, as evidenced by extensive erosion. The incision of the Gwynne outlet could have lowered the lake level from 100 to 150 feet. Such lowering would have effectively drained most of the Edmonton area.

This stage of Lake Edmonton from the maximum to the end of operation of the Gwynne outlet is called the Gwynne stage of Lake Edmonton. The time of duration of the Gwynne stage was around 40 years as evidenced by the number of varves present at a locality from which Lake Edmonton waters were drained only during the final stages of operation of the Gwynne outlet (Lsd. 8, Sec. 26, Tp. 51, R. 25).

Recent Modifications

Not all of Lake Edmonton was drained by the Gwynne outlet, and the small parts of it that persisted continued to receive sediment from the surrounding terrain; these sediments were different, however, in that they were mostly fine to medium grained sand as opposed to silt and clay of the earlier sediments. The life of these lakes was probably short as was indicated by the small amount of sediment which was deposited in them.

The next development stage was the draining of these lakes by the North Saskatchewan River. After the draining of Lake Edmonton, the North Saskatchewan River did not have a valley established, and in the area of early North Saskatchewan alluvium (as designated on the accompanying maps), the river flowed in numerous very shallow channels. A short time afterwards one of the anastomosing channels was enlarged and incised to become the present valley of the river.

The climate of Alberta during the Altithermal period, which lasted from about 7,000 to 4,000 years ago, as determined elsewhere, was apparently much warmer and drier than at present. During this time the majority of the sand dunes of the Edmonton area were formed, as judged by the fact that the dunes are not cut by the North Saskatchewan River valley or by any tributary gullies. At present all the dunes are stabilized.

In post-Altithermal time, modifications of the landscape were only very minor, and amounted to some slope wash and infilling of depressions with inorganic and organic material. A thin veneer of colluvium covers most of the steep slopes but does not modify or obscure the topography.

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APPENDIX - Commercial Deposits of Sand and Gravel

Commercial deposits of sand and gravel in the Edmonton district are classed into three groups, based on mode and time of deposition. Preglacial deposits are called Saskatchewan sand and gravel deposits. Recent deposits of rivers are called Recent alluvium. Glacial deposits of sand and gravel are referred to as glacio-fluvial deposits or simply as outwash. All three types of deposits may be made of material ranging from clay to gravel. Only major gravel and coarse sand deposits of potential or proven commercial value are described in this appendix. The reader is advised to use the following descriptions in conjunction with the maps included in this report, in order to obtain the areal extent of each deposit. All descriptions are based purely on field observations made during the field seasons of 1958 and 1959. Descriptions of gravel and sand deposits of no apparent economic use as aggregate have been omitted. Detailed descriptions of individual deposits of Saskatchewan sand and gravel and Recent alluvial gravels have been omitted as they have large variations in composition over short distances and a detailed drilling program would have to be carried out in order to describe and define them properly.

Saskatchewan Sands and Gravels

Saskatchewan sands and gravels are overlain by till and in places also by former glacial lake sediments. The overburden is variable in thickness and may exceed 100 feet. Where the overburden is thin the Saskatchewan sands and gravels have been mined successfully.

Rounded pebbles of quartzite are the main constituent of these deposits; the sand fraction is composed mainly of quartz.

The main limiting factor of economic exploitation of these deposits is the thickness of the overburden. Areas of relatively thin overburden over "Saskatchewan sands and gravels" gravel deposits are shown on figures 4 and 5.

Recent Alluvial Deposits

Recent alluvial deposits of gravel in the Edmonton area are limited to the North Saskatchewan River valley. They are of two types: (a) river terraces and (b) river bars. River terraces are broad flats adjacent to the stream which are higher than the river level. In the Edmonton district gravel on the terraces is covered by variable amounts of silt, clay and fine sand which may range from 2 to 30 feet in thickness. Detailed exploration of each individual terrace is required to determine the amount of overburden. As a general rule it may be stated that each individual terrace is covered by an approximately uniform thickness of silt and clay. Different terraces, however, may have vastly different thicknesses of overburden: one terrace may have 5 feet and another 30 feet of silt and clay covering the gravel. The thickness of gravel in the terraces is also variable, ranging from 0 to 20 feet, but it is more or less uniform for each individual terrace.

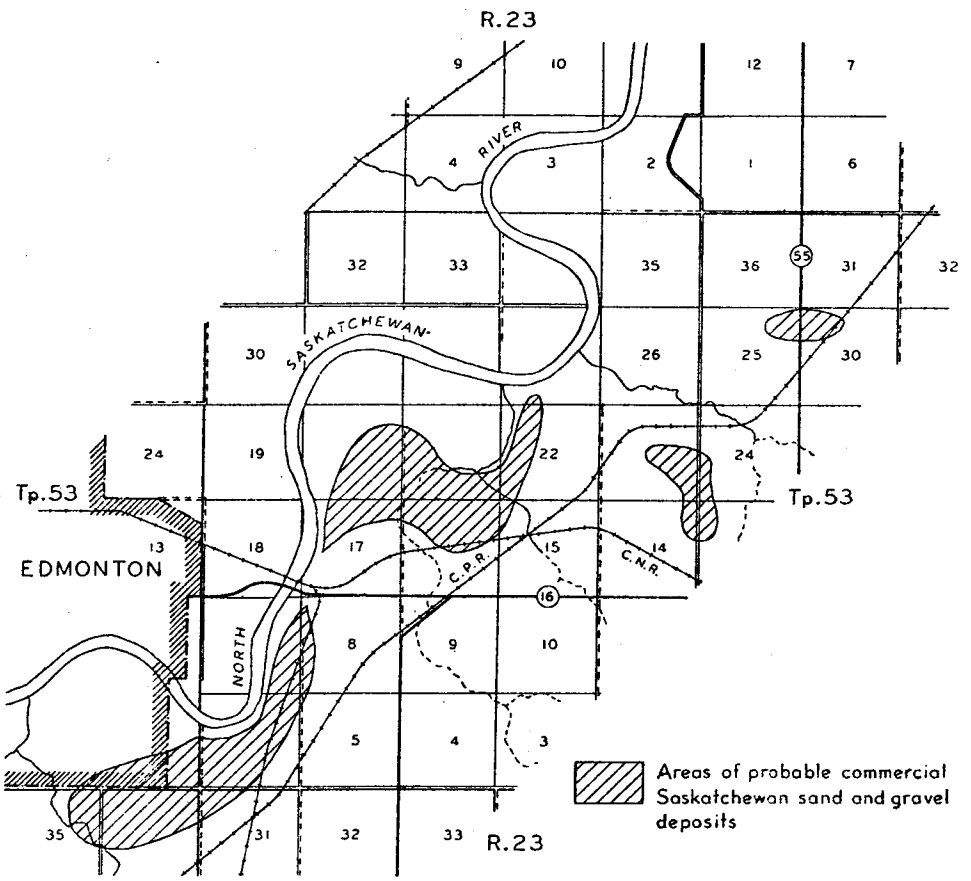

Figure 4. Locations of sand and gravel deposits of probable commercial value

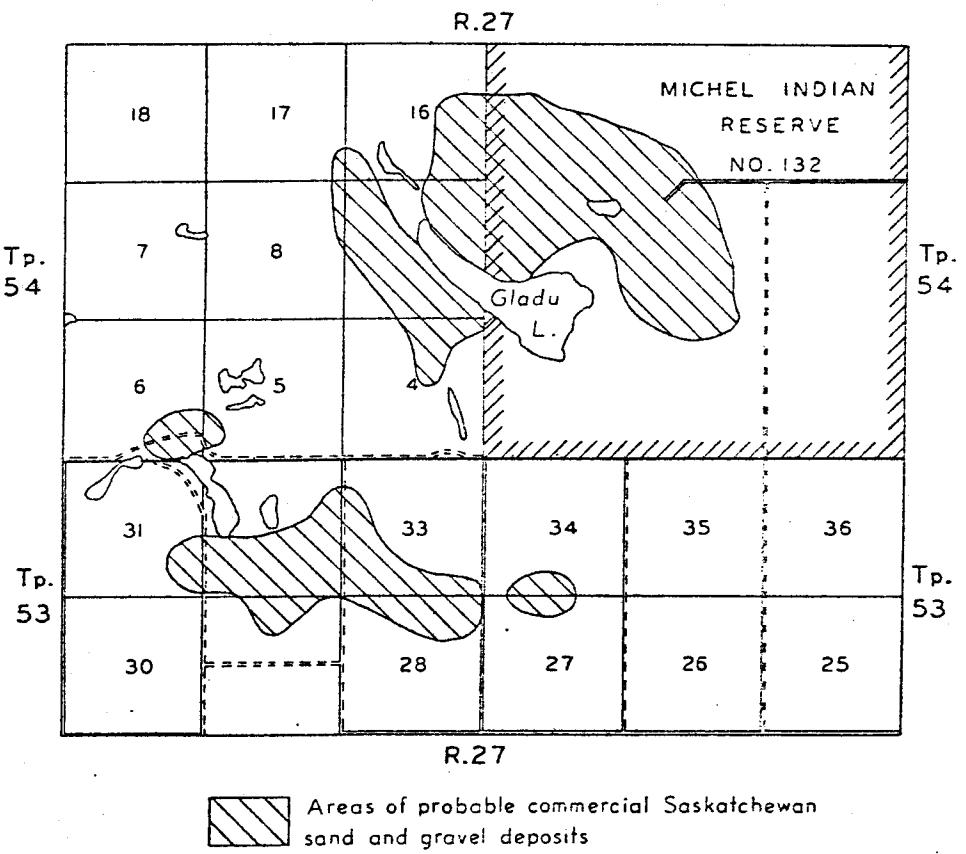

Figure 5. Locations of sand and gravel deposits of probable commercial value

River bars are accumulations of alluvium in the stream course and in the Edmonton district they range in size from a fraction of an acre to tens of acres in size. Overburden of silt and fine sand over gravel is usually shallow.

On the maps accompanying this report all alluvial deposits are shown by one symbol but only the North Saskatchewan River alluvium contains gravel. The areal extents and locations of these deposits are shown on the maps.

Glacio-fluvial Deposits

Glacio-fluvial deposits of sand and gravel of the Edmonton district were deposited from glacier-meltwater streams during the retreat of the last glacier. The deposits are characterized by having a large proportion of rocks derived from the Canadian Shield (e.g. granites) and also for the most part having poorly to very poorly rounded particles of sand and gravel. Extreme variations over short distances in mechanical composition are to be expected in most of these deposits.

Descriptions of Glacio-fluvial Deposits

Location	Extent	Remarks
Secs. 6, 7, 18, Tp. 55, R. 24	About 1/4 section	Crevasse filling about 10 feet high and 400 feet wide composed of poorly sorted gravel with numerous till and sand inclusions. One small gravel pit present showing poor quality gravel. Further exploration of this crevasse filling may reveal a better grade of gravel. Thickness 5 to 10 feet. Overburden variable.
Secs. 2, 3, 10, Tp. 54, R. 27; Secs. 34, 35, Tp. 53, R. 27	About 2 sq. miles	Outwash gravel. The gravel contains many silt and sand inclusions. A gravel pit is located in Sec. 3, Tp. 54, R. 27. Thickness of gravel 5 to 8 feet. Overburden 1 to 8 feet of sand and silt.
Secs. 11, 14, Tp. 54, R. 27	About 100 acres	Poorly sorted outwash gravel. The poor quality of gravel because of many till and sand inclusions makes this deposit difficult to exploit. Thickness about 6 feet. Overburden 0 to 2 feet of sand.

Location	Extent	Remarks
Secs. 19, 30, Tp. 52, R. 22	About 20 acres	Outwash sand, medium to coarse grained with numerous small pebbles. Some coal fragments and iron-oxide staining present in places. This deposit is very variable and it may be difficult to outline coarser deposits.
Secs. 1, 12, Tp. 52, R. 24; Secs. 6, 7, Tp. 52, R. 23	About 200 acres	Outwash sand, clean, well sorted, medium to coarse grained, some gravel lenses. Thickness on the average about 10 feet. Overburden 0 to 2 feet.
Secs. 21, 28, 29, Tp. 55, R. 23	About 1.5 sq. miles	Outwash sand, medium to coarse grained. Some pea-gravel. Numerous lenses of fine sand and silt. Economic development of this deposit is questionable because of large variability of the deposit over short distances. Average thickness about 5 feet.
Secs. 2, 3, 10, 11, Tp. 52, R. 23	About 1.5 sq. miles	Outwash sand, medium to coarse grained with numerous fine sand, silt, coal, and iron-oxide stained beds. Average thickness about 3 feet. Overburden 0 to 2 feet.
Secs. 25, 26, 35, 36, Tp. 51, R. 24	About 1 1/4 sq. miles	Outwash sand fairly clean with many pebbles and occasional small gravel lenses. Water table is close to surface. Traces of coal and iron staining present. Oberburden from 2 to 6 feet.
Sec. 27, Tp. 51, R. 23	About 100 acres	Outwash sand medium to coarse grained with numerous silt and clay beds.
Secs. 32, 33, 34, Tp. 51, R. 23; Sec. 5, Tp. 52, R. 23	About 2 sq. miles	Outwash sand, fairly clean with lenses of gravel and thin beds of silt and clay. The deposit is very variable over short distances. Overburden 0 to 2 feet.

Location	Extent	Remarks
Secs. 5, 6, 7, 8, Tp. 50, R. 21; Secs. 31, 32, Tp. 49, R. 21; Secs. 1, 12, Tp. 50, R. 21	All around the lake	Recent beach sand medium to coarse grained with occasional pebbles. The sand is clayey and silty along the western shore, and very clean along the eastern shore of the lake. Average thickness about 5 feet. Overburden 0 to 2 feet.
Secs. 2, 3, 10, 11, Tp. 50, R. 24	About 1/4 section	Spillway sand and gravel, poorly sorted and dirty, in places iron-oxide staining is heavy, some coal fragments. Gravel comprises about 1/4 of total deposit. Thickness from 5 to 8 feet. Overburden 0 to 3 feet.
Sec. 30, Tp. 49, R. 24	About 10 acres	Glacial lag gravel, dirty, poorly sorted with many large boulders. Clay-ironstone nodules common. The deposit is of very low quality and at present may have been mined out. Overburden 1 to 3 feet.
Sec. 6, Tp. 52, R. 22	Small	Outwash sand with gravel lenses, fairly clean with silt and clay lenses. Thickness about 7 feet. Overburden thin.
Sec. 36, Tp. 51, R. 23	Very small	Poorly sorted outwash sand with silt and clay lenses. The deposit may be mined out.
Secs. 16, 17, 20, 21, Tp. 54, R. 27	About 1/2 sq. mile	Outwash gravel, impure with many large boulders. Thickness variable, from 2 to 8 feet. Overburden 0 to 3 feet.
Secs. 1, 2, Tp. 54, R. 27	About 50 acres	Outwash gravel, many sand lenses present. About 5 feet thick. Overburden 1 to 4 feet.
Secs. 20, 29, Tp. 52, R. 27	About 50 acres	Outwash sand, fine to coarse grained with silt and clay lenses. Commercial use doubtful. About 10 feet thick. No overburden.

Location	Extent	Remarks
Secs. 24, 25, Tp. 53, R. 22	About 40 acres	Outwash sand and gravel, impure, silt and clay lenses common. Two to 4 feet thick. Overburden 0 to 5 feet.
Secs. 23, 24, Tp. 54, R. 22	About 40 acres	Crevasse fillings covered by shallow Lake Edmonton deposits. Sand and pebbles medium to poorly sorted, some silt and clay lenses. Overburden 2 to 10 feet.

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LEGEND

QUATERNARY

RECENT

- 14 — Slump, landslide and colluvium: sand, silt and clay mixed; unstable slopes
- 13 — Alluvium: river deposited gravel, sand and silt
- 12 — Bottomland deposit: clay, silt, sand, peat, muck and marl

PLEISTOCENE AND RECENT

- 11 — Early North Saskatchewan River alluvium: mainly sand; small pockets of coarse sand and gravel; minor silt
- 10 — Lacustrine (Lake) sand: mainly impure sand (sand, silt and clay); associated with final stages of Lake Edmonton overlying Lake Edmonton sediments

PLEISTOCENE

GLACIO-LACUSTRINE

- 9 — Lake Edmonton sediment: bedded and varved silt and clay, some sand
- 8 — Lake Edmonton sediments and ground moraine (undifferentiated): silt and clay; till, (transition zone)

GLACIO-FLUVIAL

- 7 — "Sturgeon River" valley fluvial sand: fine sand and silt; some clay
- 6 — Hummocky and pitted delta: sand and silt; minor clay
- 5 — Crevasse-filling: till; sand and gravel
- 4 — Outwash: gravel; minor sand, overlain by shallow Lake Edmonton sediments

GLACIAL

- 3 — Kame moraine: mainly sand and till
- 2 — Hummocky dead-ice moraine: mainly till; minor lenses of sand and gravel
- 1 — Ground moraine – till: unsorted clay, silt, sand and gravel, minor lenses of sand and gravel

Saskatchewan sand and gravel outcrop ▲

Bedrock outcrop ×

Stream – trench and ancient river channel

Scouring (arrow points down slope)

Geological boundary – definite

Geological boundary – approximate

Geology by L.A. Bayrock and G.M. Hughes

Main highway (16)

Local road, well travelled

Local road, not well travelled

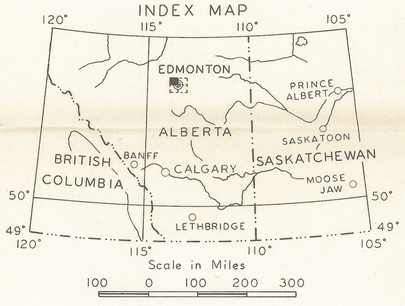
Railway

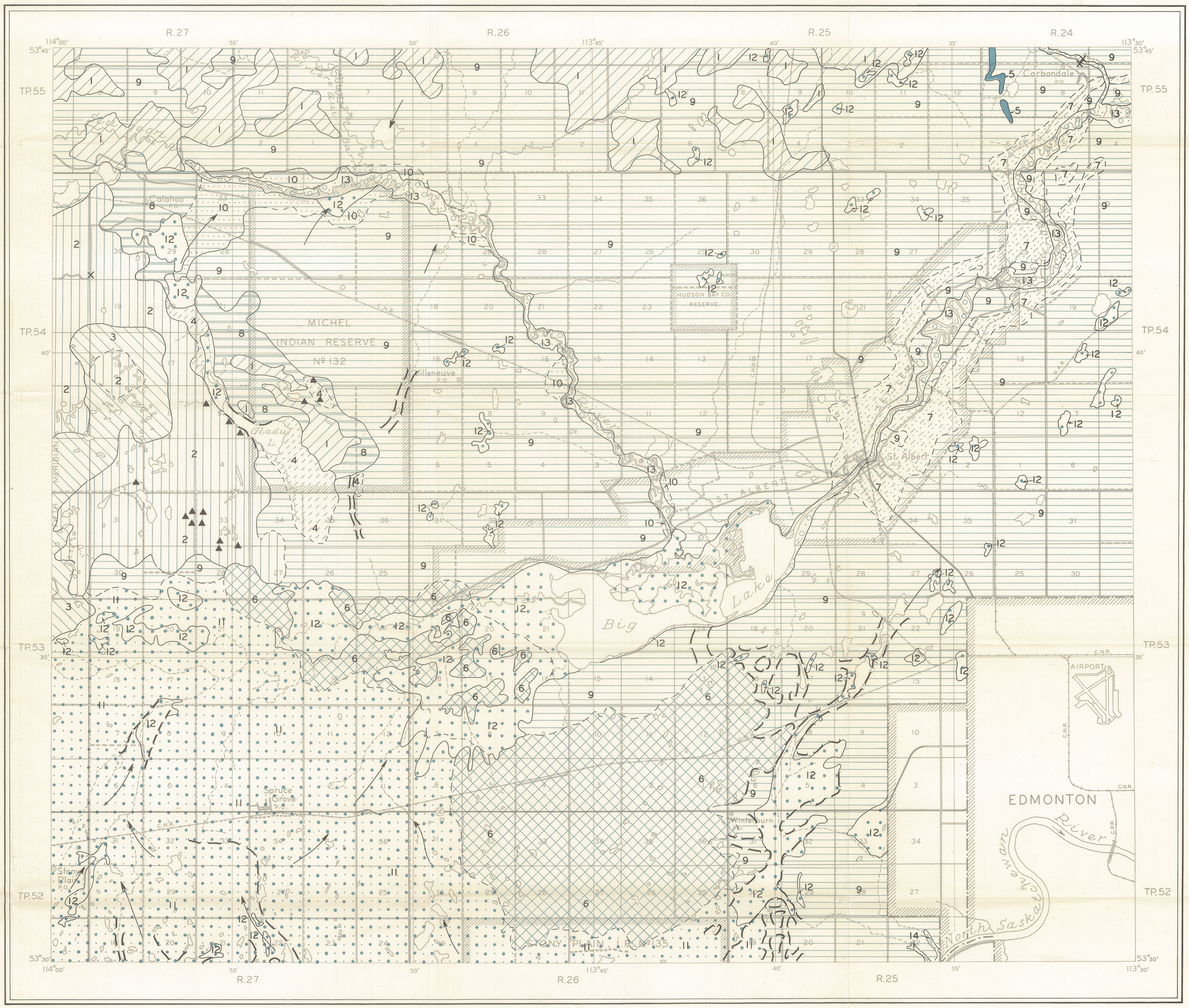
Township boundary

Section line

Cartography taken from Department of Lands and Forests, Alberta, Aerial Survey Sheet No. 83 H/12, 1952

INDEX MAP





Map to be used in conjunction with Preliminary Report No. 62-6

PRELIMINARY MAP 62-6A

SURFICIAL GEOLOGY

EDMONTON DISTRICT, ALBERTA

WEST OF FOURTH MERIDIAN

Scale: One Inch to One Mile 1/63,360

1 3/4 1/2 1/4 0 1 2 3

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LEGEND

QUATERNARY

RECENT

13 — Slump, landslide, and colluvium: sand, silt and clay mixed; unstable slopes

12 — Alluvium: river deposited gravel, sand and silt

11 — Bottomland deposit: clay, silt, sand, peat, muck and marl

10 — Aeolian: sand dunes; fine to medium grained sand

PLEISTOCENE AND RECENT

9 — Lacustrine (lake) sand: mainly impure sand (sand, silt and clay); associated with final stages of Lake Edmonton, overlying Lake Edmonton sediments

PLEISTOCENE

GLACIO-LACUSTRINE

8 — Lake Edmonton sediments: silt and clay, bedded and varved; some sand

7 — Superglacial and impounded glacial lake sediments: bedded clay and silt, some sand

6 — Superglacial and impounded glacial Lake sediments and till (undifferentiated): bedded clay and silt, some sand; till

GLACIO-FLUVIAL

5 — "Sturgeon River" valley fluvial sand: fine sand and silt, some clay

4 — Crevasse filling: till, gravel and sand

3 — Outwash sand: sand, minor gravel

GLACIAL

2 — Hummocky dead-ice moraine: till; minor pockets of sand and gravel

1 — Ground moraine; till unsorted sand, silt, clay and gravel; minor pockets of sand and gravel

Saskatchewan sand and gravel deposit ▲

Bedrock outcrop ×

Hummocky dead-ice moraine boundary

Geological boundary — definite

Geological boundary — approximate

Fluting (buried by Lake Edmonton sediments)

Stream-trench and extinct river channel

Geology by L.A. Bayrock and G.M. Hughes

Main highway (16)

Local road, well travelled

Local road, not well travelled

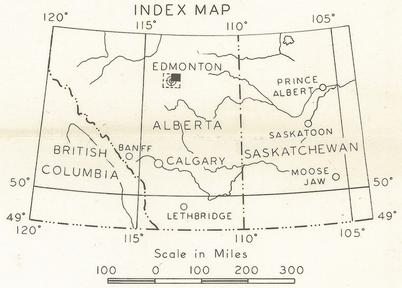
Railway

Township boundary

Section line

Cartography taken from Department of Lands and Forests, Alberta, Aerial Survey Sheet No. 83 H/11, 1952

INDEX MAP



Scale in Miles

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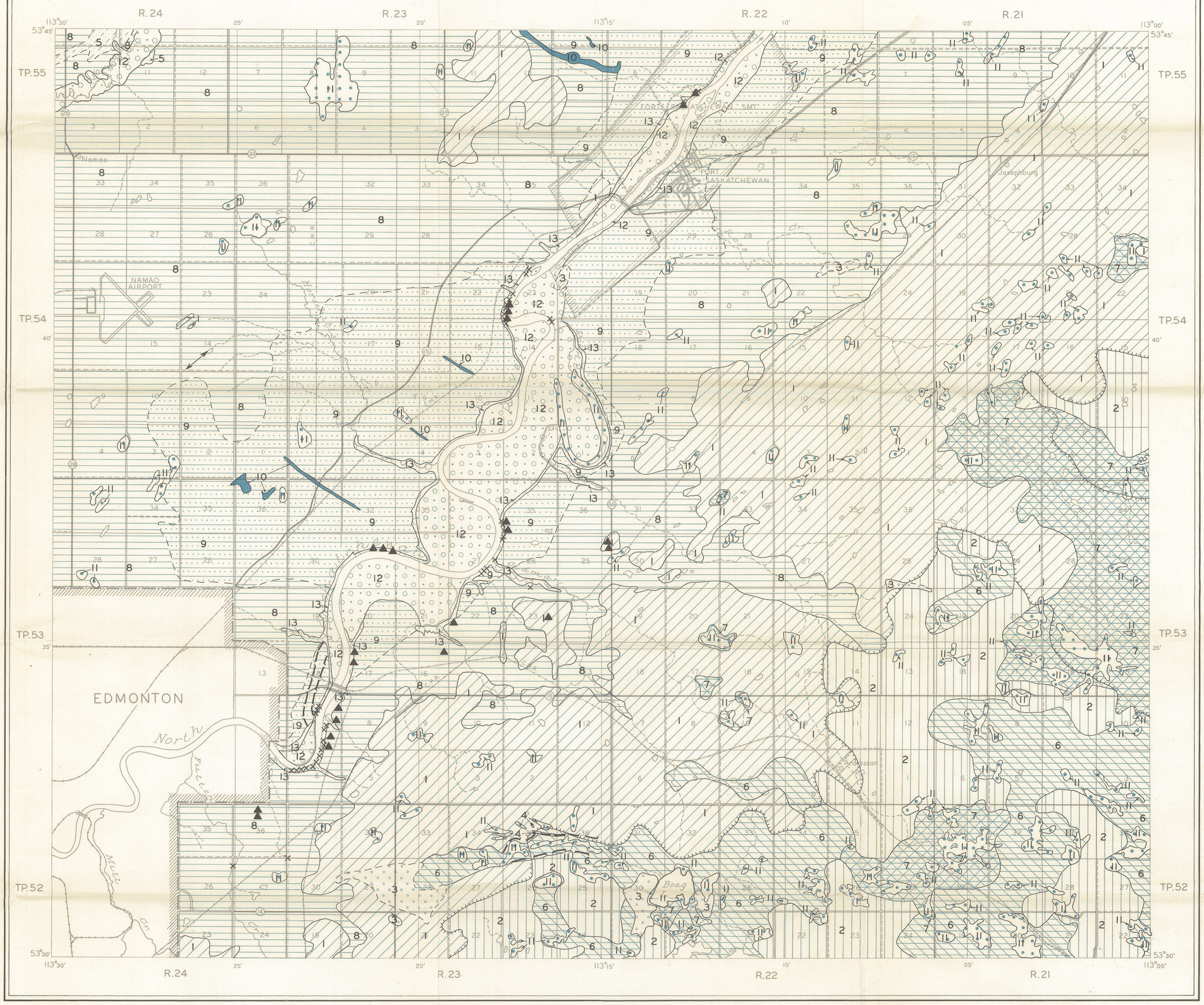

Map to be used in conjunction with Preliminary Report No. 62-6

PRELIMINARY MAP 62-6B

SURFICIAL GEOLOGY

EDMONTON DISTRICT, ALBERTA

WEST OF FOURTH MERIDIAN

Scale: One Inch to One Mile 1/63,360

1 3/4 1/2 1/4 0 1 2 3

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RESEARCH COUNCIL OF ALBERTA

LEGEND

QUATERNARY

RECENT

15 — Slump, landslide, and colluvium; sand, silt, and clay-mixed; unstable slopes

14 — Alluvium: river deposited gravel, sand and silt

13 — Bottomland sediment: clay, silt, sand, peat, muck and marl

12 — Aeolian: wind blown fine to medium grained sand

11 — Aeolian: well defined sand dunes; fine to medium grained sand

PLEISTOCENE AND RECENT

10 — Early North Saskatchewan River alluvium: mainly sand, minor pockets of coarse sand and gravel

9 — Lacustrine (lake) sand: mainly impure sand (sand with silt and clay); associated with final stages of Lake Edmonton and overlying Lake Edmonton sediments

8 — Fluvial sand overlying till: fine to medium grained sand; minor silt and gravel

7 — Fluvial sand overlying Lake Edmonton sediments: fine to medium grained sand; minor silt and gravel

6 — Fluvial sand overlying Lake Edmonton sediments and till (undifferentiated): fine to medium grained sand; minor silt and gravel

PLEISTOCENE

GLACIO-LACUSTRINE

5 — Lake Edmonton sediment: silt and clay bedded and varved, minor sand

4 — Lake Edmonton sediment over kame: silt and clay over sand, silt and gravel

GLACIO-FLUVIAL

3 — Kame: silt, sand and gravel; inclusions of till

GLACIAL

2 — Ground moraine - till: unsorted clay, silt, sand and gravel; local minor lenses of sand and gravel

CENOZOIC

CRETACEOUS

UPPER CRETACEOUS

1 — Edmonton formation; grey bentonitic sandstone and shale; coal, iron concretions

MESOZOIC

Saskatchewan sand and gravel outcrop ▲

Bedrock outcrop ×

Stream-trench and ancient river channel

Scouring (arrow points down slope)

Geological boundary - definite

Geological boundary - approximate

Geology by L.A. Bayrock and G.M. Hughes

Main highway (2)

Local road, well travelled

Local road, not well travelled

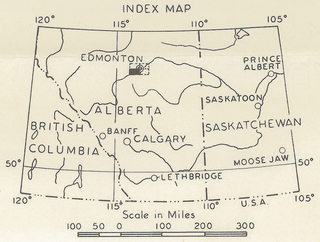
Railway

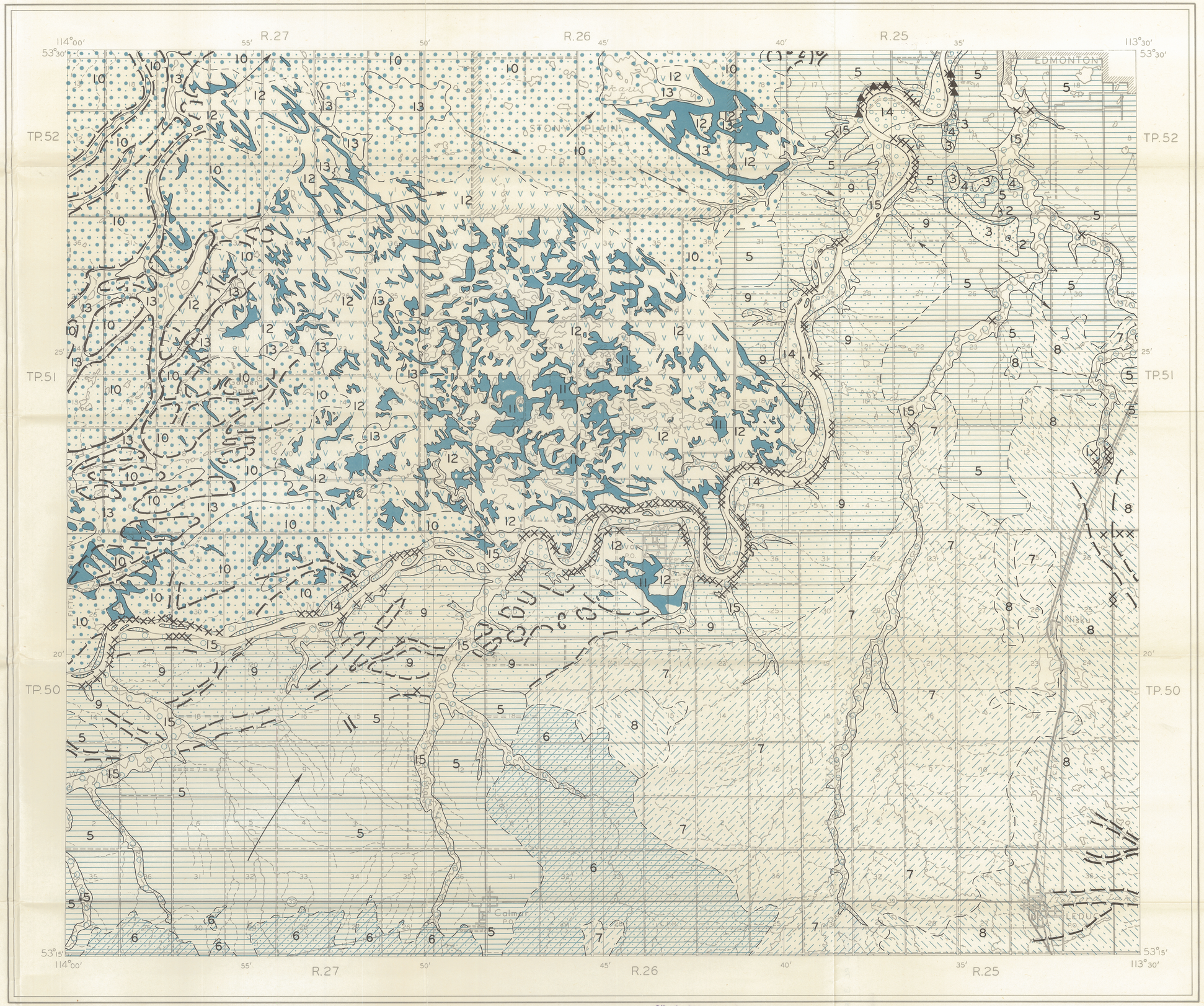
Township boundary

Section line

Cartography taken from Department of Lands and Forests, Alberta, Aerial Survey Sheet No. 83 H/5, 1952

INDEX MAP





Map to be used in conjunction with Preliminary Report No. 62 - 6

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PRELIMINARY MAP 62-6C

SURFICIAL GEOLOGY

EDMONTON DISTRICT, ALBERTA

WEST OF FOURTH MERIDIAN

Scale: One Inch to One Mile = 1/63,360

1 3/4 1/2 1/4 0 1 2 3 MILES

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RESEARCH COUNCIL OF ALBERTA

LEGEND

QUATERNERY

RECENT

11 — Alluvium: stream deposited sand, silt and gravel

10 — Bottomland deposit: clay, silt, sand, peat, muck and marl

PLEISTOCENE AND RECENT

9 — Fluvial sand overlying till: fine to medium grained sand, some silt; minor gravel lenses

8 — Fluvial sand overlying superglacial lake deposit and till, fine to medium grained sand, some silt and clay

PLEISTOCENE

GLACIO-LACUSTRINE

7 — Lake Edmonton sediments: silt and clay, bedded and varved; some sand

6 — Superglacial and impounded glacial lake sediments: clay and silt, some sand

5 — Superglacial and impounded glacial lake sediments and till (undifferentiated): clay and silt, some sand; till

GLACIO-FLUVIAL

4 — Outwash sand and gravel: mainly sand, gravel in small pockets

3 — Crevasse filling: till, gravel and sand

GLACIAL

2 — Hummocky dead-ice moraine: till; minor pockets of sand and gravel

1 — Ground moraine: till, mixture of clay silt, sand and gravel; minor pockets of sand and gravel

Bedrock outcrop ..... ×

Stream-trench and channel .....

Geological boundary - definite .....

Geological boundary - approximate .....

Western boundary of the hummocky dead-ice moraine

Geology by L. A. Bayrock and G. M. Hughes

Main highway ..... (14)

Local road, well travelled .....

Local road, not well travelled .....

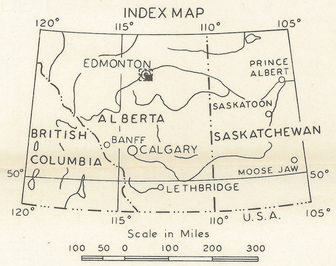
Railway .....

Township boundary .....

Section line .....

Cartography taken from Department of Lands and Forests, Alberta, Aerial Survey Sheet No. 83 H/6, 1952

INDEX MAP



Map to be used in conjunction with Preliminary Report No. 62-6

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PRELIMINARY MAP 62-6D

SURFICIAL GEOLOGY

EDMONTON DISTRICT, ALBERTA

WEST OF FOURTH MERIDIAN

Scale: One Inch to One Mile = 1/63,360

1 3/4 1/2 1/4 0 1 2 3 MILES

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