SAND AND GRAVEL RESOURCES OF THE BATTLE RIVER REGION CENTRAL ALBERTA

by

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CONTENTS

	Page
Introduction	1
Previous investigations and scope of present study	1
Geologic setting	3
Types of surficial deposits	4
Preglacial deposits	4
Glacial deposits	5
Glaciofluvial deposits	6
Glaciolacustrine (glacial lake) deposits	9
Aeolian (wind) deposits	9
Alluvial deposits	9
Gravel deposits	10
Preglacial alluvial deposits	11
Outwash deposits of delta and stream type	11
Kame and esker deposits	12
Outwash deposits of plain type	13
Recent alluvial deposits	14
References cited	15

ILLUSTRATIONS

Figure 1.	Area of study - the Battle River Region	2
Figure 2.	Sand and gravel resources map, Battle River Region (5 sheets)	in pocket

SAND AND GRAVEL RESOURCES OF THE BATTLE RIVER REGION, CENTRAL ALBERTA

INTRODUCTION

This report presents results of a compilation of preexisting data on the disposition and potential of sand and gravel deposits within the area of jurisdiction of the Battle River Regional Planning Commission (Fig. 1). The area covers over 6000 square miles in south-central Alberta between latitudes 52°20'N and 53°18'N, longitudes 111°7'W and 114°9'W. It includes all or parts of townships 39 to 50, ranges 9 to 28, west of 4th meridian, and ranges 1 to 9, west of 5th meridian.

PREVIOUS INVESTIGATIONS AND SCOPE OF PRESENT STUDY

No investigations specifically of the sand and gravel resources of this area have been made, except for a study by Holter (1975) of gravel resources of the Red Deer area, which embraces a small part of the area of this study between Rimbey and Bashaw. Surficial geology map coverage for the entire study area exists at a scale of 1:250,000 or larger; however, these sources give variable amounts of information about gravel deposits. The most comprehensive references are the reports of Bayrock (1957a, 1957b) and Gravenor and Ellwood (1957), who mapped the eastern portion of the region at a scale 1:63,500. These reports contain not only detailed descriptions of the various types of surficial deposits, but also appendices describing the location, extent and exploitability of gravel and gravelly sand.

The central part of the study area (NTS sheet 83A) was mapped at a scale of 1:250,000 by Stalker (1960). His report provides specific information about types, quality and utilization of gravel deposits and includes a map showing the distribution of surficial and subsurficial occurrences of gravel.

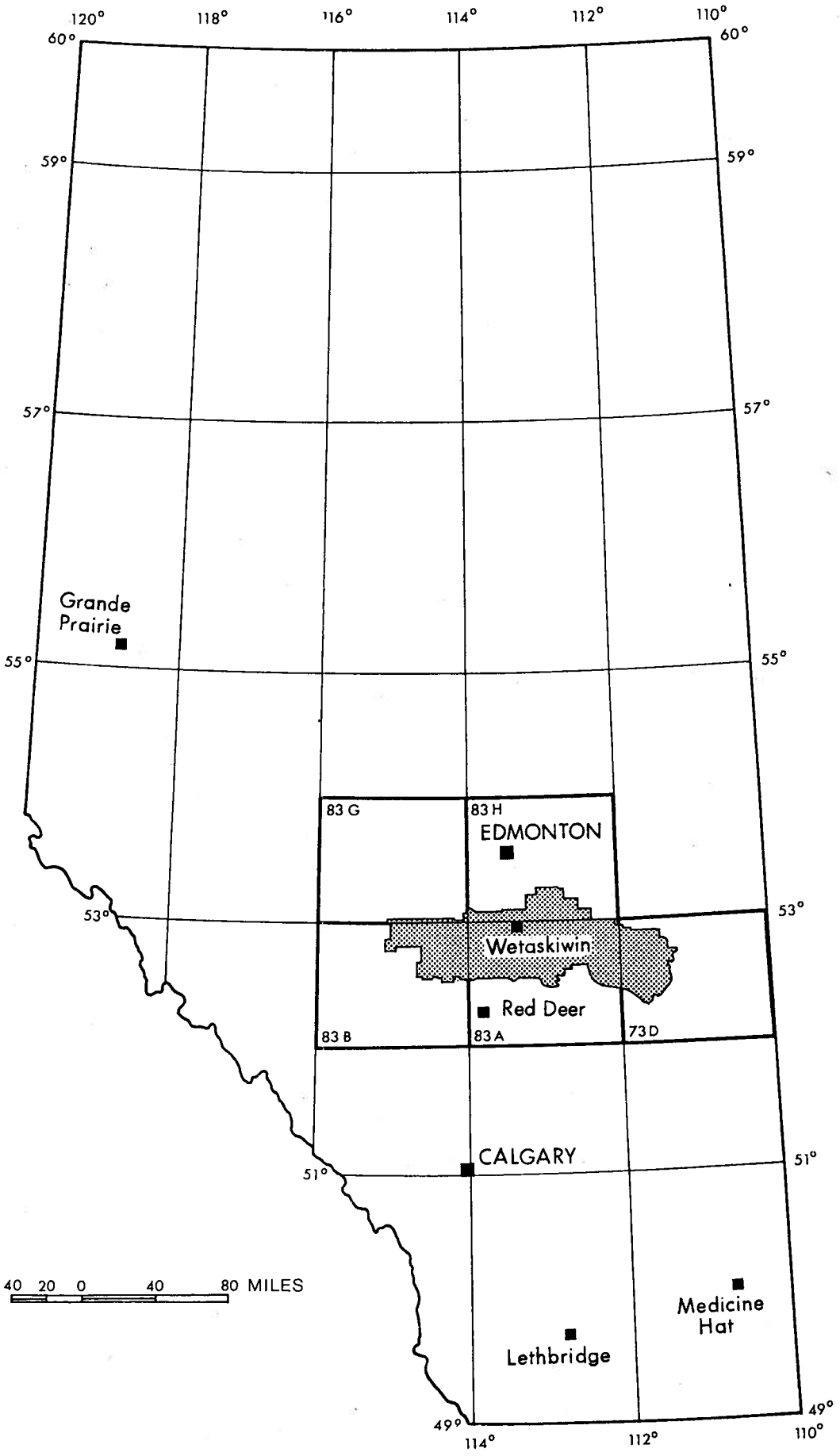

Figure 1. Area of study — the Battle River Region

The northern and the southwestern portions of the district are covered by surficial geology maps published at a scale 1:250,000 (Bayrock, 1972; Boydell *et al.*, 1974). These maps are accompanied by marginal notes, giving only a brief description of Quaternary deposits and landforms. The genetic and lithologic types of sediments are delineated on the maps, but lithological descriptions are given only in general outline, so that data on thickness, extent, and quality of aggregate materials are lacking. The northwestern part of the study area is covered by unpublished 1:50,000 scale preliminary maps, prepared by the Quaternary section, Alberta Research Council.

It should be noted that the existing geologic mapping is essentially two-dimensional, showing only the lateral delineation of deposits that lie at or very near the surface. To augment this information with data for the vertical dimension, testhole records from the Alberta Research Council Groundwater Division files were used. These records give some information on thickness and buried extent of the gravel and sand deposits. The locations of gravel and sand pits were obtained from the surficial geology maps, supplemented by information from the published NTS topographic maps (scale 1:50,000) and from some municipal agencies.

GEOLOGIC SETTING

The near-surface bedrock of the area consists of Late Cretaceous and Early Tertiary sandstones, siltstones, mudstones and shales with local ironstone beds and coal seams. The beds dip gently to the southwest and the land surface rises in this same direction as does the eroded bedrock surface. The bedrock surface is cut by deep, wide preglacial valleys running mainly in an eastern direction. A number of these were buried by glacial sediments and in places contain aggregate deposits, part of which may be of preglacial age.

The bedrock surface is covered over most of the area by a mantle of surficial sediments of glacial origin varying widely in composition from fine clays to coarse gravels. The high content of fine material and the considerable amount of loose sand and weak clay in the bedrock are reflected in the general fineness of material and the scarcity of fragments of local bedrock in the drift. Most of the various surficial deposits and landforms were created during Laurentide glaciation when the last continental ice sheet advanced from the northeast. It is believed that the glacier reached this area about 23,000 years ago and retreated about 11,000 years ago. Postglacial processes such as river erosion and deposition, and wind sculpturing somewhat modified the land surface, but were localized within relatively small areas.

TYPES OF SURFICIAL DEPOSITS

Surficial deposits are present in the subject area everywhere except on the slopes of Battle River valley and some of its tributary valleys where the bedrock is exposed. The thickness of this surficial mantle varies from 10 to 40 feet within areas of ground moraine to 50 to 125 feet within the areas of hummocky moraine and in the buried preglacial valleys. Various types of surficial deposits are present which are discussed below in relation to their mode of origin.

Preglacial Deposits

Alluvial gravel and sand, presumably of Tertiary and Early Quaternary age, directly overlie bedrock in much of the preglacial valley followed by Battle River between Camrose Creek and Driedmeat Creek. These preglacial deposits are exposed along the slopes of the valleys of Battle River and Driedmeat Creek for a distance of about 10 miles. They commonly are only 1 to 2 feet thick, but locally are in excess of 30 feet thick.

The preglacial gravel is characterized by the absence of fragments of rock types found on the Precambrian Shield, such as granite, gneiss, schist, gabbro and diorite. Except for a few fragments of local bedrock, the gravel consists of rock types found in the mountains to the west. These include hard sandstone, quartzite, chert, arkose and limestone. The gravel is well sorted, clean, of good quality and usually includes boulders up to 6 inches in diameter. Sand and silt lenses and beds are prominent in these deposits. In places the gravel is cemented with calcium carbonate, forming a hard conglomerate.

Glacial Deposits

Till is the most common surficial deposit of the Battle River Region. It forms extensive ground moraine plains and hummocky moraine "knob-and-kettle" relief, and can also be found underlying most of the younger surficial deposits.

Till is unsorted material deposited directly from a glacier. Most of it is compact, dense, very sticky and plastic if wet and extremely hard if dry. Aside from its boulder and pebble fraction this till is made up of about equal parts of sand, silt and clay, although the proportions vary from place to place. Stones with a diameter of more than 0.5 inch rarely account for more than 2 percent of the material. The predominant clay mineral is montmorillonite, the presence of which makes the till relatively impervious. The upper part of the till - 20 to 40 feet - is oxidized and brown in color. The oxidized till passes downward gradually or abruptly into unweathered till of grey to dark-grey color.

Small sand and gravel lenses are commonly found in the till, particularly in hummocky moraine, which includes numerous pockets and, in places, hills of gravel and sand. There are two main areas of hummocky moraine

within the Battle River Region: in the western part of the region, between Gull and Buck Lakes; and in the central part, between Buffalo and Miquelon Lakes. The surface of hummocky moraine varies from rolling plain to moderate or strong knob-and-kettle development. The heights of the knobs range from as little as 15 feet to 100 feet. In general, areas with this type of relief are sparsely populated and little cultivated. They contain some pasture land and the kettles commonly furnish satisfactory water supplies for stock. There are few roads and few towns. Thick bush covers much of the hummocky moraine.

On the contrary, ground moraine areas form the best farmland of the region and are well populated. They have a good soil and are rarely rolling enough to have strong soil erosion. Some of the more rolling ground moraine is used for cattle grazing or hay raising.

Glaciofluvial Deposits

The deposits of glaciofluvial origin consist of two principal types; ice contact - deposited within and in contact with the glacier, and outwash - deposited beyond the edge of the glacier.

Ice contact deposits are represented by kames and eskers. The term kame is used for mound-shaped deposits laid down by running water in any hole in the ice-sheet. The kames are scattered widely within hummocky moraine areas and, more rarely, within ground moraine areas. They have a knobby surface with heights from 15 to 30 or more feet. Kames in the subject area are composed predominantly of fine- to medium-grained sand with only minor amounts of gravel and inclusions of till and silt.

Eskers are ridges formed through deposition of sediment in the beds of streams flowing within the stagnant ice-sheet. They are widespread in the eastern part of the Battle River Region between Rosalind and Strome.

The ridges are from 5 to 30 feet high and 75 to 300 feet wide. They vary in shape, but most are continuous ridges with even tops; some are a series of coalesced hills. The eskers are commonly between 1/2 mile and 4 miles long. They are composed generally of sand and silt with pockets of till and gravel. Some of the landforms mapped as eskers by Stalker are made up predominantly of till with small pockets of sand and gravel and may actually be crevasse fillings in origin. The largest of eskers tend to contain the coarsest material and therefore the largest amount of gravel, particularly those eskers to the south of Bearhills Lake and around Rosalind. The stratified materials are usually poorly sorted, with large boulders scattered through the ridges.

Outwash deposits were laid down by glacial meltwater either along meltwater channels or as sheet deposits. They can be composed of sand, sand and gravel, or mainly of gravel. The sandy outwash consists of medium- to fine-grained sand which is similar in composition to the bedrock. Sand and gravel outwash is composed of medium- to coarse-grained sand, which contains a number of lenses and beds of poorly- to moderately-sorted gravel; it is characterized by considerable variation in the size of material from place to place.

Outwash deposits composed largely of gravel are rare and form only a small part of the total outwash present in the region. The gravel is usually well sorted but often has associated sand lenses. A number of the gravel outwash deposits are covered by a veneer of sand from 5 to 10 feet thick.

There are several large areas of outwash plains within this region. The largest are located in the central part near its southern boundary, in the vicinities of Buffalo Lake and Ponoka; the first one covers about 30 square miles. Both areas are relatively small segments of great outwash plains that stretch for many miles to the south and southeast beyond the region.

Three outwash areas lie in the eastern part of the Battle River Region, around Sedgwick and Hardisty and to the southeast of Alliance; they cover about 40 square miles altogether. Sizeable outwash areas also are located close to the northern boundary of the region in the vicinity of Miller, and in the western part of the region along Floyd Creek, each of these covering about 15 square miles. Small outwash areas are quite common and are scattered throughout the region. A number of these are of the ice-marginal type and are concentrated along the boundaries of the hummocky moraine zones.

The surface of the outwash plains is usually flat to undulating, being flattest where glaciofluvial material is finest; such deposits are composed mainly of well sorted sand with local lenses of gravel. The ice-marginal type deposits usually are coarser and include considerable gravel lenses, also small pockets of till and silt. The coarsest outwash deposits are those of delta type, found at the places where meltwater channels discharged onto outwash plains. Gravel is prominent in these deposits, commonly clean and well sorted; material finer than sand is uncommon.

Outwash deposits are also associated with glacial meltwater channels as terraces along the channels, or more rarely, as channel floor deposits. Most of these former valleys run in a southeasterly direction. The channel deposits consist of sand and gravel, the proportion of gravel being fairly significant.

The thickness of the outwash deposits is not always defined from their surface expressions; it seems to vary from less than 10 feet up to 80 feet. Gravel lenses are rarely more than 10 to 15 feet thick.

Glaciolacustrine (Glacial Lake) Deposits

Glaciolacustrine sediments of various types, deposited in a large proglacial lake known as Glacial Lake Edmonton, are located in the central part of the region, between Bearhills Lake, Red Deer Lake and Battle River. Smaller areas of lacustrine material found here and there represent former local lakes. The deposits are composed of clay and silty clay in the central low-lying part of former lakes, and of silt and sand along the former shore lines. The clay and silt areas are flat to gently undulating and typically are poorly drained; most of these areas are farmland. The sand areas are rolling and are less intensively farmed, but they generally contain good aquifers.

Aeolian (Wind) Deposits

Aeolian sands formed by wind action and redistribution of preexisting surface sand deposits occur extensively in the region. In the eastern part, aeolian sands mantle the surface of outwash areas, whereas in the central part they have been formed from glaciolacustrine sands. After recession of the glacier but before vegetation stabilized the land surface, strong winds reworked the loose sands to form dunes up to 50 feet in height. In some cases, between the sand dunes aeolian sheet sand deposits are found. The wind-blown material consists mainly of fine-grained sand. The dune areas are not important for farming or grazing, as the soil is light and sandy; conversely, they support good bush and spruce woods and are the good recreational zones. Many of the wind deposits contain large supplies of ground water.

Alluvial Deposits

Recent alluvial deposits lie along most streams in the area. The alluvium consists usually of clay, silt, sand, very small pockets of gravel

and some slump material. Bottomland deposits are composed of silt, clay and organic matter.

A large proportion of gravel is present in the alluvial terrace deposits associated with North Saskatchewan River. All terraces higher than 40 feet above river level contain gravel. Alluvial gravels also are found along Battle River north of Ponoka, the gravel apparently originating from local outwash deposits.

GRAVEL DEPOSITS

The gravel-bearing deposits found in the subject area are of various origins as described in the foregoing section, and are of unequal economic importance. They can be classified into five groups which are enumerated and ranked below according to quantity and quality of the gravels:

1. Preglacial alluvial deposits;
2. Outwash deposits of delta and stream types;
3. Kame and esker deposits;
4. Outwash deposits of plain type;
5. Recent alluvial deposits.

It should be stressed that detailed investigations of specific deposits in the area have not been conducted. The purpose of the present study is to delineate the areas with potential for aggregate deposits, to determine the areas of relatively high potential, and to give broad indications of quality, extent and thickness of various types of gravel deposits. The areas delineated as high potential are not necessarily wholly covered with gravel, but they are expected to have at least the highest proportion of gravel of the deposits outlined. Intensive exploration programs will be required to delineate the best aggregate deposits within these areas before venturing into development.

It should be noted too that for the western part of the Battle River Region there is almost no data on quality and quantity of gravel, and these characteristics can be adduced solely by extrapolation of the data available for the rest of the area.

PREGLACIAL ALLUVIAL DEPOSITS

A description of the preglacial alluvium of the area was given by Stalker (1960) who considers aggregate of this type to be the best in quality for most purposes and the greatest in quantity. These deposits are now being utilized for the manufacture of asphalt gravel and for road base aggregate. In addition, this gravel is sufficiently low in deleterious materials to be suitable for concrete aggregate.

The main restriction to its use has been that the preglacial deposits generally are deeply buried. Many of the deposits also have a high water table. Most of the gravel requires crushing before being used for purposes other than road foundations.

An average thickness for the preglacial gravel is expected to be about 10 feet. Assuming this figure and considering the extent of the exposures, Stalker (*op. cit.*) reasoned that the preglacial valley of Battle River contains hundreds of millions of cubic yards of gravel with overburden thicknesses ranging from 0 to 30 feet.

OUTWASH DEPOSITS OF DELTA AND STREAM TYPE

Sand and gravel deposits of this origin are present throughout the area and are currently the chief source of gravel for the region. They are ranked second because of lesser quality. Generally, gravel deposits of the glaciofluvial type consist of gravel beds and lenses of limited extent, intercalated with sands and gravelly sands, but in deltas and

channels the gravel is comparatively greater in extent and thickness. It is composed mainly of resistant rocks such as hard sandstone and quartzite, derived from the preglacial gravel. Rocks from the Precambrian Shield are present also, and their proportion increases in the eastern direction. Outwash gravel can contain considerable amounts of fragments derived from local bedrock such as coal, shale or clay lumps. Most of the stones are from 1 to 5 inches in diameter, but larger boulders can occur.

This gravel rarely can be utilized for either concrete or asphalt aggregate, but is especially suitable for road base and fill. The deposits are easily developed, because they are at the surface, and many even rise above surrounding areas. Those situated on the channel floors can have a high water table, however.

The gravel reserves can be very considerable. Stalker (1960) estimates the amount of gravel within deltas in the vicinity of Ponoka, Bashaw and Ferintosh to be several million cubic yards. In areal extent, the gravel deposits may range from 10 acres to as much as 3 square miles, with the thickness varying between 10 and 40 feet. The thickness of overburden, represented usually by outwash and aeolian sand, is up to 5 feet.

KAME AND ESKER DEPOSITS

Kames and eskers are the third most important source of gravels in the region. There are a number of kame hills and esker ridges throughout the area which are composed of gravel or contain gravel pockets. This gravel commonly is poorly sorted, contains many lenses of sand, much weathered and weak material, and has a wide size range with some boulders greater than a foot in diameter. Much of its content came from

local bedrock and from the Precambrian Shield. Patches of good gravel commonly are scattered among the poorer gravel.

This type of aggregate ordinarily has little use other than for road foundation purposes. With crushing, screening, and removal of weak stones its quality improves, but is never good.

Most of the kame and esker deposits are limited in size, rarely more than 10 acres in area, with thicknesses in the range of 10 to 20 feet, sometimes up to 40 feet. Eskers and kames often are capped with thin deposits of sand and silt, forming overburden thicknesses of from 5 to 20 feet. Individual deposits commonly have reserves in the range of 1,000 to 10,000 cubic yards.

OUTWASH DEPOSITS OF PLAIN TYPE

Pockets of fine gravel occur in the sand and silt areas of outwash plains. This gravel generally is poorly sorted, dirty, and contains much weak material, although in places local lenses of fine, well-sorted, clean gravel may be found. The gravel consists mainly of re-worked material from preglacial gravels with additions of local bedrock and Shield material. Gravel of this type is widespread but is used only where other gravel is not readily available. Like the kame and esker gravels it can be utilized for road purposes.

The thickness of deposits in many of the outwash areas is undetermined. It is believed to be from 20 to 50 feet (Bayrock, 1957a,b). Gravel lenses within sand areas are considerably thinner, expected to be only 5 to 6 feet. The thickness of overburden can vary greatly from 0 to 30 feet.

RECENT ALLUVIAL DEPOSITS

Recent alluvial gravel of economic importance is found along the valley of the North Saskatchewan River. Scattered pockets also occur in the Battle River valley above Ponoka. The gravel is composed of fragments from the Canadian Shield as well as from eroded preglacial gravels. River transportation has removed some of the weak material, so that much of the alluvial gravel is of fairly good quality. Deleterious materials such as coal, local bedrock fragments, ironstone, etc., are not common in this type of deposit, but they are present in places. The better of these deposits are suitable for asphalt, road-base and fill aggregate. The gravel is generally coarse and, for most purposes, requires crushing.

The sands and gravels forming the terraces of North Saskatchewan River range from 0 to 30 feet thick, overlain by 10 to 30 feet of alluvial silt and clay. These deposits require some removal of overburden for development; nevertheless, they can serve as a source of aggregate especially in western part of area, which seems to have a shortage of gravel of the other types.

REFERENCES CITED

Bayrock, L.A. (1957a): Glacial geology, Alliance-Brownfield district, Alberta; Res. Coun. Alberta Rept. 57-2.

_____(1957b): Glacial geology, Galahad-Hardisty district, Alberta; Res. Coun. Alberta Rept. 57-3.

_____(1972): Surficial geology, Edmonton, NTS 83H; Alberta Res. Coun. Map, scale 1:250,000.

Boydell, A.N., L.A. Bayrock and T.H.F. Reimchen (1974): Surficial geology, Rocky Mountain House, NTS 83B; Alberta Res. Coun. Map, scale 1:250,000.

Gravenor, C.P. and R.B. Ellwood (1957): Glacial geology, Sedgewick district, Alberta; Res. Coun. Alberta Rept. 57-1.

Holter, M.E. (1975): Gravel resources of the Red Deer area; Alberta Res. Coun. Rept. 75-3.

Stalker, A. MacS. (1960): Surficial geology of the Red Deer-Stettler map area, Alberta; Geol. Surv. Canada Mem. 306.

LEGEND

Surficial Geology

RECENT

ALLUVIAL DEPOSIT : Sand to Gravel

WIND DEPOSIT : Sand

GLACIOFLUVIAL

OUTWASH; Sand to Gravel

KAME, ESKER; Sand, Sand and Gravel

MELTWATER CHANNELS, DELTAS

GLACIAL

HUMMOCKY MORAINE

PREGLACIAL

ALLUVIAL DEPOSIT; Gravel and Sand

Geological Boundary: defined, assumed

0-10 Test Hole, from data on file of the Groundwater Division; gravel and sand interval indicated

Gravel and Sand Pit

High potential area of gravel deposits

Scale 1:250,000

5 0 5 5 0 5 10

Compiled by I. Shetsen

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WEST OF THE FIFTH MERIDIAN
U. T. M. REF. MER 117° 00'

EDMONTON 83 H

LEGEND

Surficial Geology

RECENT

ALLUVIAL DEPOSIT : Sand to Gravel

WIND DEPOSIT : Sand

GLACIOFLUVIAL

OUTWASH; Sand to Gravel

KAME, ESKER; Sand, Sand and Gravel

MELTWATER CHANNELS, DELTAS

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Gravel and Sand Pit

High potential area of gravel deposits

Scale 1:250,000

5 0 5

5 0 5 10

Compiled by I. Shetsen

Alberta Research Council

LEGEND

Surficial Geology

RECENT

ALLUVIAL DEPOSIT : Sand to Gravel

WIND DEPOSIT : Sand

GLACIOFLUVIAL

OUTWASH: Sand to Gravel

KAME, ESKER; Sand, Sand and Gravel

MELTWATER CHANNELS, DELTAS

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Gravel and Sand Pit

High potential area of gravel deposits

Scale 1:250,000

5 0 5

5 0 5 10

Compiled by I. Shetsen

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uced by the Surveys Branch, Department of Highways
onton, Alberta, 1968
maps, in part, by the Surveys and Mapping Branch
rtment of Energy, Mines and Resources, Ottawa

WEST OF THE FIFTH MERIDIAN
U. T. M. REF. MER. 117° 00'

LEGEND

Surficial Geology

RECENT

ALLUVIAL DEPOSIT : Sand to Gravel

WIND DEPOSIT : Sand

GLACIOFLUVIAL

OUTWASH: Sand to Gravel

KAME, ESKER: Sand, Sand and Gravel

MELTWATER CHANNELS, DELTAS

GLACIAL

HUMMOCKY MORAINE

PREGLACIAL

ALLUVIAL DEPOSIT : Gravel and Sand

Geological Boundary defined, assumed

0-10 Test Hole, from data on file of the Groundwater Division; gravel and sand interval indicated

Gravel and Sand Pit

High potential area of gravel deposits

Scale 1:250,000

5 0 5 10 Miles

5 0 5 10 15 Kilometers

Compiled by I. Shetsen

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WEST OF THE FOURTH MERIDIAN

73D

LEGEND

Surficial Geology

RECENT

ALLUVIAL DEPOSIT : Sand to Gravel

WIND DEPOSIT : Sand

GLACIOFLUVIAL

OUTWASH: Sand to Gravel

KAME, ESKER, Sand, Sand and Gravel

MELTWATER CHANNELS, DELTAS

GLACIAL

HUMMOCKY MORAINE

PREGLACIAL

ALLUVIAL DEPOSIT : Gravel and Sand

Geological Boundary : defined, assumed

0-10 Test Hole : from data on file at the Groundwater Division; gravel and sand interval indicated

Gravel and Sand Pit

High potential area of gravel deposits

Scale 1:250,000

5 0 5

5 0 5 10

Compiled by I. Shetsen

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WEST OF THE FOURTH MERIDIAN
U. T. M. REF. MER. 111° 00'