SAND AND GRAVEL RESOURCES OF THE GRANDE PRAIRIE AREA ALBERTA

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SAND AND GRAVEL RESOURCES OF THE GRANDE PRAIRIE AREA

TABLE OF CONTENTS

Table of Contents (continued)

ILLUSTRATIONS

Table of Contents (continued)

FOREWORD

This study is part of a program initiated in 1976 by Alberta Energy and Natural Resources and the Alberta Research Council to provide information on the sand and gravel resources of the province. Alberta Energy and Natural Resources provides the funding for the program and input into the selection of study areas. The actual investigations are conducted by the Geological Survey Department of the Alberta Research Council.

The information acquired by these studies provides a data base for resource management and land-use planning with respect to sand and gravel for both public and private lands. The studies also provide a starting point for detailed exploration programs.

The program is concerned with delineating and describing presently exploitable deposits and identifying deposits with future potential. The deposits described are, in general, mappable at a scale of 1:50,000, have a thickness of at least 1 m, and have a ratio of overburden to gravel and sand of no more than 1:1. Volume figures are estimates based on geological interpretations of the deposits and not detailed subsurface data.

INTRODUCTION

LOCATION OF STUDY AREA

Figure 1 shows the areas of the province which have been completed or are presently being studied under the program. The Grande Prairie study area is located in west-central Alberta and encompasses approximately 4200 km^2. It is situated west of the sixth meridian between Ranges 2 to 10 inclusive and bounded on the north by the top of Township 74 and on the south by the Wapiti and Simonette Rivers with the exception of Ranges 6, 7 and 8 which are bounded by the bottom of Township 69. These boundaries and the major cultural features of the area are shown in figure 2. In addition to Grande Prairie the population centers of Beaverlodge, Sexsmith and Wembley are included in the area.

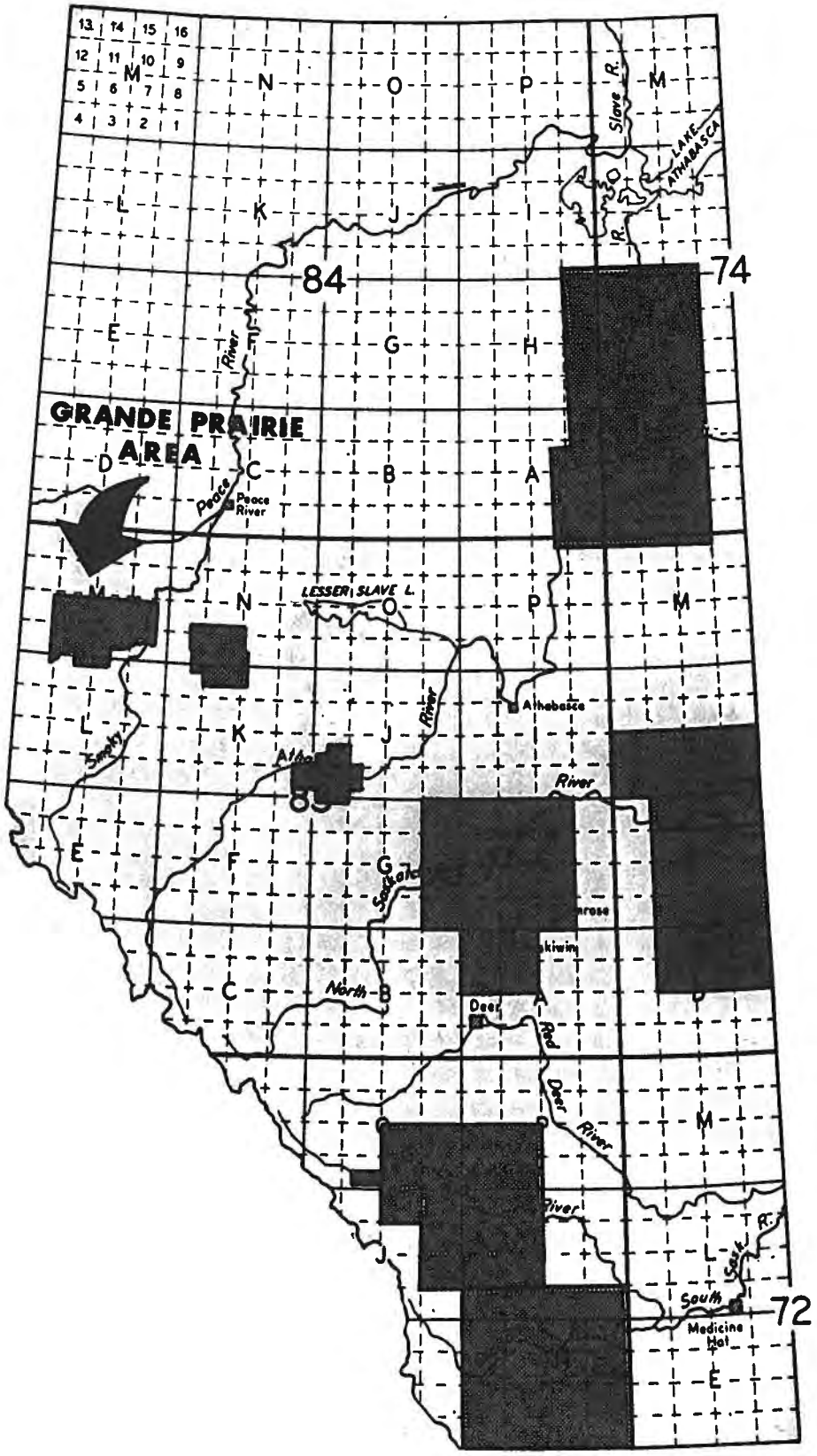

FIGURE 1. Sand and gravel resources — field study areas.

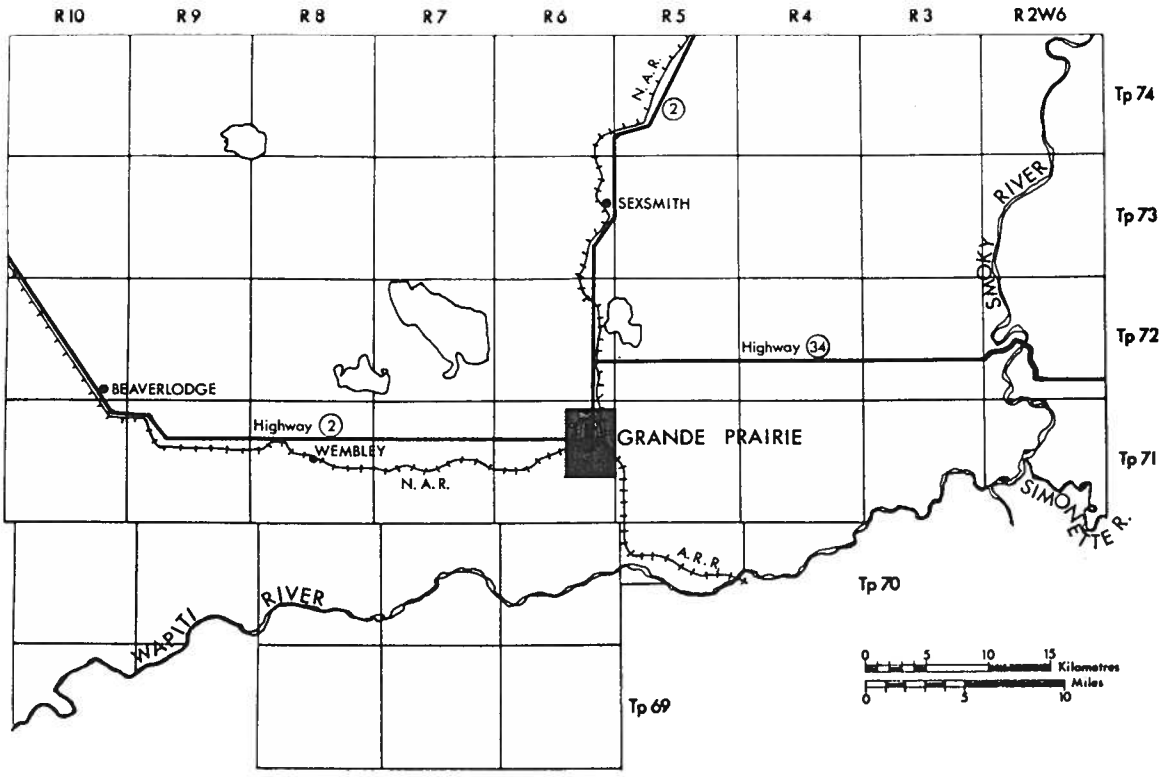

Figure 2. Grande Prairie study area.

PREVIOUS WORK

Early work by geologists in the area was confined to comments on the bedrock geology along the rivers with some mention of the agricultural capabilities of the surficial materials.

Although extraction and processing of sand and gravel in the area has been carried out since the area was settled, sand and gravel, as an economic geological resource, was first commented on by Allan and Carr in 1946. Later soils mapping by Odynsky *et al*, (1956, 1961) and surficial mapping by Jones (1961, 1966) and Henderson (1960) has produced much of the basic information required for an understanding of the aggregate resources within the study area.

A specific study into the sand and gravel resource of the Grande Prairie area was conducted by Holter (1972). This study was carried out mainly in an attempt to find aggregate suitable for concrete production and was of an explorative nature with 270 testholes being drilled during a three-week program in the summer of 1972.

In addition to the above study, exploration and testing programs have been carried out by Alberta Transportation and private suppliers of gravel and sand within the study area. Most of these programs are of a confidential nature and were not available for use on the present study.

A large number of lithologic logs of water wells which are on file with the Groundwater Department of the Alberta Research Council were available for examination. The locations of these wells along with the testhole locations of the drilling done by Holter (1972) are shown in figures 3 to indicate the density of subsurface information available.

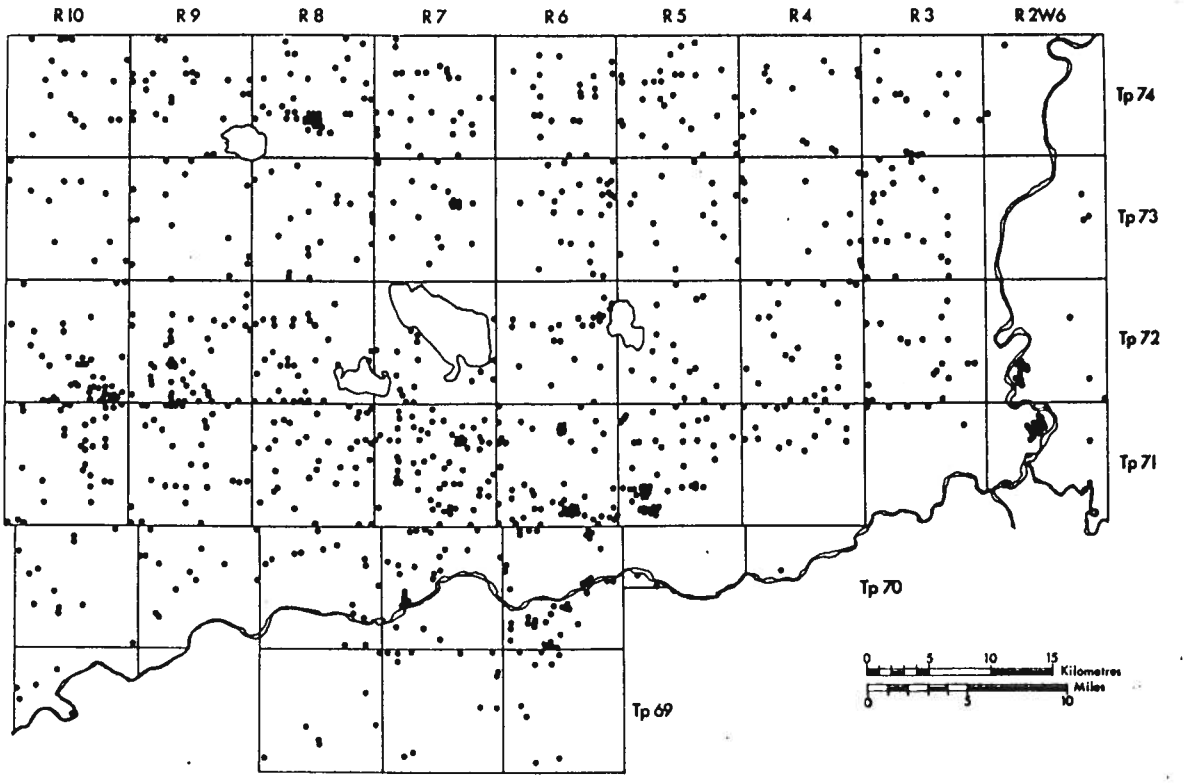

Figure 3. Locations of water wells and 1972 testholes.

METHOD OF STUDY

The first phase of the study was the compilation and review of the existing applicable information on the surficial and subsurface geology. A preliminary study of airphotos of the area was also performed prior to field investigations.

Field investigations conducted in the summer of 1977 consisted of:

(1) truck and foot traverses of the area to search for and delineate the areal extent of potential deposits;
(2) description of exposed sand and gravel sections and active or abandoned pits;
(3) further airphoto interpretation;
(4) collection of samples for later testing at the Geological Survey Department laboratory in Edmonton;
(5) boat traverses along the Wapiti and Smoky Rivers to locate and evaluate recent river deposits;
(6) exploratory drilling and sampling with a Mobile B61 auger drill (102 testholes were drilled);
(7) drilling and sampling with a Becker BDT-250 hammer drill to prove up quantities of aggregate in selected areas (73 testholes were drilled).

In addition, bulk sampling and field sieving at selected sites was performed in May, 1978.

Terms used in this report are from the industrial grain-size classification (Fig. 4), the textural subdivisions shown in figure 5 and those described in the glossary (Appendix A).

ACKNOWLEDGMENTS

Capable field assistance was provided by M. Wilson, J. Farrow and C. Carawan. P. Sham performed the laboratory analyses and W.A.D. Edwards and J. Fox reviewed and commented on the manuscript.

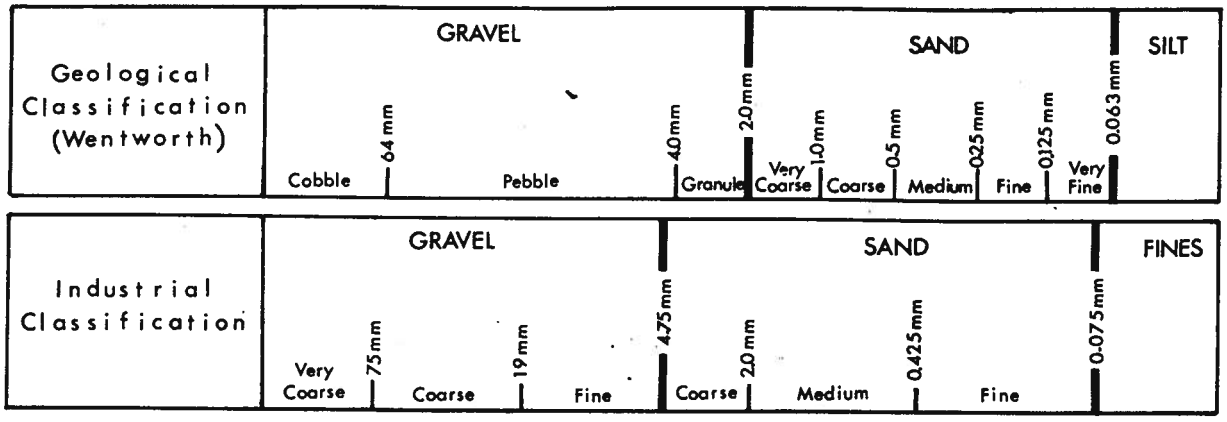

Figure 4. Geological and industrial grain size classifications.

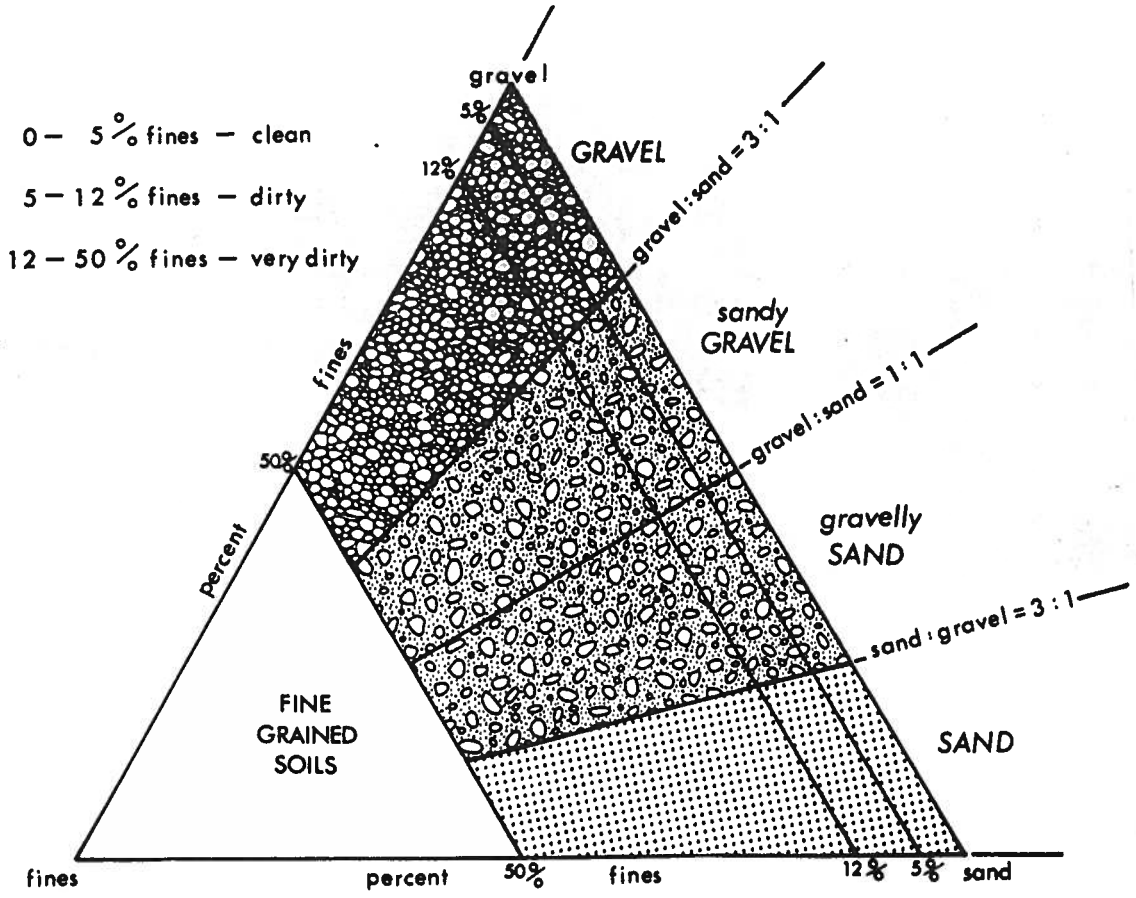

Figure 5. Terms for unconsolidated granular material.

BEDROCK GEOLOGY

The major bedrock unit underlying the study areas is the Wapiti Formation. Older Puskwaskau Formation sediments subcrop in the extreme northeast corner of the area. Both units are of Late Cretaceous age. The following descriptions are from Green (1972):

Wapiti Formation:	grey, feldspatic, clayey sandstone; grey bentonitic mudstone and bentonite; scattered coal beds; nonmarine.
Puskwaskau Formation:	dark grey, fossiliferous shale, silty in upper parts; marine.

The relatively soft, weak nature of the bedrock makes it an objectionable material as a clast constituent of gravel deposits and unsuitable as a source of quarry rock for the production of conventional construction materials.

Figure 6 shows the bedrock topography and thalwegs of preglacial valleys in the study area (Carlson and Hackbarth, 1974). The valleys are of interest as they are often partially filled with preglacial sand and gravel.

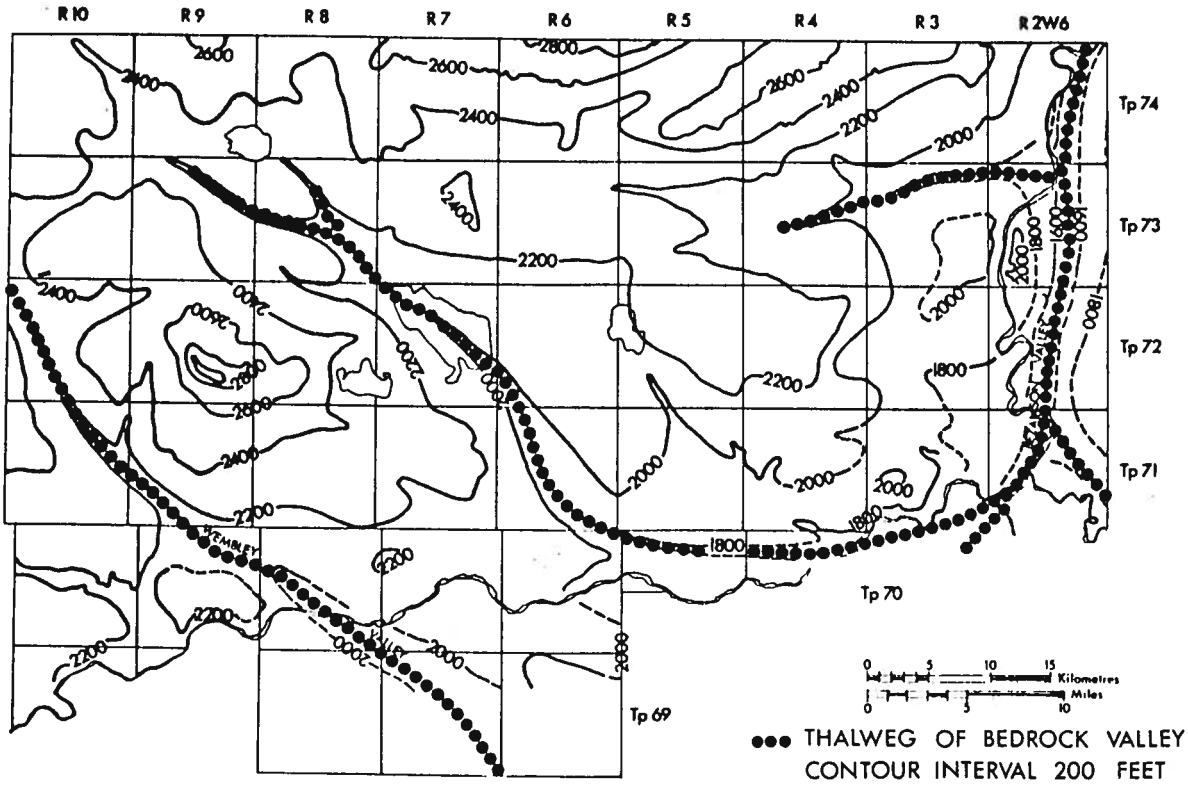

Figure 6. Thalwegs of preglacial bedrock valleys.

SURFICIAL GEOLOGY

TOPOGRAPHY

The study areas ranges in elevation from 440 m (1450 ft) above sea level in the Smoky River valley in the northeast corner of the area to over 945 m (3100 ft) above sea level atop Saskatoon Hill (Tp 72, R9). The present topgraphy (Fig. 7) is generally a subdued reflection of the bedrock surface with thicker surficial deposits in the bedrock valleys and thinner deposits over the bedrock highs. An exception to this occurs where present day rivers have downcut through surficial materials and produced steep valley walls.

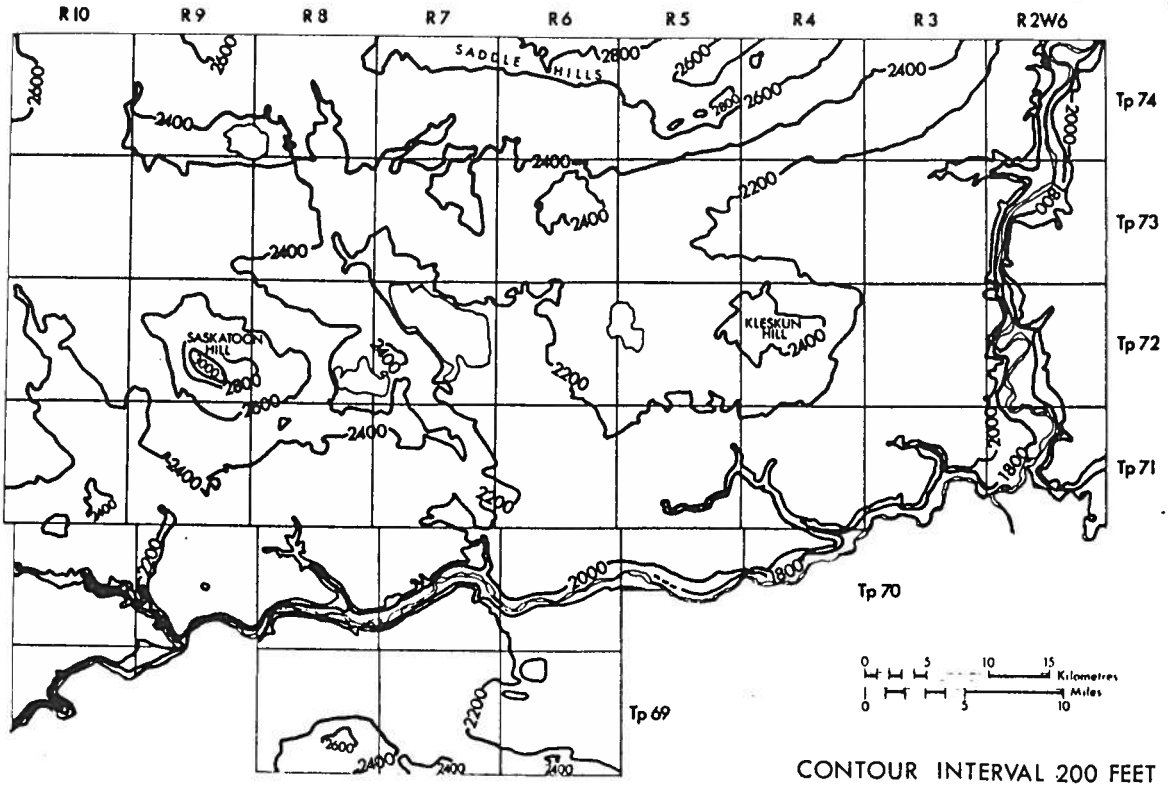

Figure 7. Topography of the Grande Prairie area.

The major topographic features in the area are the valleys of the Wapiti River flowing east and the Smoky River flowing north, Saskatoon Hill, Kleskun Hill (Tp. 72, R4), the Saddle Hills to the north and the broad, flat to undulating plain which makes up most of the area.

SURFICIAL DEPOSITS

Figure 8 (pocket illustrates the generalized distribution of the major surficial deposits in the study area. These deposits along with others not depicted in figure 8 are discussed in the following subsections with emphasis on those with potential for sand and gravel production.

Basal Alluvium

Before the advance of continental glaciers into the study area preglacial sand and gravel from a western source was deposited along some stretches of the major bedrock valleys shown in figure 7. This basal sand and gravel may have been deposited by meltwater flowing from mountain glaciers to the west or by rivers of a well developed drainage system prior to extensive mountain glaciation.

The basal alluvium was subsequently covered by 10 m to 100 m of glacial drift and is seen only where present day streams have downcut through the drift and exposed the granular material in the valley walls. The thinnest drift cover occurs in the western portion of the area.

This basal sand and gravel is not economically exploitable at present due to the depth of burial by the overlying drift and for this reason no attempt was made to delineate the boundaries of granular deposits of this type. However, information from water well logs and exposed sections in the major valleys indicate that the material is very widespread and sizeable areas with thicknesses of 5 to 10 m of granular material are expected to exist. The total volume of sand and gravel of this type could exceed 100,000,000 m^3.

Figure 9 illustrates the grain-size distributions of two samples taken from exposed sections of the basal gravel. These distributions are typical of most of the material, that is, coarse gravel carrying approximately 20 percent medium to fine-grained sand with less than 5 percent fines.

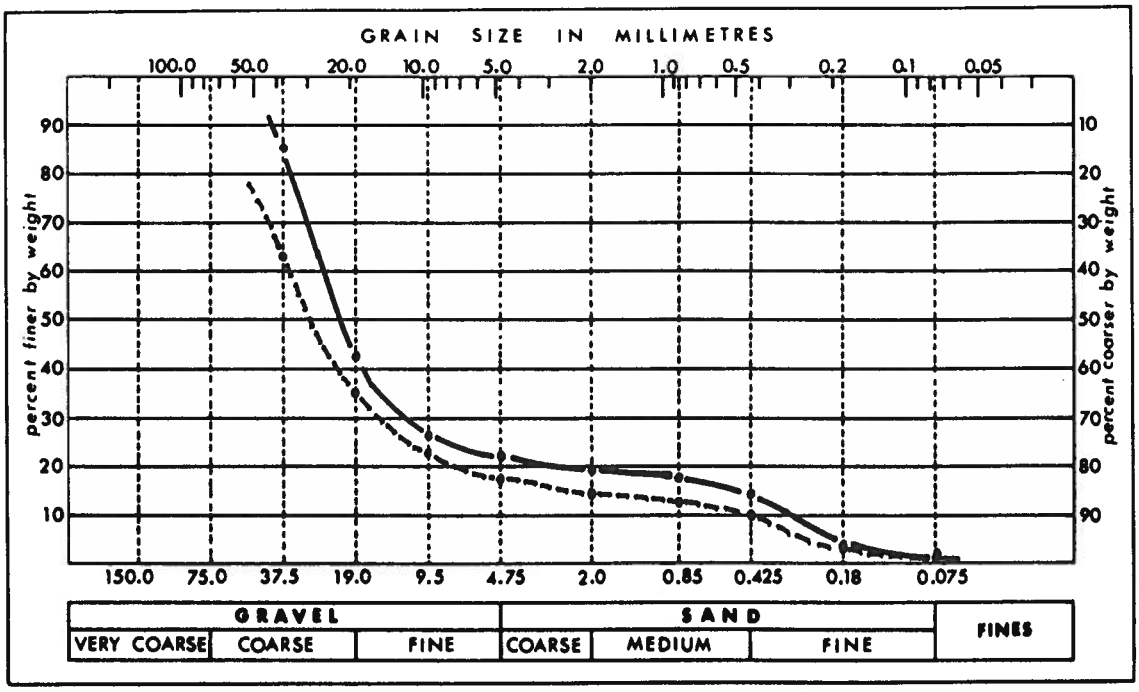

Figure 9. Gradation curves of two samples of basal gravel.

The gravel clasts are predominently subrounded to well-rounded quartzites (up to 80 percent) with sandstone, chert, carbonate and an occasional ironstone clast making up the remainder. Granite and other rock types from the Precambrian Shield are absent.

Medium to fine grained sand seams up to 1 m thick are present within the gravel bearing strata and may account for up to 25 percent of the total granular material. In the eastern portion of the area stratified silt up to 5 m thick overlies the sand and gravel. This silt is believed to have been deposited as the result of continental glaciers beginning to restrict the preglacial drainage ways.

As well as the thick overburden cover, any extraction process would also have to contend with the problems of a high water table in most cases.

Glacial Till (Fig. 8)

By volume glacial till is the most abundant of the surficial materials in the area. The till, an unsorted, unstratified mixture of clay to boulder size material deposited directly by glacier ice, blankets the bedrock and previously deposited basal alluvium. Drillholes have revealed up to 125 m of till in areas over bedrock lows, but an average thickness may be in the order of 25-30 m. The till thins considerably over bedrock highs and is absent in places on prominent highs such as Saskatoon Hill and Kleskun Hill.

In areas where till is exposed, the surface expression is generally gently undulating to undulating with occasional local irregularities such as kettle holes and hills. Near and on the Saddle Hills to the north, the till has a rolling, irregular, hummocky surface.

Scattered, discontinuous lenses of sand and gravel up to 2 m thick were occasionally found within the till during exploratory testhole drilling. Additional drilling, however, to delineate the lenses showed that these were not extensive enough to be potential sources of sand and gravel.

Glaciofluvial Deposits

Deposits laid down by meltwater from the last continental glacier are very scarce in the study area. A single kame in Tp 72, R2 and a few small areas flanking the Saddle Hills are the only ice-contact forms in the area. Outwash is found only in two small areas in the vicinity of the Smoky River.

The glaciofluvial deposits consist mainly of sand and gravel and exhibit varying degrees of stratification.

Glacial Lake Deposits (Fig. 8)

Most of the area is covered with a veneer of clay and silt with minor fine sand which was deposited in the large glacial lake which formed in front of the retreating ice sheet. The sediments are over 10 m thick in some areas with an average thickness of 3 m or less. Till underlies the glacial lake sediments throughout the area.

The lacustrine material does not completely mask the topography of the underlying till and the result is a surface expression which varies from flat to undulating.

Glacial lake beaches and associated deposits are poorly developed in the area. This is probably due to fluctuating water levels in a relatively short-lived lake. The best developed glacial lake beaches consist of a narrow zone of gravelly sand up to 1.5 m thick. Such areas have been mined locally and are virtually depleted.

Most of the glacial lake shoreline features are erosional in nature rather than depositional. They often consist of a low wave cut bluff with a thin gravelly sand lag deposit at the base. Some of these have also been mined at a local level but hold little potential for future development.

Alluvial Terraces (Fig. 8)

As the ice retreated further, the large glacial lake drained and the present drainage system developed with the Wapiti and Smoky Rivers downcutting through the glacial drift and into the underlying bedrock.

Downcutting was interrupted on at least two occasions when coarse gravel and sand from a western source was deposited in the Wapiti and Smoky River valleys as fills up to 20 m thick along some stretches. The depositions were likely due to expansions of cordilleran ice from the west (Henderson, 1960) which supplied both the coarse material and meltwater necessary for transport.

Resumed downcutting after the first deposition of alluvium, eroded and trenched through the fill leaving only remnants of it in the form of terraces 15 m to 25 m below the upland surface. These high terraces are found only along the western portion of the Wapiti River valley indicating that drainage north via the Smoky River may still have been restricted by glacier ice at that time.

The surface of the second set of terraces, present along both the Wapiti and Smoky River valleys and representing a later alluviation, is 65 m to 90 m below the tops of the valleys (50 m to 75 m above present river levels).

The gravel and sand in the terraces is very similar in both grain size and composition to the basal gravel and sand described previously. This is to be expected as both types had the same source and mode of deposition.

The material is generally clean, coarse gravel with approximately 20-25 percent medium to fine grained sand. The bimodal distribution (one mode in the gravel range and one mode in the sand range) is typical of many coarse alluvial deposits.

Subrounded to well rounded durable quartzite clasts make up 60-90 percent of the gravel size material. The remainder is composed mainly of sandstone, chert and carbonate clasts with the occasional granitic clasts from the Precambrian Shield. These Shield clasts were incoporated as the rivers eroded the local till.

Eolian Sand (Fig. 8)

As shown in figure 8, extensive wind blown deposits have developed on both sides of the Wapiti River and on the east side of the Smoky River. The material is composed of fine sand and occurs in both sheet and dune form. Dunes over 8 m high and up to 1.5 km long have been developed on a thin sheet of sand less than 2 m thick.

The eolian material overlies glaciolacustrine sediments in most cases. In the southeastern portion of Tp 70, R10 the deposit was developed on what may be deltaic material deposited in the glacial lake by meltwater from the west. As well, the surfaces of some of the alluvial terraces have been modified by wind action.

The source of most of the eolian material was the probable deltaic sediments in the western portion of the area and lacustrine sand deposited in shallow waters bordering the drainage ways as the glacial lake drained.

Because of the fine grained, uniform nature of the sand, it is not useful for construction purposes other than as fill material. The sand is readily available in large quantities for this purpose.

Recent Alluvium (Fig. 8)

Alluvium ranging from silt to gravel has been deposited in present day stream valley bottoms in the area in the form of floodplain terraces, bars and channel deposits. The source of most of this alluvium is from the local surficial and bedrock materials which the streams have eroded.

Coarse gravel and sand has been deposited along some stretches of the two major streams in the area, the Wapiti and Smoky Rivers. These deposits tend to occur in stretches of the rivers with steeper gradients and narrower floodplains. Concentrations of coarse gravel and sand in the river beds and floodplains are also found adjacent to and downstream from areas where the Wapiti and Smoky Rivers have cut across buried basal sand and gravel deposits.

Material has been extracted from these floodplain deposits at a few locations during low water stages and they will continue to be a minor source of aggregate in the area.

Recent Lake Deposits

Clay, silt and sand brought in by local streams is being deposited in the present day lakes in the area. Many of these lakes are remnants of the large glacial lake and sedimentation in them has been continuous since glacial times.

With one exception these present day lakes have not produced beaches containing extractable granular material. The exception to this is the lake which was centered in Tp 73, R4. This lake, which was drained early in this century, had developed a well defined sand beach on the east side of the lake. The sand is medium to fine grained and one pit has been developed in this deposit.

Colluvium (Fig. 8)

Colluvium, a mixture of surficial and/or bedrock debris is found on the slopes and at the base of stream valley walls in the study area.

Organic Deposits

Accumulations of muck and peat have formed in many low lying depressional basins in the study area. These organic accumulations are most common in the area covered by eolian sand.

SAND AND GRAVEL RESOURCES OF THE GRANDE PRAIRIE AREA

INTRODUCTION

This section discusses the individual deposits or areas of sand and gravel in the study area. The discussions are based mainly on surface geological observations and limited subsurface and laboratory data.

As detailed investigations of the areas have not been performed, the descriptions should be used only as a guide for the location of potentially exploitable deposits. Persons involved with planning and zoning should use the information supplied in this report to get an overall feeling for the granular reserves in the area and the effects various land use decisions use decisions may have on long-term supplies.

The locations of granular deposits, pits, testholes and some of the sample sites are shown on 1:50,000 scale maps (Figs. 11, 12, 13, 14, 15 and 16, in pockets). Figure 10 (below) is the index map for the above figures.

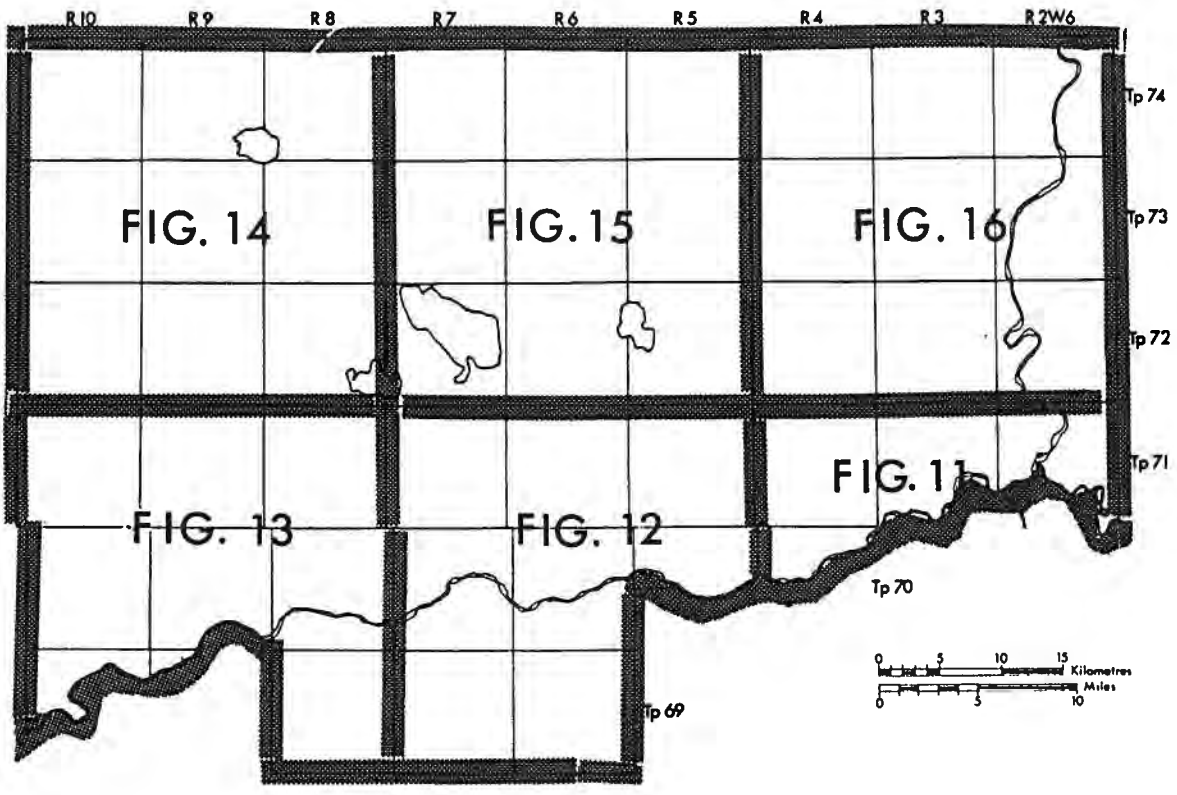

Figure 10. Index map of 1:50,000 scale figures.

AREA 1 (Fig. 11; Sec 28 and 33, Tp 71, R2)

Area 1 is a series of three alluvial terrace deposits ranging from 30 m to 80 m above the present Smoky River level. In total the terraces comprise an area of approximately 260 ha and contain an estimated 10 - 15,000,000 m^3 of gravel and sand. This is a good area for future development when the resource is required.

Much of the area is open grazing land which appears well drained and a low water table is anticipated. There is generally less than 0.5 m of overburden although fine sand seams up to 1.5 m thick occasionally occur at or near the surface.

Figure 17 shows the grain size distribution of two samples taken from the small pit which has been developed on the uppermost terrace.

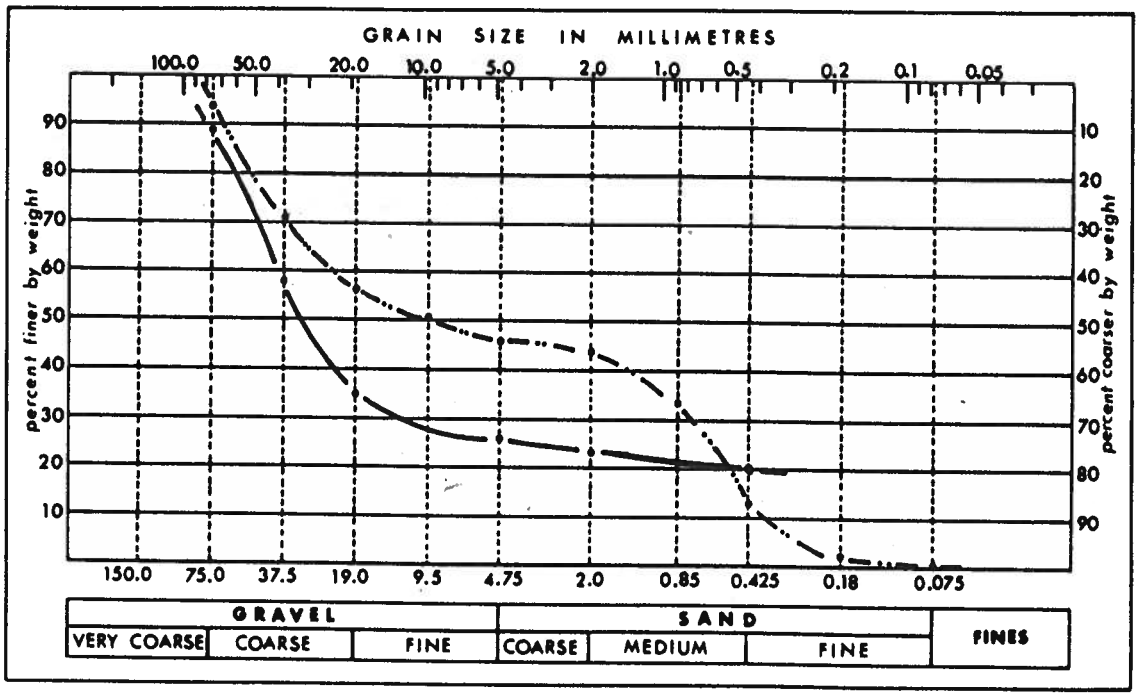

Figure 17. Gradation curves of samples from area 1.

The granular material is coarse gravel with medium to fine sand. Less than 5 percent fines are present and the amount of gravel larger than 75 mm is less than in many of the other terrace deposits. Gravel clasts are predominantly subrounded to rounded quartzite clasts with only minor amounts of other rock types present.

Although auger test drilling on the terraces was rarely able to penetrate more than 3 m of the coarse gravel, the average thickness is thought to be over 5 m.

AREA 2 (Fig. 11; Sec 21, Tp 71, R2)

This terrace deposit, 30 m above river level, has up to 5 m of coarse, sandy gravel overlying bedrock. The thickness of the deposit is not continuous over the area. Possible reserves may be in the order of 1,500,000 m^3 to 3,000,000 m^3. The apparent thin and discontinuous nature of this deposit limits its potential for development.

AREA 3 (Fig. 11: Sec 19, Tp 71, R2)

Area 3 is the first alluvial terrace deposit on the Smoky River downstream from where it is joined by the Wapiti River. The gravel and sand occurs at or near the surface and is similar to other terrace deposits. A possible 1,500,000 m^3 of material may be present. The deposit does not appear to be more than 7 m thick and the possibility of a high water table exists.

AREA 4 (Fig. 11; Sec 10, Tp 71, R3)

This alluvial terrace deposit covers approximately 120 ha and has thicknesses of 3 to 4 m of gravel and sand exposed. Although this thickness may not be continuous, substantial reserves of gravel and sand are expected to exist in the deposit (over 1,500,000 m^3).

The material is coarse gravel with medium to fine grained sand. Clasts are predominantly quartzite as in all of the alluvial terrace deposits.

AREA 5 (Fig. 11; Sec 36, Tp 70, R4)

Area 5 is an alluvial terrace deposit that has been bisected by the Bear River as it joins the Wapiti River. This deposit does not appear to have large economic quantities of gravel and sand. Coarse to fine sandy gravel overlies sandstone bedrock to a maximum thickness of 1.5 m. The granular material is discontinuous and is covered by eolian or slope wash material in some places.

AREA 6 (Fig. 11; Sec 20, 21, 28 and 29, Tp 70, R4)

Possible reserves of coarse, sandy gravel in this alluvial terrace deposit could exceed 2,000,000 m^3. The granular material (up to 5 m thick) rests on bedrock and is covered by up to 0.5 m of overburden. The area is well drained and has potential for development should the resource be required. At present there has been no extraction of material and the deposit is inaccessible to standard vehicular traffic.

AREA 7 (Fig. 12; Sec 20-24, Tp 70, R5)

Area 7 is a long alluvial terrace deposit on the north side of the Wapiti River with up to 20,000,000 m^3 of granular material present. Less than half of this is recoverable due to the present land use on the terrace. The Proctor and Gamble Pulp Mill and associated lagoons are situated in a central position on the terrace and utilize a large portion of it. West of the pulp mill, granular material has been extracted from a number of pits and this portion of the terrace is becoming depleted. Future extraction of granular material is feasible in the area east of the lagoons and possibly in a portion of the area between the pulp mill and the lagoons.

The granular material is clean coarse gravel with 15-30 percent medium-fine grained sand as illustrated in figure 18. Clasts are predominantly quartzite.

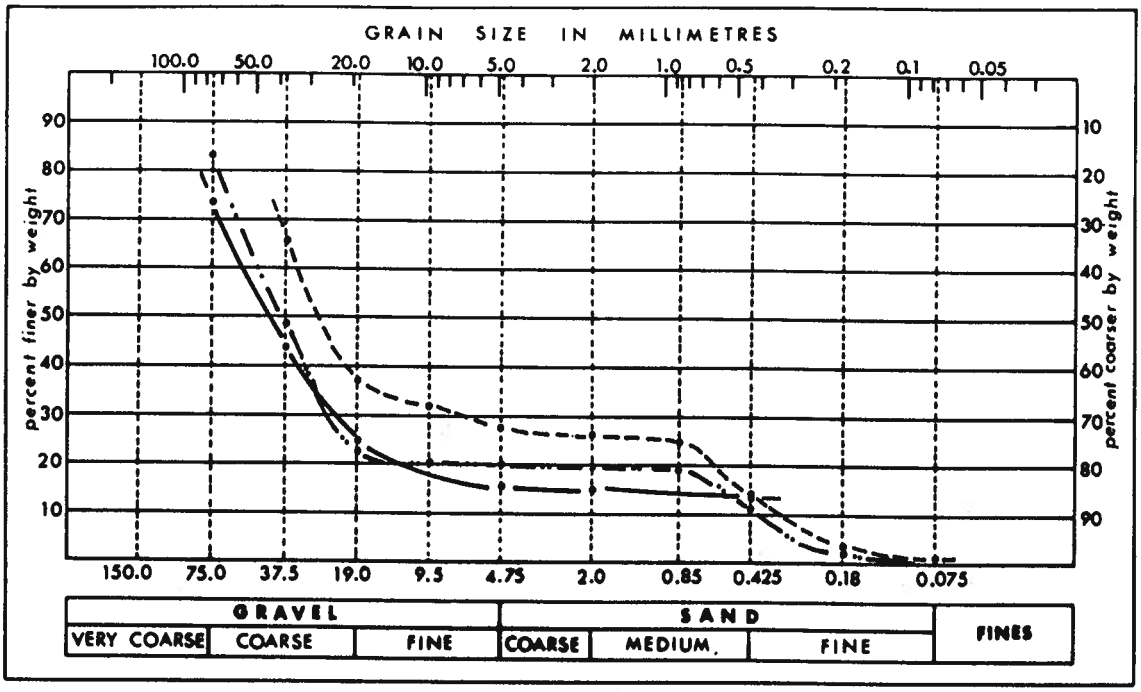

Figure 18. Gradation curves of samples from area 7.

AREA 8 (Fig. 12; Sec 19, Tp 70, R5)

Area 8 is an alluvial terrace deposit on the south side of the Wapiti River approximately 60 m above the present river level. This deposit is one of the important aggregate supplies for the area and up to 2,000,000 m^3 of granular material has been extracted from four developed pits in the deposit. Over 6,000,000 m^3 of material remains, most of which should be recoverable with proper extraction planning. This is a good deposit for continued exploitation.

The deposit lies directly on shale-sandstone bedrock and is covered by 0.5 m or less of sandy topsoil and organic debris. The thickness of granular material present varies from 6-17 m with the average thickness being approximately 10 m. The area is well drained and the water table is approximately 9 m below the surface.

The material consists mainly of coarse gravel carrying 20-30 percent medium to fine grained sand. Fines make up less than 5 percent of the material. Fine grained sand seams up to 3 m thick are present in the deposit but are discontinuous and do not appear to make up more than 10 percent of the material. Figure 19 shows two typical grain size distributions of the material.

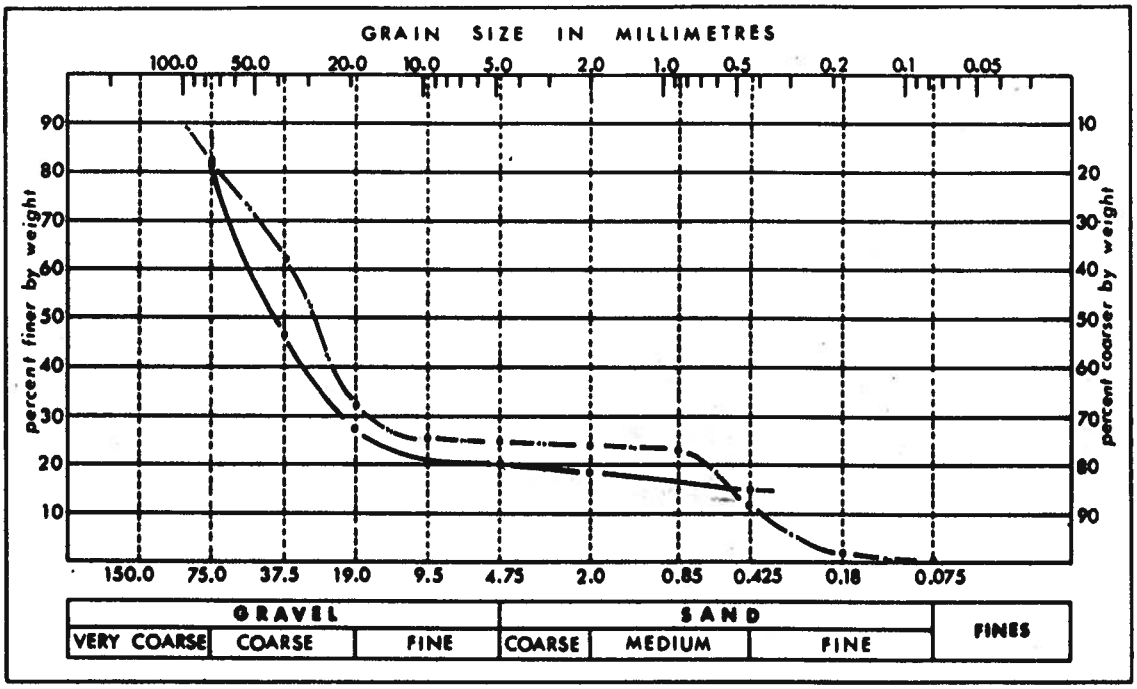

Figure 19. Gradation curves of samples from area 8.

The gravel is composed predominantly of sub rounded durable quartzite clasts (60-80 percent) with sandstone, carbonate and chert clasts making up the remainder. An occasional granitic clast is present. Coal particles in the sand fraction of the material may be present in objectionably high amounts for certain uses in some areas of the deposit.

AREA 9 (Fig. 12; Sec. 22-25, Tp 70, R6)

Granular material has been extracted from this alluvial terrace deposit on the north side of the Wapiti River since the Grande Prairie region was first settled. The material is very similar to areas 7 and 8 (coarse gravel with 20-30 percent medium to fine grained sand) and remaining reserves of 5,000,000 m^3 are expected to be present.

The western half of the terrace has been mined extensively and most of the reserves are in the eastern portion where a water table only 4-6 m below the surface is present. The granular material is generally more than 6 m thick and usually occurs at the surface but may be covered with up to 6 m of aeolian sand in some places. Bedrock underlies the gravel throughout the area.

AREA 10 (Fig. 12; Sec 18, Tp 70, R6)

Area 10 is a small remnant alluvial terrace deposit 105 m above the present Wapiti River level. The deposit has been used extensively over the years and is nearly depleted of reserves. Figure 20 shows the gradation of a sample from the area.

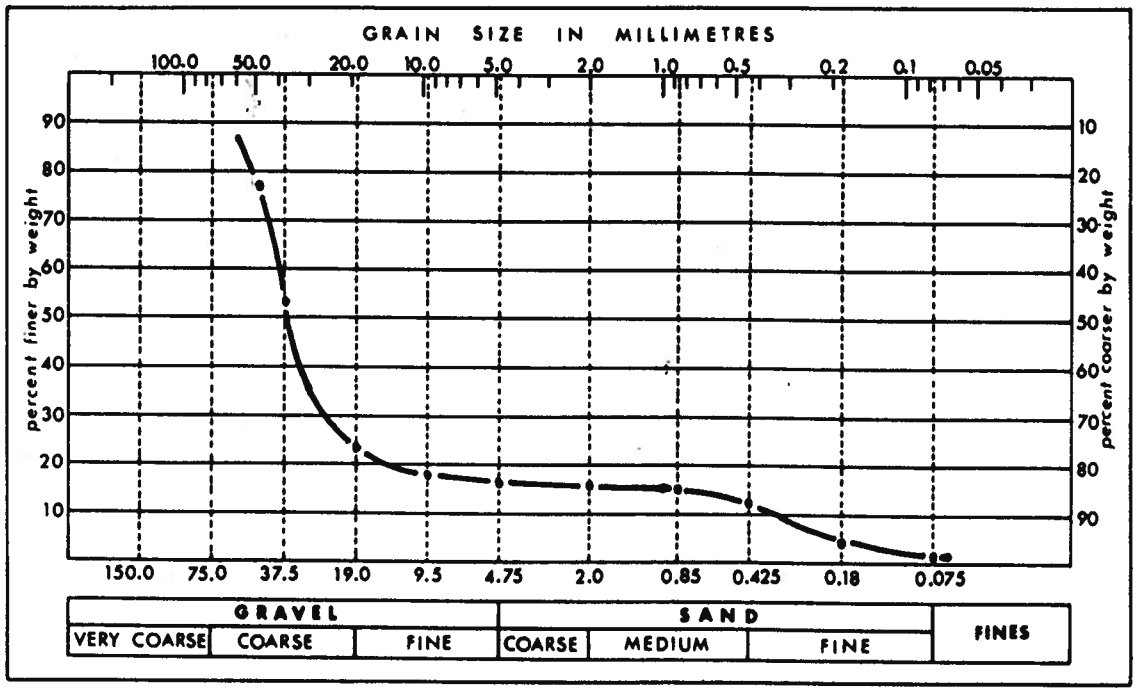

Figure 20. Gradation curve of sample from area 10.

AREA 11 (Fig. 12; Sec 13, 22 and 23, Tp 70, R7)

Area 11 is a long narrow alluvial terrace deposit on the south side of the Wapiti River approximately 60 m above river level. Two pits have been developed in the eastern portion of the area and an estimated 5,000,000 m^3 of granular material is present.

The material, which occurs at the surface, is mainly coarse gravel with 20-25 percent medium to fine grained sand. Figure 21 shows the grain size distribution of a sample from one of the developed pits.

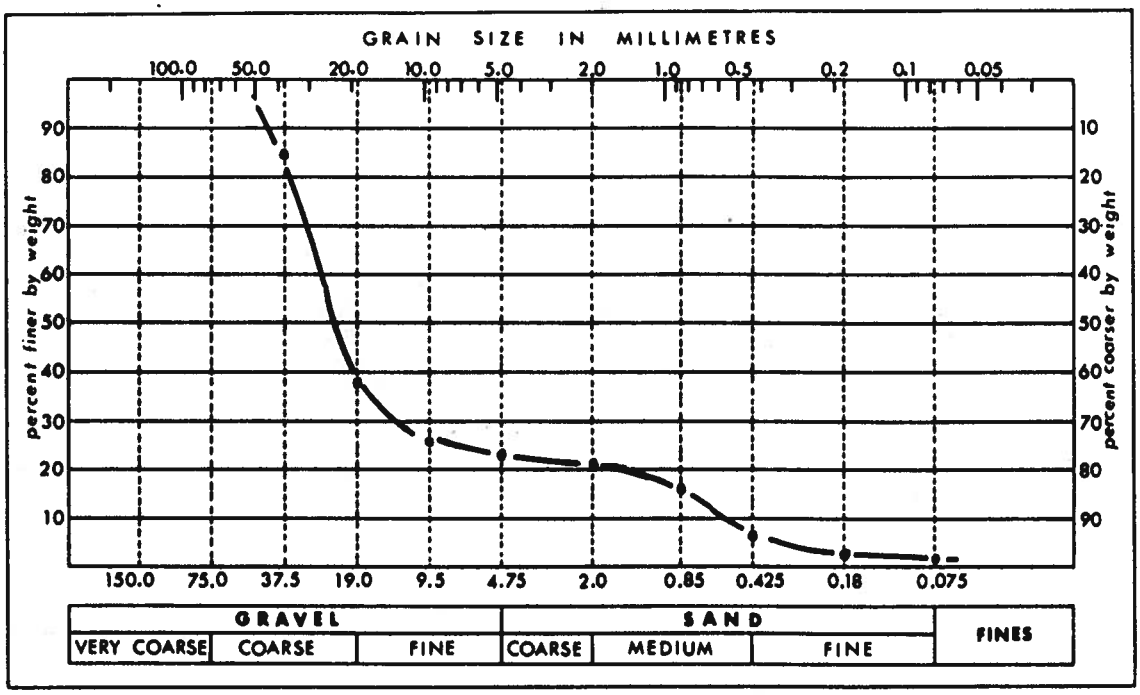

Figure 21. Gradation curve of sample from area 11.

The gravel clasts are predominantly sub-rounded quartzites with minor amounts of sandstone and carbonates and only an occasional granitic clast.

AREA 12 (Fig. 12; Sec 7, 17-18, Tp 70, R7)

This terrace is approximately 4 km long and 200 m wide. The thickness of granular material varies from 0-3.5 m with the thickest areas at the east end of the terrace. One pit has been developed at the eastern end and an estimated 300,000 m^3 of material may have been removed. Remaining extractable reserves may be in the order of 300,000 to 600,000 m^3. The deposit lies directly on bedrock and has very little overburden except for a heavy tree cover.

Figure 22 is the grain size distribution of a sample from the developed pit. Maximum clast size present is approximately 25 cm.

The gravel is composed predominantly of sub-rounded quartzite clasts.

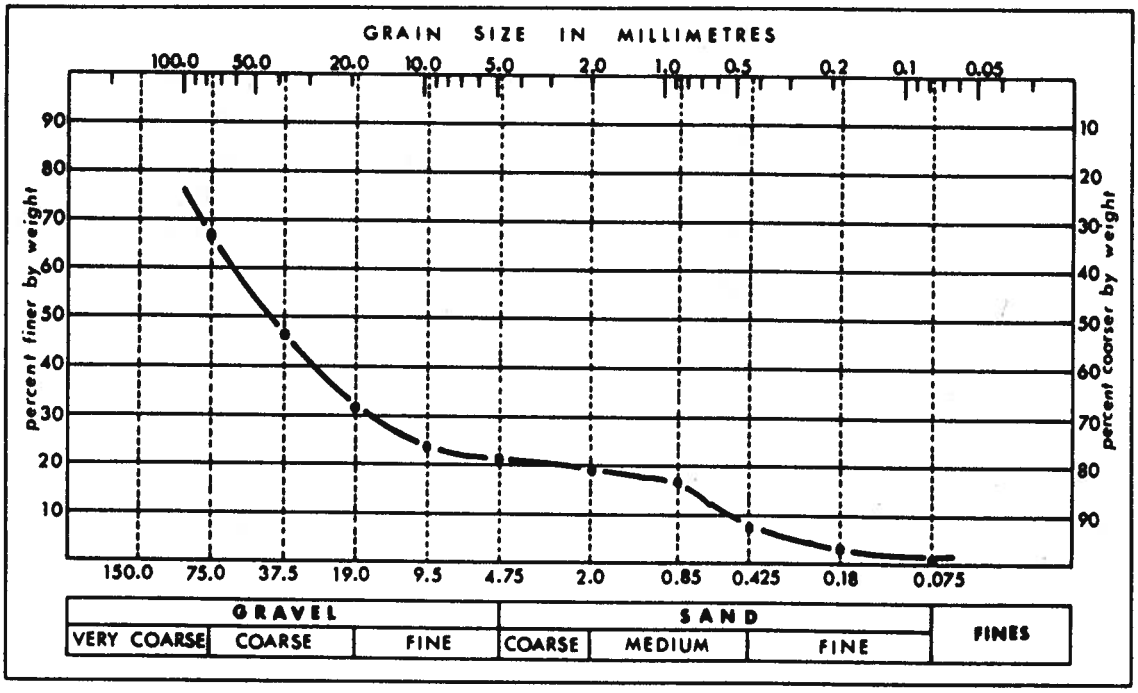

Figure 22. Gradation curve of sample from area 12.

AREA 13 (Fig. 13: Sec 11, Tp 70, R8)

This remanent alluvial terrace may contain up to 1,000,000 m^3 of gravel and sand. The area appears to be well drained, has very little overburden, and

may be a good source for future extraction. No development has taken place to date. Material in the deposit is similar to other alluvial terrace deposits (i.e. coarse grained gravel with medium to fine grained sand).

AREA 14 (Fig. 13; Sec 31-32, Tp 69, R9; Sec 36, Tp 69, R10)

This alluvial terrace has potential gravel and sand reserves of 30,000,000 m^3. Surface drainage is good and the water table is generally more than 9 m below the surface. The deposit is a good source for future extraction.

The deposit occurs at the surface and overlies sandstone or shale bedrock with an average thickness of granular material of over 9 m. The gravel beds are coarse grained and carry approximately 20 percent medium to fine grained sand. Figure 23 shows the grain size distribution of a sample of gravel recovered from a Becker Drill testhole in this deposit.[1] The gravel size material is made up predominantly of hard, durable quartzite clasts with minor amounts of carbonate and sandstone clasts.

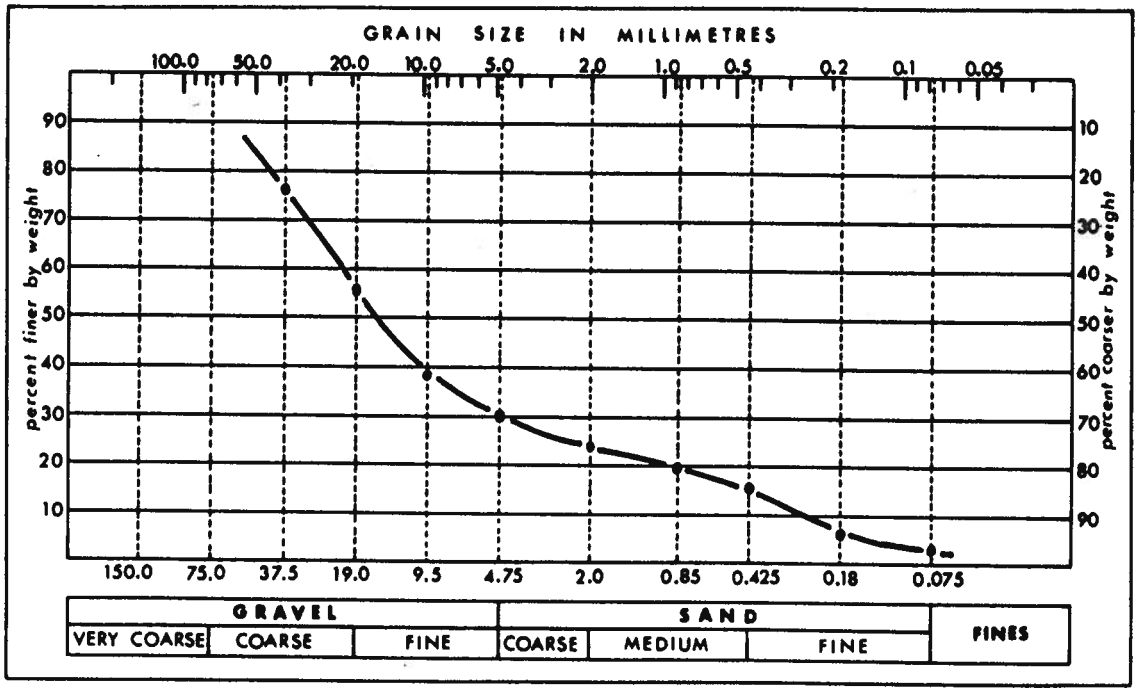

Figure 23. Gradation curve of sample from area 14[1].

[1] Due to this drilling mechanism in place gravel will be coarser than the sample represents.

Medium to fine grained sand beds up to 3 m thick make up 25-35 percent of the deposit. The usefulness of this sand is limited by its fine grained nature.

Up to 1978 there had been no extraction of granular material from this deposit. A bridge across the Redwillow River between R9 and R10 would cut the deadhaul distance to populated centers such as Beaverlodge and Wembley considerably and thereby make the deposit more economical to develop.

AREA 15 (Fig. 13; Sec 33-36, Tp 69, R10; Sec 1-3, Tp 70, R10)

Up to 20,000,000 m^3 of gravel and sand are present on this high level terrace but the potential for large scale development and extraction of aggregate is limited by a high water table and the abundance of fine to medium grained sand beds which are of limited economic value.

The deposit has very little overburden, averages 5 or 6 m thick and overlies unoxidized glaciolacustrine sediments or till. The material consists of clean, coarse, sandy gravel interfingered with clean fine to medium grained sand beds. These sand beds make up over 50 percent of the total material. The gravel is composed predominantly of sub-rounded quartzite clasts. Figure 24 is an example of the grain size distribution of the gravel beds.

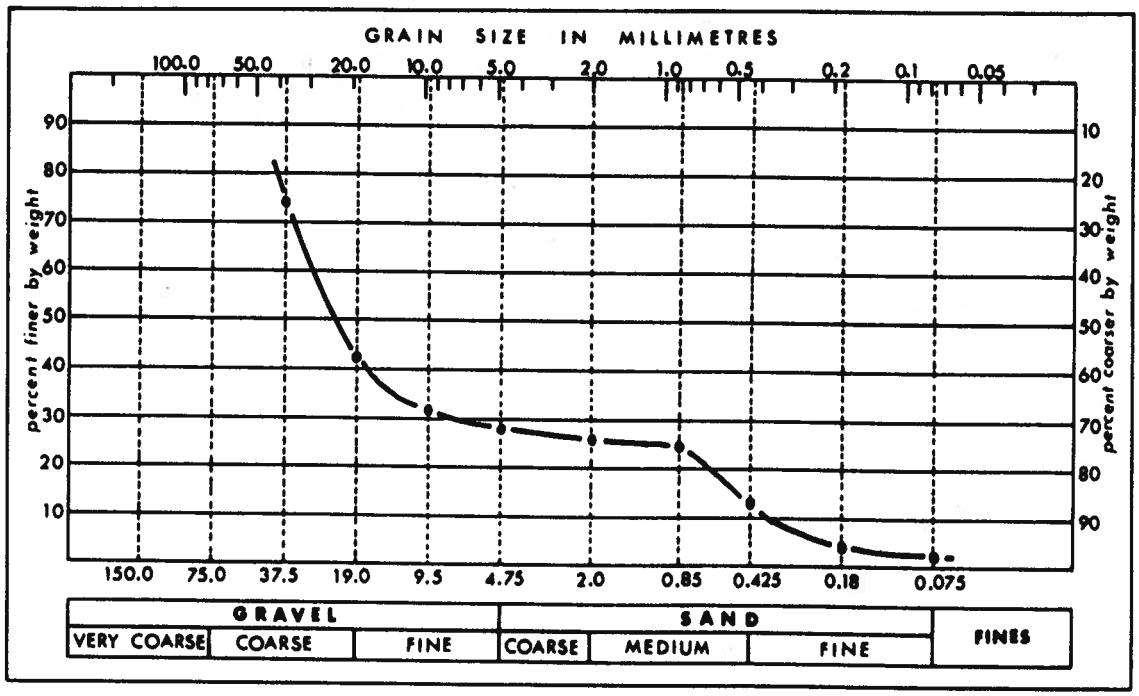

Figure 24. Gradation curve of sample from area 15.

Due to the high water table and poor surface drainage muskeg covers over half of the area and on the higher non muskeg parts the water table is still only 2-3 m below the surface.

One small pit has been developed in the area and although there is 6 m of gravel and sand at this location the high water table limits the working depth of the pit to 1.5 m.

The problem of a high water table can be partially overcome by the use of dragline equipment for extraction or by costly drainage procedures.

AREA 16 (Fig. 13; Sec 18, Tp 69, R10)

Possible gravel and sand reserves of 3,500,000 m^3 remain in this high level alluvial terrace deposit.

The granular material is coarse, sandy gravel with as much as 20 percent of the material larger than 75 mm. Figure 25 shows the grain size distribution of two samples from the deposit. The percentage of gravel ranges from 60 to 85 percent and there is generally less than 5 percent fines present. Sand

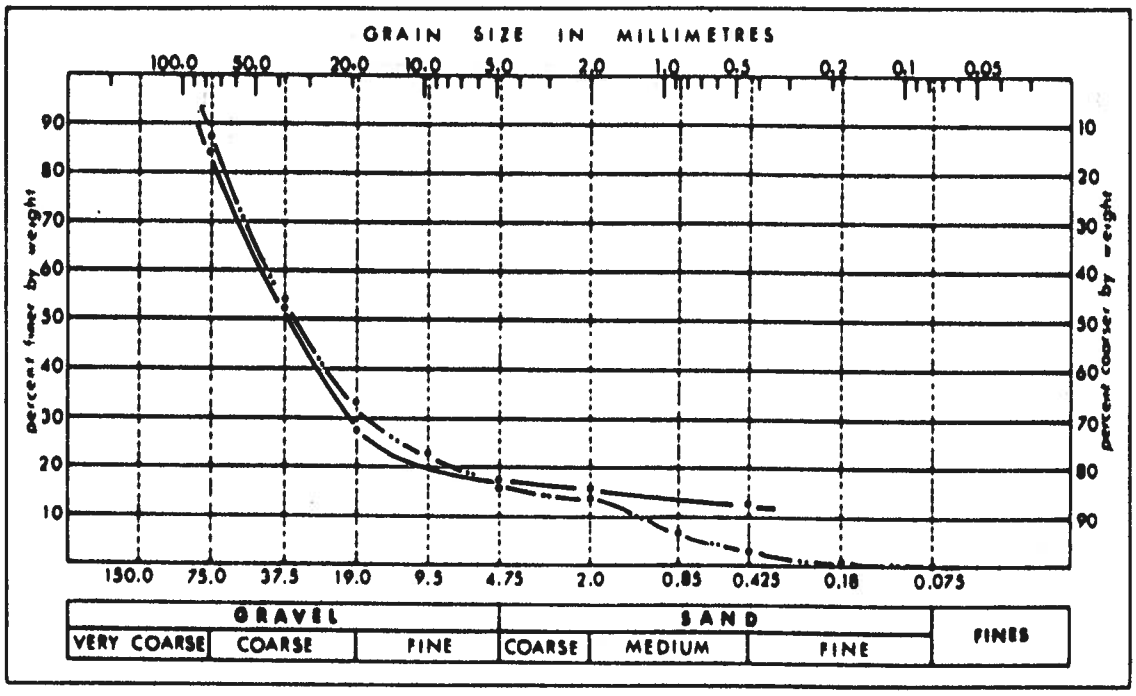

Figure 25. Gradation curves of two samples from area 16.

in the deposit is medium to fine grained and present in seams up to 2 m thick as well as interstitial to the gravel clasts.

The gravel is predominantly sub-rounded quartzite clasts with only minor amounts of other rock types present. Minor amounts of coal and clay shale particles are present.

There is very little overburden on the deposit and drilling revealed that the deposit is underlain by till at the north end and sandstone bedrock at the south end of the terrace. The average thickness of the deposit is 7 m but it varies from 3-11 m. The area has a low water table and surface drainage is good.

There is presently one active pit in the deposit which is used to supply road aggregate for a large surrounding area to the north. Material is transported up to 50 km in some cases.

AREA 17 (Fig. 13; Sec 19-22, Tp 70, R10)

Area 17 is comprised of low terrace deposits associated with the Red Willow River. The deposits consist of a few meters of gravelly sand overlying till or bedrock. The gravelly sand is coarse to fine grained and carries up to 10 percent fines. These deposits are small and grade laterally into silt accumulations.

Material has been extracted from a few places within the area but the small amount and the quality of the material does not warrant development except at a very local level.

AREA 18 (Fig. 13; Sec 4, Tp 71, R9)

Area 18 is an area of basal alluvium (preglacial gravel) which has been exposed and modified by the Beaverlodge River which has downcut through 15 m of till at this location.

Granular material consisting of coarse quartzite gravel clasts and medium to fine grained sand was formed into a wide flood plain deposit as the Beaverlodge River worked back and forth over the preglacial gravel.

The area has been worked extensively over the years and remaining reserves are minimal.

AREA 19 (Fig. 16; Sec 4-5, 8-9, Tp 72, R2)

Area 19 is a series of three alluvial terraces on the east side of the Smokey River. Combined they contain over 10,000,000 m^3 of gravel and sand reserves.

Figure 26 shows the grain size distribution of two samples from the uppermost terrace. The granular material is coarse gravel with 25-30 percent medium to fine grained sand. Hard durable quartzite clasts are the predominant gravel material with only minor amounts of other rock types present.

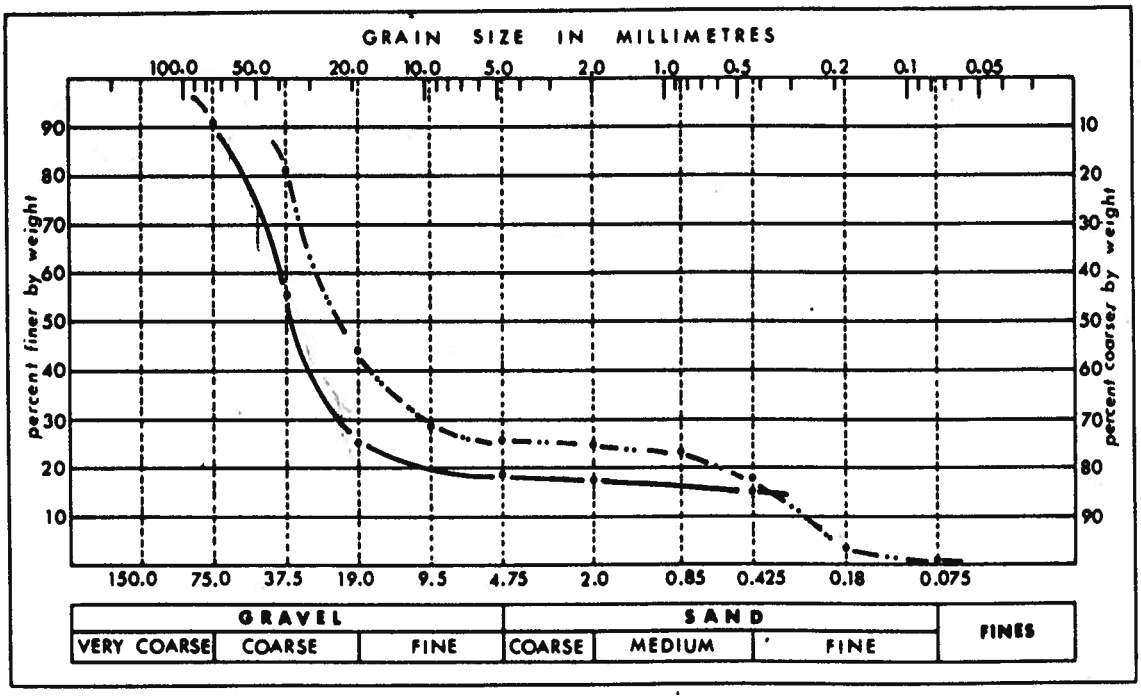

Figure 26. Gradation curves of two samples from area 19.

On the intermediate and uppermost terrace the gravel which occurs at the surface is 3-5 m thick and is underlain by unoxidized clay or sand in some cases. A high water table (3-4 m below the surface) is present throughout most of the higher terrace which has three developed pits on it.

The lower terrace, which has not been developed, contains the bulk of the reserves and is the better prospect for future exploitation. On this terrace the gravel which occurs at the surface is up to 15 m thick and is underlain by bedrock. The water table is 10 m or more below the surface.

AREA 20 (Fig. 16; Sec 17-18, Tp 72, R2)

Area 20, a series of alluvial terraces on the west side of the Smokey River, contains up to 3,000,000 m^3 of granular material. This amount may not be recoverable due to Highway No. 34 utilizing some of the area on the terraces.

The granular material occurs at the surface and is similar to area 19 (coarse gravel with 25-30 percent medium to fine grained sand). Thicknesses of 10 m are common on all terraces and a low water table is present. Pits have been developed on two of the terrace levels.

AREA 21 (Fig. 16; Sec 30, Tp 72, R2)

One pit has been operated in area 21 which is the only kame present in the study area. The feature is over 20 m high and is composed of poorly stratified granular material and large blocks or beds of till.

The granular material is variable in grain size and ranges from gravel with 20 percent sand to fine grained sand. Gravel in the deposit is coarse to fine grained and composed of up to 50 percent crystalline clasts from the Precambrian Shield. Some of these clasts are highly weathered and along with other soft concretionary ironstone fragments from the local bedrock make up as much as 10 percent of the material in some places.

Detailed subsurface testing could possibly reveal areas of better quality material within the kame but this is not expected to be the case.

AREA 22 (Fig. 16; Sec 27, Tp 74, R2)

Area 22 is a small area of outwash material situated high on the side of the Smokey River valley. This material was likely deposited at an early stage in the formation of the valley.

The granular deposit consists of alternating coarse to fine sandy gravel beds and coarse to medium grained sand beds. The beds average 10 m thick. Quartzite clasts are the predominant gravel material but up to 35 percent of the clasts are of Precambrian Shield origin. Coal particles are also present within the beds.

One pit has been operated in the small deposit and remaining reserves are minimal.

AREA 23 (Fig. 16; Sec 7 and 18, Tp 73, R3)

Area 23 is a beach deposit developed on the east side of a remnant of the glacial lake which covered most of the area. The lake persisted until it wad drained early in this century.

The deposit is only about 65 m wide and is composed of medium grained sand. It rises 2 m above the surrounding area which has a near surface water table.

The material may have some potential for fine aggregate for concrete or mortar usage but would require screening and washing. One pit has presently been developed on a minor scale.

SUMMARY

The alluvial terrace deposits contain the bulk of the exploitable sand and gravel resources within the study area and almost all of the present production comes from this source. An estimated 100,000,000 m^3 to 150,000,000 m^3 of granular material of this type is expected to be present.

Quality of the gravel may be lowered by the presence of coal fragments which may be as high as 3 percent in some areas within a deposit. Fine-grained sand seams which are of limited value and the lack of coarser to medium-grained sand in the deposits also lower the quality somewhat.

With little or no overburden and usually a low water table the alluvial terrace deposits are generally convenient to develop and work; but as the deposits do occur in major river valleys, environmental considerations should be taken into account when planning pit development and future extraction.

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APPENDIX A

GLOSSARY

aggregate - hard, inert, construction materials (such as sand, gravel, crushed stone, slag, or other mineral material) used for mixing with a cementing or bituminous material to form concrete, mortar, plaster, etc., or used alone as in railroad ballast.

alluvium - material deposited during relatively recent geological time by water; includes clay, silt, sand, or gravel in stream beds, floodplains, terraces, alluvial fans, etc.

bedrock - in-place pre-Quaternary material exposed at the surface or underlying the surficial material.

bentonitic - said of a material with a high content of the mineral montmorillonite, usually exhibiting pronounced swelling upon wetting.

carbonate clast - a rock fragment derived from sedimentary rock composed chiefly of calcite and/or dolomite.

clay - a rock or mineral fragment or detrital particle of any composition having a diameter less than 1/256 mm (Wentworth scale).

clean - said of sand and/or gravel than contains less than 5 percent fines.

cobble - gravel having a diameter in the range of 75 to 250 mm. Syn: very coarse gravel.

Cretaceous - the final period of the Mesozoic era, thought to have covered the span of time between 136 and 65 million years ago.

deleterious rock (type) - a rock fragment which when used as aggregate will break or crumble into smaller sized fragments or react with the cementing agent or fluids within the mix to expand, shrink or break-down to weaken the mixture (such as soft sandstone, weathered gneiss, and some chert).

deltaic deposit - a body of sediment deposited by a stream flowing into the standing water of a lake or the sea.

deposit (sand, gravel, aggregate) - an accumulation of sand and/or gravel left by a natural process or agent, usually wind, water or gravity.

dirty gravel - said of gravel that contains between 5 and 12 percent fines.

dirty sand - said of sand that contains between 5 and 12 percent fines.

durable rock (type) - a rock fragment which is hard and inert and can be used as aggregate without breaking, crumbling or reacting with the cementing material (such as quartzite, fresh granite or limestone).

fines - sediment with particle diameters less than .075 mm.

floodplain - flat land bordering a stream and subject to periodic flooding by the stream. Two or more levels may be present.

fluvial bar - a ridge-like accumulation of sand, gravel or other alluvial material formed in the channel (or former channel) of a stream where a decrease in velocity induces deposition.

friable - a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder, such as a soft or poorly cemented sandstone.

glacial - pertaining to distrinctive features and materials produced by or derived from glaciers and ice sheets.

glacial lake deposit - material deposited in lakes affected by glacier ice or by meltwater flowing directly from glaciers; composed of well-sorted clay, silt, or sand.

glaciofluvial deposit - material deposited by streams flowing from, on or within melting glacier ice, generally composed of sorted, stratified sand and gravel; includes outwash, kame, esker, etc.

granitic clast - a rock fragment derived from a coarse grained, plutonic rock composed principally of quartz and alkali feldspar.

granular material (unconsolidated) natural occurring mineral sediment in which more than 50 percent of the sediment is greater than .075 mm in diameter. Syn: sand and gravel.

gravel - naturally occurring rock or mineral fragments larger than 4.75 mm in diameter; an unconsolidated, natural accumulation of granular material which contains more than 3 parts gravel for every part sand.

gravelly sand - an unconsolidated, naturally occurring granular material which contains a ratio of sand to gravel between 3:1 and 1:1 (50 to 75 percent sand).

ice-contact (deposit) - material deposited in contact with glacier ice by meltwater; includes kames, eskers, and kame terraces.

ironstone - a banded sedimentary rock of ferruginous composition, often found as a compact, rounded, subspherical mass (concretion); ironstone tends to fracture and break when used as aggregate (deleterious).

kame - a steep-sided hill, knob, hummock or short irregular ridge composed chiefly of poorly sorted and stratified sand and gravel deposited by a subglacial or supraglacial stream as an alluvial fan or delta against or upon a glacier or ice sheet.

lacustrine (deposit) - material deposited in a lake.

lag (gravel) - a residual accumulation of coarse, usually hard rock fragments left behind after currents have winnowed or washed away the finer material.

outwash - a glaciofluvial deposit formed in front of the margin of glacier ice; a pitted outwash deposit is a deposit whose otherwise flat surface is marked by many irregular shallow depressions.

overburden - the soil, silt, till, or other unconsolidated material overlying a gravel or sand deposit which must be removed prior to mining.

Precambrian Shield - geologic region of Canada within which Precambrian crystalline and sedimentary complexes are exposed. Syn: Canadian Shield.

preglacial - pertaining to the time preceding a period of glaciation.

quartzite clast - a rock fragment derived from a sedimentary or metamorphic rock consisting of quartz grains or crystals cemented with secondary silica such that the rock breaks across or through the grains rather than around them.

sand - naturally occurring rock or mineral fragments larger than 0.75 mm in diameter and smaller than 4.75 mm; an unconsolidated, natural

accumulation of granular material which contains more than 3 parts sand for every part gravel.

sand and gravel - see granular material.

sandstone - a clastic sedimentary rock composed principally of fragments of sand size (usually quartz) united by a cementing material (commonly silica, iron oxide, or calcium carbonate); an excellent to poor aggregate material depending on the strength of the cementing bond, and the amount of weathering it has been subjected to, and the reaction of the rock to weathering.

sandy gravel - an unconsolidated naturally occurring granular material which contains a ratio of gravel to sand between 3:1 and 1:1 (50 to 75 percent gravel).

shale - a fine-grained sedimentary rock formed by the consolidation of clay, silt or mud and characterized by a finely stratified structure, shale is generally soft but sufficiently indurated so that it will not fall apart on wetting; a poor aggregate material because of its softness and fissility.

silt - a rock or mineral fragment or detrital particle having a diameter in the range of 1/256 to 1/16 mm (Wentworth scale).

siltstone - an indurated or somewhat indurated silt having the texture and composition but lacking the fine lamination or fissility of shale; a poor to fair aggregate depending on the hardness of the rock.

terrace - a relatively flat, elongate surface bounded by an ascending slope on one side and a descending slope on the other side. Alluvial terrace - terraces composed of sediments (commonly sand and gravel) originally deposited by stream action and later cut through by the stream, leaving the former floodplain surface some distance above the bed of the present stream.

till - unsorted and unstratified sediment deposited directly by glacier ice.

valley fill - outwash confined within a valley.

R4 R3 R2 W5

Tp 71

Tp 70

Glen Leslie

Smoky River

Simonette River

Wapiti River

Bear River

LEGEND

AREA OF GRANULAR MATERIAL 6
(numbers refer to descriptions in report)

ARC TESTHOLE ..... •

ACTIVE OR ABANDONED PIT 0

Scale 1: 50,000
Contour Interval 50 feet

FIGURE 11. SAND AND GRAVEL RESOURCES — SOUTHEAST

LEGEND

ALLUVIUM / COLLUVIUM, undifferentiated

EOLIAN SAND

ALLUVIAL TERRACES

GLACIAL LAKE DEPOSITS
-higher elevations may contain areas of glacial till.

GLACIAL TILL
-lower elevations may contain areas of glacial lake deposits.

GEOLOGY MODIFIED FROM J.F. JONES (1961, 1966)

R10 R9 R8 R7 R6 R5 R4 R3 R2W6

Tp 74

Tp 73

Tp 72

Tp 71

Tp 70

Tp 69

0 5 10 15 Kilometres
0 5 10 Miles

FIGURE 8. SURFICIAL DEPOSITS OF THE GRANDE PRAIRIE AREA

LEGEND

AREA OF GRANULAR MATERIAL 6
(numbers refer to descriptions in report)

ARC TESTHOLE ..... •

ACTIVE OR ABANDONED PIT ..... ⊕

FIGURE 11. SAND AND GRAVEL RESOURCES — SOUTHEAST

Scale 1: 50,000
Contour Interval 50 feet

R7 R6 R5W6

Tp 71 Tp 71

Tp 70 Tp 70

Tp 69 Tp 69

R7 R6

LEGEND

AREA OF GRANULAR MATERIAL 2
(numbers refer to descriptions in report)

ARC TESTHOLE ..... •

ACTIVE OR ABANDONED PIT ..... Ⓟ

FIGURE 12. SAND AND GRAVEL RESOURCES — SOUTH CENTRAL

Scale 1:50,000
Contour Interval 50 feet

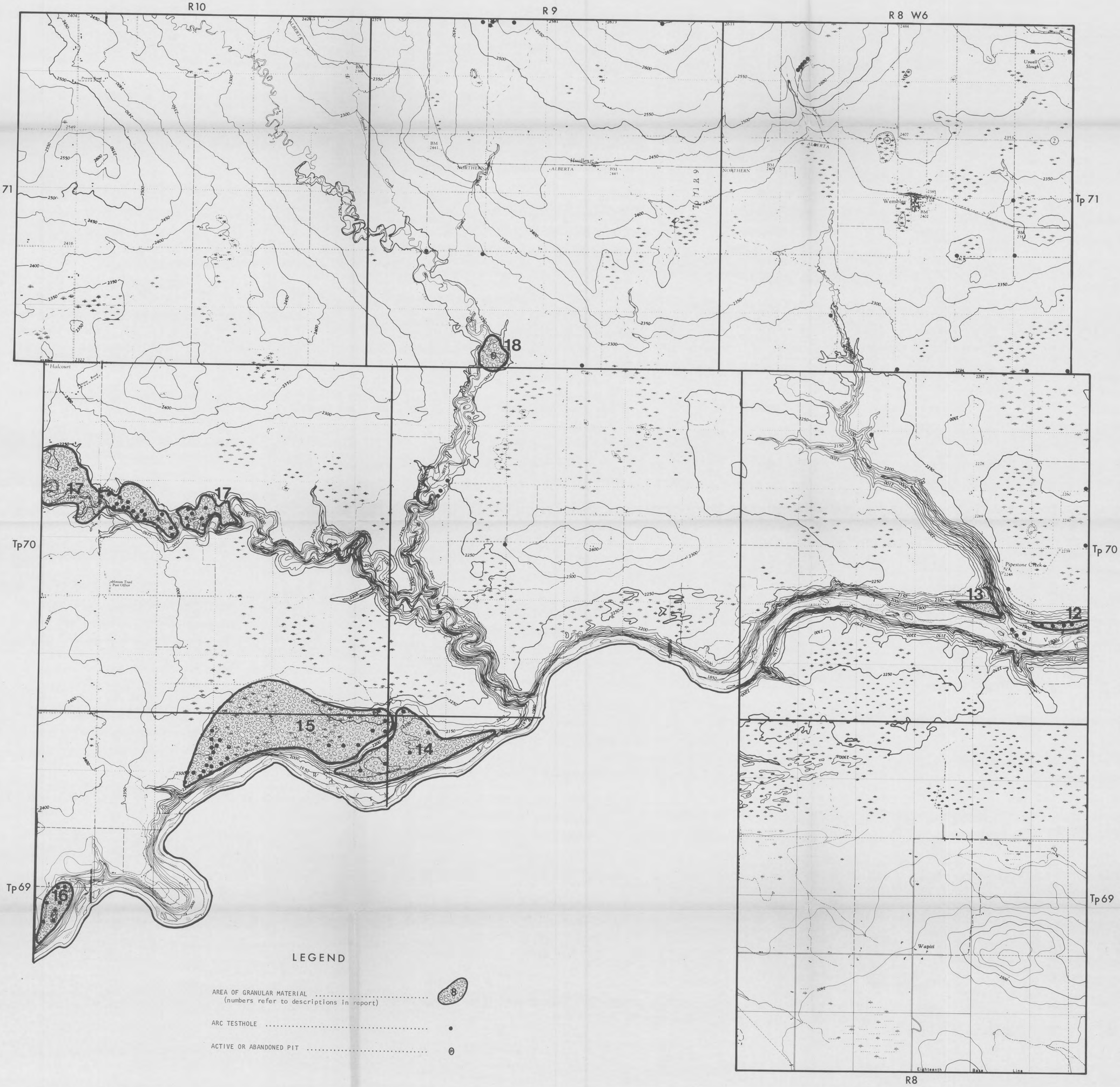
R10 | R9 | R8 W6

Tp 71

Tp 70

Tp 69

R8



LEGEND

AREA OF GRANULAR MATERIAL 8
(numbers refer to descriptions in report)

ARC TESTHOLE ..... •

ACTIVE OR ABANDONED PIT ..... P

FIGURE 13. SAND AND GRAVEL RESOURCES — SOUTHWEST

Scale 1: 50,000
Contour Interval 50 feet

R10 R9 R8 W6

Tp 74

Tp 73

Tp 72

R10 R9 R8

LEGEND

AREA OF GRANULAR MATERIAL 7
(numbers refer to descriptions in report)

ARC TESTHOLE ..... •

ACTIVE OR ABANDONED PIT ..... ⊕

Scale 1:50,000
Contour Interval 50 feet

FIGURE 14. SAND AND GRAVEL RESOURCES – NORTHWEST

R7 R6 R5 W6

Tp74 Tp73 Tp72

LEGEND

AREA OF GRANULAR MATERIAL ..... (numbers refer to descriptions in report)

ARC TESTHOLE .....

ACTIVE OR ABANDONED PIT .....

FIGURE 15. SAND AND GRAVEL RESOURCES — NORTH CENTRAL

Scale 1:50,000
Contour Interval 50 feet

OFR 1980-9

R4 R3 R2 W6

Tp 74 Tp 74

Tp 73 Tp 73

Tp 72 Tp 72

R4 R3 R2

LEGEND

AREA OF GRANULAR MATERIAL 4
(numbers refer to descriptions in report)

ARC TESTHOLE ..... •

ACTIVE OR ABANDONED PIT 0

Scale 1:50,000
Contour Interval 50 feet

FIGURE 16. SAND AND GRAVEL RESOURCES – NORTHEAST