

SAND AND GRAVEL RESOURCES OF THE  
ATHABASCA OIL SANDS REGION,  
NORTHEAST ALBERTA

Phase I

Proposed Townsite Area

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March, 1980

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## ABSTRACT

This study covers a site of the proposed new town on the east side of the Athabasca River, 88 km (55 mi) north of Fort McMurray, northeast Alberta. The most extensive deposit in the area is fine and fine to medium grained sand unsuitable for the aggregate production. In the western portion of the site a few testholes encountered medium grained sand with a grain size distribution mainly within the grading limits for fine aggregates. In the southwestern corner of the townsite, near the crest of the slopes of the Athabasca River valley, two testholes penetrated fine to coarse, dirty to clean gravelly sand with the content of gravel between 15 and 50 percent. The distribution of the medium grained and gravelly sand is difficult to determine because they might vary considerably over short distances. Further drilling would be required to assess the potential of these deposits for construction purposes.

## INTRODUCTION

This study was commissioned by the Resource Evaluation and Planning Division of Alberta Energy and Natural Resources. The purpose of the study, as outlined in a proposal dated March 5, 1980, was to identify any economically recoverable aggregate resources in the area of the proposed new town, prior to urban development of the site.

The following report is based on the presently available information on sand and gravel deposits of the area.

## LOCATION

The site of the proposed new town which would serve the Alsands oil sands plant, is situated on the east side of the Athabasca River, 88 km (55 mi) north of Fort McMurray. The area covers approximately 64 sq km (25 sq mi), between steep slopes of the Athabasca River valley in the west and McClelland Lake in the east. The area includes parts of Tp 98 and 99 and Rge 9 and 10 west of 4th Meridian (Fig. 1).

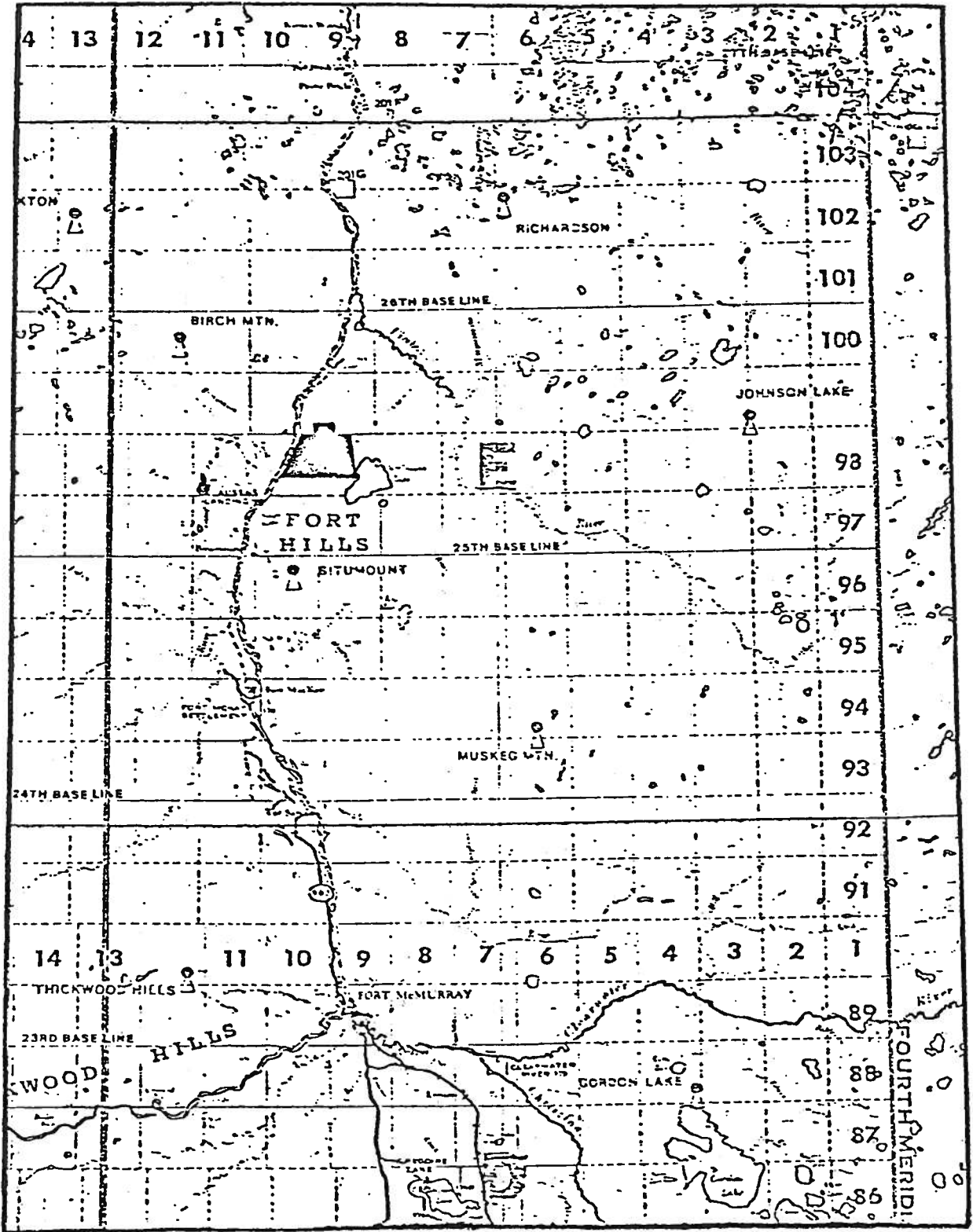


FIGURE 1. Location map of study area.

At present, access to the townsite is limited. A forestry air strip is present at Bitumount, 16 km (10 mi) southwest of the site. A winter road exists on the east side of the Athabasca River, extending from Fort Mackay through the proposed townsite to Fort Chipewyan. A number of trails and cut lines occur locally, providing winter access to the area.

#### PREVIOUS WORK

No investigations specifically of the sand and gravel resources of the site have been made except for an office air photo study by J.D. Mollard and D.G. Mollard (1974), which covered a territory of 25,000 sq km (9648 sq mi) centred around Fort McMurray. This study was conducted at the request of the Alberta Department of Lands and Forests, with a purpose to provide some preliminary information on aggregate resources of the region which could be used in planning follow-up field investigations.

In the area of the proposed townsite, Dr. Mollard indicated four sand prospects rated from "doubtful" to "fair" (Fig. 2). No potential gravel sources have been identified in the aerial photographs. The general conclusion of the study was that the granular material prospects of the region proved to be difficult to identify and rate confidently because of extensive and often dense tree cover.

In 1975, Alberta Energy and Natural Resources and Alberta Research Council, in cooperation, initiated a project to evaluate the surficial geologic deposits in potential mining areas of the Athabasca Oil Sands region. The study was conducted by Quaternary GeoSciences Ltd. (1976, 1977) and covered an area of 4400 sq km (1720 sq mi), between Tp 91 to 98 and Rge 7 to 13 west of 4th Meridian. At the request of the Northwest Alberta Regional Commission, the survey also included a drilling program to obtain geologic and geotechnical data on the three potential townsites (Fig. 2):

Townsite 7: northeast of McClelland Lake

Townsite 8: McLelland Lake west

Townsite 9: Fort Hills.

## LEGEND



Boundary of geological and geotechnical survey by Quaternary GeoSciences Ltd. (1976).



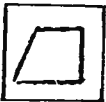
Boundary of proposed townsites studied by Quaternary GeoSciences Ltd. (1976).



Area of parcel (site) 8c studied by Klohn Leonoff Consultants Ltd. (1978).



Sand prospects identified in airphotos by J.D. Mollard (1974).



Boundary of study area.

R11

R10

6.

R9

R8

R7

25th Base Line

N

TP 101

TP 100

TP 99

TP 98

TP 97

TP 96

TP 95

TOWNSHIP 7

TOWNSHIP 8

TOWNSHIP 9

McClain Lake

Lake

R11

R10

R9

R8

R7



## 7.

Based primarily on this study, an area of approximately 64 sq km (25 sq mi) denoted as Parcel (site) 8C was selected for closer examination. It included the northern portion of Townsite 8 and an area between Townsites 7 and 8, west of McClelland Lake (Fig. 2). A geotechnical evaluation of Parcel 8C was undertaken by Klohn Leonoff Consultants Ltd. (1978).

Both geotechnical surveys proved that although fine to medium grained sand is widespread in the area, no potential for large reserves of coarse sand and gravel exists within the proposed townsite.

### GEOLOGIC SETTING

The following brief description of the geologic framework of the area is based on the data obtained by the geotechnical studies. The surficial geology map of the townsite area (Fig. 3) and the geologic cross section (Fig. 4) are copied from the report by Quaternary GeoSciences Ltd. (1976).

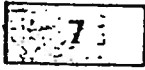
The surficial deposits in the bulk of the site are underlain by the Upper Devonian Waterways Formation which consists of interbedded limestone, argillaceous limestone and, to a lesser extent, shale. The south part of the site is underlain by the Cretaceous McMurray Formation consisting primarily of quartzose sand impregnated with heavy oil. The bedrock deposits occur at the depths ranging from 45 to 75 m (150 to 250 ft) below surface.

Glacial till overlies the bedrock deposits throughout the townsite. Depth to the till varies between 3 m (10 ft) in the west to 45 m (150 ft) in the central and east portions of the site. The thickness of till ranges between 30 and 55 m (100 and 180 ft). The till changes from silty to sandy clay till, characterized by a pink gray colour. Lenses and layers of clay as well as black tar sand and bituminous layers were observed within the till. The upper 3 to 15 m (10 to 50 ft) of the till have generally a less sandy composition.

## LEGEND (Figure 3)

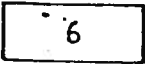
## RECENT

## Erosional Features



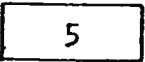
Eroded slope, gully, stream valley: discontinuous colluvial cover on slopes; discontinuous alluvial gravel, sand, silt and clay along streams.

## Organic Deposits

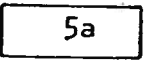


Muskeg: generally less than 10 feet thick but occasionally up to 20 feet thick; woody muskegs generally thin and sedge and string bogs thicker; in places the muskeg is somewhat discontinuous.

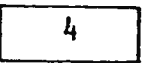
## Alluvial Deposits



Alluvial sand: minor silt and clay; confined mainly to the floodplain of the Athabasca River.



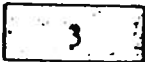
Alluvial sand, silt and clay: minor sand and gravel; common along most streams; generally discontinuous and less than 5 feet thick.



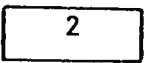
Silt and clay, minor sand: common along modern lakes; generally less than 5 feet thick.

## PLEISTOCENE

## Glaciofluvial Deposits




Meltwater channel sediment: medium to coarse grained sand, overlying thin sand and gravel and lag gravel containing many large boulders; in part early Athabasca River alluvium.



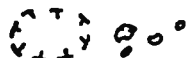
Outwash sand: forms outwash plains; surface level to gently undulating; fine to coarse grained, generally medium grained; generally thick; overlain by discontinuous aeolian sand.



Outwash sand and gravel: forms outwash plains consisting primarily of sand with gravel lenses and bars and terraces consisting of gravel and sand; surface level to gently undulating.

Geologic Boundary: defined, approximate..... 

Geologic Cross Section..... 

Karst Area and Sink Holes..... 

Scale: 1:50,000

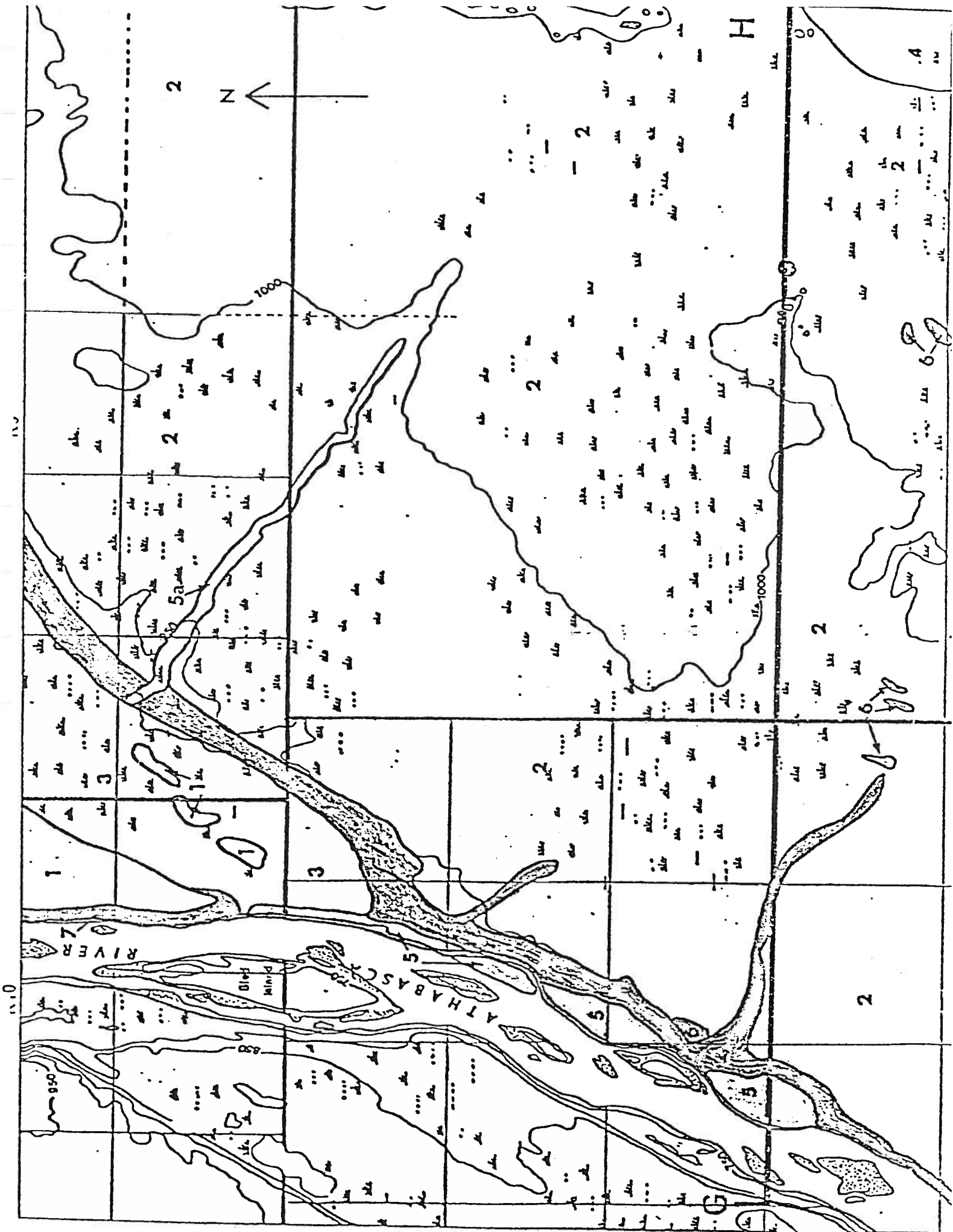




FIGURE 3. Surficial geology of townsite area

LEGEND (Figure 4)

- 5b Alluvial sand: minor silt and clay; confined mainly to the floodplain of the Athabasca River.
- 5a Alluvial silt and clay: minor sand and gravel; common along most streams.
- 3 Outwash sand: medium to coarse grained sand with occasional pebbles.
- 1 Glacial till: unsorted, unstratified sediment composed of clay, silt and sand with pebbles and boulders.
- Km Bedrock: McMurray Formation.
- Dw Bedrock: Waterways Formation.

Geologic Contact: defined, approximate..... 

Water Table..... 

SCALE

Horizontal: 1:50,000

Vertical: 1" = 100'



Athabasca River

SH 1-22-10

QG 29

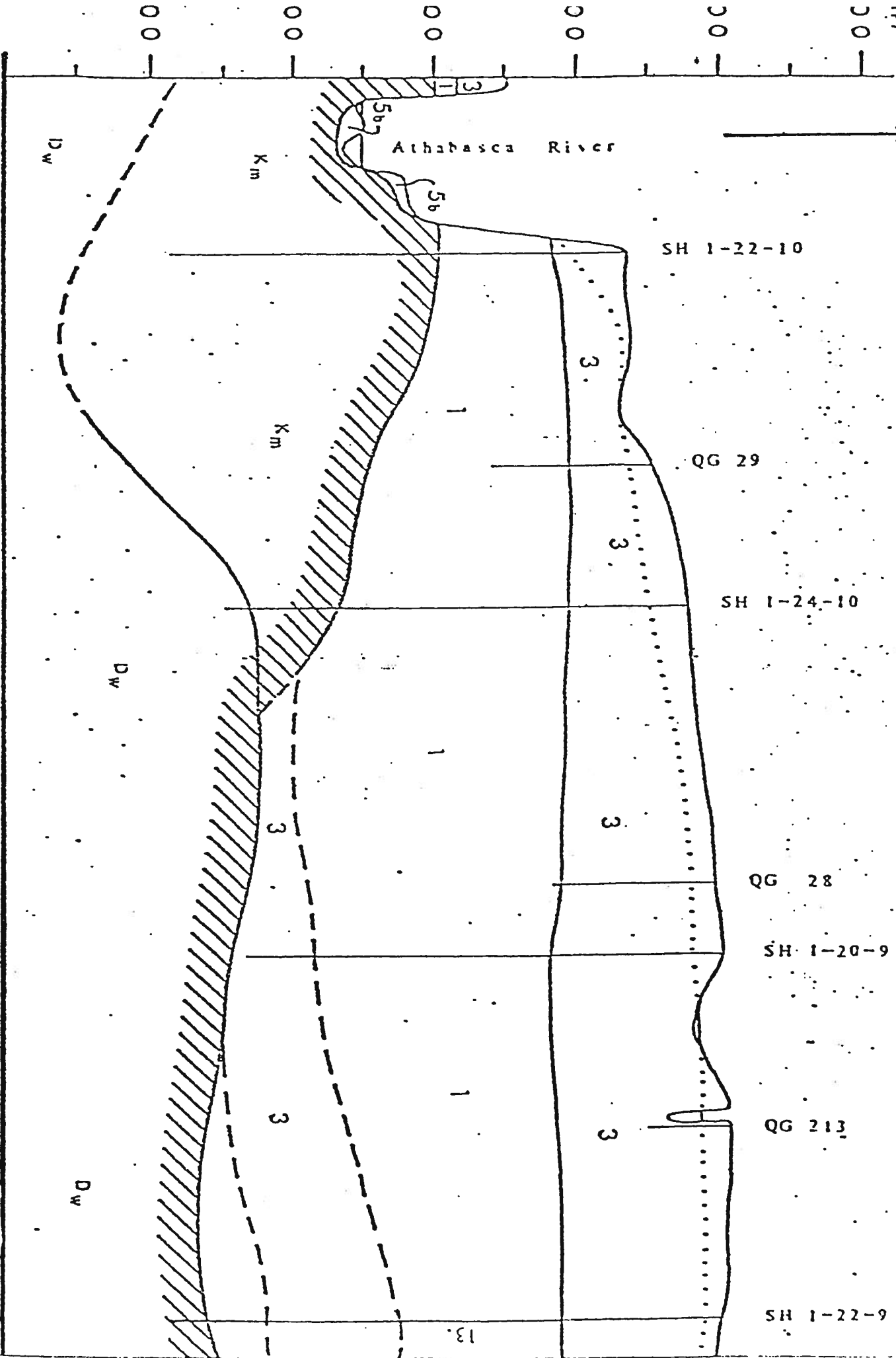
SH 1-24-10

QG 28

SH 1-20-9

QG 213

6-22-1 HS



Outwash sand contributes the major surficial deposit in the area, forming an undulating plain with elevations between 275 and 300 m (900 and 1000 ft) above sea level. The thickness of outwash varies from 3 to 45 m (10 to 150 ft), averaging 15 m (50 ft). The predominant material is fine to medium grained sand with occasional layers of clay, silt and bitumen. Gravelly sand was encountered in only 2 testholes near the crest of the Athabasca River slope, in the southwestern corner of the site.

The upper portion of outwash sand has been reworked by wind action. The aeolian sands consist mainly of clean fine material and occur in sheet or dune form over most of the area. The sheet sand is discontinuous and less than .3 m (1 ft) thick. The dunes are from 1.5 to 6 m (5 to 20 ft) high and several hundred feet long.

Organic cover is generally thin in the area. The total thickness of topsoil is 2.5 to 5 cm (1 to 2 in), increasing up to 15 cm (6 in) in the western part of the townsite. Thicker organic deposits (muskeg) occur locally in a few small bogs along the southern and western borders of the site. These bogs are dominated by mosses with only a few sedges and forbs.

Alluvial deposits are confined to the floodplain of the Athabasca River. They consist mainly of silty sand with minor silt and clay.

#### SAND AND GRAVEL RESOURCES

##### SAND AND GRAVEL DEPOSITS WITHIN THE BOUNDARIES OF THE TOWNSITE

The sand of outwash and aeolian origin is exposed at surface over most of the townsite and has a thickness ranging from 3 to 45 m (10 to 150 ft), average 15 m (50 ft). The thickness of the sand generally decreases to the west toward the slopes of the Athabasca River valley.

The sand varies from fine to medium grained, with overall gradation between #200 and #10 mesh sieves. The coarse sand and gravel fractions do not exceed 5 percent over most of the area. The silt portion contributes 2 to 15 percent, averaging about 5 percent.

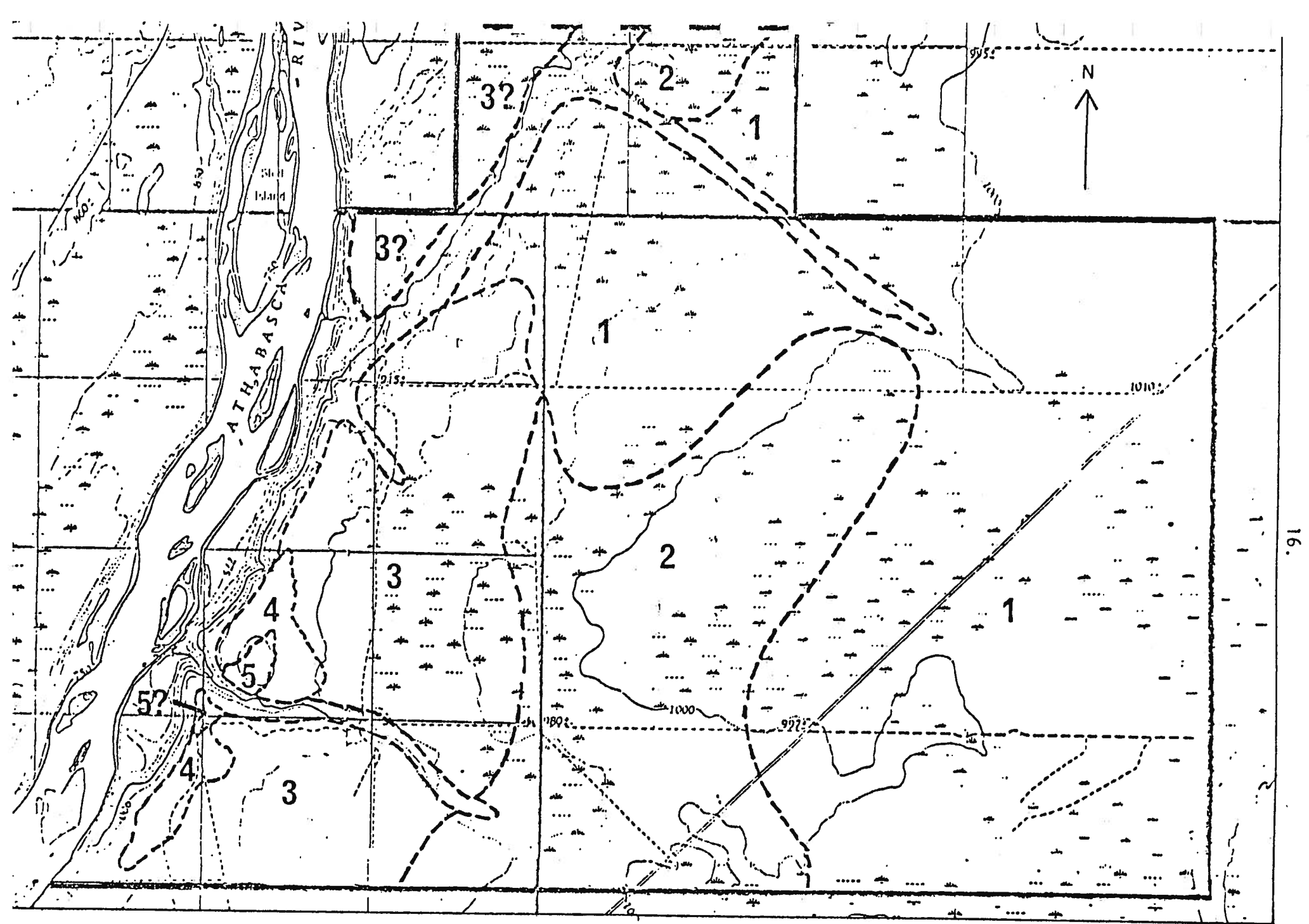
Although the sand is quite variable over short distances, the material on the whole tends to become coarser with depth and from the east to the west (Fig. 5). In the eastern, and partly in the northern, part of the site, in the vicinity of McClelland Lake, the predominant deposit at or near surface is fine grained, well sorted sand with size concentrations between #200 and #40 mesh sieves (Fig. 6). The amount of fines ranges between 2 and 10 percent.

The central part of the townsite is composed mainly of fine to medium grained sand with prevailing sizes between #60 and #20 mesh sieves (Fig. 7). The silt portion varies between 0 and 15 percent.

In the western portion of the site most of the testholes penetrated medium grained sand. The sieve analysis of material from three testholes showed the concentration of sizes between #40 and #10 mesh sieves (Figs. 8 and 9). The coarse sand and gravel fractions contribute 0 to 10 percent. The silt portion varies between 0 and 15 percent. Sands with similar composition were also encountered in a few testholes in the central part of the area at depths between 3 and 6 m (10 and 20 ft) below surface.

In the southwestern corner of the townsite two testholes encountered sand with higher concentrations of gravel. The composition of material is quite different in these testholes (Fig. 10). The deposit penetrated in testhole 1027 (Fig. 11) consists of gap graded, medium to coarse, clean sand with 50 percent gravel and cobble sizes, whereas the sand material in testhole 1028 (Fig. 11) is fine to coarse dirty with the gravel content not exceeding 15 percent. The thickness of the gravelly sand is about 7.5 m (25 ft).

The extent of the deposit is uncertain. The nearest testholes, at a distance of about 1.6 km (1 mi) encountered medium grained sand with only traces of gravel. The possibility exists that the gravelly sand has a very limited extent and



Scale: 1:50,000

FIGURE 5. Sand deposits in townsite area.

- 1. Fine sand.
- 2. Fine to medium sand.
- 3. Medium sand.
- 4. Fine to coarse sand with up to 15 percent of gravel.
- 5. Medium to coarse sand with up to 50 percent of gravel.



# GRADATION CURVE

CANADIAN STANDARD SIEVE SERIES

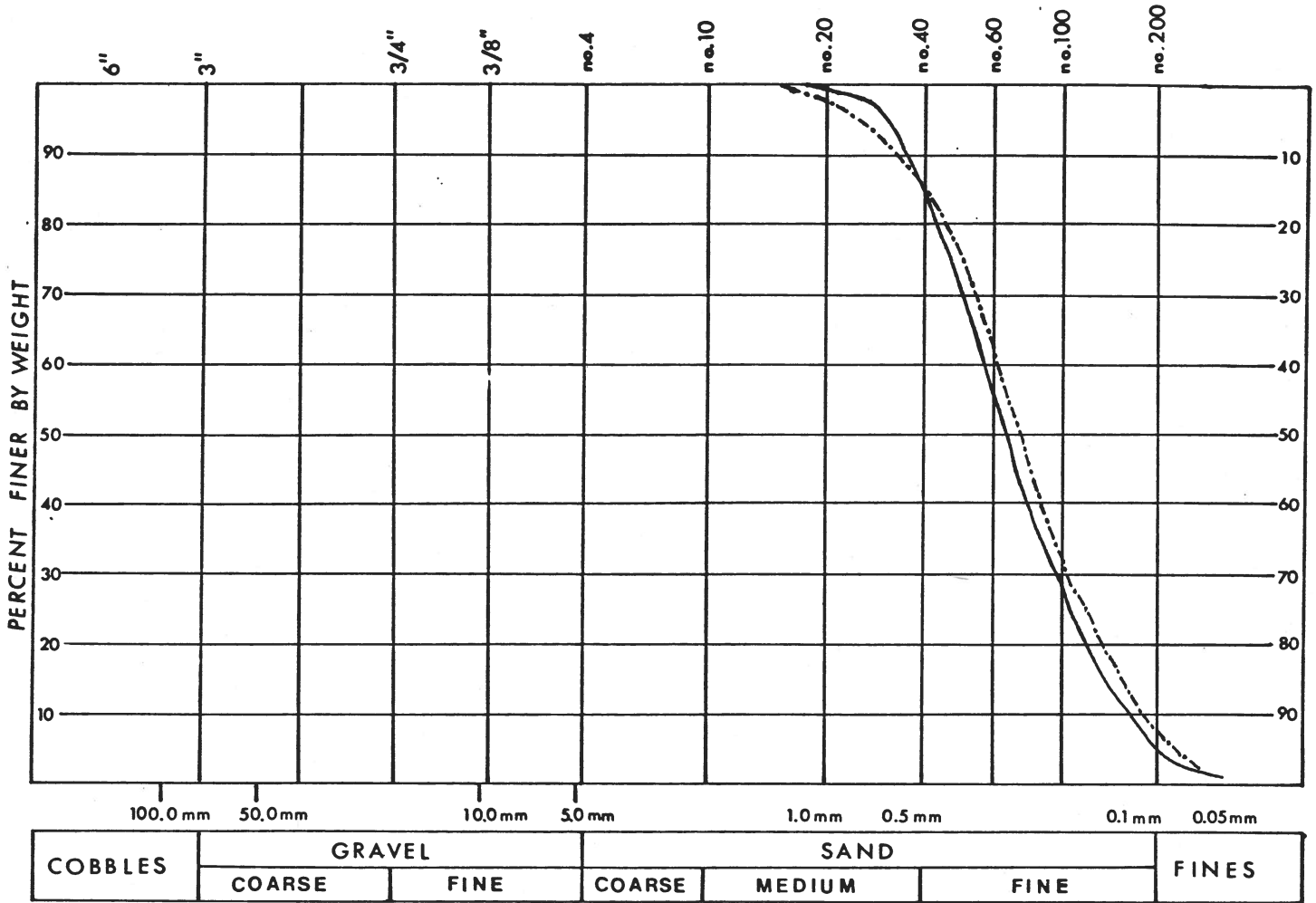



FIGURE 6. Grain size distribution of fine grained sand.

Testholes 28 and 31, Quaternary GeoSciences Ltd. (1976)

-  Testhole 28
-  Testhole 31

# GRADATION CURVE

CANADIAN STANDARD SIEVE SERIES

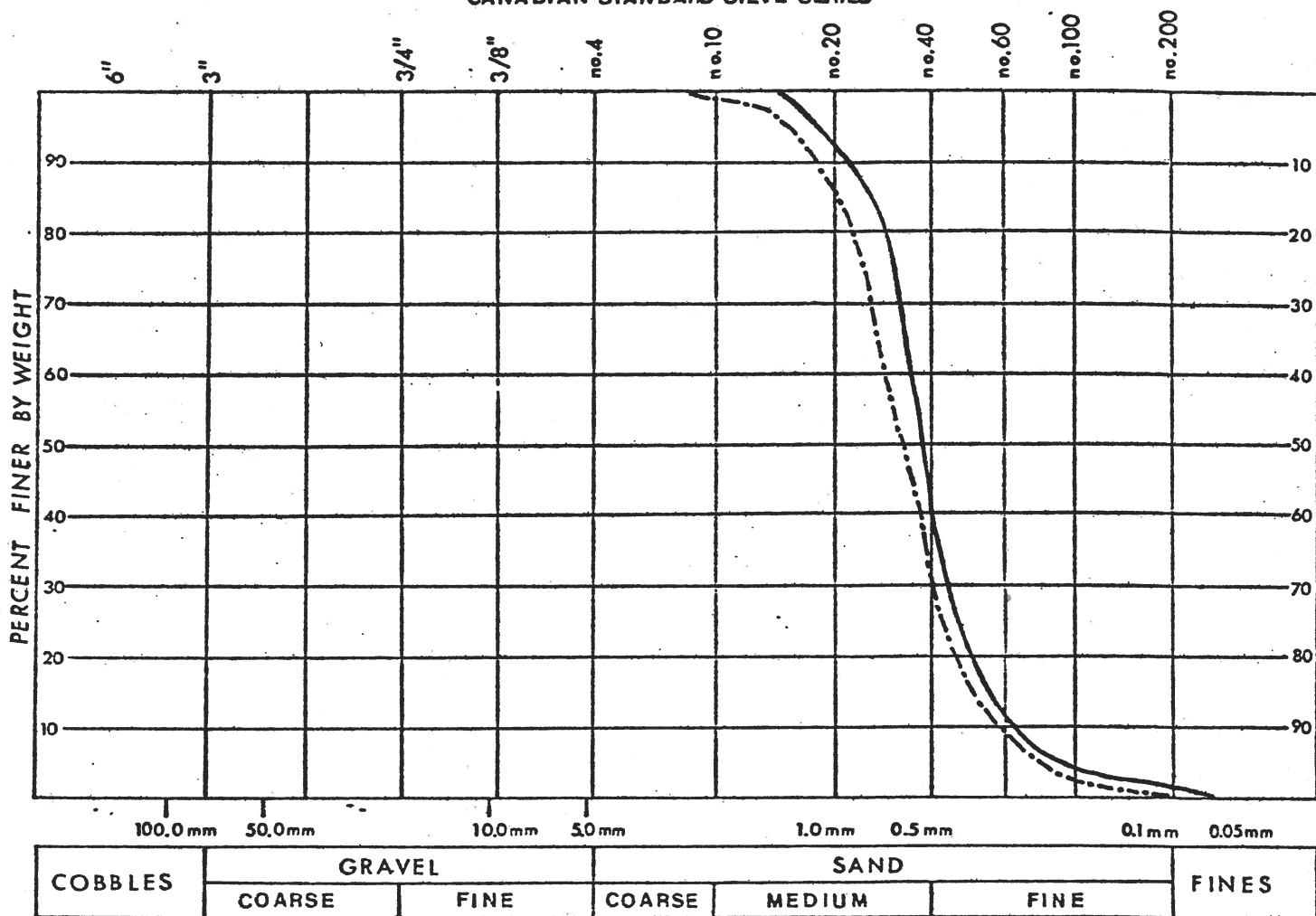




FIGURE 7. Grain size distribution of fine to medium grained sand.

Testhole 207, Quaternary GeoSciences Ltd. (1976)

-  Depth 7 ft.
-  Depth 16 ft.

# GRADATION CURVE

CANADIAN STANDARD SIEVE SERIES

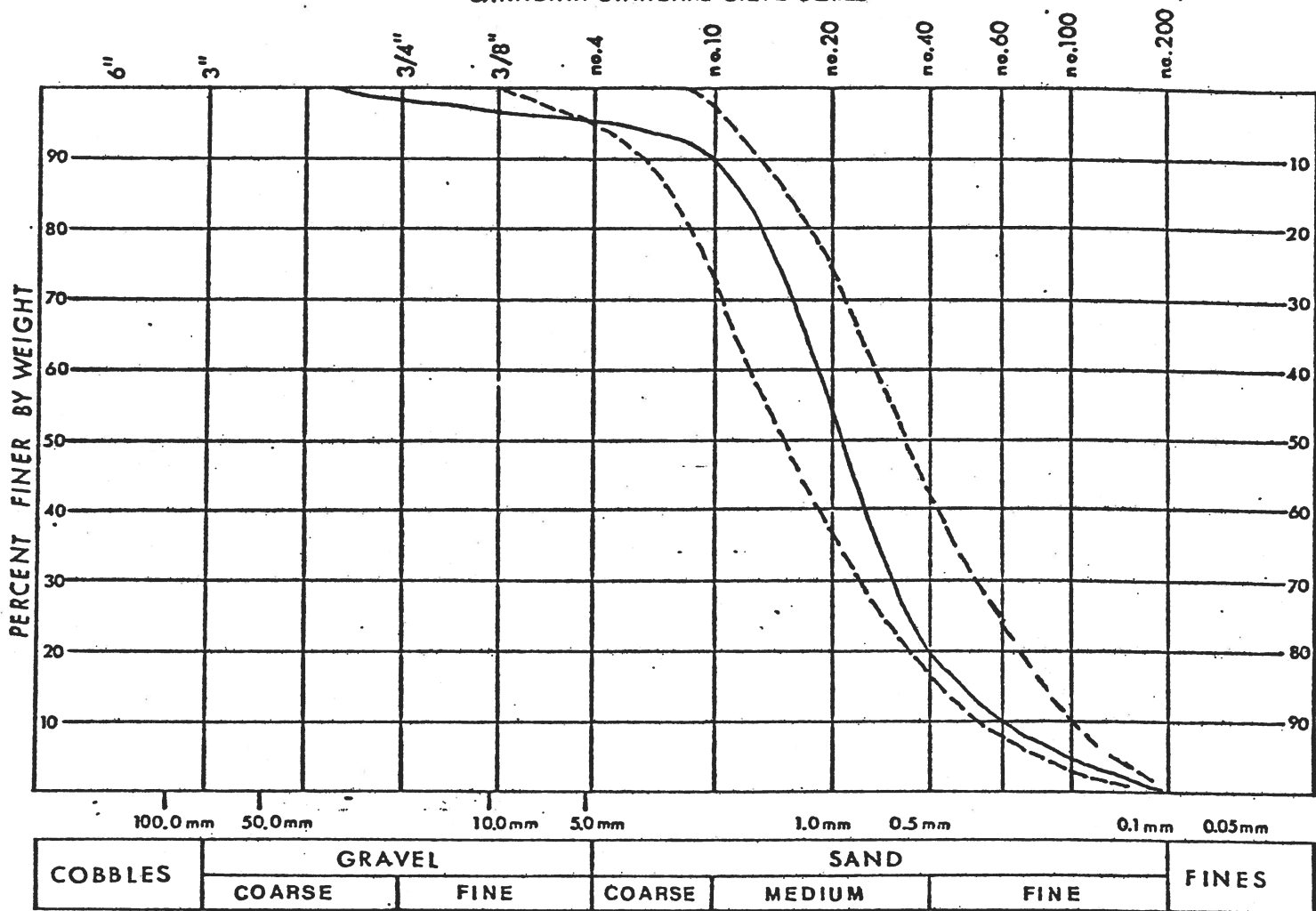


FIGURE 8. Grain size distribution of medium grained clean sand.

Testhole 1031, depth 16 ft, Klohn Leonoff Consultants Ltd. (1978)

 ASTM C<sub>33</sub>-74<sup>a</sup> grading limits for fine aggregate.

# GRADATION CURVE

CANADIAN STANDARD SIEVE SERIES

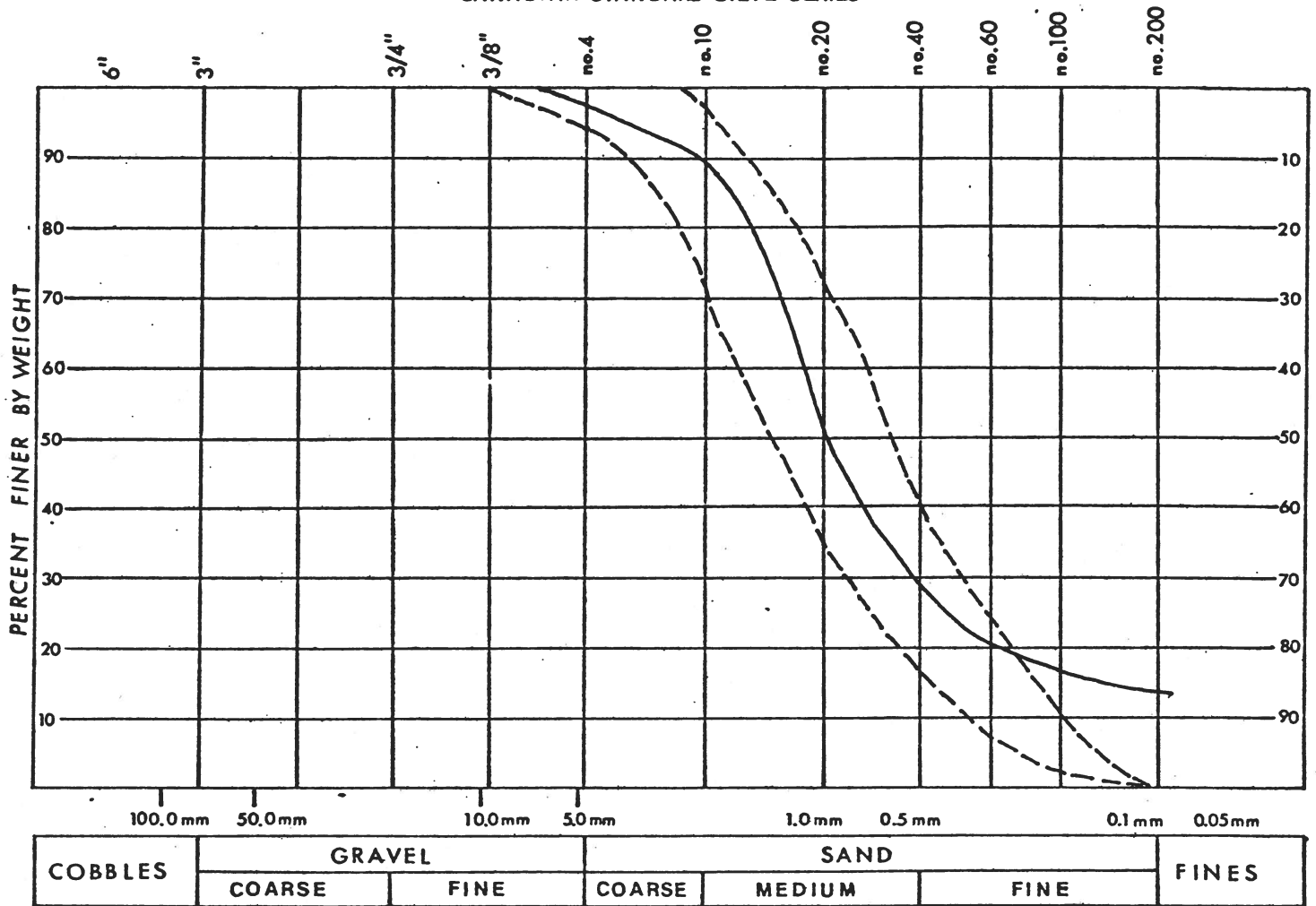


FIGURE 9. Grain size distribution of medium grained dirty sand.

Testhole 1025, depth 6 ft, Klohn Leonoff Consultants Ltd. (1978)

 ASTM C<sub>33</sub>-74<sup>a</sup> grading limits for fine aggregate.

# GRADATION CURVE

CANADIAN STANDARD SIEVE SERIES

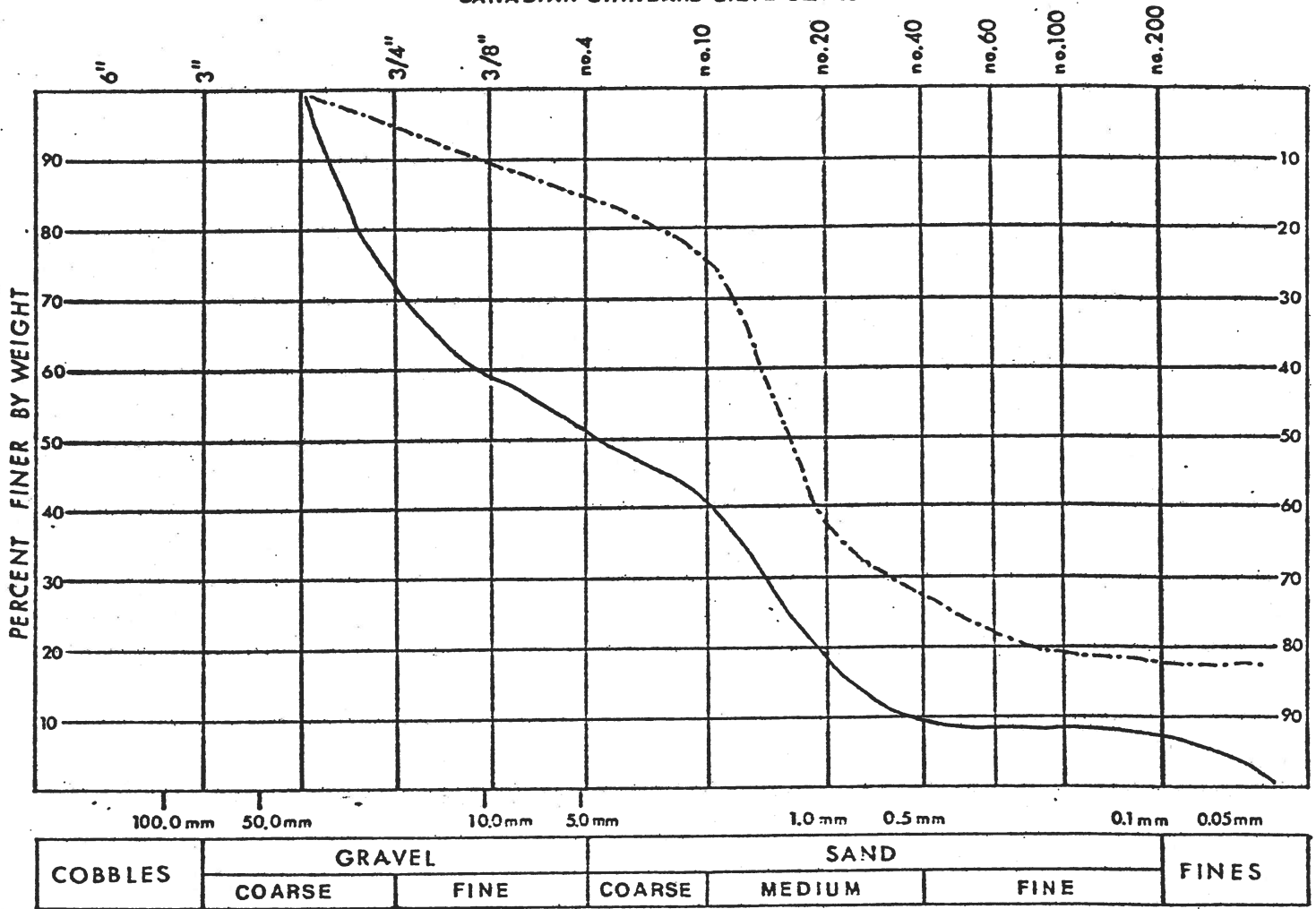


FIGURE 10. Grain size distribution of gravelly sand.

Testholes 1027 and 1028, Klohn Leonoff Consultants Ltd. (1978)



Testhole 1027, depth 8 ft.

Testhole 1028, depth 7 ft.



FIGURE 11. Sand and gravel prospect in southwestern corner of townsite area.

Scale 1:21120

1. Medium to coarse sand with gravel content up to 50 percent.
2. Fine to coarse sand with gravel content up to 15 percent.
3. Medium grained sand.

Testhole.

23.

constitutes no more than occasional lenses within outwash sand. However, considering the thickness and air photo expression of the deposit and the general trend of material distribution in the area, it is more likely that the silty sand with up to 15 percent of gravel forms an outwash terrace and extends for some distance along the slopes of the Athabasca River. The clean sand with up to 50 percent of gravel appears to be confined to a limited area of about 20 to 25 acres in the central part of the terrace (Fig. 11).

The sand deposits range from loose to medium dense. The sand material is mainly loose within the upper 3 m (10 ft) and medium dense at depths of 3 to 10.5 m (10 to 35 ft) below surface. The sands are dry to moist above the water table, with moisture content varying between 0 and 30 percent. The water table occurs at depths from 1 to 13.5 m (3 to 45 ft), average 6 m (20 ft) below surface.

None of the granular material deposits, within the townsite boundaries, can be considered as ideally suitable for the manufacture of aggregate.

Most of the sands in the area are too fine grained to be used for the aggregate production, although they could be utilized as blending sands, if required.

The grain size distribution of the medium grained sand meets, to some extent, the A.S.T.M. grading requirements for fine aggregate material (Figs. 8 and 9), but the grading would have to be corrected by removing silt portion and/or by addition of suitable fine or coarse blending sands. The sand contains coarse gravel and cobble fractions which would also have to be removed.

The supply of gravelly sand in the southwestern corner of the townsite (Fig. 11) appears to be too small for a large scale pit operation, although more detailed survey of the deposit is desirable to confirm the quantity and quality of the deposit. If the areal extent and gravel concentration are proved to be adequate, this material might be utilized, after screening and crushing, locally for general construction purposes.

24.

## POTENTIAL AGGREGATE RESOURCES IN THE VICINITY OF THE TOWNSITE

Figure 12 outlines the potential areas of sand and gravel deposits shown on the surficial geology maps by Quaternary GeoSciences Ltd. (1976, 1977). These areas indicate localities where sand and gravel are known to occur on surface. The boundaries of the deposits are approximated from air photographs. Detailed drilling would be required to determine the suitability of sand and gravel for aggregate supply.

The best sand and gravel prospects identified in air photographs by J.D. Mollard (1974) are also shown on figure 12.

### Sand and Gravel

A major sand and gravel deposit is situated in the vicinity of the Bitumount air strip where sand and gravel constitute an outwash bar along the Richardson Forestry Road (Site 1, Fig. 12). The bar is up to .8 km (.5 mi) wide and at least 4.8 km (3 mi) long. Based on results from 5 testholes, the sand and gravel occurs on surface and varies from 1.5 to 6.3 m (5 to 21 ft) in thickness. The material is well graded and low in deleterious rocks. The gravel content varies from 18.3 to 62.5 percent.

In 1978, a detailed granular material study near the Bitumount air strip was carried out by the Materials Division of Alberta Public Works. The data from this investigation was not available. The only reference to the quality of the granular material was found in the report by Klohn Leonoff Consultants Ltd. (1978). The sand and gravel deposit near the Bitumount air strip is gap graded and has an excess of medium and coarse grained sand.

A large sand and gravel terrace is present along the east side of the Athabasca River in the vicinity of Susan Lake (Site 2, Fig. 12). The terrace is approximately .8 km (.5 mi) wide and 4.8 km (3 mi) long. The quality of the deposit is



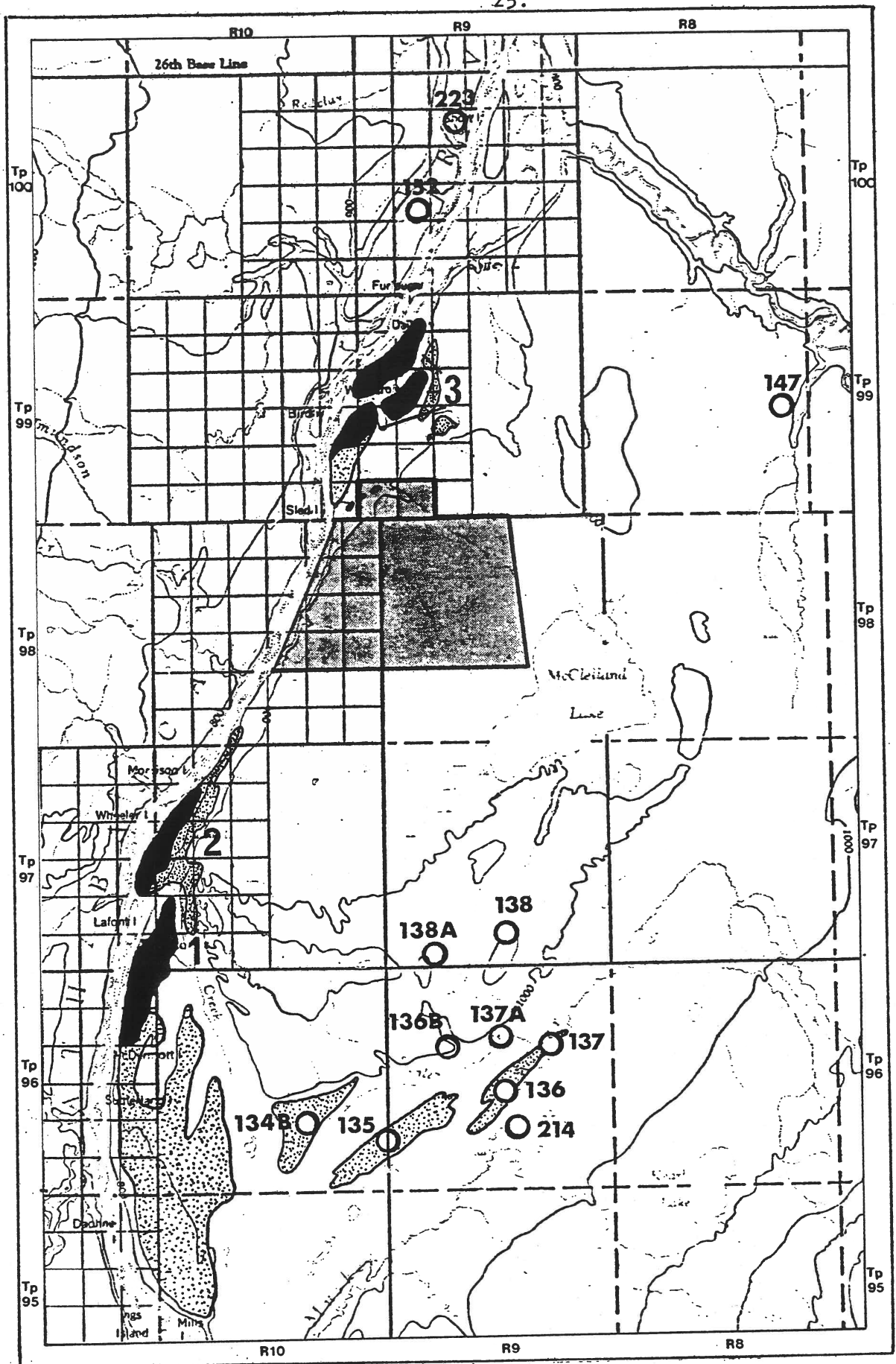


FIGURE 12. Potential sand and gravel resources in vicinity of townsite area  
Scale: 1:250,000

1. Sand and gravel prospects from reports by Quaternary GeoSciences Ltd. (1976, 1977).
2. Sand prospects from reports by Quaternary GeoSciences Ltd. (1976, 1977).
3. Sand and gravel prospects from report by J.D. Mollard.

unknown. Existing data from oil company explorations indicate that the sand and gravel is generally from 3 to 6 m (10 to 20 ft) thick. Several attempts were made to drill testholes in this deposit but the boulder content is too high for auger drills to penetrate.

A potential source of sand and gravel occurs north of the townsite (Site 3, Fig. 12). Several bars and terraces are present along the Athabasca River valley. They are similar in air photo expression to ones to the south that contain sand and gravel. No testholes were drilled in these prospects because of the lack of access trails.

#### Sand

Fine and fine to medium grained sand is readily available in the area. This material is abundant in the extensive outwash plains on the east side of the Athabasca River valley.

Fine to coarse, well graded sand, suitable for the manufacture of aggregate, appears to be of more sporadic occurrence. It is known to constitute outwash bars and terraces present within a few miles south of Bitumont air strip and Fort Hills (Fig. 12). Fine to coarse sand is believed to compose also meltwater channel sediments scattered along both sides of the Athabasca River. Further drilling would be required to determine the distribution of this material.

#### CONCLUSIONS

No potential for large reserves of good quality granular material for aggregate production exists within the boundaries of the proposed townsite. However, some of the deposits in the townsite area might be utilized and should be studied further. These are the medium grained sand and the fine to coarse, gravelly sand in the western portion of the site. The material of this composition is not overly abundant in the vicinity of the townsite. It is recommended that a test drilling program be conducted to assess the extent and quality of these deposits prior to urban development of the western part of the townsite.

27.

REFERENCES

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