Manitoba

Energy and Mines

Aggregate Report AR85-4

Surficial Geology and Aggregate Resource Inventory of the Rural Municipality of Shell River

November, 1985

UMA Engineering Ltd.
Engineers & Planners

MANITOBA ENERGY AND MINES

SURFICIAL GEOLOGY AND AGGREGATE RESOURCE INVENTORY

OF THE

RURAL MUNICIPALITY OF SHELL RIVER

NOVEMBER, 1985

PREPARED BY
UMA ENGINEERING LTD.
Engineers and Planners
1479 Buffalo Place
Winnipeg, Manitoba
R3T 1L7
UMA JOB NO. 41 06 1601 024 01 03

UMA Engineering Ltd.
Engineers & Planners

1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7
Telephone (204) 284-0580, Telex 07-57562

Our File: 41 06 1601 024 01 03

November 6, 1985

Mines Branch
Manitoba Energy and Mines
555 - 330 Graham Avenue
Winnipeg, Manitoba
R3C 4E3

Attention: Mr. W. A. Bardswich
Director of Mines

Dear Sir:

Re: Surficial Geology and Aggregate Resource Inventory
of the Rural Municipality of Shell River

We are pleased to submit our report on the surficial geology and aggregate resources of this area. The submission includes a written report on our findings plus a detailed map illustrating the surficial geology and gravel resources of the study area. We hope that the findings will be helpful in future planning and management of these resources.

We would like to thank you for the opportunity to participate on this project and we look forward to working with you again in the future.

Yours truly,

UMA ENGINEERING LTD.

R. Hood, P.Eng.
Vice President & Manager
Manitoba & Northwestern Ontario
LB/dh

T. Wingrove, P.Eng.
Director
Earth Sciences Division

SUMMARY

The Rural Municipality of Shell River is dominated by a large till plain, which covers the central and western portions of the study area and hummocky moraine which covers the eastern portion. These two units trend in a north-south direction and are cut by three major spillway channels; the Assiniboine River Valley, the Shell River Valley and the Big Boggy Creek Valley. Outwash plain deposits, associated with the upper reaches of these drainage courses, are located adjacent to the valleys. Valley terrace deposits are found within all three valleys but are more predominant within the Shell Valley. Shale bedrock underlies the Quaternary units but does not outcrop in the study area.

Aggregate resources are found within the valley terrace deposits, the outwash plain deposits and in small isolated outwash features in the till plain and hummocky moraine. The valley terrace deposits account for 60% of the total resources, the outwash plains 40% and the isolated outwash features less than 1%. These resources are located throughout the study area situated largely within or adjacent to the major spillway channels.

Total aggregate reserves in the study area are estimated at 460 million cubic metres. Over 250 million cubic metres, or 55% of this total, is high quality material; 190 million cubic metres, or 40%, is medium quality material; and only 20 million cubic metres, or 5%, is low quality material. These figures are ultimate volumes and may be reduced by factors such as geologic variations and pit management methods.

Present consumption of aggregate in the study area is by the Department of Highways, the Municipality and one local producer. Their estimated annual usage is approximately 17 000 cubic metres of gravel and 2600 cubic metres of winter sand. All three users obtain their required aggregate from within the municipality with no forseeable future shortages.

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1.0 INTRODUCTION

1.1 Purpose and Scope

The purpose of this report is to present the findings of a surficial geology and aggregate resource inventory of the Rural Municipality of Shell River. The main objectives of the inventory were to: map and characterize all surficial geology units within the study area; map and determine the quantity and quality of the aggregate resources in these units; and determine the existing and projected demand and use for sand and gravel.

The scope of the work was established in the "Proposal for Consulting Services" submitted by UMA Engineering Ltd. in February, 1985 in response to the "Terms of Reference" prepared by Manitoba Energy and Mines. The scope of the work was broken down into three phases and included:

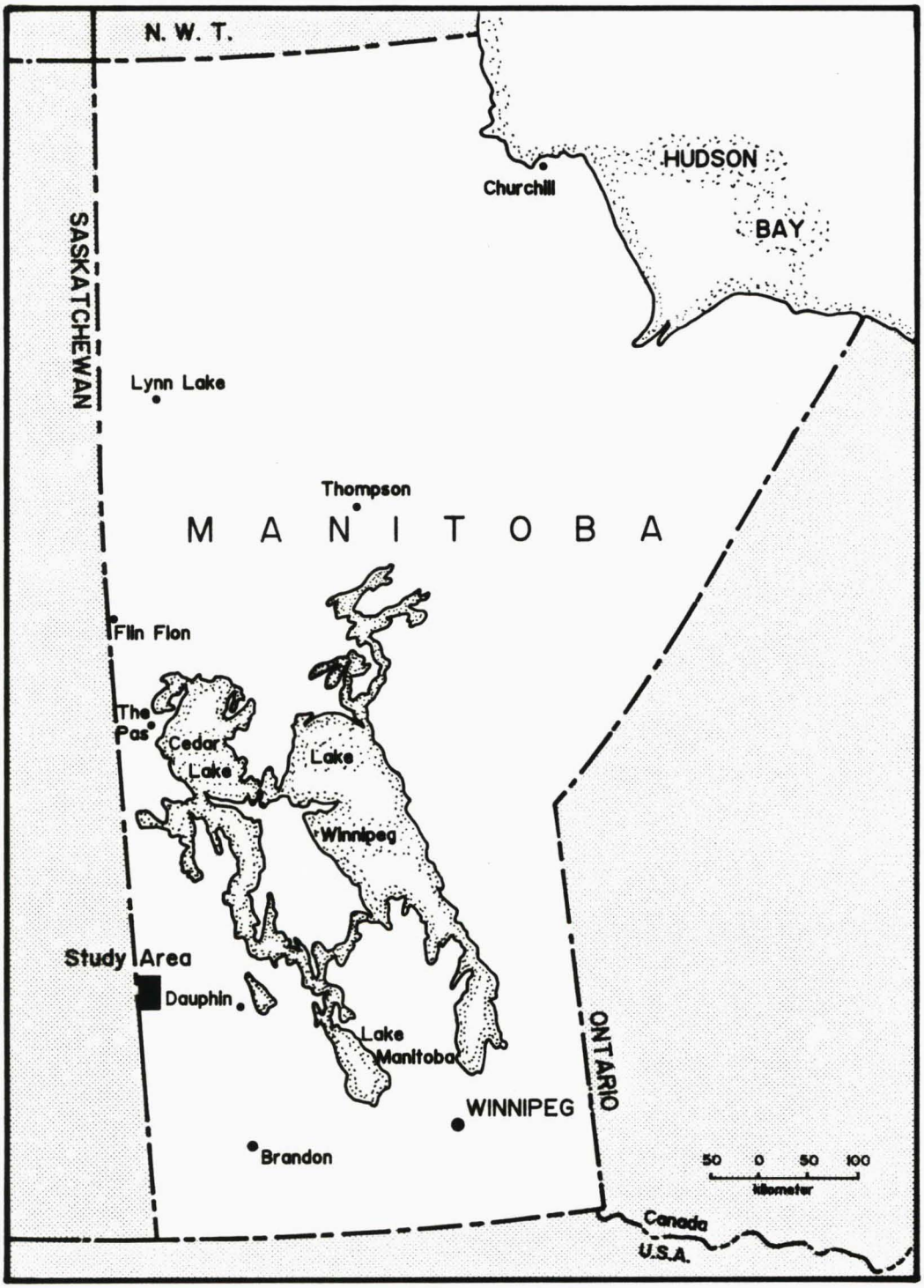
I Compilation and review of existing relevant data and preliminary air photo interpretation.

II Field investigation involving ground truthing, test pitting, detailed sampling, gradation analysis and petrographic evaluation.

III Map preparation and report.

1.2 Location of the Study Area

The study area (Fig. 1) is located in west central Manitoba, along the Manitoba-Saskatchewan border, approximately 90 kilometres west of Dauphin. The municipality covers 750 square kilometres and extends between Townships 25 and 28 and Ranges 28 and 29 west.



UMA Engineering Ltd.
Engineers & Planners
1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

SURFICIAL GEOLOGY AND AGGREGATE RESOURCE INVENTORY

TITLE: LOCATION OF STUDY AREA	
JOB No. 1601-024-01-03	DATE: NOVEMBER 1985
DRAWN: M.S.	DWG. No. FIGURE 1
CHECKED: L. BIELUS	

The area is served by the Canadian National Railway and contains the Town of Roblin. Access to the study area is provided by Provincial Highways 5 and 83 plus many secondary provincial and municipal roads.

1.3 Methodology

The initial phase of the study involved compilation of existing data and preliminary air photo interpretation. Information was obtained from all potential sources and an evaluation of the depositional history and stratigraphy of the area was determined. Original air photo interpretation was used to produce a preliminary surficial geology map of the study area and to identify potential aggregate sources and location of existing pits. Air photos at a scale of 1:50 000 were used for the general mapping with data plotted on a 1:50 000 N.T.S. base map.

An extensive field reconnaissance of the entire study area was undertaken at the completion of Phase I to refine the preliminary surficial geology map. This was done in terms of surficial unit boundaries and developing more detail on the type and origin of the sediments in the area. All accessible areas were visited in the field and original air photo interpretations verified. All relevant exposures illustrating the Quaternary history and the various surficial units were described in detail, photographed and noted on the preliminary map for future reference. Air photos were re-examined on the basis of the field reconnaissance and the surficial geology map finalized.

Sand and gravel deposits and existing pits were identified during the air photo interpretations and visited on site during the field program. A sampling program was developed using information from the air photo interpretation, site reconnaissance and Department

of Highways aggregate records. Undeveloped aggregate deposits were sampled utilizing backhoe test pits, road cut exposures and hand dug holes. Each of the various exposures was logged in detail and channel samples collected. Logs of the backhoe test pits are shown in Appendix A with field station logs shown in Appendix B. Existing pits were sampled by collecting a channel sample from the pit face.

Aggregate resource information was recorded in detail using Mineral Resources Division data forms 1, 2 and 4 (Appendix C). The majority of information was recorded directly onto the data forms at the exposure site. Form 1 was used to outline the deposit area, deposit depth and per cent depletion, for the calculation of reserve volumes. Form 2 was used to describe the basic lithology, deleterious substances, height of stratigraphic section and estimated gravel content at each deposit exposure. Form 4 was filled out during laboratory testing summarizing the sieve analysis results of the granular samples collected during the field program.

The three computer forms were submitted to the Aggregate Resources Section and were processed by their computer system "PLSTCNG". This system calculates the reserve volume, grain size parameters and outputs a quality assessment for each deposit and exposure. An example of the output for one deposit is presented in Appendix D. A summary of all the deposit data is contained in Appendix E.

Deposit and exposure sites were identified by a unique numbering system. Each deposit was assigned a five digit number starting at 14301 and increasing in numerical order. Sites visited within a particular deposit were denoted as exposures and assigned three digit numbers preceeded by the letters TP for test pit exposures, GP for gravel pit exposures and FS for field station exposures. If the exposure site was sampled, a letter S appears after the

exposure number. Locations of all sites are shown on the surficial geology Map AR85-4.

The demand and use of aggregate in the municipality was assessed by surveying the local towns, railways, municipal office and Department of Highways regional office. Base data on the historic demand for aggregate in the area was obtained for a period of five years and a relationship was developed between supply and demand.

1.4 Presentation of Data

The information obtained during this study is presented in the published report and accompanying map, computer data file and background data file.

The present report provides a description of the Quaternary stratigraphy and Quaternary events in the study area. The distribution of high, medium and low quality resources is discussed and a tabulated summary of sand and gravel deposits is given. The supply and demand of aggregate within the study area is also discussed. A 1:50 000 scale map of the area illustrates the Quaternary geology and emphasizes all sand and gravel deposits and existing pits. The quality of each granular deposit is indicated as well as all field data sources.

The data file is a computer based storage system maintained by the Aggregate Resources Section. The file contains all exposure descriptions, ownership information and detailed grain size analysis data for each of the field exposures noted on the 1:50 000 scale map and calculated deposit volumes. An example of this output is presented in Appendix D. The computer files are available through the Aggregate Resources Section of Manitoba Energy and Mines.

The background data file contains all the working notes, records, maps and air photographs used during the study. These materials are also retained by Manitoba Energy and Mines.

1.5 Acknowledgments

UMA Engineering Ltd. would like to extend its appreciation to all of the individuals who helped make the completion of this study a success: Mr. R. V. Young and his staff at the Aggregate Resources Section, who provided assistance during all phases of the study; staff members from the Manitoba Department of Highways, who supplied us with information on the existing pits and the department's consumption figures; the secretary-treasurer of the municipality for providing gravel consumption data for the municipality; as well as the various local contractors and land owners for providing us with information and access to their properties.

The UMA study team consisted of:

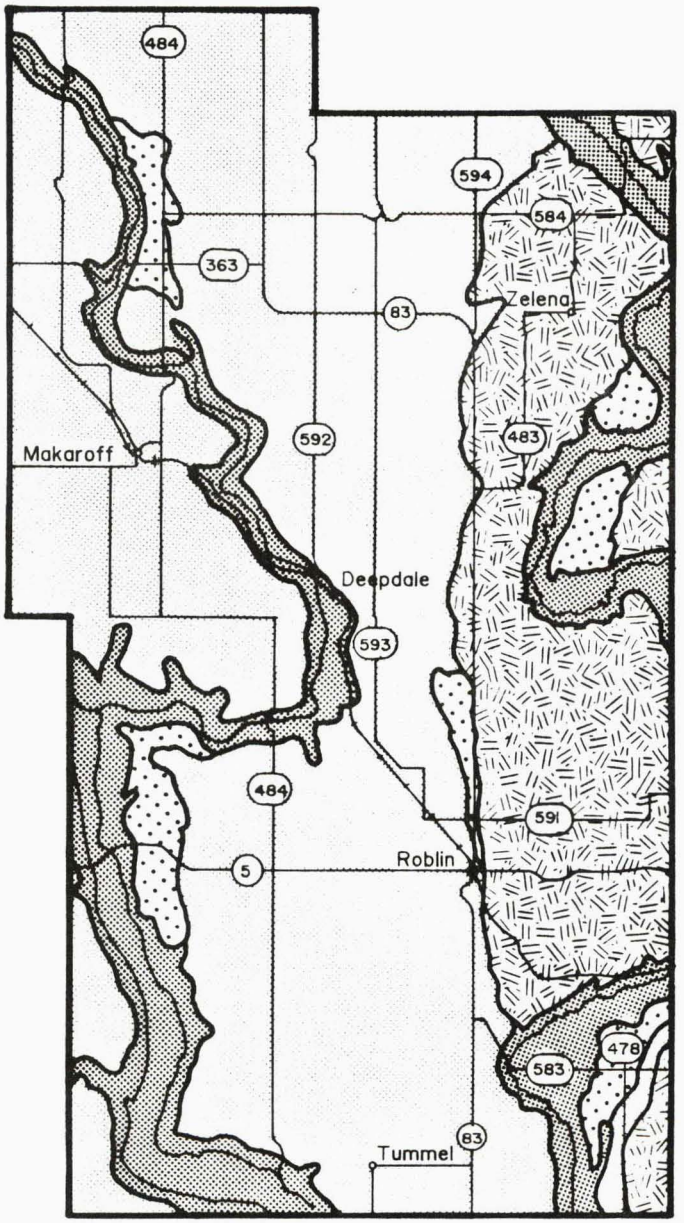
T. Wingrove, P.Eng.
L. Bielus, E.I.T.
T. Hunter, C.E.T.

2.0 SURFICIAL GEOLOGY

2.1 Physiography

There are four main physiographic divisions within the Rural Municipality of Shell River. These consist of a till plain, stagnation moraine, outwash plain and major river valleys (Fig. 2).

The till plain is the major physiographic unit within the study area and is referred to by Klassen (1979) as the Assiniboine River Plain. The unit trends north-south and covers the central and western portions of the study area. It is generally a flat lying feature with a slight slope from east to west. Local relief on the plain is usually less than 3 m (Photo 1). The till plain is situated adjacent to the stagnation moraine along the east side of the study area and is cut by an old spillway channel along the west side. Adjacent to this channel, several large areas of the till plain have been eroded and reworked by glacial meltwaters. Elevations of these areas are approximately 5 m lower than the surrounding plain and local relief is minimal. Signs of erosion as well as deposition can be seen. The plain is also cut by several smaller and partially buried meltwater channels (Photo 2). These channels are located in the northern and southern portions of the study area and are generally connected to the larger spillway channels. There is a concentration of flutings in the northeastern corner of the till plain. These flutings are oriented in a northwest-southeast direction and suggest a southeasterly flowing ice sheet. South of Roblin, the plain exhibits a pattern of parallel ridges oriented in a northeast-southwest direction, giving the surface a corrugated texture. This is also evidence of a southeasterly ice flow direction. In both of these areas local relief is generally higher than the surrounding till plain.



LEGEND

- MAJOR RIVER VALLEYS - steep sides, flat bottoms, valley terraces
- OUTWASH PLAIN - low relief, limited aerial extent
- STAGNATION MORAINE - moderate to high local topography, hummocky
- TILL PLAIN - low relief, occasional local outwash features, areas reworked by water

UMA Engineering Ltd.
Engineers & Planners
1479 [illegible] Winnipeg, Manitoba, Canada R3T 1R7

SURFICIAL GEOLOGY AND AGGREGATE RESOURCE INVENTORY

TITLE: PHYSIOGRAPHIC DIVISIONS	
JOB No. 1601-024-01-03	DATE: NOVEMBER 1985.
DRAWN: M.S.	DWG. No. FIGURE 2
CHECKED: L. BIELUS	

Photo 1
Glacial Till Plain - Unit 1a;
Twp 26, Rge 28, Sec 12, NE 1/4

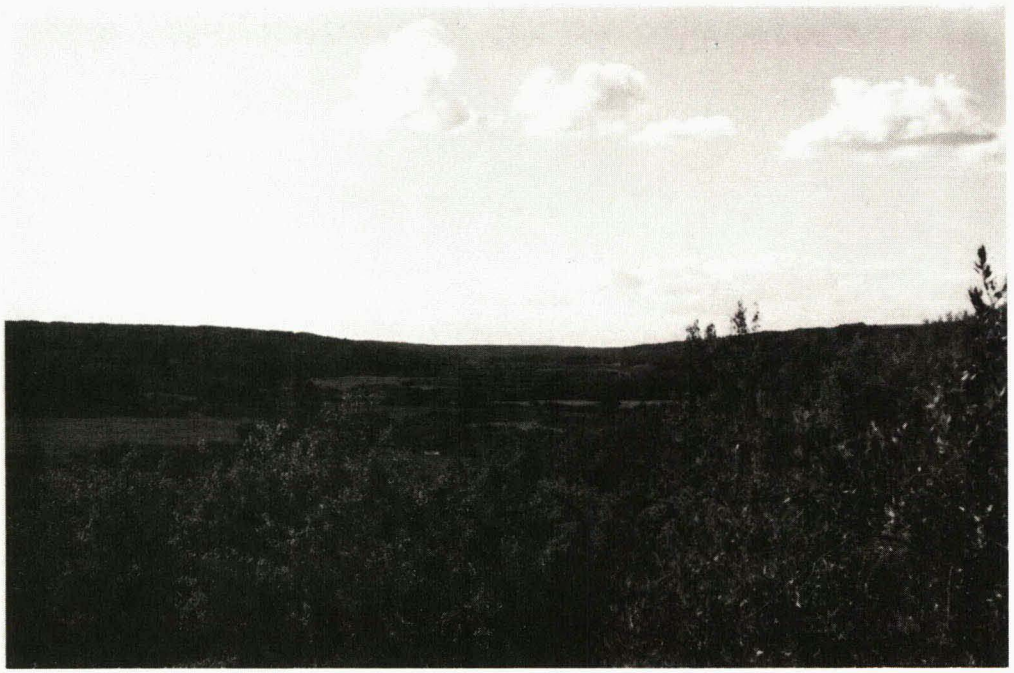


Photo 2
Partially Buried Meltwater Channel - Unit 2a;
Twp 28, Rge 28, Sec 14, SE 1/4

Stagnation moraine is situated along the eastern boundary of the municipality and forms the southwestern corner of Klassen's Duck Mountain Upland. This unit also trends north-south and exhibits a hummocky topography. Local relief on the moraine is between 3 and 8 m with numerous shallow depressions. These depressions are often water filled and commonly known as sloughs (Photo 3). A concentration of very deep depressions can be observed along the moraine's western boundary in the northern portion of the study area. In this area local relief is in the order of 10 to 20 m.

Several outwash plains are present in the study area, situated adjacent to the major spillway channels. These plains generally occur at elevations higher than the neighbouring spillway channels but lower than the surrounding till plain. They are usually of small areal extent and exhibit almost no local relief (Photo 4).

The Assiniboine and Shell Rivers and Big Boggy Creek offer a striking topographic contrast to the surrounding till plain and stagnation moraine. Locally they exhibit as much as 50 to 100 m of relief and can be 1 to 2 km in width (Photo 5). They are generally steep sided with broad flat bottoms. They contain very large terraces in some areas, particularly along the Shell River (Photo 6). The present waterways are underfit streams which are meandering within old glacial spillway channels.

2.2 Bedrock Geology

The study area is underlain by marine shale of the Upper Cretaceous Riding Mountain Formation. Wickenden (1945) and Lang (1961) have mapped and described the formation in the area as a soft, medium to light grey shale. The formation includes a soft clayey facies as well as a hard siliceous facies.

Photo 3
Slough Depression in Hummocky Moraine - Unit 2a;
Twp 28, Rge 28, Sec 3, NE 1/4

Photo 4
Outwash Plain - Unit 4a;
Twp 26, Rge 29, Sec 8, SE 1/4

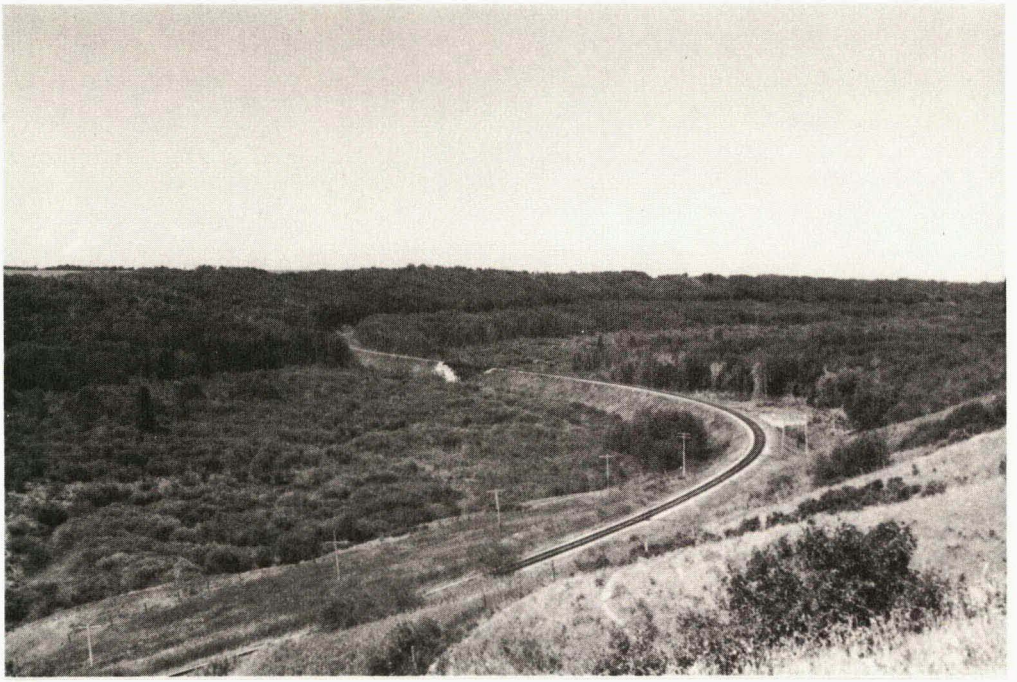


Photo 5
Big Boggy Creek Valley - Unit 7;
Twp 27, Rge 29, Sec 1, NE 1/4

Photo 6
Valley Terrace Deposit - Unit 5;
Twp 25, Rge 28, Sec 22, SW 1/4

There were no exposures of the Riding Mountain Formation observed within the study area, due to the relatively thick layer of drift that overlies the shale bedrock. Klassen (1979) noted two outcrop exposures of the shale within the Assiniboine River Valley but these could not be found during the field program. It is believed that these exposures were observed at an elevation now flooded by the artificial lake created within the valley.

There are several locations within the Assiniboine River Valley that show some indication of slope movement. These areas consist of inactive landslides observable on air photographs as well as active movements that are noticeable in the field. These movements may be related to failure surfaces on or within the shale unit.

2.3 Quaternary Deposits

2.3.1 Stratigraphy

The stratigraphy of west-central Manitoba, including the present study area, has been established through detailed studies by Klassen (1975, 1979). His investigations included several test holes to establish and name the various stratigraphic units. The findings of this study agree with the stratigraphy proposed by Klassen down to the Shell Formation. Klassen's Largs and Tee Lakes Formations are deeply buried and not exposed within the study area. A summary of the Quaternary units observed in the study area is presented in Table 1.

Table 1

Summary of Geological Units
in the
Rural Municipality of Shell River

Age	Unit	Landform	Composition
Recent	Colluvium	Valley Slopes	sand, silt, clay, some gravel
	Alluvium	Flood Plains	sand, silt, clay, organics
Post-Glacial	Glacio-Lacustrine Deposits	Plains	silt, clay
	Valley Terrace Deposits	Terraces	sand, gravel
	Outwash Deposits	Plains	gravel, sand, silt, clay
Glacial	Zelena Formation	Moraine Plateau, Stagnation Moraine	silty clayey till
	Lennard Formation	Till Plain	sandy silty till
	Minnedosa Formation	Till Plain	sandy silty till
	Shell Formation	Till Plain	sandy silty till

2.3.2 Glacial Deposits

The Shell Formation is the oldest glacial unit observed in the study area. The till unit can be seen in several locations on the Assiniboine River Plain, in both cuts and excavations, as well as within the Assiniboine and Shell River valleys. On the Duck Mountain Uplands, the formation can only be observed during subsurface investigations. The Shell Till is typically light olive brown or yellowish brown grading into a dark olive grey near the top of the formation. The unit is a sandy silty till which is generally sandier than the other till formations in the area. Klassen indicates that the formation is commonly discontinuous and usually consists of one till unit, but in places includes several tills and intertill sediments. A weathering zone on the upper surface of the till separates it from the overlying Minnedosa Formation. Klassen concludes that the Shell Formation is of early Wisconsin or pre-Wisconsin age.

The Minnedosa Formation is one of the most widespread till units observable within the study area. The formation can be seen in numerous road cuts and excavations on both the Assiniboine River Plain and the Duck Mountain Uplands. The till unit is generally a silty to clayey silty till with a yellowish brown to dark yellowish brown colour. Clay contents within this unit are commonly higher than those of the other formations. Orientations of elongated pebbles in the formation outcrops, indicate a southwest ice flow direction. Klassen, (1979), dates the formation as early Wisconsin.

The Lennard Formation occurs over most of the Assiniboine River Plain and forms the till plain, units 1a and 1b, within the present study area (Photo 1). The Lennard Till is commonly dark greyish brown and is somewhat darker than the underlying, more strongly oxidized till of the Minnedosa Formation (Photo 7). The

till unit is less dense and siltier than the underlying till unit and has a fabric which is oriented to the southeast. The contact between these two formations is also marked by a boulder pavement which can be seen in some road cuts. Klassen comments that the Lennard Formation was deposited during the late Wisconsin glaciation by a southeasterly flowing ice sheet.

The Zelena Formation covers the Duck Mountain Uplands and forms the stagnation moraine, units 2a and 2b, within the study area (Photo 3). The Zelena Till is usually yellowish brown, or very dark greyish brown where oxidized and dark olive grey where unoxidized (Photo 8). The till unit is commonly less indurated and siltier than the underlying till of the Minnedosa Formation and was deposited during the final stagnation of the late Wisconsin ice sheet.

Within both the Lennard and Zelena Formations, localized outwash features (Photo 9) can be found. These features are generally quite small in areal extent, usually less than 5 hectares, and are of much lower quality than the other granular deposits. They are not evident on air photos. Additional deposits not identified by this mapping project may exist within the till plain or stagnation moraine.

Within the Zelena Formation a small moraine plateau, unit 3, was observed in the northeast corner of the study area (Photo 10). This feature is flat lying and consists of a stratified sequence of silts and clays with some traces of sand and gravel.

Photo 7
Lennard Till - Unit 1a;
Twp 26, Rge 29, Sec 22, SE 1/4
(Shovel is approximately 1 m in length)

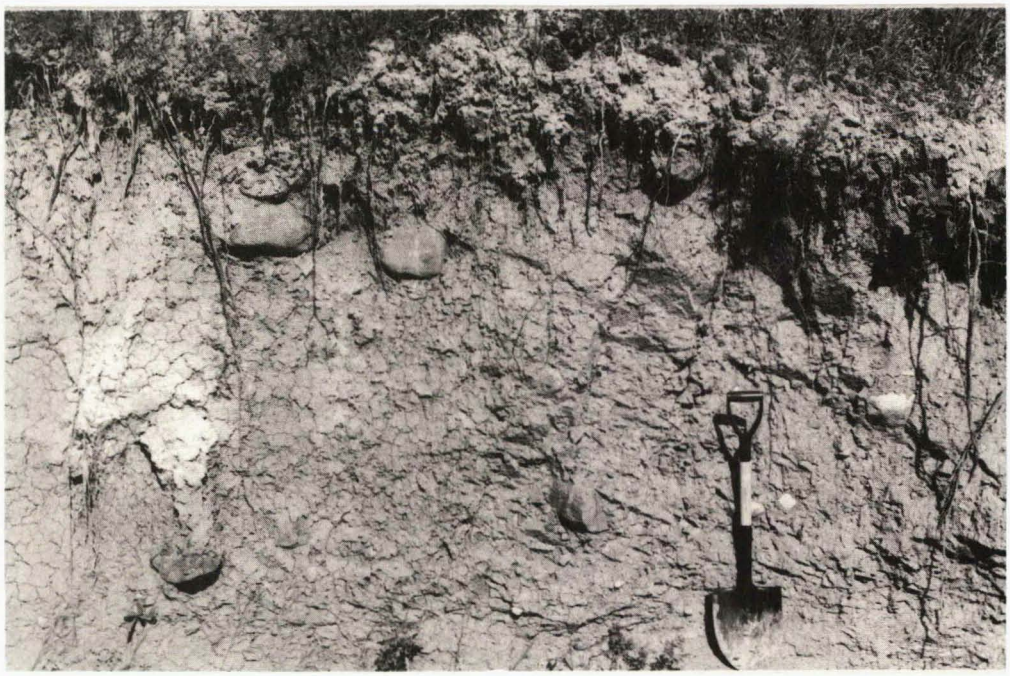


Photo 8
Zelena Till - Unit 2a;
Twp 26, Rge 28, Sec 10, SE 1/4
(Shovel is approximately 1 m in length)

2.3.3 Post-Glacial Deposits

Post-glacial deposits in the form of outwash, valley terrace and glacio-lacustrine deposits are present within the study area. These deposits are smaller in areal extent than the previously mentioned glacial units but contain the majority of the aggregate resources in the area.

Outwash deposits, units 4a and 4b, are found throughout the study area, and are generally situated adjacent and parallel to the major river valleys. The units are relatively thin, flat lying features which usually show little relief (Photo 4). The outwash is primarily a sandy gravel (unit 4a, Photo 11), that commonly grades to a gravelly sand from north to south within a deposit. In contrast to these higher quality deposits, low quality outwash deposits of sand, silt and clay can also be found within the study area (unit 4b, Photo 12). These lower quality deposits however, are generally smaller features and limited in number.

Valley terrace deposits, unit 5, are found along both the Assiniboine and Shell Rivers as well as Big Boggy Creek. The deposits generally occur as non-paired terraces situated at various levels. They range in size from broad flat areas several kilometres square (Photo 5), to short narrow ledges a few hundred metres in width and length. Their surfaces are usually flat to slightly irregular and commonly stepped. The deposits consist of extremely coarse sand and gravel (Photo 12), and are more prominent along the Shell Valley than the Assiniboine or Big Boggy Creek valleys.

A small glacio-lacustrine deposit, unit 6, occurs within the study area. The unit consists of silt and clay deposited as a small pro-glacial lake. The deposit is a flat lying feature with almost no local relief and is much lower in elevation than the surrounding till plain.

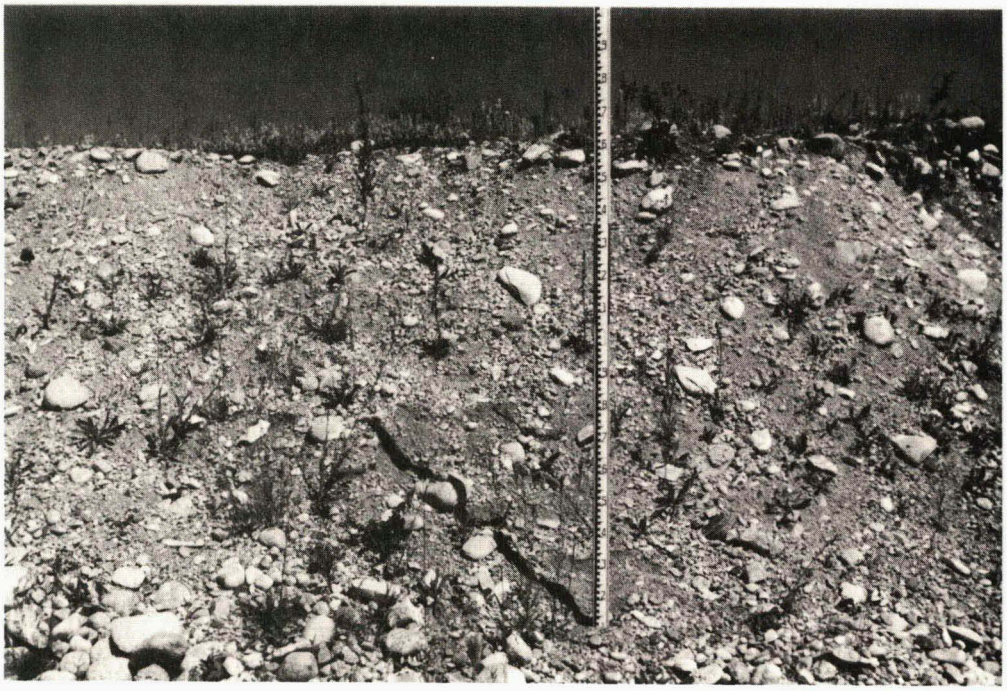


Photo 9
Local Isolated Outwash Feature - Unit 1a;
GP 135, Deposit 14342 (Divisions are in tenths of a meter)

Photo 10
Moraine Plateau - Unit 3;
Twp 28, Rge 28, Sec 36, NE 1/4

Photo 11
Outwash Plain - Unit 4a;
GP 151, Deposit 14336
(Shovel is approximately 1 m in length)

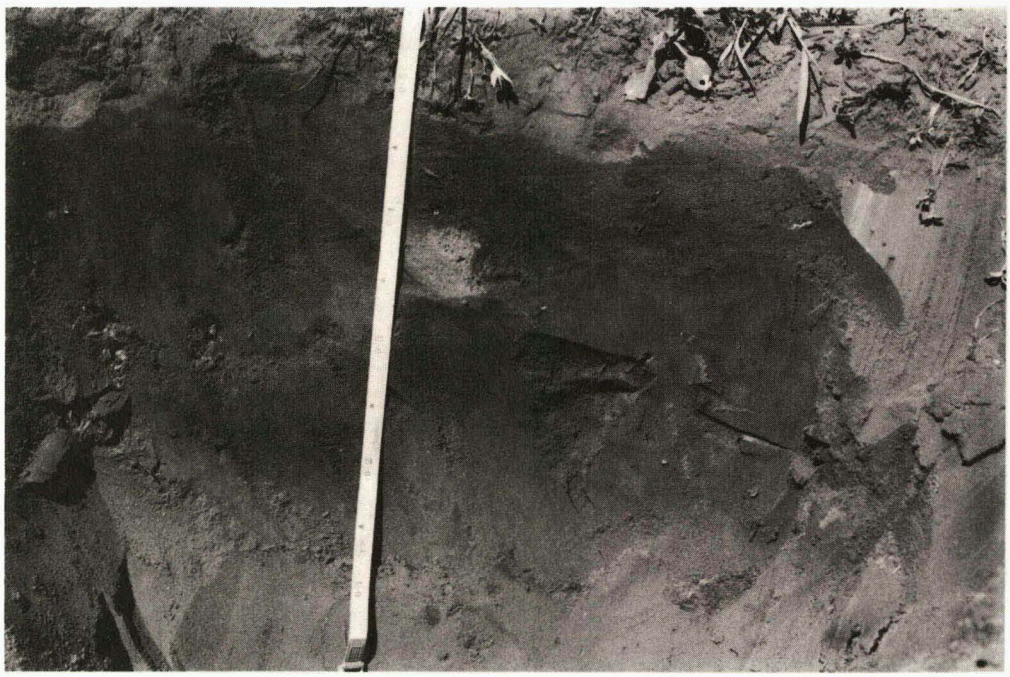


Photo 12
Outwash Plain - Unit 4b;
FS 106, Deposit 14303
(Tape is approximately 0.5 m long)

2.3.4 Recent Deposits

Recent deposits found within the study area consist of alluvium, colluvium and organics.

Alluvium, unit 7, is present along almost the entire length of the Shell River and Big Boggy Creek valley bottoms. In contrast, along the Assiniboine River, only a few small deposits can be found since the valley is typically V-shaped with extremely steep side slopes. The alluvium observed in the study area is commonly made up of silt and clay with some fine to medium sands and organics.

Colluvium, unit 8, is also present along the valley side slopes of the three major valleys as well as several tributary streams. These slopes vary between 10 and 20 per cent and are composed of sand, silt, and clay. The materials along the valley slopes are generally slumped and show evidence of previous and present slope instability at several locations.

Organics are common throughout the study area but do not occur as large enough deposits to warrant a discrete map unit. Organics can be found in many of the sloughs throughout the stagnation moraine and within many of the buried or partially buried meltwater channels. Organic areas consist of peat, muck, marl and modern plant detritus.

2.4 Quaternary History

The Quaternary history of the Rural Municipality of Shell River and surrounding areas, has been studied over many years and has most recently been described by Klassen (1975, 1979). The various Quaternary units observed in the study area have been summarized in Table 1.

The Shell Formation is the oldest glacial unit that can be observed in the study area. It is believed to be of early Wisconsin or pre-Wisconsin age. Plant detritus overlying the formation was used to determine a minimum age of 38 000 radio-carbon years B.P. (Klassen, 1979). The Minnedosa Formation overlies the Shell Formation throughout the study area. This unit shows evidence of a southwesterly flowing ice sheet and is also believed to be of early Wisconsin age. These units can be observed in several road cuts and within the major river valley walls.

The Lennard Formation was deposited during the last, late Wisconsin, glacial advance and formed the till plain in the study area. The direction of flutings and corrugated moraine ridges that are found on the till plain agrees with Klassen's interpretation of deposition by a southeasterly flowing ice sheet. During the slow withdrawal of the ice sheet, the Assiniboine Spillway (Photo 5) and later a portion of the Shell channel, were excavated and served as spillways to conduct meltwater from the retreating ice mass into glacial Lake Agassiz. The volume of the meltwater flow is indicated by the size of the eroded valleys.

During the final stagnation of the late Wisconsin ice sheet, the Zelena Formation was deposited. This stagnant ice sheet, situated between the retreating Assiniboine lobe and the Valley River sublobe (Klassen, 1975), formed the hummocky moraine and moraine plateau found along the eastern side of the study area. Further retreat of the latter two ice masses resulted in continued development of the Assiniboine and Shell River spillways as they respectively drained meltwater from glacial Lake Assiniboine and the Duck Mountain Uplands.

As the ice sheet continued to melt and retreat to the north, deposition of the outwash features took place. Although the

depositional history of these features is somewhat uncertain it is believed that they were deposited during the early developing stages of the meltwater flow system, along ice-marginal channels.

With the continued retreat of the ice sheet to the north and the decline in meltwater flow, successively lower valley terrace levels were developed in the three spillway channels. During this time period a small pro-glacial lake basin was also formed in the northern part of the study area. It is likely that this feature formed along the northeastern margin of the melting Assiniboine ice lobe (Klassen, 1975).

Recently the spillway channels have developed broad floodplains and contain small meandering underfit streams. The valley walls have eroded and slumped over much of their length and tributary streams are cutting down to the base level represented by the major river systems.

3.0 SAND AND GRAVEL SAMPLING PROGRAM

3.1 General

The sampling program consisted of three components:

1) a field reconnaissance program
2) a backhoe test pitting program
3) sample analysis

3.2 Field Reconnaissance Program

Once the initial air photo interpretation was completed, a detailed field reconnaissance program was established. This program was designed to serve two purposes. The first was to verify the air photo interpretation on unit boundary locations, material type and material descriptions. The second was to investigate and delineate all existing gravel deposits as well as any potential new sites, the latter information being used to form the framework for the backhoe test pitting program.

All existing gravel pits were visited in the field during the reconnaissance program and the areal extent of the gravel deposits delineated. The depositional characteristics of each unit as well as the relationship to the surrounding surficial units and topographic features were noted. Similar relationships were then investigated in areas where no resource development had taken place, to check on the probability of identifying new aggregate resources. Potential sites were also selected based on geologic interpretation of probable aggregate occurrence. The areal extent of new deposits was delineated in the field and areas to be test pitted were noted.

3.3 Backhoe Test Pitting Program

The backhoe test pitting program was developed using the findings of the field reconnaissance program. A total of 38 test pits were dug, 16 of which were sampled. The location of each test pit is shown on the surficial geology map accompanying this report and a summary of each log is presented in Appendix A.

At each deposit, one test pit was generally completed within an existing pit with one or two exploratory test pits located outside the limits of the developed gravel pit. This methodology was used in an attempt to delineate the total extent of the deposit as well as its overall depth. In determining the depth of a deposit, test pits were completed at the bottom of existing pits to attain greater depths. In several of these test pits, determining the bottom of the deposit was hampered by the presence of the water table.

New deposits were investigated by test pitting in areas identified to have the highest probability for containing aggregate resources. These probable areas were selected in features similar in nature to existing deposits or in features interpreted to have aggregate potential by their geologic setting and depositional history.

The results of the test pitting program were quite positive. The areal extent of the deposits was found to be much more extensive than the present pit limits and investigation of unknown aggregate areas were found to contain equally good aggregate.

3.4 Sample Analysis

Generally, each deposit within the study area was sampled to allow for gradation and petrographic analysis. Channel samples were

used for these analyses and were collected from either existing gravel pit walls or exploratory test pit faces. Usually each existing gravel pit noted in the study area was sampled, with the exception of those that were either overgrown or so reworked that a representative sample could not be collected. Test pits were sampled when it appeared that the quality of the developed deposit changed or when checking on the aggregate potential of undeveloped areas.

Testing of the samples was based on the methods employed by the Aggregate Resources Section with the data being entered on their computer form 4 (Appendix C). A petrographic analysis was completed on the pebbles retained on the 1/2", 3/8", 1/4" and #4 sieves which consisted of checking the percentage of general crystaline, general carbonate and shale pebbles within a particular sample. A representative sample was also retained from each of the samples tested, for the Section's background file.

4.0 AGGREGATE RESOURCES

4.1 Aggregate Deposits

4.1.1 General

The aggregate deposits of the Rural Municipality of Shell River can be grouped into three categories: valley terrace deposits, outwash plains and isolated outwash features within the till plain and hummocky moraine. The geology of these units has been discussed in the preceding section and therefore the following discussion will focus on the aggregate potential of these deposits.

4.1.2 Valley Terrace Deposits

The valley terrace deposits comprise the majority of aggregate resources in the study area. They are generally flat lying features which are located within the major spillway valleys. The terraces were formed by meltwater flow and can be observed as long narrow deposits on a valley side slope or as large stepped areas within the valley bottoms. These deposits are along the entire length of the Shell River Valley and in places along the Big Boggy Creek and Assiniboine River Valleys.

The deposits are generally of small or moderate areal extent but are usually very deep. Thicknesses average around 10 m but have been observed as high as 20 m. These deposits are often massive in nature and seldom show any signs of layering. They do, however, show a gradual coarsening towards the river margins and upstream limits of the deposit.

The deposits usually exhibit a very high gravel content and contain a high percentage of cobble to boulder size material

(Photo 13). It is not uncommon to see large stockpiles of processed oversized cobbles and boulders within existing pits. On average the deposits were found to contain 40 to 75 per cent gravel, 20 to 50 per cent sand and 1 to 3 per cent silt and clay. Where shale was present within a deposit its percentage was nominal. These figures are based on the gradations of the collected samples which are summarized in Appendix E. Detailed sieve analysis data may be obtained through the Aggregate Resources Section Computer Data File. An example of this information is presented in Appendix D.

4.1.3 Outwash Plains

The outwash plains comprise 40 per cent of the total volume of aggregate resources found in the study area. The deposits are generally flat to gently irregular features that are situated adjacent and parallel to the major spillway channels. The outwash plains are not part of the spillway valley, but it is believed that they were formed during the early stages of meltwater flow, along ice marginal channels.

The deposits are generally much larger in areal extent than the valley terrace deposits, but are also much thinner. Average thicknesses for this unit are between 4 and 5 m. Like the valley terrace deposits, the outwash plains are usually massive in nature, although they do show more evidence of layering and crossbedding. Within the two deposits that are situated along the Assiniboine and Big Boggy Creek Valleys, the aggregate becomes finer towards the south. This textural change was not found in the deposits located on the east side of the study area, along the Shell River Valley.

The deposits usually exhibit a medium gravel content and do not contain the large percentages of cobbles and boulders that were found in the terraces (Photo 14). There are a few areas of

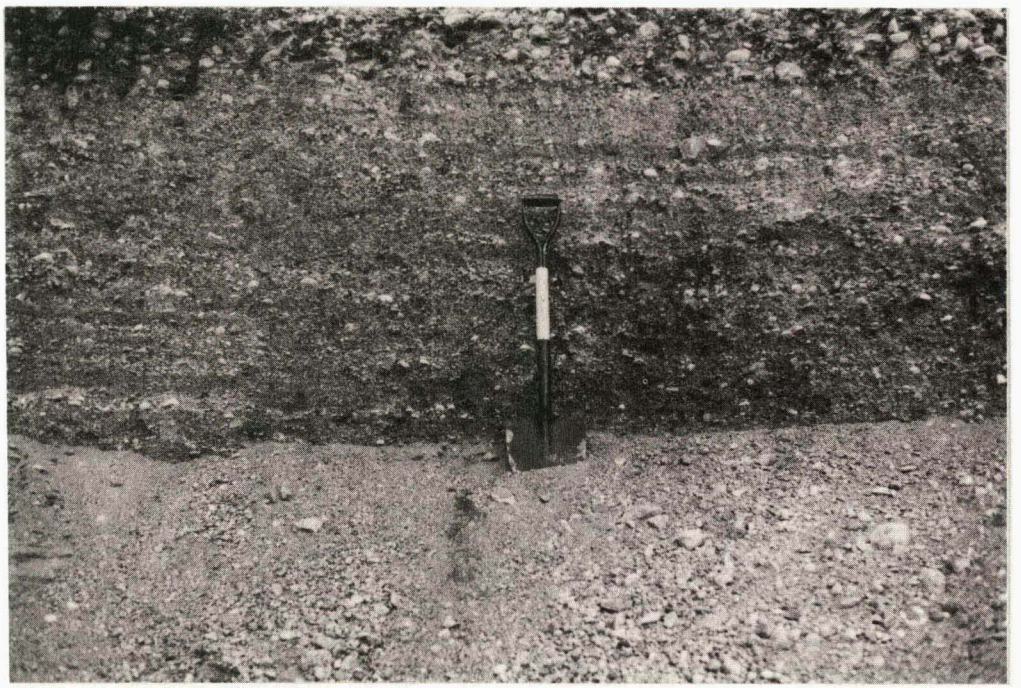


Photo 13
Valley Terrace Deposit - Unit 5;
GP 103, Deposit 14302
(Shovel is approximately 1 m in length)

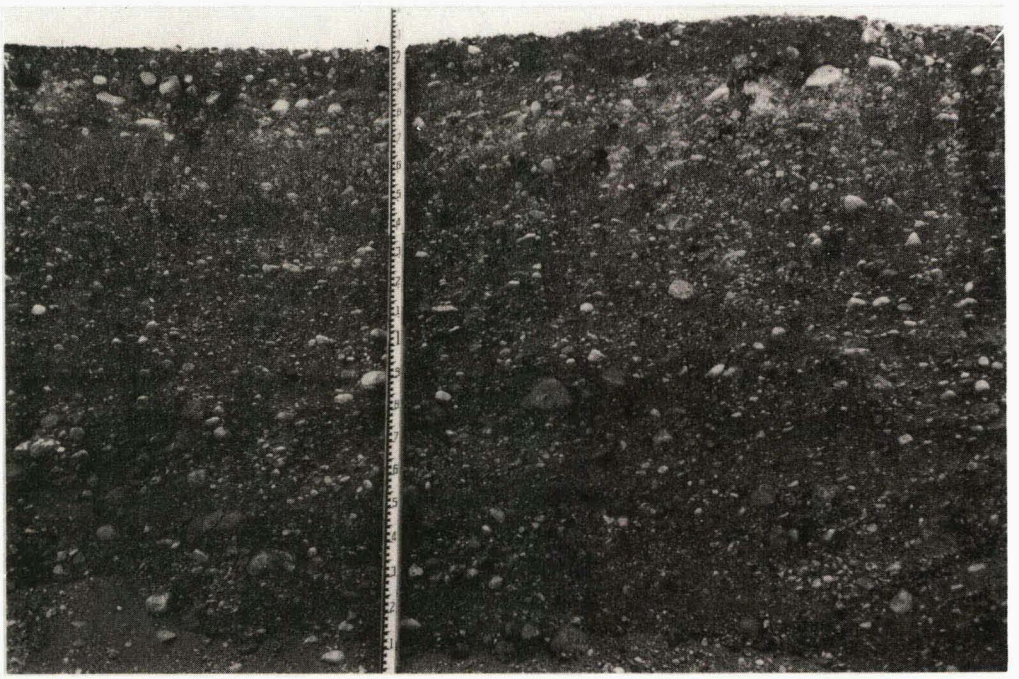


Photo 14
Outwash Plain Deposit - Unit 4a;
GP 138, Deposit 14326
(Divisions are in tenths of a meter)

outwash that contain a very low gravel content but these areas are limited in number. On average the deposits contain 40 to 60 per cent gravel, 40 to 60 per cent sand and 1 to 5 per cent silt and clay. Nominal amounts of shale were observed in these deposits. The lower quality deposits were found to contain large amounts of sand, silt and clay.

4.1.4 Isolated Outwash Deposits

Isolated outwash deposits occur within the till plain and hummocky moraine throughout the study area. These deposits were probably deposited by small pockets of circulating water within the ice sheet. The deposits occur randomly and have no distinct features that can be used for identification. They tend to have a broad range of gradation sizes with a high percentage of coarse material and a high percentage of fines (Photo 9).

These deposits are very small in areal extent and range in thickness from 1 to 5 m. The deposits are generally of low quality although some higher quality deposits were observed. On average the deposits contain 10 to 50 per cent gravel, 45 to 90 per cent sand and 1 to 5 per cent silt and clay. They also contain nominal amounts of shale.

4.2 Aggregate Reserves

The Rural Municipality of Shell River contains an estimated 460 million cubic metres of granular material. Approximately 280 million cubic metres of this is located in the valley terrace deposits, 175 million cubic metres within the outwash plains and 5 million cubic metres within the isolated outwash features. The individual deposit volumes for each of the three major aggregate sources are shown on Tables 2, 3 and 4 respectively. For each deposit type, the table lists deposit numbers, the volume of

reserves in a particular deposit and a categorization of low, medium or high quality.

The valley terrace deposits contain the majority of aggregate reserves in the study area. These deposits account for over 60% of the total with 75% of that volume classified as high quality material (Table 2). The remaining 25% is classified as medium quality gravel with less than 1% rated as low quality. Most of these reserves are contained within deposits 14302, 14314, 14332 and 14334. These deposits are generally located within the Shell River Spillway.

The outwash plain deposits are not as numerous as the valley terrace deposits, but still account for just under 40% of the total reserves. These deposits contain approximately 20% high quality material, 70% medium quality gravel and 10% low quality gravel (Table 3). The deposits are generally similar in size and occur on either side of the study area, adjacent to the major spillway channels.

The isolated outwash features are large in number but small in total volume. They account for less than 1% of the total aggregate reserves in the area. These deposits contain approximately 10% high quality material, 55% medium quality and 35% low quality gravel (Table 4). The deposits are randomly located throughout the study area and generally of equal size.

The above reserves were calculated by multiplying the estimated areal extent of each deposit by an approximation of the deposit's economic thickness. This method of quantity calculation tends to overstate the actual material available as it does not take into account variables such as: non-uniform thickness; local variations in material quality; pit management; stripping ratios; or rights-of-way for roads. Each of these factors would serve to reduce the actual amount of extractable material.

Table 2

Summary of Reserves

Valley Terrace Deposits

Deposit Number	Low Quality (cubic metres)	Medium Quality (cubic metres)	High Qaulity (cubic metres)
14301		9 200 000	
14302			106 700 000
14304		5 000 000	
14308		4 500 000	
14309			15 000 000
14312		11 250 000	
14314			43 400 000
14319			14 850 000
14327	15 000		
14328			1 140 000
14332			23 400 000
14333			3 375 000
14334		24 000 000	
14337	1 600 000		
14338		14 100 000	
14340			4 750 000
Sub-Totals	1 615 000	68 050 000	212 615 000
Total			282,280,000
% of Total	0.6%	24.1%	75.3%

Table 3

Summary of Reserves

Outwash Plain Deposits

Deposit Number	Low Quality (cubic metres)	Medium Quality (cubic metres)	High Qaulity (cubic metres)
14303	15 500 000		
14305	600 000		
14306		2 600 000	
14307		21 030 000	
14315			34 500 000
14318		29 500 000	
14326		29 787 500	
14335		2 000 000	
14336		37 875 000	
Sub-Totals	16 100 000	122 792 500	34 500 000
Total			173 392 500
% of Total	9.3%	70.8%	19.9%

Table 4

Summary of Reserves

Isolated Outwash Features

Deposit Number	Low Quality (cubic metres)	Medium Quality (cubic metres)	High Qaulity (cubic metres)
14310	125 000		
14311	125 000		
14313	50 000		
14316		250 000	
14317		62 500	
14320	250 000		
14321		750 000	
14322		500 000	
14323	250 000		
14324			250 000
14325		250 000	
14329	125 000		
14330		25 000	
14331			125 000
14339		62 500	
14341			62 500
14342	62 500		
14343	250 000		
14344		62 500	
Sub-Totals	1 237 500	1 962 500	473 500
Total			3 637 500
% of Total	34.0%	54.0%	12.0%

4.3 Demand and Use of Aggregate

The annual demand and use of aggregate in the Municipality of Shell River was investigated and summarized as part of the study. This information is required to develop an understanding of the relationship between supply and demand. The annual demand estimates were based on recent municipal and Department of Highways consumption records as well as local use by gravel producers.

The quality of the information obtained on the demand figures is considered to be accurate. Both the municipal and provincial governments keep up to date figures on consumption. The general observations on aggregate demand and use within the study area are presented below. An analysis of the relationship between supply and demand follows.

The Rural Municipality of Shell River keeps exact monthly records on the amount of aggregate used in the study area for road maintenance. These figures were obtained from the municipal office and compiled for the last seven years. The total quantity calculated was averaged over the seven year period and an annual usage figure was obtained. The average annual total is approximately 10 500 cubic metres. The figure is a combination of 9000 cubic metres of road gravel and 1500 cubic metres of winter sand per year.

The Department of Highways also maintain exact records on the amount of aggregate consumed within the study area. They have approximately 200 kilometres of roadway in the municipality, which they upgrade yearly at 100 cubic metres per kilometre. Total aggregate consumption is 7000 cubic metres of road gravel and 1000 cubic metres of winter sand per year. These figures only account for annual road and shoulder maintenance and do not represent

quantities that can be consumed during major reconstruction projects. No projects of this nature have taken place during the the past seven years but can account for up to 1500 cubic metres of road gravel per kilometre of construction.

There is one private gravel producer within the municipality who supplies the aggregate requirements of the local residents. Based on interviews with the producer, private consumption is approximately 1000 cubic metres of cement gravel per year and 100 cubic metres of sand.

These figures represent the average annual consumption within the municipality and do not or cannot take into account major construction projects. These large projects have pronounced effects on aggregate consumption and can reduce the equivalent of several years of average consumption within a short period of time. Although it is almost impossible to account for these types of demands, their significance must be considered.

4.4 Supply Versus Demand

The supply of aggregate within the municipality is extremely large. Deposits are located throughout the study area and are situated within the valley terraces of the major spillway channels, within the outwash plains adjacent to these channels and in isolated outwash features scattered throughout the till plain and hummocky moraine. The resources are generally of medium to high quality with limited zones of poor quality material. Development within the existing areas has been minimal and there is substantial room for additional mining.

The total estimate of reserves in the municipality is approximately 460 million cubic metres. Approximately 60% of this material is located within the valley terrace deposits, Table 2; 40% is located within the outwash plain deposits, Table 3; and

less than 1% is located in the isolated outwash features, Table 4. Approximately 250 million cubic metres or 55% of the total reserves is high quality material, 190 million cubic metres or 40% of the total reserves is medium quality material and only 20 million or 5% of the total reserves is low quality gravel. As mentioned earlier these quantities overstate the actual amounts of material available but they still represent an extremely large volume of high quality aggregate.

Estimated annual demand from the three recognized consumers is 17 000 cubic metres of road gravel and 2600 cubic metres of sand. These quantities represent a minimal portion of the total reserves available and therefore, no supply problems can be expected in the foreseeable future. Table 5 compares supply and demand of aggregate within the municipality for the present year.

Table 5

1985 Supply and Demand

Supply (cubic metres)		Demand (cubic metres)	
Quality		User	
High	250 000 000	Municipality	10 500
Medium	190 000 000	Department of Highways	8 000
Low	20 000 000	Private	1 100
Total	460 000 000	Total	19 600

Even major demands on aggregate resources from large construction projects can be easily met with no adverse affects on long term supply availability. Each of the three consumers have their choice of where to obtain their supplies and are not restricted to a particular area. Abundant sources of high quality aggregate are situated throughout the study area.

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APPENDIX A

SUMMARY OF TEST PIT LOGS

TP101	-	0.0 - 0.3 m	Topsoil - black - organic
		0.3 - 0.9 m	Medium to coarse sand - compacted - massive structure - sharp interface - contains organics - weak oxidation
		0.9 - 4.5 m	Coarse sand and gravel - compacted - massive structure - strong oxidation - contains clay lumps - 50% carbonates - rounded - 50% crystallines - sub-rounded to rounded - large percentage of cobbles and boulders
TP102	-	0.0 - 0.2 m	Topsoil - black - organic
		0.2 - 0.8 m	Medium to coarse sand - compacted - massive structure - sharp interface - weak oxidation
		0.8 - 5.0 m	Fine to medium sand and gravel - compacted - massive structure - strong oxidation - contains clay lumps - 55% carbonates - rounded - 45% crystallines - sub-rounded to rounded - small percentage of cobbles and boulders
TP103	-	0.0 - 10.0 m	Coarse sand and gravel - pit wall - compacted - massive structure - strong oxidation - weathered pebbles - 50% carbonates - rounded - 50% crystallines - rounded to sub-rounded - large percent of cobbles, some boulders
		10.0 - 17.0 m	Coarse sand and gravel - base of pit - as above - water table at 12.0 m
TP104	-	0.0 - 0.3 m	Topsoil - black - organic

	0.3 - 5.0 m	Coarse sand and gravel - compacted - massive structure - strong oxidation - clay lumps - 60% carbonates - rounded - 40% crystallines - rounded to sub-rounded - large percentage of cobbles and boulders
TP105 -	0.0 - 0.5 m	Topsoil - black - organic
	0.5 - 1.2 m	Fine to medium sand - compacted - massive structure - contains some silt - sharp interface
	1.2 - 5.4 m	Fine sand - compacted - massive structure - weak oxidation
TP106 -	0.0 - 4.5 m	Coarse sand and gravel - compacted - massive structure - strong oxidation - weathered pebbles - 60% carbonates - rounded - 40% crystallines - rounded to sub-rounded - large percentage of cobbles, some boulders
TP107 -	0.0 - 0.4 m	Topsoil - black - organic
	0.4 - 5.0 m	Till - sandy, silty clay - massive structure - small percent of stones - few cobbles
TP108 -	0.0 - 0.2 m	Topsoil - black - organic - sandy
	0.2 - 3.0 m	Fine to medium sand - friable - silty - sharp interface - massive structure

	3.0 - 5.0 m	Till - sandy, silty clay - massive structure - small percent of stones - no cobbles or boulders
TP109 -	0.0 - 0.1 m	Topsoil - black - organic - sandy
	0.1 - 4.1 m	Coarse sand and gravel - compacted - massive structure - strong oxidation - 65% carbonates - rounded - 35% crystallines - rounded to sub-rounded - no cobbles or boulders
	4.1 - 5.0 m	Fine to medium sand - friable - massive structure - contains clay lumps - 60% carbonates - rounded - 40% crystallines - rounded
TP110 -	0.0 - 3.0 m	Sand and gravel - pit wall - some horizontal bedding - strong oxidation - some clay lumps - 60% carbonates - rounded - 40% crystallines - rounded to sub-rounded
	3.0 - 5.0 m	Sand and gravel - base of pit - as above
	5.0 - 7.0 m	Till - sandy, silty clay - very stony - massive
TP111 -	0.0 - 0.3 m	Topsoil - black - organic - gravelly
	0.3 - 1.0 m	Coarse gravel and boulders - very compacted - massive structure - strong oxidation - contains clay - large percentage of boulders

TP112	-	0.0 - 0.3 m	Topsoil - black - organic - sandy
		0.3 - 3.0 m	Coarse gravel and boulders - compacted - massive structure - contains clay - strong oxidation - 65% carbonates - rounded - 35% crystallines - rounded to sub-rounded - large percentage of boulders
		3.0 - 5.0 m	Coarse sand and gravel - as above - no clay content - fewer boulders
TP113	-	0.0 - 0.5 m	Topsoil - black - organic
		0.5 - 1.2 m	Coarse sand and gravel, boulders - compacted - massive structure - high clay content - strong oxidation - 55% carbonates - rounded - 45% crystallines - rounded to sub-rounded - large percentage of boulders and cobbles
		1.2 - 4.5 m	Coarse sand and gravel - as above - no clay content - weathered pebbles - fines from top to bottom
TP114	-	0.0 - 0.1 m	Topsoil - black - organic - gravelly
		0.1 - 2.5 m	Medium to coarse sand and gravel - friable - massive - sharp interface - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - rounded to sub-rounded - boulders and cobbles
		2.5 - 4.0 m	Medium to coarse sand - friable - massive structure - weak oxidation

TP115	-	0.0 - 0.3 m	Topsoil - black - organic - gravelly
		0.3 - 5.0 m	Coarse sand and gravel, boulders - friable - massive structure - strong oxidation - weathered pebbles - 60% carbonates - rounded - 40% crystallines - rounded to sub-rounded - large percentage of boulders and cobbles
TP116	-	0.0 - 0.2 m	Topsoil - black - organic - gravelly
		0.2 - 4.0 m	Till - silty, sandy clay - very stony - massive structure
TP117	-	0.0 - 0.3 m	Topsoil - black - organic - gravelly
		0.3 - 5.5 m	Coarse sand and gravel, boulders - compacted - massive structure - strong oxidation - contains some clay - 50% carbonates - rounded - 50% crystallines - rounded to sub-rounded - large percentage of cobbles and boulders
TP118	-	0.0 - 0.6 m	Topsoil - black - organic
		0.6 - 1.6 m	Fine to medium sand - friable - massive structure - sharp interface - strong oxidation
		1.6 - 5.0 m	Sand and gravel - compacted - massive structure - strong oxidation - weathered pebbles - 70% carbonates - rounded - 30% crystallines - rounded to sub-rounded - small percentage of cobbles

TP119	-	0.0	- 0.4 m	Topsoil - black - organic
		0.4	- 2.0 m	Coarse sand and gravel, boulders - compacted - massive structure - strong oxidation - 55% carbonates - rounded - 45% crystallines - rounded to sub-rounded - large percentage of boulders
TP120	-	0.0	- 3.0 m	Coarse sand and gravel, cobbles - gravel pit - friable - massive structure - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - rounded to sub-rounded - large percentage of cobbles
		3.0	- 5.0 m	Coarse sand and gravel, cobbles - as above - water table at 4 m
TP121	-	0.0	- 0.5 m	Topsoil - black - organic - gravelly
		0.5	- 1.4 m	Fine to medium sand - friable - massive structure - strong oxidation - 50% carbonates - rounded - 50% crystallines - rounded
		1.4	- 2.2 m	Silty clay to clay - compacted - massive structure - firm
		2.2	- 5.0 m	Coarse sand and gravel, cobbles - compacted - massive structure - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - rounded to sub-rounded - large percentage of cobbles
TP122	-	0.0	- 0.2 m	Topsoil - black - organic - sandy

	0.2 - 0.8 m	Clay - compacted - massive structure - firm - some silt
	0.8 - 4.0 m	Medium to coarse sand, fine gravel - friable - massive structure - weak oxidation - 70% carbonates - rounded - 30% crystallines - sub-rounded to rounded
TP123 -	0.0 - 1.0 m	Topsoil - black - organic
	1.0 - 4.5 m	Clay - compacted - massive structure - firm - moist - some silt and stones
TP124 -	0.0 - 0.3 m	Topsoil - black - organic - sandy
	0.3 - 5.0 m	Sand and gravel, cobbles - friable - massive structure - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - sub-rounded to rounded - minor cobbles, boulders
	5.0 - 5.5 m	Till - silty, sandy clay - massive structure - very stony
TP125 -	0.0 - 3.0 m	Sand and gravel, cobbles - gravel pit - friable - massive structure - strong oxidation - weathered pebbles - 60% carbonates - rounded - 40% crystallines - sub-rounded to rounded
	3.0 - 4.5 m	Sand and gravel, cobbles - base of pit - as above

		4.5 - 5.5 m	Till - silty clay - massive structure - some stones
TP126	-	0.0 - 0.3 m	Topsoil - black - organic
		0.3 - 1.2 m	Medium sand - friable - massive structure - weak oxidation - sharp interface
		1.2 - 4.8 m	Medium to coarse sand, gravel - compacted - massive structure - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - rounded to sub-rounded
TP127	-	0.0 - 0.5 m	Topsoil - black - organic
		0.5 - 1.0 m	Fine sand - friable - massive structure - sharp interface - some clay
		1.0 - 5.7 m	Coarse sand and gravel - compacted - massive structure - strong oxidation - weathered pebbles - 60% carbonates - rounded - 40% crystallines - sub-rounded to rounded - cobbles, boulders
TP128	-	0.0 - 4.0 m	Coarse sand and gravel, cobbles - gravel pit - compacted - massive structure - strong oxidation - weathered pebbles - 60% carbonates - rounded - 40% crystallines- sub-rounded to rounded
		4.0 - 5.5 m	Coarse sand and gravel, cobbles - base of pit - as above

	5.5 - 7.3 m	Medium to coarse sand - compacted - massive structure - weak oxidation
TP129 -	0.0 - 0.6 m	Topsoil - black - organic
	0.6 - 3.2 m	Coarse sand and gravel, cobbles - compacted - massive structure - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines- sub-rounded to rounded - some cobbles and boulders - water table at 3.2 m
TP130 -	0.0 - 0.7 m	Topsoil - black - organic - sandy
	0.7 - 1.2 m	Fine to medium sand - compacted - massive structure - weak oxidation - sharp interface
	1.2 - 2.8 m	Medium sand and gravel - compacted - massive structure - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - sub-rounded to rounded
	2.8 - 3.5 m	Clay - compacted - massive structure - firm - moist
TP131 -	0.0 - 2.5 m	Coarse sand and gravel, cobbles - gravel pit - compacted - massive structure - strong oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - sub-rounded to rounded - cobbles
	2.5 - 4.6 m	Coarse sand and gravel, cobbles - base of pit - as above

	4.6 - 5.0 m	Clay - sandy - silty - compacted - massive - firm
TP132 -	0.0 - 3.0 m	Sandy gravel, cobbles - gravel pit - compacted - massive structure - weak oxidation - weathered pebbles - 55% carbonates - rounded - 45% crystallines - sub-rounded to rounded - some cobbles
	3.0 - 4.6 m	Sandy gravel, cobbles - base of pit - as above
	4.6 - 5.0 m	Till - silty, clay - compacted - massive structure - stony - water table at 5.0 m
TP133 -	0.0 - 1.3 m	Sandy gravel - compacted - massive structure - weak oxidation - weathered pebbles - 75% carbonates - rounded - 25% crystallines - rounded to sub-rounded - no cobbles, boulders - sharp interface
	1.3 - 5.7 m	Fine to medium sand - compacted - massive structure - weak oxidation
TP134 -	0.0 - 0.3 m	Topsoil - black - organic
	0.3 - 5.0 m	Coarse sand and gravel - compacted - massive structure - strong oxidation - weathered pebbles - carbonate concretions - 55% crystallines - rounded - 45% carbonates - rounded - cobbles, boulders

TP135	-	0.0 - 0.2 m		Topsoil - black - organic
		0.2 - 5.0 m		Coarse sand and gravel - similar to TP134 - fines slightly towards the bottom
TP136	-	0.0 - 0.3 m		Topsoil - black - organic
		0.3 - 5.0 m		Coarse sand and gravel, boulders - similar to TP134 - some clay
TP137	-	0.0 - 0.2 m		Topsoil - black - organic
		0.2 - 5.0 m		Coarse sand and gravel, boulders - similar to TP134 - some clay
TP138	-	0.0 - 0.4 m		Topsoil - black - organic
		0.4 - 5.0 m		Coarse sand and gravel, boulders - similar to TP134 - more cobbles and boulders

APPENDIX B

SUMMARY OF FIELD STATIONS

FS101	Road Cut	-	Colluvium - silty clay till - compacted - minor zones of outwash gravel
FS102	Road Cut	-	Colluvium - silty clay till - compacted - 10 m high - boulders, moderate amount of stones - old borrow pit
FS103	Hand Dug Hole	-	Valley Terrace - gravel ridge - coarse sand and gravel - cobbles, boulders - compact - strong oxidation - weathered pebbles - 50% carbonates - 50% crystallines
FS104	Road Cut	-	Outwash Plain - 0.3 m silty sand over fine to medium sand - compacted massive structure - low quality
FS105	Road Cut	-	Till Plain - modified by water erosion - 0.5 m silt overlying silty to sandy clay till - very stony, boulders
FS106	Road Cut	-	Outwash Plain - 0.4 m silty sand overlying fine to medium sand - compacted - massive structure
FS107	Road Cut	-	Valley Terrace - 2.0 m coarse sand and gravel, boulders - compacted - massive structure - weathered pebbles - strong oxidation - 60% carbonates - 40% crystallines - some clay
FS108	Hand Dug Hole	-	Till Plain - Hummocky - silty, sandy clay till - some zones of minor gravel - boulders

FS109	Road Cut	-	Valley Terrace - coarse sand and gravel - 4.0 m high - compacted - massive structure - clay content - strong oxidation - 60% carbonates - 40% crystallines - some cobbles, boulders
FS110	Road Cut	-	Valley Terrace - as above in FS109 - no clay content - 10.0 m high
FS111	Road Cut	-	Till Plain - hummocky - sandy clay till - minor traces of outwash gravel - 5.0 m high
FS112	Road Cut	-	Valley Terrace - fine to coarse gravel - some cobbles - 3.0 m high - strong oxidation - 55% crystallines - 45% carbonates
FS113	Road Cut	-	Outwash Plain - coarse sand and gravel, boulders - 3.0 m high - clay content - strong oxidation - 60% carbonates - 40% crystallines - compacted - massive
FS114	Road Cut	-	Outwash Plain - coarse sand and gravel - cobbles, boulders - clay content - strong oxidation - 60% carbonates - 40% crystallines
FS115	Road Cut	-	Till Plain - hummocky - silty sandy clay till - zones of gravelly outwash - 3.0 m high - massive structure - boulders

FS116	Road Cut	-	Outwash Plain - sand and gravel - some boulders - 10.0 m high - clay content - strong oxidation - 70% carbonates - 30% crystallines
FS117	Road Cut	-	Colluvium - silty, sandy clay till - 10.0 m high - stones, cobbles, boulders - massive structure - compacted
FS118	Road Cut	-	Moraine Plateau - silty clay over clay - massive structure - flat lying area
FS119	Hand Dug Hole	-	Outwash Plain - sand and gravel - cobbles - strong oxidation - clay content - 55% carbonates - 45% crystallines - massive structure
FS120	Hand Dug Hole	-	Valley Terrace - 0.3 m coarse sand and gravel over till - clay content - weak oxidation - 55% crystallines - 45% carbonates
FS121	Road Cut	-	Colluvium - silty, sandy clay till - minor zones of gravel - 5.0 m high - cobbles, boulders
FS122	Road Cut	-	Colluvium - silty clay till - some stones, no boulders - material becomes stonier to the east
FS123	Road Cut	-	Colluvium - silty, sandy clay till - side of hill slumping - 8.0 m high - possible borrow pit - zones of isolated gravel

APPENDIX C

COMPUTER FORMS

FORM 1

SAND & GRAVEL INVENTORY

DEPOSIT STATUS

DEPOSIT NO: ________ __ SUB

LANDFORM __ (if K specify landform under depcom field)

DEPOSIT COMMENTS ______________________________

OWNERSHIP & RESERVES

LOCATION							OWNERSHIP				
TWP	RNG	SCT	¼ SCT	APPROXIMATE AREA (HA.)	AVERAGE DEPTH (m.)	% DEPLETED NOT AVAILABLE					

MG-9465

Sand and Gravel Inventory

Form 2

Exposure — Stratigraphic Section Data

DEPOSIT NO. SUB

TOWNSHIP RANGE SECTION 1/4 SECTION

EXPOSURE NO.

EXPOSURE TYPE

EXP. LAND USE

SUR. LAND USE

THICKNESS OF ECONOMIC UNIT (m.)

ESTIMATED GRAVEL CONTENT

Y M D
DATE EXAMINED

MATERIAL DESCRIPTION

COMMENTS

STRATIGRAPHIC SECTION

GEOLOGIST

HEIGHT OF SECTION

HEIGHT EXAMINED

DEPTH TO WATER TABLE (m.)

MATERIAL AT BASE OF SECTION

% LITHOLOGY % LITHOLOGY

PRIMARY SECONDARY
GROSS LITHOLOGY

PRIMARY SECONDARY CHANNEL SAMPLE (Y, N)

DELETERIOUS SUBSTANCES

CHECK
MATERIAL LARGER THAN 15CM AVAILABLE BUT NOT SAMPLED

STRATIGRAPHIC SECTION

GEOLOGIST

HEIGHT OF SECTION

HEIGHT EXAMINED

DEPTH TO WATER TABLE (m.)

MATERIAL AT BASE OF SECTION

% LITHOLOGY % LITHOLOGY

PRIMARY SECONDARY
GROSS LITHOLOGY

PRIMARY SECONDARY CHANNEL SAMPLE (Y, N)

DELETERIOUS SUBSTANCES

CHECK
MATERIAL LARGER THAN 15CM AVAILABLE BUT NOT SAMPLED

FORM 3

SIEVE ANALYSIS

DEPOSIT NO. | SUB | TWP. | RNG. | SCT. | ¼ SCT. | EXPOSURE | STRAT. SCT.

SAMPLE NO. [ ][ ][ ][ ][ ][ ] [ ] [ ][ ][ ] [ ][ ][ ] [ ][ ] [ ][ ] [ ][ ][ ][ ] [ ]

COMMENT _____

CRUSHABLE MATERIAL [ ] (1 = YES, 0 = NO)

WEIGHT OF FINE FRACTION _____ GMS.

WEIGHT BEFORE WASHING _____ GMS. WEIGHT AFTER WASHING _____ GMS.

Screen	mm	phi units	Weight on Sieve (Gms.)	
4"	101.6	-6.65		
3½"	88.9	-6.47		
3"	76.2	-6.25		
2½"	63.5	-6.00		
2"	50.8	-5.67		COARSE FRACTION
1½"	38.1	-5.25		
1"	25.4	-4.67		
3/4"	19.1	-4.25		
5/8"	15.9	-4.00		
1/2"	12.7	-3.67		
3/8"	9.5	-3.25		
1/4"	6.35	-2.67		
#4	4.76	-2.25		
#8	2.38	-1.25		
#10	2.00	-1.00		
#16	1.19	-0.25		
#30	0.59	+0.75		FINE FRACTION
#40	0.42	+1.25		
#50	0.30	+1.75		
#80	0.177	+2.50		
#100	0.149	+2.75		
#200	0.074	+3.75		
< 200				

APPENDIX D

EXAMPLE OF COMPUTER PRINTOUT

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

DEPOSIT 014302 OTHER (DESCRIBE) VALLEY TERRACE

TOWN	RANGE	SECTION	QUARTER				
025	28W	14	NW	4,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
		15	NE	12,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
			NW	7,200,000	CU.M.	800000	CU.M.DEPL/NOT AVAIL
			SE	3,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
		16	NE	2,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
		21	SE	5,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
		22	NE	10,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
			NW	5,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SE	9,000,000	CU.M.	3000000	CU.M.DEPL/NOT AVAIL
			SW	9,500,000	CU.M.	500000	CU.M.DEPL/NOT AVAIL
		23	NE	2,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
			NW	10,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	12,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
		25	NW	6,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
		26	SE	8,000,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	2,000,000	CU.M.		CU.M.DEPL/NOT AVAIL

DEPOSIT RESERVES 106,700,000 CU.M.

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

EXPOSURE GP106 (014302 025 28W 22 SE) VISITED 85082

SAND AND GRAVEL PIT ACTIVE PIT

20.0 M. COARSE SAND AND GRAVEL, SMALL BOULDERS VALLEY TERRACE

SECTION A GEOLOGIST LB SECTION HEIGHT 5.0 M. EXAMINED 5.0 M.

BASE SAME AS IN PIT WALL WATER TABLE .0 M.

LITHOLOGY 50 % GENERAL CARBONATES 50 % GENERAL PRECAMBRIANS

DELETERIOUS IRON OXIDE INCRUSTATIONS OR CONCRETIONS

SAMPLE-- COBBLES % PEBBLES 30.39 % GRANULES 24.73 % SAND 42.39 % SILT/CLAY 2.49 %

SAMPLE IDENTIFICATION 014302 025-28W-22SE GP106A VALLEY TERRACE

AVAILABILITY OF CRUSHABLE MATERIAL ON SITE - YES

WEIGHT OF SAND 17463.30 GMS. WASHED SAMPLE - WEIGHT BEFORE 1014.10 AFTER 987.30 % LOSS 2.64

SIEVE SIZE	FINE FRACTION (GMS.)	SIEVE WEIGHTS (GMS.)	PERCENT	PERCENT PASSING	PERCENT RETAINED
4 IN		0.0	0.0	100.00	0.0
3 1/2 IN		0.0	0.0	100.00	0.0
3 IN		0.0	0.0	100.00	0.0
2 1/2 IN		0.0	0.0	100.00	0.0
2 IN		931.70	4.57	95.43	4.57
1 1/2 IN		517.20	2.54	92.89	7.11
1 IN		838.80	4.12	88.78	11.22
3/4 IN		630.90	3.10	85.68	14.32
5/8 IN	33.00	568.28	2.79	82.89	17.11
1/2 IN	15.50	266.92	1.31	81.58	18.42
3/8 IN	25.80	444.29	2.18	79.40	20.60
1/4 IN	62.50	1076.28	5.28	74.12	25.88
# 4	53.40	919.57	4.51	69.61	30.39
# 8	244.80	4215.57	20.68	48.93	51.07
# 10	47.90	824.86	4.05	44.88	55.12
# 16	214.40	3692.07	18.11	26.77	73.23
# 30	156.90	2701.89	13.26	13.51	86.49
# 40	57.20	985.01	4.83	8.68	91.32
# 50	41.80	719.82	3.53	5.15	94.85
# 80	18.20	313.41	1.54	3.61	96.39
# 100	3.40	58.55	0.29	3.32	96.68
# 200	9.80	168.76	0.83	2.49	97.51
<200 + W	29.50	508.00	2.49	0.0	100.00
TOTALS	1014.10	20381.87			

SPLITTING FACTOR 17.22

FINENESS MODULUS 4.75

% COBBLES 0.0 % PEBBLES 30.39 % GRANULES 24.73 % SAND 42.39 % SILT/CLAY 2.49

APPENDIX E

SUMMARY OF DEPOSIT DATA

SUMMARY OF COMPUTER PRINTOUT DATA

Size Classification:

Gravel	-	> 2 mm
Sand	-	0.074 mm - 2 mm
Silt/Clay	-	< 0.074 mm

Lithology:

C	-	General Carbonates
X	-	General Crystallines
S	-	Shale

Gravel Content:

H	-	> 60% Gravel
M	-	20 - 60% Gravel
L	-	< 20% Gravel

DEPOSIT NUMBER	EXPOSURE NUMBER	PER CENT GRAVEL	PER CENT SAND	PER CENT SILT/CLAY	GRAVEL CONTENT	LITHOLOGY	OWNERSHIP	RESERVES (CUBIC METRES)
14301	GP101	-	-	-	M	50C/50X	Private	9 200 000
	GP102	-	-	-	M	55C/45X		
	TP101	46.09	54.59	4.33	M	50C/50X		
	TP102	23.40	75.86	0.73	M	55C/45X		
14302	GP103	58.50	30.14	1.36	M	50C/50X	Private	106 700 000
	GP104	78.11	20.65	1.24	H	50C/50X		
	GP105	54.35	43.60	2.05	M	50C/50X		
	GP106	55.12	42.39	2.49	M	50C/50X		
	GP107	-	-	-	H	50C/50X		
	TP103	-	-	-	M	50C/50X		
	TP104	74.89	23.75	1.36	H	60C/40X		
	FS103	-	-	-	M	50C/50X		
14303	TP105	-	-	-	L	-	Private	15 500 000
	FS104	-	-	-	L	-		
	FS105	-	-	-	L	-		
14304	TP106	52.52	45.97	1.52	M	60C/40X	Private	5 000 000
	FS107	-	-	-	M	60C/40X		

DEPOSIT NUMBER	EXPOSURE NUMBER	PER CENT GRAVEL	PER CENT SAND	PER CENT SILT/CLAY	GRAVEL CONTENT	LITHOLOGY	OWNERSHIP	RESERVES (CUBIC METRES)
14305	TP108	-	-	-	L	50C/50X	Private	600 000
14306	GP108	53.54	34.27	2.19	M	70C/30X	Private	2 600 000
	GP109	-	-	-	M	65C/35X		
	GP110	-	-	-	L	65C/35X		
14307	GP111	-	-	-	M	65C/35X	Private/ Crown	21 030 000
	GP112	-	-	-	M	65C/35X		
	GP113	37.54	59.32	3.14	M	60C/40X		
	GP114	-	-	-	M	60C/40X		
	GP115	57.84	41.16	1.00	M	70C/30X		
	TP109	43.07	54.55	2.38	M	65C/35X		
	TP110	-	-	-	M	60C/40X		
14308	FS109	-	-	-	H	60C/40X	Private	4 500 000
	FS110	51.58	47.11	1.31	M	60C/40X		
14309	TP111	-	-	-	H	65C/35X	Private	15 000 000
	TP112	68.07	28.55	3.38	H	65C/35X		
14310	GP116	-	-	-	L	65C/35X	Private	125 000
14311	GP117	-	-	-	L	60C/40X	Private	125 000

DEPOSIT NUMBER	EXPOSURE NUMBER	PER CENT GRAVEL	PER CENT SAND	PER CENT SILT/CLAY	GRAVEL CONTENT	LITHOLOGY	OWNERSHIP	RESERVES (CUBIC METRES)
14312	GP118	-	-	-	M	50C/50X	Private	11 250 000
	GP119	55.20	41.49	3.32	M	50C/50X		
14313	GP120	-	-	-	L	55C/45X	Private	50 000
14314	GP121	57.61	40.68	1.71	M	55X/45C	Private/ Crown	43 400 000
	GP122	69.11	31.22	0.66	H	65C/35X		
	GP125	-	-	-	H	55C/45X		
	TP113	75.16	23.22	1.63	H	55C/45X		
	TP114	26.38	66.46	1.37	M	55C/45X		
	TP117	-	-	-	H	55X/45C		
	FS112	-	-	-	H	55C/45X		
14315	GP124	65.62	31.88	2.51	H	60C/40X	Private	34 500 000
	TP115	62.77	35.43	1.80	H	60C/40X		
	FS113	-	-	-	H	60C/40X		
	FS114	-	-	-	H	60C/40X		
14316	GP123	58.22	40.98	0.80	M	60C/40X	Private	250 000
14317	GP126	45.30	51.64	3.06	M	60C/40X	Private	62 500
14318	GP127	-	-	-	M	55C/45X	Private	29 500 000
	GP128	64.31	34.28	1.41	H	60C/40X		

DEPOSIT NUMBER	EXPOSURE NUMBER	PER CENT GRAVEL	PER CENT SAND	PER CENT SILT/CLAY	GRAVEL CONTENT	LITHOLOGY	OWNERSHIP	RESERVES (CUBIC METRES)
	GP129	-	-	-	M	60C/40X		
	GP130	43.05	55.41	1.54	M	65C/35X		
	GP131	-	-	-	M	55C/45X		
	TP120	-	-	-	M	55C/45X		
	TP121	44.45	53.27	2.27	M	50C/50X		
14319	GP132	-	-	-	H	65C/35X	Private	14 850 000
	TP118	58.00	40.36	1.64	M	70C/30X		
	TP119	64.73	32.98	2.29	H	55C/45X		
14320	GP133	-	-	-	L	60C/40X	Private	250 000
14321	FS116	48.57	49.63	1.79	M	70C/30X	Private	750 000
14322	GP134	30.68	68.55	0.78	M	70C/30X	Private	500 000
14323	TP122	3.33	95.13	1.53	L	70C/30X	Private	250 000
14324	GP135	65.28	30.68	4.04	H	70C/30X	Private	250 000
14325	GP136	47.39	51.72	0.89	M	55C/45X	Private	250 000
14326	GP137	52.03	46.86	0.85	M	55C/45X	Private/ Crown	29 787 500
	GP138	56.82	42.39	0.79	M	65C/35X		
	GP139	64.01	31.73	4.26	H	60C/40X		

DEPOSIT NUMBER	EXPOSURE NUMBER	PER CENT GRAVEL	PER CENT SAND	PER CENT SILT/CLAY	GRAVEL CONTENT	LITHOLOGY	OWNERSHIP	RESERVES (CUBIC METRES)
	TP124	-	-	-	M	55C/45X		
	TP125	-	-	-	M	60C/40X		
	FS119	-	-	-	M	55C/45X		
14327	FS120	-	-	-	L	55C/45X		15 000
14328	GP140	71.22	25.30	3.48	H	55C/45X	Private	1 140 000
14329	GP141	-	-	-	L	60C/40X	Private	125 000
14330	GP142	51.13	47.03	1.85	M	60C/38X/2S	Private	25 000
14331	GP143	66.53	31.27	2.20	H	60C/40X	Private	125 000
14332	GP144	74.54	22.13	3.34	H	75C/25X	Private	23 400 000
	TP126	43.44	53.77	2.79	M	55C/45X		
	TP129	66.03	29.67	4.30	H	55C/45X		
	TP130	-	-	-	H	50C/50X		
14333	GP145	-	-	-	H	60C/40X	Private	3 375 000
	GP146	-	-	-	H	60C/40X		
	TP127	-	-	-	H	60C/40X		
	TP128	66.63	32.42	0.95	H	60C/40X		
14334	GP147	57.60	40.60	1.80	M	60C/40X	Private/ Crown	24 000 000

DEPOSIT NUMBER	EXPOSURE NUMBER	PER CENT GRAVEL	PER CENT SAND	PER CENT SILT/CLAY	GRAVEL CONTENT	LITHOLOGY	OWNERSHIP	RESERVES (CUBIC METRES)
14335	GP148	48.92	49.53	1.55	M	55C/45X	Private	2 000 000
	TP131	-	-	-	M	55C/45X		
14336	GP149	68.16	27.81	4.02	H	55C/45X	Private/ Crown	37 875 000
	GP150	48.51	48.92	2.57	M	55C/45X		
	GP151	43.28	55.86	0.86	M	65C/35X		
	GP152	47.58	50.04	2.38	M	60C/40X		
	GP153	66.49	31.41	2.10	H	55C/45X		
	GP154	39.27	59.88	0.85	M	60C/40X		
	TP132	-	-	-	M	55C/45X		
	TP133	26.78	71.12	2.09	M	75C/25X		
14337	GP155	-	-	-	L	60C/40X	Crown	1 600 000
14338	GP156	30.72	67.81	1.47	M	50C/50X	Private/ Crown	14 100 000
14339	GP157	51.02	46.11	2.87	M	55C/45X	Private	62 500
14340	GP158	-	-	-	H	55C/45X	Crown	4 750 000
	TP134	77.53	20.21	2.26	H	55C/45X		
	TP135	-	-	-	H	55C/45X		

DEPOSIT NUMBER	EXPOSURE NUMBER	PER CENT GRAVEL	PER CENT SAND	PER CENT SILT/CLAY	GRAVEL CONTENT	LITHOLOGY	OWNERSHIP	RESERVES (CUBIC METRES)
	TP136	78.93	18.33	2.74	H	55C/45X		
	TP137	-	-	-	H	50C/50X		
	TP138	-	-	-	H	55C/45X		
14341	GP159	66.24	30.77	2.99	H	55C/45X	Crown	62 500
14342	GP160	14.11	83.46	2.43	L	50C/50X	Crown	62 500
14343	GP161	-	-	-	L	55C/45X	Private	250 000
14344	GP162	48.33	48.06	3.61	M	70C/30X	Crown	62 500