Aggregate Report AR84-1

Surficial Geology and Aggregate Resource Inventory of the Rural Municipality of Whitemouth

By R.V. Young

Manitoba
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ABSTRACT

Detailed surficial geology investigations and an aggregate resource inventory were carried out within the Rural Municipality of Whitemouth. Field investigations included aerial photograph interpretation and ground reconnaissance to determine map units. Surficial deposits consist of bogs, clays, till plains and wave-washed bedrock. Elevations of beach and littoral deposits are recorded illustrating successive water plane levels of Lake Agassiz. Beach ridge, littoral and glaciofluvial deposits constitute sources of sand and gravel within the municipality. Total reserves of sand and gravel are estimated at 20.4 million cubic metres of which 5.5 million cubic metres are medium-high quality. The isolated location of the higher quality sand and gravel deposits necessitates the importing of sand and gravel to supply regional demand within the municipality.

INTRODUCTION

OBJECTIVES

Surficial geology mapping and an aggregate resource inventory were carried out within the Rural Municipality of Whitemouth with the following objectives:

1. to map the surficial geology at a scale of 1:50 000; and
2. evaluate the quality and reserves of available aggregate resources.

LOCATION AND ACCESS

The municipality comprises 684 square kilometres and is located 80 kilometres east of Winnipeg (Fig. 1) between latitudes 49°48′ North to 50°07′ North and longitudes 95°49′ West to 96°05′ West, and from Townships 10 to 13 and Ranges 11 and 12 East of Principal Meridian. The largest settlement is the Town of Whitemouth.

Access is provided by paved Highways 11, 15 and 44, and by gravelled Provincial Roads 307, 406, 408 and 506. Other road access is by section and forestry roads. Both the Canadian National and Canadian Pacific Railroads serve the municipality. Access is restricted in large areas due to extensive bog deposits and dense forest.

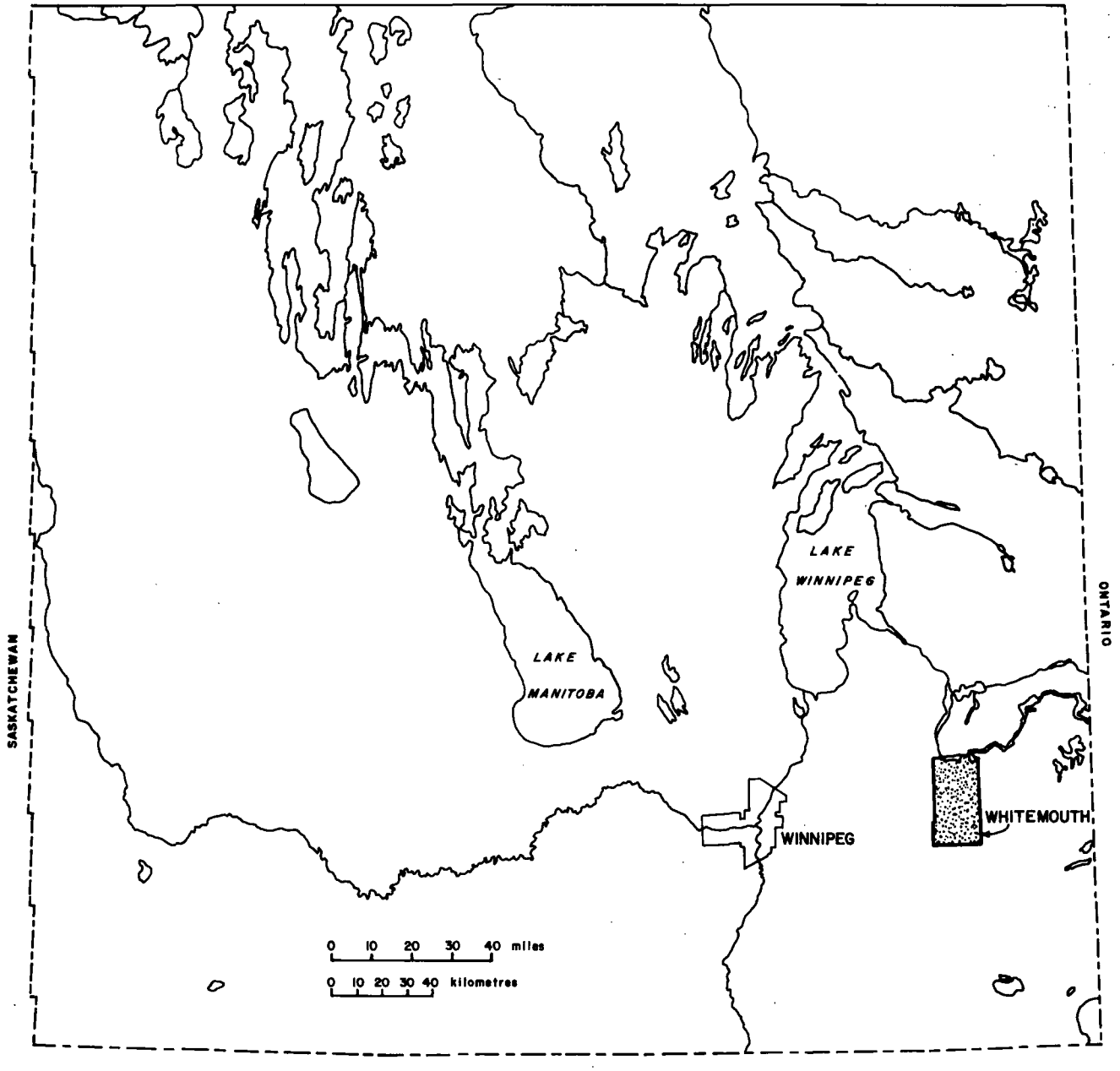

FIGURE 1. Location of the Rural Municipality of Whitemouth study area.

PHYSIOGRAPHY AND DRAINAGE

The western portion of the study area, at a maximum elevation of 305 m a.s.l. (metres above sea level) consists primarily of swamp and till deposits. The eastern portion consists of exposed bedrock outcrops at elevations of approximately 290 m a.s.l. The central portion consists of till and clay plains adjacent to the Whitemouth River.

The study area is within the Winnipeg River Basin which includes the Winnipeg, Whitemouth and Birch Rivers. The Whitemouth and tributary Birch Rivers flow northwards from an elevation of 289 m a.s.l. into the Winnipeg River system at Seven Sisters Falls at 259 m a.s.l. Numerous bogs are present, with the largest being the Whitemouth Bog northeast of Whitemouth.

PREVIOUS WORK

Early workers included Upham (1890) who described the extent of Lake Agassiz and elevations of beaches in southern Manitoba. The first detailed description and surficial geology map of the study area was presented by Johnston (1921). Antevs (1931) described ice recession in Manitoba and Johnston (1934) described the character of surficial deposits overlying the bedrock in the Winnipeg map area. The deformation and elevation of Lake Agassiz beaches of southern Manitoba were described in detail by Johnston (1946).

Surficial deposits in the Lake Agassiz basin were described by Elson (1965) and the soils within the municipality mapped and described by Smith et al. (1967). The surficial geology west of Range 11 East was mapped and described by McPherson (1968, 1970) and Fenton (1974) at scales of 1:250 000. A portion of the study area was previously inventoried for aggregate potential by Underwood McLellan and Associates Limited (1976). A brief description of the surficial geology and Quaternary events was made by Nielsen (1977). Glacial stratigraphy and history of southeastern Manitoba were described by Teller and Fenton (1980). Bog deposits including several shallow profiles through several bogs within the study area were discussed by Bannatyne (1980, 1964). A preliminary assessment of the aggregate resource potential and surficial geology was previously reported by Young (1983).

Several maps by Teller et al. (1976) and Little (1980) show surface deposits, bedrock topography and drift thickness for portions of the study area. An overview of the glacial depositional history and surficial deposits for Manitoba is shown on Mineral Resources Division Map 81-1 (1981).

PRESENT STUDY

Geological field investigations were conducted during the summer of 1983. Map units were delineated from air photographs at scales of 1:50 000 and 1:15 840 and checked in the field. Available roadcuts, natural exposures and hand dug test pits were used to identify and evaluate selected deposits.

Samples collected were confined to sand and gravel deposits. Laboratory analysis included determining the grain size distribution between the 0.074 and 101.6 mm sizes and pebble lithologies of the 4-16 mm size fraction. Sizes less than 0.074 mm were recorded as the combined silt/clay fraction. Material larger than 150 mm was not sampled but was recorded in the field as crushable material.

The general quality of sand and gravel was assessed for each deposit from the grain size data and pebble lithologies The area, average depth and reserve estimates were calculated for each deposit.

Acknowledgements

The author wishes to thank P. Berk who assisted with the field work and B. Bannatyne for critically reviewing the manuscript. Maps and figures accompanying this report were drafted by E. Truman under the direction of R. Sales.

BEDROCK GEOLOGY

The municipality is underlain by Precambrian bedrock. The central portion is underlain by Archean granite and minor granodiorite, while the bedrock in the northeast and southwest was metamorphosed by early intrusive rocks including tonalite, minor granodiorite, granite and related gneiss. Detailed geology of the northern portion of the municipality was presented by McRitchie and Weber (ed. 1971) and the eastern portion by Lamb (1975) and Janes (1976).

Bedrock in the west and south is covered by extensive glacial drift which is up to 15 m deep along the Whitemouth River and up to 47 m deep along the western portion of the study area. Abundant bedrock outcrops are located along the eastern boundary of the municipality and along the Winnipeg River.

SURFICIAL GEOLOGY

QUATERNARY HISTORY

The history of late Wisconsinan glaciation in southern Manitoba was discussed in detail by Teller and Fenton (1980) who identified 5 till formations. The first late Wisconsinan glacial advance into the area was towards the southwest about 24 000 years ago depositing the Senkiw and equivalent Whiteshell Till Formations. The next advance was from the northwest and deposited the Roseau Formation which was later overlain by early Lake Agassiz sediments. A readvance southeast over the lake sediments deposited the Whitemouth Lake Formation and a second readvance deposited the Marchand Formation. About 11 000 years before present ice retreated from southern Manitoba for the last time and the study area was covered by Lake Agassiz which disappeared from southern Manitoba about 9200 years ago (Teller and Last, 1980).

SURFICIAL DEPOSITS

Bedrock Outcrops

Extensive bedrock outcrops are found along the eastern portion of the study area. The bedrock exhibits a well abraded surface (Fig. 2). Drift cover is usually absent and there are extensive swamp deposits between the bedrock knolls. The bedrock unit consists of a wave-washed bedrock with minor sandy till, and/or clay veneer overlying the bedrock. No outcrops were observed west of the Whitemouth River although minor isolated outcrops were observed along the Whitemouth River during periods of low water. Extensive outcrops were also observed downstream from the hydro dam at Seven Sisters Falls and along the Winnipeg River.

FIGURE 2: An example of glacially abraded and wave-washed bedrock, map unit 1(a).

Glacial Deposits

Glacial deposits consist of till and two glaciofluvial sand and gravel deposits (deposits 2810 and 2809). Two tills are identified, a carbonate-rich silty till and a discontinuous sandy till. The silty till comprises a series of till plains partially overlain by either swamp or clay deposits. The sandy till occurs as a discontinuous veneer overlying the bedrock along the eastern portion of the study area.

Deposit 2810 is a wave-washed glaciofluvial sand and gravel deposit flanked by fine grained littoral sand. Although there was no observed bedding within the deposit some cobbles appeared to be imbricated and mixed with large pockets of fine sand. The absence of well defined bedding and sorting suggests the sand and gravel underwent minimal transport and has been deposited as a kame. Poorly defined horizontally bedded fine sand ridges along the southern portion of the deposit suggest a reworking of the deposit into minor beaches by Lake Agassiz. The beaches are at the same elevation, 302 m a.s.l., as a well defined beach ridge near Lewis. The second glaciofluvial deposit (2809) consists of 3 m of bedded pebbly sand overlain by a till veneer.

Late Glacial Deposits

Late glacial deposits include lacustrine clay, littoral sand and beach ridges. Extensive clay deposits are located along the Whitemouth River. The clay occurs as either a massive unit greater than 10 m thick or as a thin veneer less than 1.0 m thick overlying the till. The clay plain has minimal relief and is generally below the 282 m a.s.l. contour. Numerous iceberg scours occur within the clay plain in the northwestern portion of the study area. The clays west of Whitemouth were once used for brick manufacture (Bannatyne, 1970, p. 90).

Several deposits of littoral sand are located along the western portion of the study area. A roadcut through deposit 2804 showed 2.0 m of fine sand overlying till. Deposits 2806 and 2807 are pebbly sand deposits with minor gravel.

Two well developed beach ridges occur within the study area. A notable beach ridge (deposit 2801) representing a major stillstand of Lake Agassiz is located south of Lewis at an elevation of 302 m a.s.l. rising 12.0 m above the surrounding terrain. A second well developed strandline is located in the Scotts Hill area (Fig. 3) at an elevation of 285 m a.s.l. This strandline consists of 0.5 - 1.0 m of fine sand overlying a sandy till. A minor strandline southwest of Stony Hill is at an elevation of 288 m a.s.l. Littoral deposits 2804 and 2805 and minor strandlines north of Stony Hill are all at elevations of 281 m a.s.l.

Elevations of beach ridges and littoral deposits are shown in Table 1.

TABLE 1. WATER PLANE LEVELS OF LAKE AGASSIZ

Elevations (metres above sea level)	Feature	Deposit Number
302	Prominent Strandline	2801
288	Minor Strandline	
286	Littoral Deposit	2804-2807
285	Prominent Strandline	2808
281	Minor Strandline	

Three main water plane levels of Lake Agassiz are inferred, the 302, 285-288 and 281 m a.s.l. elevations, with major beach ridges at the 302 and 285 m a.s.l. elevations. Fenton (1974) identified the 302 m a.s.l. elevation as the Ossawa strandline.

Postglacial Deposits

Postglacial deposits consist of alluvium and swamp. Swamp deposits cover extensive areas and include the Lewis, Contour and Whitemouth Bogs (Fig. 4). Bogs sampled in the Elma area by Bannatyne (1980) are shallow, up to 2-3 m deep and underlain by sand, gravel or sandy clay. Minor swamp deposits are also located between bedrock knolls in the eastern portion of the study area.

Present-day alluvial deposits are located along the Whitemouth and Birch Rivers. The alluvium consists of silts with minor sand (Fig. 5).

FIGURE 3: Airphoto stereopair (7817-221-222) illustrating 1. beach deposit 2808 and 2. bedrock outcrop.

FIGURE 4: Whitemouth Bog deposits near the entrance to Whiteshell Provincial Park adjacent to Provincial Road 307.

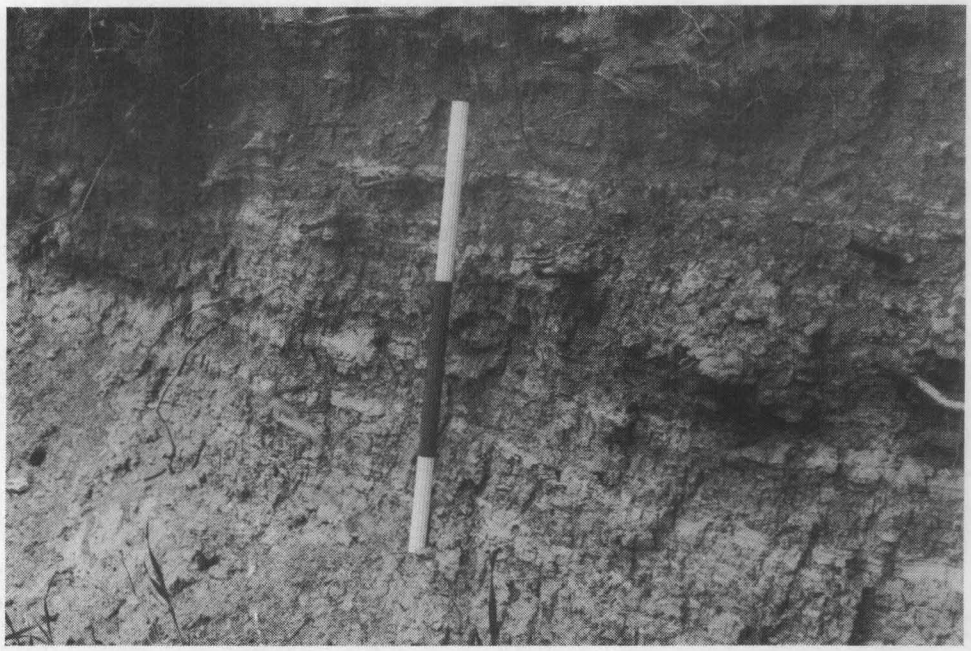

FIGURE 5: Present-day floodplain deposits consisting of silts at the Whitemouth River bridge crossing at Seven Sister Falls. Survey rod divided into 1 foot (0.3 metre) units.

SAND AND GRAVEL RESOURCES

ANALYSIS OF SAND AND GRAVEL

A total of 10 sand and gravel deposits were identified as well as several minor strandlines which were not defined as deposits (sufficient extent to justify exploration and development). A total of 9 samples were analyzed from 10 different deposits. One sample was also analyzed from a minor strandline not classified as a deposit. The grain size distribution for each sample is shown in Table A-1 and the deposit characteristics are shown in Table A-2 of Appendix A. Deposit and sample locations are shown on the map accompanying this report.

QUALITY OF SAND AND GRAVEL

The quality of each sampled deposit is based upon the percentage gravel (size greater than 2.0 mm). The quality of deposits not sampled was estimated based upon morphology, genesis, and airphoto signature. Size fractions greater than 8 cm were normally not included with the deposit sample. Size fractions greater than 15 cm are recorded in the field and referred to as crushable material. Due to the complexity of sampling the cobble and boulder size fractions, those fractions were not included with the sample and are not reflected in the grain size distribution.

Only two sand and gravel deposits within the study area have economic significance. Glaciofluvial deposit 2810 consists of boulders, cobbles and pebbly sand (Fig. 6). This deposit exceeds 10 m in depth and is flanked by finegrained littoral sand. The deposit has been utilized for municipal and fireguard road maintenance in the past. The second deposit, 2809, is a partially buried glaciofluvial deposit consisting of bedded sands and gravel. The deposit is 3.0 m deep and gravel has been removed below the water table by a dredge.

Other potential aggregate sources include low quality beach ridges and littoral deposits. Three samples from two beach ridges, samples RY100 (Fig. 7), RY101 and RY120 show the deposits range from 79-93 percent sand. Two additional minor littoral deposits, 2806 and 2807 (Fig. 8), have been identified but the proximity of the water table to the surface restricts mineral extraction.

RESERVES AND ANNUAL DEMAND FOR SAND AND GRAVEL

Total estimated reserves of sand and gravel are shown in Table A-2 of Appendix A. Total reserves are estimated at 20.4 million cubic metres. Estimated reserves by quality are summarized in Table 2.

TABLE 2. ESTIMATED RESERVES OF SAND AND GRAVEL BY QUALITY

('000 cubic metres)

QUALITY	ESTIMATED RESERVES
High	—
Medium-High	5 562.8
Medium	232.0
Medium-Low	663.6
Low	13 995.4
Total:	20 453.8

Table 2 shows the majority of available reserves are low quality. These deposits consist of fine sand. Medium to medium-low quality deposits include deposits 2806-2808 from which mineral extraction is restricted by the high water table. Deposits of medium and medium-high quality include deposits 2809 and 2810. Combined reserves of higher quality sand and gravel from these deposits total 5,794.8 million cubic metres.

Estimated annual demand for sand and gravel is shown in Table 3:

TABLE 3. ESTIMATED ANNUAL DEMAND FOR SAND AND GRAVEL

('000 cubic metres)

User	Demand
R.M. of Whitemouth	17.0
Department of Highways	
Sand	0.5
Sand and Gravel	1.5
Private	1.0
Total:	20.0

The demand for sand and gravel was based upon a review of applications for mineral dispositions and reported quarry returns on file with the Mineral Resources Division and interviews with the Department of Highways and Rural Municipality of Whitemouth. The largest demand is for municipal road maintenance which utilizes 17,000 cubic metres annually.

Because of the isolated location of deposit 2810 this deposit supplies a limited regional demand necessitating the Rural Municipality to obtain sand and gravel from Crown leases outside the municipality. It is anticipated that deposit 2809 may be able to supply some municipal requirements.

CONCLUSIONS

Surficial deposits consist primarily of bogs, clays, and till plains. Extensive areas of bedrock outcrops are located along the eastern portion of the municipality. Sand and gravel resources are derived from beach, littoral and glaciofluvial deposits. The beach and littoral deposits consist primarly of fine sand. The regionally significant sources of sand and gravel are two glaciofluvial deposits with combined reserves of 5.7 million cubic metres.

FIGURE 6: Glaciofluvial deposit 2810 illustrating the grain size variations of the sand and gravel. Survey rod is divided into 1 foot (0.3 metre) units.

FIGURE 7: Beach ridge deposit 2801 at site RY100. The deposit is 1.5 m deep and composed of pebbly fine sand. Survey rod is divided into 1 foot (0.3 metre) units.

FIGURE 8: Littoral deposit 2807 at site RY107. The water table is within 0.5 m of the surface restricting mineral extraction.

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APPENDIX A

TABLE A-1. GRAIN SIZE DISTRIBUTION

DEPOSIT	2801		2801		2806		2807		2808	
SAMPLE	RY100		RY101		RY103		RY107		RY112	
	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED
4½ IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
3½ IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
3 IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
2½ IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
2 IN	100.00	0.0	100.00	0.0	100.00	0.0	93.08	6.92	100.00	0.0
1½ IN	100.00	0.0	100.00	0.0	100.00	0.0	93.08	6.92	100.00	0.0
1 IN	99.29	0.71	100.00	0.0	100.00	0.0	85.69	14.31	96.00	4.00
¾ IN	98.62	1.38	100.00	0.0	100.00	0.0	78.87	21.13	92.10	7.90
⅝ IN	97.82	2.18	100.00	0.0	99.42	0.58	76.66	23.34	91.02	8.98
½ IN	97.27	2.73	100.00	0.0	97.31	2.69	72.41	27.59	89.84	10.16
⅜ IN	95.64	4.36	100.00	0.0	94.89	5.11	67.52	32.48	87.43	12.57
¼ IN	93.53	6.47	99.86	0.14	88.63	11.37	63.18	36.82	84.43	15.57
#4	91.97	8.03	99.80	0.20	84.26	15.74	60.49	39.51	82.74	17.26
#8	88.63	11.37	99.62	0.38	74.52	25.48	55.01	44.99	78.47	21.53
#10	87.75	12.25	99.53	0.47	71.29	28.71	53.41	46.59	77.09	22.91
#16	85.19	14.81	99.31	0.69	62.25	37.75	49.04	50.96	73.42	26.58
#30	79.45	20.55	98.09	1.91	49.41	50.59	40.84	59.16	66.63	33.37
#40	68.70	31.30	95.59	4.41	43.46	56.54	34.88	65.12	61.20	38.80
#50	35.12	64.88	84.70	15.30	34.21	65.79	30.06	69.94	53.78	46.22
#80	11.36	88.64	39.01	60.99	16.68	83.32	26.80	73.20	40.97	59.03
#100	9.62	90.38	32.61	67.39	13.35	86.65	26.16	73.84	38.86	61.14
#200	8.63	91.37	22.92	77.08	10.54	89.46	24.56	75.44	32.49	67.51
<200		100.00		100.00		100.00		100.00		100.00
% Cobbles	0.00		0.00		0.00		0.00		0.00	
% Pebbles	8.03		0.20		15.74		39.51		17.26	
% Granules	4.22		0.27		12.97		7.08		5.64	
% Sand	79.12		76.61		60.75		28.84		44.60	
% Silt/clay	8.63		22.92		10.54		24.56		32.49	

TABLE A-1. GRAIN SIZE DISTRIBUTION (Cont'd)

DEPOSIT	2809		2810		2810		2810			
SAMPLE	RY100		RY118A		RY118B		RY118C		RY120	
	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED	PERCENT PASSING	PERCENT RETAINED
4 IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
3½ IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
3 IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
2½ IN	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0	100.00	0.0
2 IN	100.00	0.0	94.47	5.53	100.00	0.0	100.00	0.0	100.00	0.0
1½ IN	88.15	11.85	92.33	7.67	93.54	6.46	92.52	7.48	100.00	0.0
1 IN	79.35	20.65	86.95	13.05	86.38	13.62	87.07	12.93	100.00	0.0
¾ IN	73.29	26.71	80.02	19.98	80.51	19.49	80.21	19.79	100.00	0.0
⅝ IN	71.09	28.91	75.26	24.74	76.53	23.47	77.42	22.58	100.00	0.0
½ IN	68.80	31.20	71.16	28.84	71.70	28.30	74.09	25.91	100.00	0.0
⅜ IN	63.93	36.07	66.10	33.90	66.36	33.64	69.46	30.54	100.00	0.0
¼ IN	59.21	40.79	59.41	40.59	58.11	41.89	63.39	36.61	99.83	0.17
#4	55.58	44.42	54.92	45.08	52.51	47.49	58.58	41.42	99.74	0.26
#8	48.92	51.08	44.95	55.05	41.81	58.19	41.36	58.64	99.47	0.53
#10	47.37	52.63	42.16	57.84	38.70	61.30	36.11	63.89	99.34	0.66
#16	43.47	56.53	34.40	65.60	30.23	69.77	21.46	78.54	98.63	1.37
#30	34.83	65.17	18.36	81.64	14.37	85.63	8.96	91.04	96.18	3.82
#40	28.37	71.63	10.24	89.76	7.74	92.26	6.25	93.75	93.68	6.32
#50	24.49	75.51	5.17	94.83	3.74	96.26	4.64	95.36	88.60	11.40
#80	22.74	77.26	2.62	97.38	1.80	98.20	3.25	96.75	39.74	60.26
#100	22.49	77.51	2.21	97.79	1.46	98.54	2.85	97.15	27.44	72.56
#200	21.88	78.12	1.09	98.91	0.65	99.35	1.76	98.24	5.36	94.64
<200		100.00		100.00		100.00		100.00		100.00
% Cobbles	0.00		0.00		0.00		0.00		0.00	
% Pebbles	8.03		44.42		45.49		41.42		0.26	
% Granules	25.49		12.77		13.81		22.47		0.40	
% Sand	21.88		1.09		0.65		1.76		93.98	
% Silt/clay	8.63		22.92		10.54		24.56		5.36	

TABLE A-2. SAND AND GRAVEL RESOURCES

Deposit	Sample	Area (hectares)	Average Depth (metres)	Lithology[1] % Precambrian	% Carbonate	Crushable Material	Available Aggregate ('000 cubic metres)	Estimated[2] Quality
2801		412.2	1.5				6,091.9	
	100			56	44	NO		Low
	101			90	7	NO		Low
2802		32.3	1.5				484.5	Low
2803		400.9	1.5				5,638.5	Low
2804		40.8	2.0				816.0	Low
2805		64.3	1.5				964.5	Low
2806	103	45.9	1.0	22	78	NO	366.8	Medium-Low
2807	107	15.4	0.5	32	68	YES	68.8	Medium
2808	112	78.7	0.5	50	50	NO	296.8	Medium-Low
2809	114	6.8	3.0	50	50	NO	163.2	Medium
2810		79.0	5.5				5,562.8	
	118A			100		YES		Medium
	118B			100		YES		Medium-High
	118C			100		YES		Medium-High
Minor Strandline	120		1.5			NO		Low
TOTAL							20,453.8	

1. 4-16 mm size

2. Estimated Quality — Percent Gravel

80-100	High
60-80	Medium-High
40-60	Medium
20-40	Medium-Low
0-20	Low