Aggregate Report AR93-1

Aggregate Resources in the Rural Municipalities of Albert and Pipestone

by H.D. Groom

Manitoba
Energy and Mines
Mines Branch

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TABLE OF CONTENTS

FIGURES

TABLES

MAPS

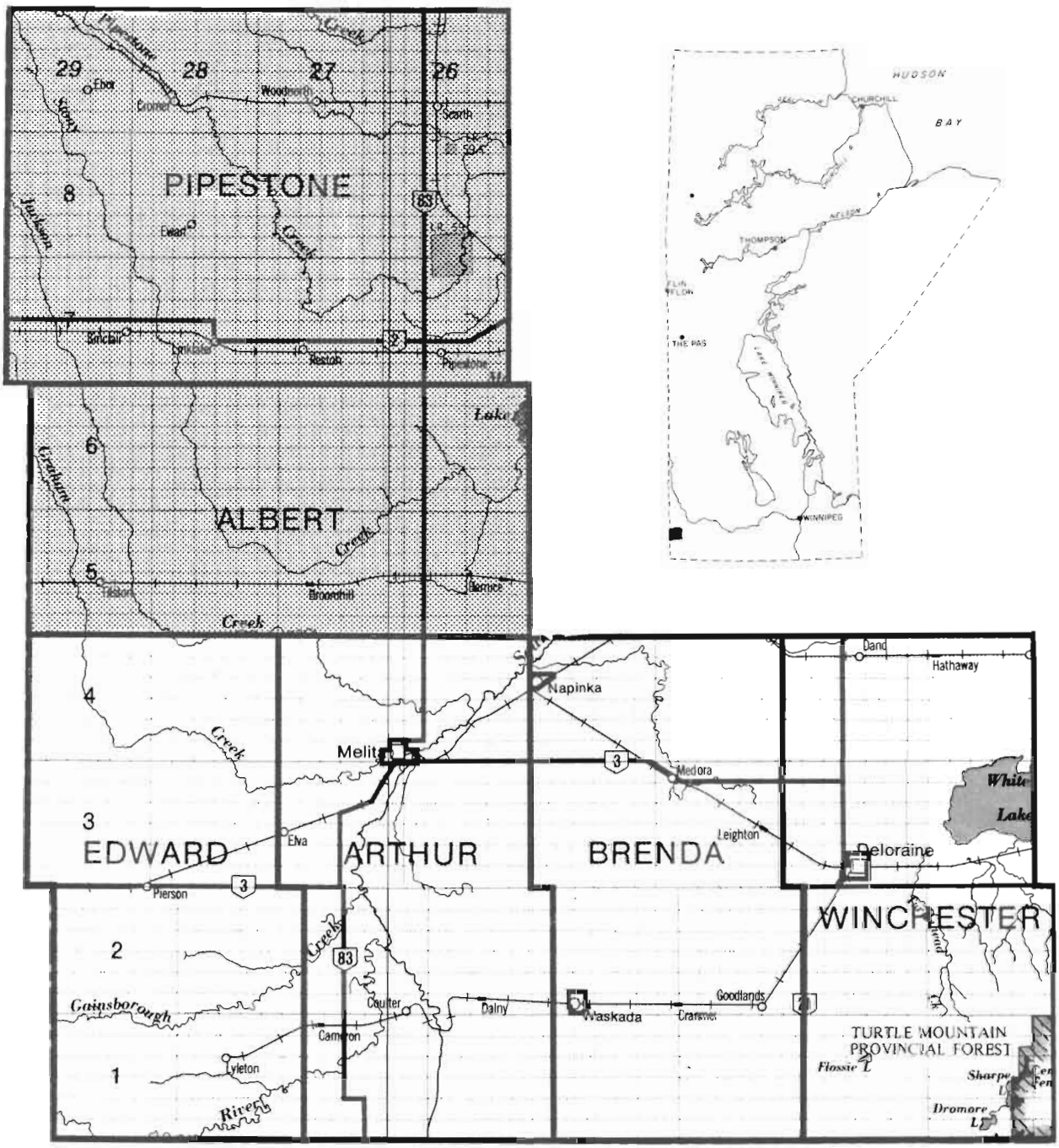

Figure 1: Location map of the R.M.s of Albert and Pipestone.

INTRODUCTION

OBJECTIVES

An aggregate resource inventory was carried out in the rural municipalities of Albert and Pipestone during the summer of 1989 in order to:

1. delineate the sand and gravel resources at a scale of 1:50 000; and
2. provide an estimate of the aggregate reserves in the area.

The information is used to provide aggregate users with resource information for construction needs and to facilitate land-use planning designed to protect high quality aggregate deposits from sterilization.

LOCATION AND ACCESS

The boundaries of the rural municipalities of Albert and Pipestone encompass 1 865 km^2 between Townships 5-9 and Ranges 26-29W in southwestern Manitoba (Fig. 1). The project area includes six 1:50 000 map sheets in NTS areas 62F/6, 7, 10, 11, 14 and 15.

The area is primarily a farming district. The town of Virden, located just north of the study area, is the major service centre. The villages of Pipestone, Reston, Sinclair and Cromer all are important locally. Highways 2 and 83 and a network of gravelled Provincial Roads and section roads provide good access to most parts of the district.

PHYSIOGRAPHY

The Rural Municipalities of Albert and Pipestone lie in the Souris River Plain and Souris Basin area of the Saskatchewan Plain. The bedrock surface dips to the west. Overlying glacial sediments are correspondingly thicker to the west. Overall, the present day surface slopes gently to the northeast. Along the Saskatchewan-Manitoba border, elevations fall from 550 metres above sea level (m.a.s.l.) in the north to 500 m.a.s.l. in the south. Along the eastern boundary, elevations fall from 442 m.a.s.l. in the south to 435 m.a.s.l. in the north.

The topography is generally flat to gently rolling except in the area of Pipestone Creek. On till plains and delta surfaces, linear ridges and circular rims around depressions rise 1 to <3 m high. Relief in the central part of the area, which is underlain by lake sediments, is generally 1 to <2 m. The walls of the valley of Pipestone Creek are >30 m high in the area north of Cromer where the valley is about 1 km wide; the valley shallows and widens southward. A ridge of gravel and till lies within the valley, flanking the creek. The main part of the ridge lies south of the creek but small portions of the same feature are found on the north bank. This ridge rises as much as 22 m above the valley floor.

Major drainage channels are Jackson, Graham, Pipestone and Stony creeks. These creeks all flow southeastwards across the till plain, but flow east or northeastwards across the lacustrine sediments, generally below the 445 m contour.

METHODOLOGY

Surficial deposits were delineated on 1:50 000 scale airphotos. Airphoto interpretation was based on surficial units outlined by Elson (1961) and incorporated information from Manitoba Department of Highways and Transportation Service gravel pit inventory files.

Gravel pits, road cuts and natural exposures were examined during the first part of the field investigation. This was followed by a backhoe program to test the extent, depth and quality of identified aggregate deposits.

Aggregate samples were processed in two stages. In the field, samples that weighed between 75 and 100 kilograms were passed through 6" (15.2 cm), 3" (7.5 cm), 1½" (3.8 cm) and ¾" (1.9 cm) screens. The weights of the 3", 1½", ¾" and <¾" fractions were recorded and the relative abundance of the 3-6" and the >6" fractions noted. A representative sample of the <¾" fraction was sieved in the laboratory. Sieve intervals are shown in Appendix A.

Pebble counts of the ¾" to 1½" fraction were used to determine the content of carbonate, sandstone and Precambrian intrusive, volcanic and metamorphic lithologies, as well as the extent of deleterious factors such as shale, chert, concretions, weathering and cementation.

Gravel deposits were delineated on 1:15 850 scale airphotos and transferred to 1:50 000 scale photos for use in the 1:50 000 scale maps that accompany this report (Maps AR93-1-1 and AR93-1-2, in pocket).

Deposit reserves were obtained by multiplying area by proven aggregate depths; sterilization and depletion factors were taken into account.

PREVIOUS WORK

The surficial geology of the area has been mapped at a scale of 1:126 720 and the glacial history was outlined by Elson (1956, 1961) as part of a regional study of southwestern Manitoba and southeastern Saskatchewan. The soils of the area were mapped at a scale of 1:126 720 by Ehrlich *et al.* (1956) and Ellis and Shafer (1974) and at a scale of 1:20 000 by Eilers *et al.* (1978). Maps of drift thickness are included in groundwater studies prepared by Betcher (1983). The Albert-Pipestone area is within the area being studied by Sun (1993), who is researching the history of glacial Lake Hind.

The bedrock geology was mapped by Wickenden (1945) and Bannatyne (1970), and the units were further described by McNeil and Caldwell (1981). A map of the regional bedrock topography, at a scale of one inch to eight miles, has been produced by Klassen *et al.* (1970). Klassen and Wyder (1970) discuss the location and fill of buried valleys; the bedrock topography map that accompanies their report has a scale of 1:250 000.

ACKNOWLEDGEMENTS

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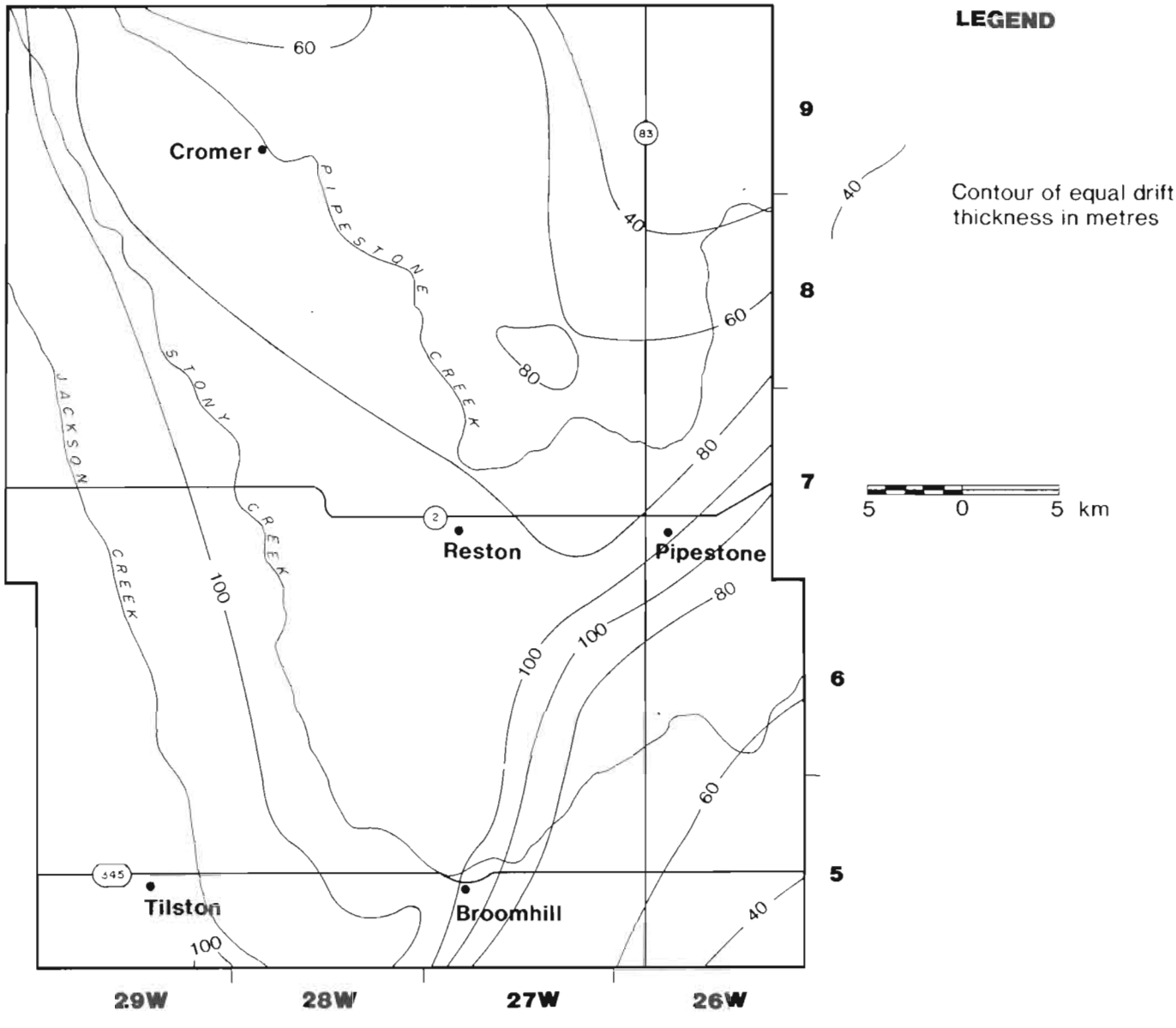

Figure 2: Drift thickness map (after Betcher, 1983).

BEDROCK GEOLOGY

The municipalities are underlain by the Odanah Member of the Pierre Shale. Bannatyne (1970) assigned this unit to the Riding Mountain Formation, but work by McNeil and Caldwell (1981) resulted in a revised nomenclature that abandoned the use of the name "Riding Mountain Formation" and assigned its members to the Pierre Shale. The Odanah Member is a hard grey siliceous marine shale with thin interbeds of soft olive-grey shale. Bentonite beds occur infrequently throughout the unit.

Bedrock in the Albert-Pipestone area is overlain by <40 to >100 m of Quaternary sediments (Fig. 2; Betcher, 1983). These sediments are thickest where they infill the Pierson Valley, an early Pleistocene channel that lies within the preglacial Missouri River Valley (Klassen and Wyder, 1970).

LATE GLACIAL HISTORY

A generalized map of the surficial sediments in the region is shown in Figure 3. The sequence of late Wisconsinan events, particularly the deglacial history of the area, is outlined in Elson (1956). The surface till was deposited by southeastward-flowing ice during the Late Wisconsinan. As the ice thinned during retreat, re-entrants formed around heights of land such as Turtle Mountain to the east and Moose Mountain to the west in Saskatchewan. Glacial Lake Souris formed at the ice front. Ice marginal channels and eskers carried sediments southeastward, depositing a series of outwash fans and deltas along the north and west shores of the lake. The Pembina Trench was the northern outlet; as the trench deepened, Lake Souris shrank in size until it was entirely contained within the north basin. At this stage, Elson (1956) refers to the lake as Glacial Lake Hind. The majority of the fans were deposited in Lake Souris; a prominent wave-cut scarp at the 442 m level was formed during the Napinka phase of Lake Hind. Further deepening of the trench caused Lake Hind to recede completely from the area.

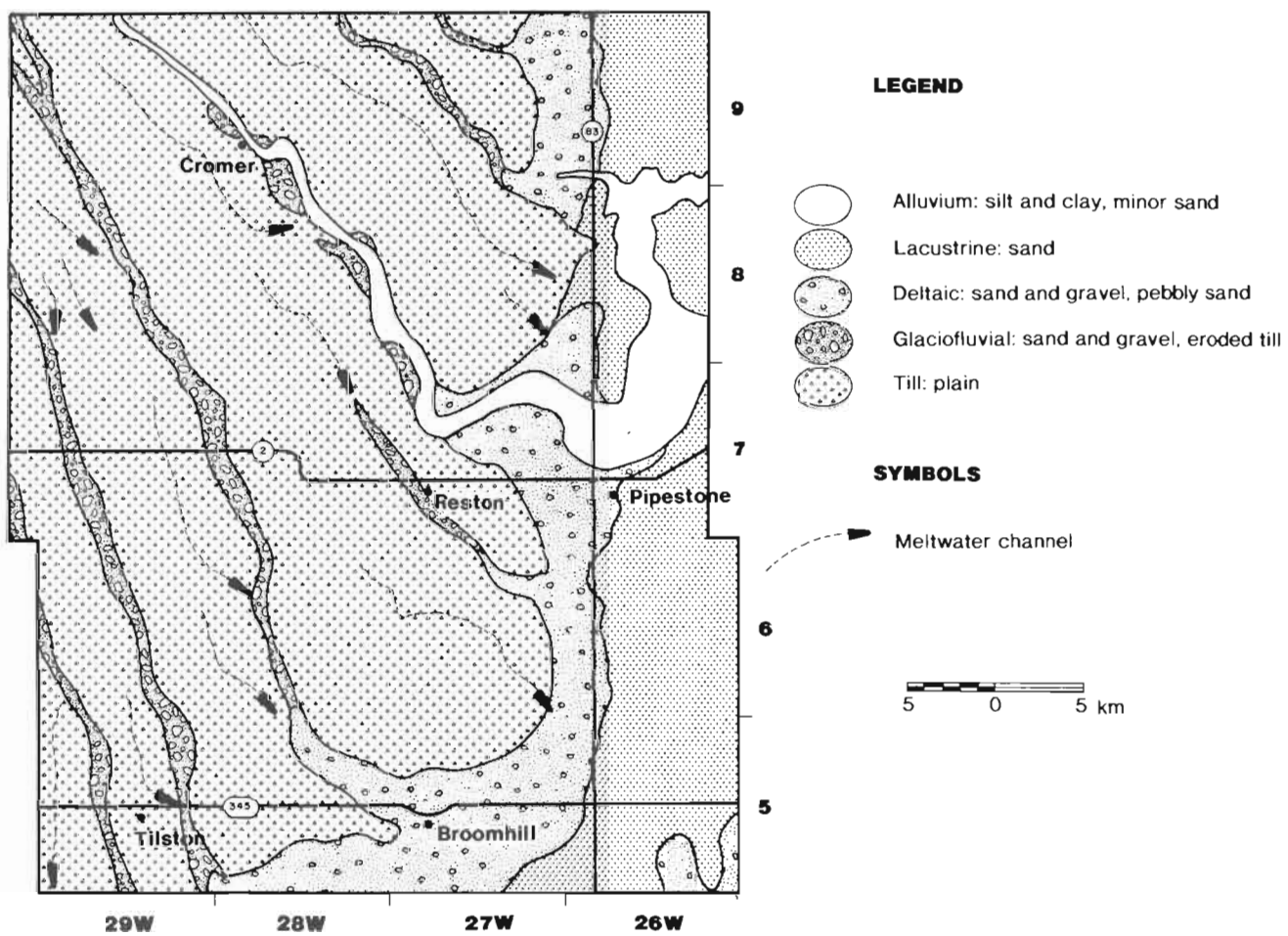

Figure 3: Surficial geology of the R.M.s of Albert and Pipestone (modified from Elson, 1961).

AGGREGATE RESOURCES

INTRODUCTION

The sand and gravel resources of the Albert-Pipestone area formed as meltwater channels flowed from the ice front, creating deltas at their mouths as they entered Lake Souris. As such, the deposits tend to be linear in the western part of the area and open to a broader areal extent in the central and eastern portions of the municipalities.

Deposit and sample locations, as well as deposit production potential, are shown on Maps AR93-1-1 and AR93-1-2 (in pocket). Information about the deposits is presented in summary tables in the text and in detail in the appendices. Table 1 summarizes pit status, material type, reserves and site specific information for each deposit. Table 2 summarizes grain size data for all samples. Detailed sieve results are given in Appendix B. Pebble lithology of the 3/4" to 1½" (1.9-3.8 cm) fraction and the percentage of deleterious components in each sample are presented in Appendix C. Appendix D consists of logs of the backhoe test pits. Appendix E summarizes aggregate information contained in Manitoba Department of Highways Block Files. Appendix F contains maps that show the location of crown lands in the municipalities. Appendix G is a glossary of relevant terms.

AGGREGATE RESERVES

Much of the Albert-Pipestone area is underlain by sand (map unit 5), pebbly sand (unit 4a) and sand and gravel (unit 4b). The sand and pebbly sand units have been shown on the map, but were excluded from reserve calculations as they have limited economic value. As well, since the deltaic deposits were formed by rivers as they flowed into the lake, the boundaries between units are gradational and their positions as shown on the maps are necessarily arbitrary. The line between the gravel (4b) and pebbly sand (4a) portions of each delta deposit is a best fit based on field observations and tests; pockets of gravel occur in the areas of unit 4a and there is much sand in the portions that are marked as unit 4b.

There are 61 869.5 x 10^3 cubic metres of aggregate reserves in the Albert-Pipestone area. Of these, 32 308.2 x 10^3 m^3 are in the R.M. of Albert and 29 561.3 x 10^3 m^3 in the R.M. of Pipestone. Table 3 shows aggregate reserves classified by production potential for deposits within each municipality. Production potential depends not only on quantity and quality of the aggregate in the deposit, but also on factors such as hauling distance to the job site, the availability of alternative sources, and land-use conflicts that may prevent gravel extraction. These criteria have been considered in the calculation of the production potential figures (Table 4).

CONCLUSIONS

Aggregate reserves in the R.M.s of Albert and Pipestone are found in deltaic and meltwater channel deposits scattered throughout the area. The deltaic deposits are generally the best sources of aggregate as they have greater thickness and areal extent; however, the meltwater stream deposits are important for meeting local, small volume needs and most have pits in them. The esker deposits along Pipestone Creek are generally a good source of aggregate and several have been extensively mined.

The R.M. of Pipestone has, by far, the greater abundance of aggregate in high production potential deposits, concentrated primarily in esker and deltaic deposits. These deposits contain pockets of coarse gravel and have variable, but generally low, amounts of shale. The activity in the largest of these deposits (12042) relates mainly to the maintenance of P.T.H. 83. The R.M. of Albert, on the other hand, has much lower reserves with "high production potential". The largest deltaic deposit (12066) has been given a medium potential because of the greater haulage distance between the coarse apex and P.T.H. 83.

In conclusion, the Albert-Pipestone area has more than enough aggregate to meet its needs for the foreseeable future. The distance of the region from major urban centres and the low development pressure within the two municipalities make it unlikely that this situation will change.

Table 1: Aggregate deposits in the R.M.s of Albert and Pipestone

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12001	HM214s	Inter.	40	297.2	Shale
	HM214A	Aband.			
	HB944				
12002	HM215s	Inter.	41	180.3	
	HM216	Inter.			
	HB945				
	HB946				
	HB947				
12003	HM213s	Inter.	39	166.6	
12004	HM295	Aband.		162.3	
	HM296	Aband.			
	HM297s	Inter.	42		
	HB931				
	HB932As		62		
	HB932Bs		60		
	HB934				
	HB935				
	HB936				
12005	HM218s	Inter.	1	400.3	
	HM219	Aband.			
	HM220s	Inter.	53		
	HM221s	Inter.	31		
	HM222s	Inter.	50		
12006	HM228	Aband.		752.0	
	HB941				
	HB943s	Aband.	42		
12007	HM225As	Inter.	53	1 019.0	
	HM225Bs	Inter.	52		
	HM226s	Inter.	25		
	HM227s	Aband.	30		
	HM229s	Inter.	59		
	HM230				
	HM231				
	HB937				
	HB938				
	HB939				
	HB940				
12008	HM302	Aband.		12.2	
	HM303	Aband.			
12009	HM300	Aband.		12.0	
12010	HM304s		44	132.2	
	HM305	Aband.			
	HM306s	Aband.	36		

* Aband. = Abandoned; pit has not been used in several years, usually has begun to revegetate; not necessarily depleted.
Inter. = Intermittent; pit is active or has been in recent use.

** Shale content is based on visual estimate on site, percentage shale, *e.g.*, (5%) is percent by weight of the 5-10 mm fraction.

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12011	HM298s	Aband.	43	56.6	
	HA170				
	HA171				
	HA172				
12012	HM299s	Inter.	50	0.6	
12013	HM177s	Aband.	26	2 693.9	
	HM178	Aband.			
	HM180s	Inter.	40		
	HM181s		20		
	HM307s	Aband.	24		
	HM308s	Inter.	39		
	HM309s	Inter.	44		
	HM310	Aband.			
	HM311				
	HA175s		26		
12014	HM312			25.5	Dugout shows 1.5 m very sandy, fine pebble gravel above the water; till at bottom of dugout
12015	HM343	Aband.		185.3	
12016	HM345			14.3	Ditch cut shows at least 1m very sandy fine pebble gravel
12017	HM173	Aband.		11.0	Pit depleted
12018	HM344			37.1	Ditch cut shows at least 1m sandy fine pebble gravel
12019	HA205			177.9	
	HA206				
12020	HM266As	Inter.	47	376.6	
	HM266Bs		38		
	HA143s		45		
	HA144				
12021	HM267s		37	1 944.9	
	HM268As	Inter.	44		
	HM268Bs	Inter.	48		
	HM313	Inter.			
	HM334				
	HB963s		47		
	HB964				
	HA169				
12022	HM336s	Inter.	54	181.4	
12023	HM314s	Aband.	28	72.4	
12024	HB949s		28	38.1	Ditch cut: >3 m sandy fine pebble gravel
12025	HM236	Aband.		369.5	Gravel remains to north

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Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12026	HB950			206.3	Deposit is generally <2 m pebble gravel over till
	HB951	Aband.			
	HB952s		49		
	HB953				
	HB954				
	HB955				
	HB956				
12027	HM237	Aband.		73.0	Minor reserves remain south of the pit
12028				40.5	Unopened deposit
12029	HM238s	Inter.	39	37.1	
	HM240				
12030	HM239s	Inter.	36	32.1	
12031	HM245s	Inter	39	270.4	
	HM246s	Aband.	49		
12032	HM243s	Inter.	52	386.7	
	HM244	Aband.			
12033	HM242s	Inter.	38	13.5	
12034	HM287	Aband.		741.8	
	HM288	Aband.			
	HM289	Aband.			
	HM290s	Inter.	56		
	HM291s	Aband.	51		
	HM292	Aband.			
	HM293	Aband.			
	HM341s	Inter.	58		
12035	HM210s	Aband.	42	1 093.2	
	HM211				
	HM212s	Inter.	44		
	HB965				
	HB966s		53		
	HB967				
	HB968				
	HB969				
	HB970				
12036	HM294As	Aband.	37	106.0	
	HM294Bs	Aband.	28		
12037	HM197	Aband.		968.6	
	HM197A	Inter.			
	HM248s	Aband.	35		
	HA138				
	HA139s		44		
	HA140				
	HA141s		57		
	HA142				

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Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12038					Unopened deposit
12039	HM198s	Aband.	35	20.3	
12040	HM193	Aband.		571.8	
	HM194	Aband.			
12041	HM164s		32	--	Deposit is primarily coarse sand or pebbly sand.
	HM171				
	HM172s		40		
	HA137				
	HA182				
	HA183				
	HA184s		9		
12042	HM165			15 641.6	
	HM166s	Aband.	52		
	HM167s	Inter.	47		
	HM169s	Inter.	49		
	HM170	Aband.			
	HM183s	Aband.	15		
	HM185				
	HM186s	Aband.	44		
	HM187	Aband.			
	HM188	Aband.			
	HM189	Aband.			
	HM190	Aband.			
	HM191s	Inter.	46		
	HA115s		41		
	HA116				
	HA117s		51		
	HA118				
	HA119s		33		
	HA120				
	HA121				
	HA122s		10		
	HA123s		36		
	HA124s		52		
	HA125s		52		
	HA126				
	HA127				
	HA128s		47		
	HA129s		44		
	HA130				
	HA131s		45		
	HA132				
	HA133				
	HA134s		41		
	HA135s		41		

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** Shale content is based on visual estimate on site; percentage shale, *e.g.*, (5%) is percent by weight of the 5-10 mm fraction.

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12042 cont'd	HA136				
	HA177				
	HA178s		46		
	HA179				
	HA180				
	HA181				
	HA185				
	HA186s		41		
	HA187				
	HA188s		31		
	HA189				
	HA190				
	HA204				
12043	HM200	Aband.		2 198.8	
	HM202s		20		
	HM315s		31		
	HM316	Aband.			
	HM318	Aband.			
	HM319s	Inter.	37		
	HM320s	Aband.	47		
	HM321s	Aband.	30		
	HM531				
	HM532				
	HA191				
	HA192				
	HA193				
	HA194				
	HA195s		28		
	HA196				
12044	HM184			--	Deposit is primarily coarse sand or pebbly sand; pockets of fine pebble gravel occur locally
	HM201				
	HM249	Aband.			
	HM250				
	HM251s		6		
	HM252				
	HM322				
	HM329				
	HM331				
	HM533				
	HB971				
12045	HM530			84.5	Gravel is depleted in the south and shallow over sand in the north
12046	HM282s	Inter.	39	45.4	

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Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12047	HA164s		36	67.5	
	HA166				
12048	HM281	Aband.		19.6	
12049	HM284	Aband.		15.2	
12050	HM283s	Inter.	53	29.8	
12051	HM263s	Aband.	43	758.4	
12052	HA163			56.7	
12053	HM260			1 249.2	
	HM261s		45		
	HM347	Inter.			
	HA163s		47		
12054	HM264s	Aband.	48	147.6	
	HM265	Aband.			
12055	HM270As	Inter.	32	873.7	
	HM270Bs	Inter.	28		
	HM271s	Inter.	38		
	HA156				
	HA157				
	HA158				
	HA159s		42		
	HA160				
12056				51.2	Unopened deposit
12057	HM234s		35	942.4	
	HM235s	Aband.	37		
	HM277s	Aband.	48		
	HM278	Aband.			
	HA151				
	HA152s		49		
	HA153				
	HA154				
	HA155				
12058				17.5	Unopened deposit
12059	HM272s	Aband.	30	987.3	
	HM273s	Aband.	39		
	HM274s	Aband.	32		
	HM275				
	HM276	Aband.			
	HM279				
	HM340s	Aband.	38		
12060	HM233s	Aband.	25	136.8	
12061				84.8	Unopened deposit

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Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4)* (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12062	HB986			2 888.9	Northern extension of deposit #11826 in Edward-Arthur report (AR92-5)
	HA145				
	HA146				
	HA147s		39		
	HA148				
	HA149				
	HA150s		40		
12063	HM527			--	Deposit is primarily coarse sand or pebbly sand.
	HM528				
	HB987				
	HB988				
12064	HM286s	Aband.	37	71.1	
12065	HM326s	Aband.		189.0	
	HM328s	Aband.	40		
12066	HM203s	Inter.	41	20 713.7	
	HM204s	Aband.	37		
	HM205	Aband.			
	HM206	Aband.			
	HM207	Aband.			
	HM208	Aband.			
	HM253				
	HM254				
	HM255	Aband.			
	HM256	Aband.			
	HM257s		34		
	HM258	Aband.			
	HM259s	Inter.	48		
	HM265				
	HM325s	Inter.	37		
	HM327	Aband.			
	HM330				
	HM332s		44		
	HM333	Aband.			
	HM337				
	HM338				
	HM339	Inter.			
	HB972s		41		
	HB973				
	HB974				
	HB975				
	HB976s		39		
	HB977				
	HB978s		51		
	HB979				
	HB980s		43		

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Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76 mm)	Estimated Reserves ('000s m^3)	Comments
12066 cont'd	HB981				
	HB982				
	HB983				
	HB984s		47		
	HB985				
	HB989				
	HB990s		30		
	HB991				
	HB992				
	HB993s		25		
	HB994				
	HB995s		44		
	HB996				
	HB997				
	HB998s		36		
	HB999				
	HA101				
	HA102				
	HA103s		42		
	HA104				
	HA105s		38		
	HA106s		43		
	HA107				
	HA108				
	HA109				
	HA110s		34		
	HA111s		22		
	HA112s		17		
	HA113				
	HA114				
	HA197				
	HA198				
12067	HM323	Aband.		25.1	
12068	HM324	Aband.		25.8	
12069	HM153			123.9	
12070	HA202			247.5	Northern extension of deposit #11801 in Edward-Arthur report (AR92-5)
12071				256.8	Northern extension of deposit #11806 in Edward-Arthur report (AR92-5)
		Total Reserves		61 869.5	

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** Shale content is based on visual estimate on site; percentage shale, *e.g.*, (5%) is percent by weight of the 5-10 mm fraction.

Table 2: Summary of Grain Size Distribution of Gravel Samples

Deposit Number	Sample Number	% Gravel (> #4) (> 4.76 mm)	% Sand (4.76 mm-0.07 mm)	% Silt and Clay (<0.07 mm)	Oversize on Site (>6")
12001	HM214	40	56	4	-
12002	HM215	41	55	4	X
12003	HM213	39	55	6	X
12004	HM297	42	55	3	X
	HB932A	62	34	4	-
	HB932B	60	37	3	-
12005	HM218	1	95	4	-
	HM220	53	44	3	X
	HM221	31	67	2	X
	HM222	50	46	4	X
12006	HB943	42	53	5	X
12007	HM225A	53	44	3	X
	HM225B	52	45	3	X
	HM226	25	68	7	X
	HM227	30	64	6	X
	HM229	59	39	2	X
12010	HM304	44	49	7	-
	HM306	36	60	4	-
12011	HM298	43	48	9	X
12012	HM299	50	45	5	X
12013	HM177	26	73	1	-
	HM180	40	57	3	X
	HM181	20	77	3	X
	HM307	24	73	3	-
	HM308	39	59	2	X
	HM309	44	54	2	-
	HA175	26	68	6	-
12020	HM266A	47	50	3	X
	HM266B	38	60	2	X
	HA143	45	53	2	-
12021	HM267	37	60	3	X
	HM268A	44	53	3	X
	HM268B	48	50	2	X
	HB963	47	44	9	X
12022	HM336	54	42	4	X
12023	HM314	28	69	3	X
12024	HB949	28	70	2	-
12026	HB952	49	45	6	X
12029	HM238	39	57	4	-
12030	HM239	36	61	3	X
12031	HM245	39	59	2	X
	HM246	49	46	5	X
12032	HM243	52	44	4	X
12033	HM242	38	34	4	-
12034	HM290	42	56	2	-
	HM291	45	51	4	X
	HM341	38	58	4	X

Deposit Number	Sample Number	% Gravel (> #4) (> 4.76 mm)	% Sand (4.76 mm-0.07 mm)	% Silt and Clay (<0.07 mm)	Oversize on Site (>6")
12035	HM210	42	54	4	X
	HM212	44	52	4	X
	HB966	53	43	4	X
12036	HM294A	37	59	4	X
	HM294B	28	56	6	X
12037	HM248	35	63	2	-
	HA139	44	53	3	-
	HA141	57	40	3	-
12039	HM198	35	62	3	X
12041	HM164	32	66	2	-
	HM172	40	57	3	X
	HA184	9	87	4	-
12042	HM166	56	42	2	X
	HM167	47	50	3	-
	HM169	49	49	2	X
	HM183	15	83	2	X
	HM186	44	53	3	X
	HM191	46	51	3	X
	HA115	41	57	3	-
	HA117	51	47	2	X
	HA119	33	65	2	X
	HA122	10	88	2	-
	HA123	36	62	2	X
	HA124	52	44	4	X
	HA125	52	45	3	-
	HA128	47	51	2	X
	HA129	44	54	2	X
	HA131	45	52	3	-
	HA134	41	56	3	X
	HA135	41	56	3	-
	HA178	46	52	2	-
	HA186	41	57	2	X
	HA188	31	67	2	-
12043	HM202	20	77	3	-
	HM315	31	67	2	-
	HM319	37	60	3	-
	HM320	47	50	3	-
	HM321	30	67	3	-
	HA195	28	69	3	-
12044	HM251	6	92	2	-
12046	HM282	39	57	4	X
12047	HA164	36	61	3	-
12050	HM283	53	42	5	X
12051	HM263	43	52	5	-
12053	HM261	45	51	4	-
	HA163	47	50	3	X
12054	HM264	48	49	3	-
12055	HM270A	32	65	3	X
	HM270B	28	70	2	X
	HM271	38	60	2	-
	HA159	42	56	2	-

Deposit Number	Sample Number	% Gravel (> #4) (> 4.76 mm)	% Sand (4.76 mm-) (0.07 mm)	% Silt and Clay (<0.07 mm)	Oversize on Site (>6")
12057	HM234	35	61	4	-
	HM235	37	61	2	-
	HM277	48	47	5	X
	HA152	49	45	6	-
12059	HM272	30	67	3	-
	HM273	39	59	2	X
	HM274	32	65	3	-
	HM340	38	59	3	-
12060	HM233	25	73	2	-
12062	HA147	39	58	3	X
	HA150	40	57	3	-
12064	HM286	37	60	3	X
12065	HM326	40	57	3	X
	HM328	33	60	7	X
12066	HM203	41	54	5	X
	HM204	37	59	4	-
	HM257	34	63	3	-
	HM259	48	49	3	-
	HM325	37	62	1	X
	HM332	44	55	1	X
	HB972	41	56	2	X
	HB976	39	59	2	-
	HB978	51	43	6	-
	HB980	43	55	2	-
	HB984	47	49	4	-
	HB990	30	66	4	-
	HB993	25	72	3	-
	HB995	44	52	4	X
	HB998	36	62	2	-
	HA103	42	54	4	-
	HA105	38	60	2	-
	HA106	43	56	1	-
	HA110	34	62	4	X
	HA111	22	76	2	-
	HA112	17	81	2	-
NO DEPOSIT					
	HM162				
	HM217	40	53	7	X
	HM247	49	43	8	X
	HM262	26	71	3	-

Table 3: Aggregate Reserves in the R.M.s of Albert and Pipestone

Rural Municipality	Production Potential High ('000 m^3)	Medium ('000 m^3)	Low ('000 m^3)	Total ('000 m^3)
Albert	903.5	27 163.5	4 241.2	32 308.2
Pipestone	21 184.5	5 221.5	3 155.3	29 561.3
Total	22 088.0	32 385.0	7 396.5	61 869.5

Table 4: Aggregate Quality and Development Potential Criteria

	Criteria	HIGH	MEDIUM	LOW
AGGREGATE QUALITY	Stone %	>30	15-30	0-15
	Sand %	0-35	35-70	>70
	Mud %	0-7	7-17	>17
	Shale %	0-5	5-12	>12
	Thickness	>5 m	2-5 m	<2 m
	Uniformity	high	medium	low
DEPOSIT DEVELOPMENT POTENTIAL	Aggregate Quality	high	medium	low
	<6"	abundant	moderate	minor
	>6"	minor	moderate	abundant
	Overburden	<2 m	2-4 m	>4 m
	Binder	yes	minor	none
	Water Table	>5 m	2-5 m	<2 m
	Geological Potential	good	moderate	low
	Verification	proven	limited	untested
	Local Access	0-1 km	1-5 km	>5 km
	Quarrying Status	active	intermittent	inactive
	Transportation Diff.	high	medium	low
	Planning Constraints	none	conditional	sterilized
	Speciality Material	yes		no
	Aggregate Substitute	none	marginal	proximal

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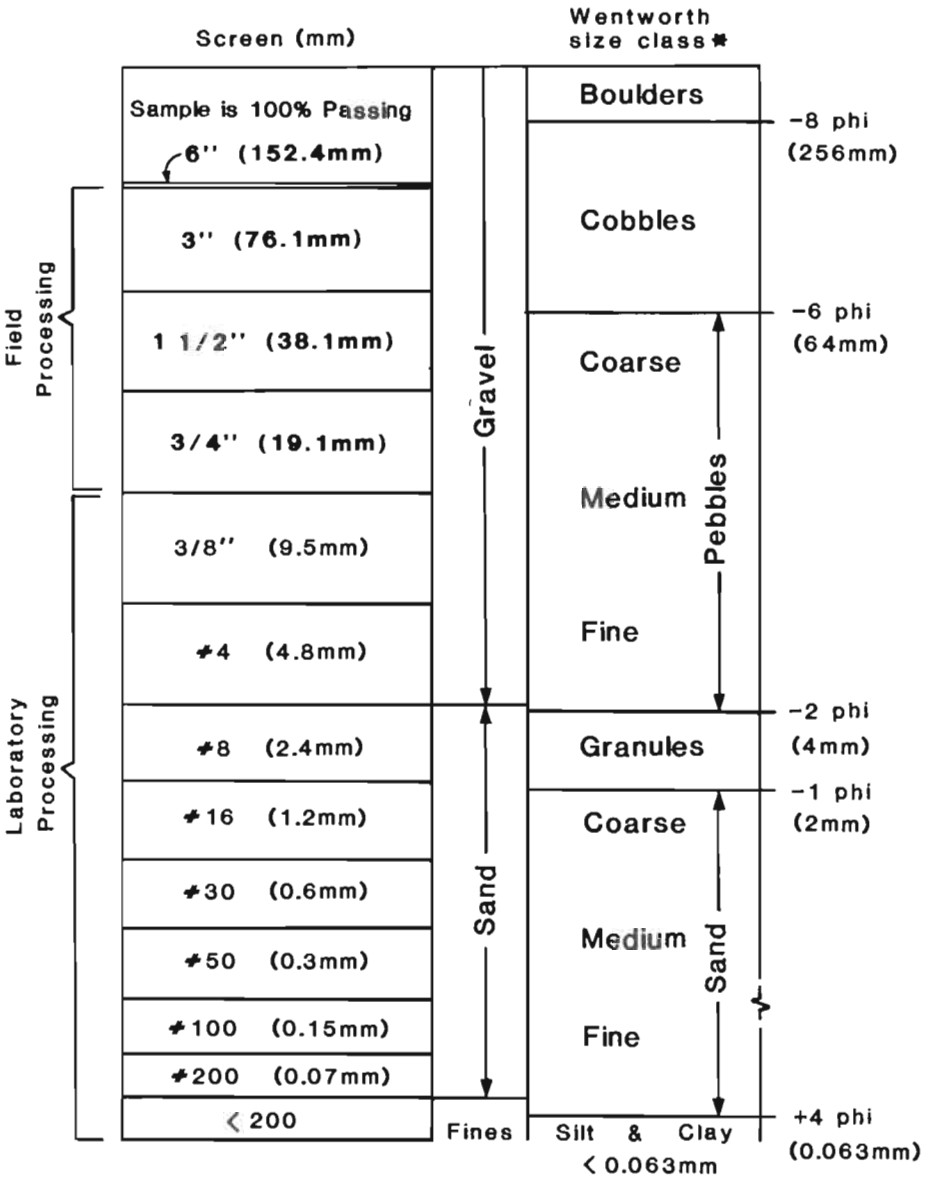
APPENDIX A
GRAIN SIZE CLASSIFICATION AND SIEVE INTERVALS



* modified from Folk, 1974

Figure A-1: Grain size classification.

APPENDIX B
SIEVE SAMPLE DATA

Deposit Number		12001	12002	12003	12004	12004
Sample Number		HM214	HM215	HM213	HM297	HB932A
3"-6" / >6"		S/-	A/M*	A/A	M/S	M/-
	3"	100	98	97	99	100
%	1½"	100	95	93	85	89
	¾"	83	87	85	74	71
P	⅜"	74	77	76	65	54
A	#4	60	59	61	58	38
S	#8	50	42	39	51	28
S	#16	40	33	19	38	24
I	#30	26	24	10	21	20
N	#50	11	11	7	7	11
G	#100	5	5	6	4	6
	#200	4	4	6	3	4

Deposit Number		12005	12005	12005	12005	12006
Sample Number		HM218	HM220	HM221	HM222	HB943
3"-6" / >6"		-/-	A/M	M/S	M/S	A/A
	3"	100	96	100	100	100
%	1½"	100	81	99	95	90
	¾"	100	65	92	82	79
P	⅜"	100	57	81	69	67
A	#4	99	47	69	50	58
S	#8	94	36	54	33	49
S	#16	66	26	36	23	33
I	#30	27	18	16	17	18
N	#50	9	8	5	9	10
G	#100	5	4	3	6	7
	#200	4	3	2	4	5

Deposit Number		12007	12007	12007	12007	12007
Sample Number		HM225A	HM225B	HM226	HM227	HM229
3"-6" / >6"		A/M	A/M	A/A	S/S	M/S
	3"	100	93	100	100	100
%	1½"	93	86	96	98	96
	¾"	77	73	89	90	75
P	⅜"	62	63	86	84	54
A	#4	47	48	75	70	41
S	#8	32	31	57	48	33
S	#16	20	17	36	28	28
I	#30	13	10	22	16	24
N	#50	7	6	13	9	9
G	#100	4	4	9	7	3
	#200	3	3	7	6	2

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12010	12010	12011	12012	12013
Sample Number		HM304	HM306	HM298	HM299	HM177
3"-6" / >6"		S/-	-/-	M/S	M/S	S/-
	3"	100	100	99	100	100
%	1½"	96	96	89	92	97
	¾"	82	89	76	74	90
P	⅜"	69	76	66	62	83
A	#4	56	64	57	50	74
S	#8	39	54	48	42	65
S	#16	22	46	35	33	52
I	#30	14	27	24	23	33
N	#50	10	9	17	12	9
G	#100	8	5	12	7	2
	#200	7	4	9	5	1

Deposit Number		12013	12013	12013	12013	12013
Sample Number		HM180	HM181	HM307	HM308	HM309
3"-6" / >6"		S/S	S/S	S/-	M/S	S/-
	3"	100	100	100	100	100
%	1½"	90	100	97	97	92
	¾"	78	98	91	86	82
P	⅜"	69	94	84	73	68
A	#4	60	80	76	61	56
S	#8	52	61	69	50	44
S	#16	41	42	58	35	28
I	#30	26	24	34	15	12
N	#50	10	12	9	5	5
G	#100	4	5	4	2	2
	#200	3	3	3	2	2

Deposit Number		12013	12020	12020	12020	12021
Sample Number		HA175	HM266A	HM266B	HA143	HM267
3"-6" / >6"		-/-	M/S	S/S	S/-	A/M
	3"	100	100	100	100	90
%	1½"	98	98	100	91	80
	¾"	92	87	94	77	75
P	⅜"	85	73	77	64	69
A	#4	74	53	62	55	63
S	#8	58	38	46	48	55
S	#16	41	27	29	34	36
I	#30	28	14	11	9	12
N	#50	14	8	4	4	5
G	#100	7	4	2	3	4
	#200	6	3	2	2	3

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12021	12021	12021	12022	12023
Sample Number		HM268A	HM268B	HB963	HM336	HM314
3"-6" / >6"		A/M	A/M	A/A	A/A	M/S
	3"	100	93	100	94	99
%	1½"	89	83	90	81	91
	¾"	74	70	77	66	84
P	⅜"	66	60	66	54	78
A	#4	56	52	53	46	72
S	#8	42	41	41	38	65
S	#16	27	27	31	27	55
I	#30	14	15	25	14	38
N	#50	6	6	17	7	13
G	#100	3	3	12	5	5
	#200	3	3	9	4	3

Deposit Number		12024	12026	12029	12030	12031
Sample Number		HB949	HB952	HM238	HM239	HM245
3"-6" / >6"		-/-	A/S	S/-	S/S	S/S
	3"	100	95	100	100	100
%	1½"	95	84	97	94	97
	¾"	90	75	85	86	88
P	⅜"	83	61	75	75	78
A	#4	72	51	61	64	61
S	#8	54	37	46	50	41
S	#16	31	25	32	36	24
I	#30	14	16	19	20	11
N	#50	5	11	8	7	4
G	#100	3	8	4	4	3
	#200	2	6	4	3	2

Deposit Number		12031	12032	12033	12034	12034
Sample Number		HM246	HM243	HM242	HM290	HM291
3"-6" / >6"		A/M	M/S	M/-	M/-	A/S
	3"	94	100	98	95	96
%	1½"	79	89	92	89	85
	¾"	66	70	83	83	75
P	⅜"	60	60	73	72	65
A	#4	51	48	62	58	55
S	#8	40	36	51	47	44
S	#16	29	24	37	38	30
I	#30	19	18	22	22	14
N	#50	10	11	10	6	7
G	#100	7	6	5	2	5
	#200	5	4	4	2	4

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12034	12035	12035	12035	12036
Sample Number		HM341	HM210	HM212	HB966	HM294A
3"-6" / >6"		M/S	S/S	M/S	M/M	S/S
	3"	100	100	100	100	100
%	1½"	98	95	92	82	94
	¾"	81	80	82	64	85
P	⅜"	71	69	71	57	75
A	#4	62	58	56	47	63
S	#8	49	40	41	36	42
S	#16	34	22	29	22	23
I	#30	19	16	22	13	16
N	#50	9	7	13	7	9
G	#100	5	4	6	5	6
	#200	4	4	4	4	4

Deposit Number		12036	12037	12037	12037	12039
Sample Number		HM294B	HM248	HA139	HA141	HM198
3"-6" / >6"		M/M	S/-	S/-	M/-	M/S
	3"	96	100	100	100	99
%	1½"	92	95	97	87	95
	¾"	87	89	87	69	85
P	⅜"	83	78	75	55	77
A	#4	72	65	56	43	65
S	#8	54	48	41	32	51
S	#16	34	28	28	22	35
I	#30	23	14	20	15	22
N	#50	12	5	8	6	9
G	#100	8	3	5	4	4
	#200	6	2	3	3	3

Deposit Number		12041	12041	12041	12042	12042
Sample Number		HM164	HM172	HA184	HM166	HM167
3"-6" / >6"		-/-	M/M	-/-	M/S	M/-
	3"	100	96	100	100	100
%	1½"	100	83	100	95	97
	¾"	93	75	99	76	84
P	⅜"	83	68	96	57	71
A	#4	68	60	91	44	53
S	#8	50	51	83	37	38
S	#16	29	41	69	25	25
I	#30	12	26	48	12	15
N	#50	4	9	21	5	9
G	#100	2	4	7	2	4
	#200	2	3	4	2	3

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12042	12042	12042	12042	12042
Sample Number		HM169	HM183	HA186	HM191	HA115
3"-6" / >6"		S/S	S/S	A/-	S/S	S/-
	3"	100	100	94	100	100
%	1½"	89	97	80	87	94
	¾"	78	94	70	74	80
P	⅜"	62	90	65	63	69
A	#4	51	85	56	54	59
S	#8	40	80	48	46	48
S	#16	25	69	37	33	36
I	#30	10	37	21	14	20
N	#50	4	8	8	6	8
G	#100	2	3	4	3	3
	#200	2	2	3	3	2

Deposit Number		12042	12042	12042	12042	12042
Sample Number		HA117	HA119	HA122	HA123	HA124
3"-6" / >6"		A/M	A/A	S/-	M/S	A/M
	3"	98	96	100	98	99
%	1½"	89	89	100	91	84
	¾"	77	83	100	84	69
P	⅜"	64	75	95	76	57
A	#4	49	67	90	64	48
S	#8	40	60	83	51	39
S	#16	32	48	64	29	27
I	#30	24	32	35	11	11
N	#50	8	14	8	4	6
G	#100	3	4	3	2	5
	#200	2	2	2	2	4

Deposit Number		12042	12042	12042	12042	12042
Sample Number		HA125	HA128	HA129	HA131	HA134
3"-6" / >6"		M/-	M/M	S/S	S/-	M/S
	3"	96	100	100	100	100
%	1½"	80	85	94	87	94
	¾"	66	72	79	73	83
P	⅜"	54	62	69	63	71
A	#4	48	53	56	55	59
S	#8	42	42	45	47	47
S	#16	27	27	31	32	36
I	#30	12	15	14	12	22
N	#50	5	6	4	5	8
G	#100	4	3	3	4	3
	#200	3	2	2	3	3

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12042	12042	12042	12042	12043
Sample Number		HA135	HA178	HA186	HA188	HM202
3"-6" / >6"		S/-	-/-	A/A	S/-	-/-
	3"	100	100	100	100	100
%	1½"	91	95	88	96	99
	¾"	79	83	78	85	94
P	⅜"	72	69	69	78	87
A	#4	59	54	59	69	80
S	#8	46	42	49	61	66
S	#16	32	26	38	48	51
I	#30	15	13	21	32	30
N	#50	5	7	6	13	9
G	#100	3	3	2	3	4
	#200	3	2	2	2	3

Deposit Number		12043	12043	12043	12043	12044
Sample Number		HM319	HM320	HM321	HA195	HM251
3"-6" / >6"		S/-	M/-	S/-	-/-	-/-
	3"	95	95	100	100	100
%	1½"	92	86	96	95	100
	¾"	82	74	91	88	99
P	⅜"	74	63	83	80	97
A	#4	63	53	70	72	94
S	#8	49	43	53	58	92
S	#16	34	33	35	39	87
I	#30	19	21	19	18	65
N	#50	8	10	8	7	20
G	#100	4	4	4	4	5
	#200	3	3	3	3	2

Deposit Number		12043	12046	12047	12050	12051
Sample Number		HM315	HM282	HA164	HM283	HM263
3"-6" / >6"		S/-	M/S	S/-	A/M	-/-
	3"	100	100	100	94	100
%	1½"	97	93	93	83	97
	¾"	88	79	84	68	84
P	⅜"	79	72	75	54	70
A	#4	69	61	64	47	57
S	#8	58	50	51	40	47
S	#16	41	35	35	28	33
I	#30	21	17	20	17	19
N	#50	8	8	7	10	10
G	#100	3	5	4	7	6
	#200	2	4	3	5	5

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12053	12053	12054	12055	12055
Sample Number		HM261	HA163	HM264	HM270A	HM270B
3"-6" / >6"		-/-	A/A	S/-	S/S	S/S
	3"	100	100	100	100	98
%	1½"	97	84	96	98	92
	¾"	79	69	77	94	85
P	⅜"	65	64	64	85	76
A	#4	55	53	52	68	72
S	#8	47	36	41	49	66
S	#16	41	21	29	25	54
I	#30	28	14	21	14	29
N	#50	13	6	11	7	6
G	#100	6	4	5	4	2
	#200	4	3	3	3	2

Deposit Number		12055	12055	12057	12057	12057
Sample Number		HM271	HA159	HM234	HM235	HM277
3"-6" / >6"		S/-	S/-	S/-	-/-	A/A
	3"	100	95	100	100	98
%	1½"	90	85	95	97	89
	¾"	78	75	87	87	73
P	⅜"	72	65	76	72	62
A	#4	62	58	65	63	52
S	#8	53	52	54	55	40
S	#16	41	42	41	44	26
I	#30	23	24	22	24	16
N	#50	6	7	7	8	11
G	#100	2	3	4	3	7
	#200	2	2	4	2	5

Deposit Number		12057	12059	12059	12059	12059
Sample Number		HA152	HM272	HM273	HM274	HM340
3"-6" / >6"		S/-	S/-	S/S	S/-	S/-
	3"	100	100	100	100	98
%	1½"	95	96	99	97	90
	¾"	79	87	89	87	80
P	⅜"	65	80	76	81	75
A	#4	51	70	61	68	62
S	#8	36	56	46	51	49
S	#16	22	39	30	30	31
I	#30	17	19	15	14	13
N	#50	12	6	5	9	6
G	#100	8	3	3	5	4
	#200	6	3	2	3	3

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12061	12062	12062	12064	12065
Sample Number		HM233	HA147	HA150	HM286	HM326
3"-6" / >6"		-/-	M/S	M/-	S/S	M/S
	3"	100	98	100	100	97
%	1½"	99	82	94	95	94
	¾"	95	71	82	83	84
P	⅜"	86	67	70	74	72
A	#4	75	61	60	63	60
S	#8	63	54	50	51	40
S	#16	49	43	38	36	20
I	#30	27	23	24	14	13
N	#50	8	7	10	8	6
G	#100	3	3	4	4	4
	#200	2	3	3	3	3

Deposit Number		12066	12066	12066	12066	12066
Sample Number		HM203	HM204	HM257	HM259	HM325
3"-6" / >6"		M/S	S/-	-/-	S/-	S/S
	3"	99	100	100	100	99
%	1½"	97	95	96	94	90
	¾"	87	88	85	80	77
P	⅜"	76	78	75	66	69
A	#4	59	63	66	52	63
S	#8	40	43	58	41	56
S	#16	24	25	48	30	41
I	#30	15	12	32	17	21
N	#50	9	7	13	7	6
G	#100	6	5	5	4	2
	#200	5	4	3	3	1

Deposit Number		12065	12066	12066	12066
Sample Number		HM328	HM332	HB972	HB976
3"-6" / >6"		M/M	S/S	M/M	S/-
	3"	100	100	100	100
%	1½"	98	95	90	93
	¾"	95	80	77	81
P	⅜"	84	67	68	70
A	#4	67	56	59	61
S	#8	49	46	52	49
S	#16	34	35	42	36
I	#30	21	22	21	17
N	#50	14	8	6	5
G	#100	10	3	3	3
	#200	7	1	2	2

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		12066	12066	12066	12066	12066
Sample Number		HB978	HB980	HB984	HB990	HB993
3"-6" / >6"		M/-	S/-	S/-	S/-	-/-
	3"	100	100	100	100	100
%	1½"	84	92	92	94	99
	¾"	65	79	80	86	91
P	⅜"	56	68	72	81	82
A	#4	49	57	53	70	75
S	#8	41	45	36	56	67
S	#16	28	30	23	39	54
I	#30	18	20	17	21	33
N	#50	11	9	11	10	12
G	#100	7	4	6	5	4
	#200	6	2	4	4	3

Deposit Number		12066	12066	12066	12066	12066
Sample Number		HB995	HB998	HA103	HA105	HA106
3"-6" / >6"		M/S	-/-	S/-	-/-	S/S
	3"	100	100	99	100	95
%	1½"	86	97	96	93	91
	¾"	76	88	84	82	84
P	⅜"	65	75	75	71	72
A	#4	56	64	58	62	57
S	#8	48	50	42	54	43
S	#16	39	33	31	42	25
I	#30	27	19	19	24	12
N	#50	14	7	11	8	5
G	#100	6	3	6	3	2
	#200	4	2	4	2	1

Deposit Number		12066	12066	12066	NODEP	NODEP
Sample Number		HA110	HA111	HA112	HM217	HM247
3"-6" / >6"		M/S	-/-	-/-	A/M	A/M
	3"	98	100	100	96	96
%	1½"	94	100	100	86	86
	¾"	84	94	93	78	69
P	⅜"	77	88	90	70	60
A	#4	66	78	83	60	51
S	#8	56	66	75	47	43
S	#16	42	51	62	31	33
I	#30	24	33	33	18	22
N	#50	9	12	8	12	14
G	#100	5	3	3	9	10
	#200	4	2	2	7	8

* A=abundant; M=moderate; S=scarce; -=not present

Deposit Number		NODEP
Sample Number		HM262
3"-6" / >6"		-/-
	3"	100
%	1½"	100
	¾"	95
P	⅜"	86
A	#4	74
S	#8	58
S	#16	34
I	#30	17
N	#50	10
G	#100	4
	#200	3

* A=abundant; M=moderate; S=scarce; -=not present

APPENDIX C
% PEBBLE LITHOLOGY OF THE ¾" - 1 ½" FRACTION

	Deposit Number	12001	12002	12003	12004	12004
	Sample Number	HM214	HM215	HM213	HM297	HB932
%	Carbonate	67	51	55	63	51
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	1	2	2	1	1
I	Greywacke, Argillite	1	-	9	-	1
T	pC -crystalline	24	36	32	25	35
H	pC -volcanic	4	9	-	8	4
O	DELETERIOUS					
L	Chert	-	-	-	-	1
O	Concretions	1		1	3	2
G	Shale	2	2	-	-	-
Y	Weathered	-	-	1	-	-
%	Sample encrusted/cemented	66	69	-	75	26
%	SHALE (5-10mm fraction)	<1	<1	<1	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12005	12005	12005	12006	12007
	Sample Number	HM220	HM221	HM222	HB943	HM225A
%	Carbonate	58	51	25	46	55
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	-	-	6	1	3
I	Greywacke, Argillite	-	1	-	13	3
T	pC -crystalline	34	48	52	37	35
H	pC -volcanic	6	*	17	1	3
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	1	-	-	1	-
G	Shale	1	-	-	1	-
Y	Weathered	-	-	-	-	-
%	Sample encrusted/cemented	71	73	69	3	59
%	SHALE (5-10mm fraction)	<1	<1	<1	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12007	12007	12007	12007	12010
	Sample Number	HM225B	HM226	HM227	HM229	HM304
%	Carbonate	56	52	61	41	56
	Sandstone, Arkose	1	-	-	-	-
L	Quartzite	6	3	3	1	2
I	Greywacke, Argillite	6	4	1	1	6
T	pC -crystalline	24	36	28	45	30
H	pC -volcanic	1	*	6	10	3
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	-	3	1	1	2
G	Shale	-	-	-	1	1
Y	Weathered	6	2	-	-	-
%	Sample encrusted/cemented	-	68	72	57	3
%	SHALE (5-10mm fraction)	<1	<1	<1	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12010	12011	12012	12013	12013
	Sample Number	HM306	HM298	HM299	HM177	HM180
%	Carbonate	71	60	55	45	62
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	-	-	1	2	2
I	Greywacke, Argillite	-	1	1	3	5
T	pC -crystalline	25	31	35	48	27
H	pC -volcanic	3	7	5	*	2
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	1	1	2	1	1
G	Shale	-	-	1	-	1
Y	Weathered	-	-	-	-	-
%	Sample encrusted/cemented	54	53	49	35	19
%	SHALE (5-10mm fraction)	-	<1	<1	<1	4

* pC crystalline and volcanic grouped together

	Deposit Number	12013	12013	12013	12013	12013
	Sample Number	HM181	HM307	HM308	HM309	HA175
%	Carbonate	33	49	51	53	45
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	-	1	2	1	-
I	Greywacke, Argillite	-	-	1	6	2
T	pC -crystalline	33	35	39	36	37
H	pC -volcanic	*	4	5	2	*
O	DELETERIOUS					
L	Chert	-	1	-	-	-
O	Concretions	-	-	1	1	3
G	Shale	33	9	1	-	8
Y	Weathered	-	1	-	1	5
%	Sample encrusted/cemented	46	74	81	8	42
%	SHALE (5-10mm fraction)	5	3	2	1	2

* pC crystalline and volcanic grouped together

	Deposit Number	12020	12020	12020	12021	12021
	Sample Number	HM266A	HM266B	HA143	HM267	HM268A
%	Carbonate	47	37	37	56	50
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	3	-	4	1	1
I	Greywacke, Argillite	3	1	5	1	3
T	pC -crystalline	42	48	52	33	35
H	pC -volcanic	4	12	*	7	10
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	-	1	1	2	-
G	Shale	1	-	1	-	1
Y	Weathered	-	-	-	-	-
%	Sample encrusted/cemented	34	67	57	85	66
%	SHALE (5-10mm fraction)	<1	<1	<1	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12021 HM268B	12021 HB963	12022 HM336	12023 HM314	12026 HB952
%	Carbonate	44	55	29	54	53
	Sandstone, Arkose	4	-	3	-	1
L	Quartzite	5	1	4	1	-
I	Greywacke, Argillite	5	5	10	1	-
T	pC -crystalline	31	36	39	34	39
H	pC -volcanic	*	1	2	8	*
O	DELETERIOUS					
L	Chert	-	-	1	-	1
O	Concretions	4	2	4	1	2
G	Shale	-	-	2	-	1
Y	Weathered	3	-	6	-	2
%	Sample encrusted/cemented	3	4	19	62	38
%	SHALE (5-10mm fraction)	<1	<1	<1	2	<1

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12029 HM238	12030 HM239	12031 HM245	12031 HM246	12032 HM243
%	Carbonate	54	55	54	58	53
	Sandstone, Arkose	-	-	-	-	1
L	Quartzite	1	3	1	-	-
I	Greywacke, Argillite	4	2	1	10	2
T	pC -crystalline	30	37	36	22	32
H	pC -volcanic	6	*	5	5	10
O	DELETERIOUS					
L	Chert	2	-	1	-	-
O	Concretions	1	2	1	2	2
G	Shale	2	-	1	-	-
Y	Weathered	-	1	-	3	-
%	Sample encrusted/cemented	11	54	64	61	53
%	SHALE (5-10mm fraction)	2	<1	<1	<1	-

* pC crystalline and volcanic grouped together

	Deposit Number	12033	12034	12034	12034	12035
	Sample Number	HM242	HM290	HM291	HM341	HM210
%	Carbonate	49	60	53	50	45
	Sandstone, Arkose	-	-	-	3	-
L	Quartzite	1	3	3	2	1
I	Greywacke, Argillite	4	-	-	3	-
T	pC -crystalline	34	29	30	34	44
H	pC -volcanic	5	5	8	-	9
O	DELETERIOUS					
L	Chert	2	-	-	-	1
O	Concretions	4	2	5	1	-
G	Shale	1	1	1	2	-
Y	Weathered	-	-	-	5	-
%	Sample encrusted/cemented	37	49	73	20	80
%	SHALE (5-10mm fraction)	2	<1	<1	<1	-

* pC crystalline and volcanic grouped together

	Deposit Number	12035	12035	12036	12036	12037
	Sample Number	HM212	HB966	HM294A	HM294B	HM248
%	Carbonate	50	53	49	52	58
	Sandstone, Arkose	-	-	-	6	-
L	Quartzite	2	2	1	2	1
I	Greywacke, Argillite	8	5	-	4	1
T	pC -crystalline	38	31	38	27	28
H	pC -volcanic	*	6	11	1	12
O	DELETERIOUS					
L	Chert	1	-	-	-	-
O	Concretions	-	2	1	2	-
G	Shale	1	1	-	-	-
Y	Weathered	-	-	-	6	-
%	Sample encrusted/cemented	37	21	90	17	86
%	SHALE (5-10mm fraction)	1	-	-	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12037	12037	12039	12041	12041
	Sample Number	HA139	HA141	HM198	HM164	HM172
%	Carbonate	54	53	48	56	54
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	2	2	-	2	1
I	Greywacke, Argillite	2	10	3	1	3
T	pC -crystalline	34	28	44	41	38
H	pC -volcanic	6	7	*	*	*
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	-	-	4	-	1
G	Shale	1	1	1	-	2
Y	Weathered	1	-	-	-	1
%	Sample encrusted/cemented	55	12	71	54	76
%	SHALE (5-10mm fraction)	<1	<1	<1	2	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12042	12042	12042	12042	12042
	Sample Number	HM166	HM167	HM169	HM183	HM18
%	Carbonate	50	45	39	57	59
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	1	2	-	-	1
I	Greywacke, Argillite	1	2	8	-	4
T	pC -crystalline	47	42	53	42	32
H	pC -volcanic	-	8	-	-	3
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	1	-	-	-	-
G	Shale	-	-	-	-	-
Y	Weathered	-	1	-		-
%	Sample encrusted/cemented	64	73	32	81	68
%	SHALE (5-10mm fraction)	-	<1	1	-	-

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12042 HM191	12042 HA115	12042 HA117	12042 HA119	12042 HA123
%	Carbonate	50	45	55	63	48
	Sandstone, Arkose	-	-	-	-	1
L	Quartzite	1	1	4	2	1
I	Greywacke, Argillite	7	12	8	1	6
T	pC -crystalline	40	37	23	24	39
H	pC -volcanic	2	*	5	6	*
O	DELETERIOUS					
L	Chert	-	1	-	1	1
O	Concretions	-	1	-	2	2
G	Shale	-	1	1	1	-
Y	Weathered	-	2	-		2
%	Sample encrusted/cemented	19	23	50	35	35
%	SHALE (5-10mm fraction)	-	<1	<1	<1	1

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12042 HA124	12042 HA125	12042 HA128	12042 HA129	12042 HA131
%	Carbonate	58	46	58	49	60
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	-	-	2	1	1
I	Greywacke, Argillite	5	5	5	2	5
T	pC -crystalline	30	41	28	44	28
H	pC -volcanic	2	3	5	4	6
O	DELETERIOUS					
L	Chert	1	3	-	-	-
O	Concretions	4	-	1	-	-
G	Shale	-	2	-	-	-
Y	Weathered	-	-	1	-	-
%	Sample encrusted/cemented	26	45	30	60	37
%	SHALE (5-10mm fraction)	<1	<1	<1	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12042	12042	12042	12042	12042
	Sample Number	HA134	HA135	HA178	HA186	HA188
%	Carbonate	50	56	49	53	56
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	2	4	1	-	-
I	Greywacke, Argillite	3	1	11	10	3
T	pC -crystalline	36	30	34	34	37
H	pC -volcanic	6	7	*	*	*
O	DELETERIOUS					
L	Chert	1	-	-	-	1
O	Concretions	1	2	2	1	2
G	Shale	1	-	1	2	1
Y	Weathered	-	-	2	-	-
%	Sample encrusted/cemented	32	76	17	10	47
%	SHALE (5-10mm fraction)	3	<1	<1	1	2

* pC crystalline and volcanic grouped together

	Deposit Number	12043	12043	12043	12043	12043
	Sample Number	HM202	HM319	HM320	HM321	HA195
%	Carbonate	48	53	58	53	51
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	1	1	-	3	2
I	Greywacke, Argillite	2	5	1	1	3
T	pC -crystalline	47	31	33	28	39
H	pC -volcanic	*	6	7	5	*
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	1	1	1	2	2
G	Shale	1	3	-	7	1
Y	Weathered	-	-	-	1	2
%	Sample encrusted/cemented	81	71	87	65	43
%	SHALE (5-10mm fraction)	<1	2	<1	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12044 HM251	12044 HM315	12046 HM282	12047 HA164	12050 HM283
%	Carbonate	33	50	60	55	64
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	-	1	1	-	2
I	Greywacke, Argillite	-	2	2	3	5
T	pC -crystalline	58	39	28	31	18
H	pC -volcanic	9	5	8	*	10
O	DELETERIOUS					
L	Chert	-	-	-	1	-
O	Concretions	-	2	1	3	1
G	Shale	-	1	-	2	-
Y	Weathered	-	-	-	5	-
%	Sample encrusted/cemented	75	78	76	40	53
%	SHALE (5-10mm fraction)	3	1	1	-	-

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12051 HM263	12053 HM261	12053 HA163	12054 HM264	12055 HM270A
%	Carbonate	48	50	53	51	55
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	1	2	1	-	2
I	Greywacke, Argillite	9	-	11	6	3
T	pC -crystalline	40	42	34	37	35
H	pC -volcanic	-	6	*	4	*
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	1	-	-	1	1
G	Shale	1	-	-	-	4
Y	Weathered	-	-	1	1	-
%	Sample encrusted/cemented	3	66	7	19	34
%	SHALE (5-10mm fraction)	<1	<1	-	<1	-

* pC crystalline and volcanic grouped together

	Deposit Number	12055	12055	12055	12057	12057
	Sample Number	HM270B	HM271	HA159	HM234	HM235
%	Carbonate	46	54	45	51	50
	Sandstone, Arkose	9	-	-	1	1
L	Quartzite	2	2	2	2	2
I	Greywacke, Argillite	5	3	6	-	5
T	pC -crystalline	18	35	38	46	42
H	pC -volcanic	1	2	*	*	*
O	DELETERIOUS					
L	Chert	1	-	-	-	-
O	Concretions	-	3	2	-	-
G	Shale	14	1	-	-	-
Y	Weathered	5	-	7	-	-
%	Sample encrusted/cemented	-	21	35	61	27
%	SHALE (5-10mm fraction)	3	1	1	<1	1

* pC crystalline and volcanic grouped together

	Deposit Number	12057	12057	12059	12059	12059
	Sample Number	HM277	HA152	HM272	HM273	HM274
%	Carbonate	54	56	46	50	62
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	2	1	-	1	1
I	Greywacke, Argillite	1	8	7	1	1
T	pC -crystalline	33	28	36	36	26
H	pC -volcanic	7	6	8	8	9
O	DELETERIOUS					
L	Chert	-	-	-	2	-
O	Concretions	1	1	3	1	1
G	Shale	2	-	-	1	-
Y	Weathered	-	-	-	-	-
%	Sample encrusted/cemented	53	7	59	78	90
%	SHALE (5-10mm fraction)	1	-	<1	<1	-

* pC crystalline and volcanic grouped together

	Deposit Number	12059	12061	12062	12062	12064
	Sample Number	HM340	HM233	HA147	HA150	HM286
%	Carbonate	55	50	54	54	53
	Sandstone, Arkose	9	1	-	-	-
L	Quartzite	1	2	3	2	-
I	Greywacke, Argillite	5	-	2	2	4
T	pC -crystalline	19	47	35	32	33
H	pC -volcanic	*	*	3	9	8
O	DELETERIOUS					
L	Chert	-	-	1	-	-
O	Concretions	4	-	1	1	1
G	Shale	1	-	1	-	1
Y	Weathered	6	-	-	-	-
%	Sample encrusted/cemented	5	62	40	50	41
%	SHALE (5-10mm fraction)	-	<1	<1	-	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12065	12066	12066	12066	12066
	Sample Number	HM326	HM203	HM204	HM254	HM257
%	Carbonate	55	52	57	61	36
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	3	1	-	1	4
I	Greywacke, Argillite	2	2	1	4	2
T	pC -crystalline	27	41	37	30	42
H	pC -volcanic	2	*	*	2	17
O	DELETERIOUS					
L	Chert	-	-	-	-	-
O	Concretions	-	4	4	1	-
G	Shale	1	-	1	-	-
Y	Weathered	-	-	-	1	-
%	Sample encrusted/cemented	73	52	92	32	67
%	SHALE (5-10mm fraction)	<1	<1	<1	<1	<1

* pC crystalline and volcanic grouped together

	Deposit Number	12066	12066	12066	12066	12066
	Sample Number	HM259	HM325	HM328	HM332	HM338
%	Carbonate	59	45	60	53	39
	Sandstone, Arkose	-	-	-	-	11
L	Quartzite	1	2	2	-	5
I	Greywacke, Argillite	4	1	-	-	1
T	pC -crystalline	27	42	30	39	37
H	pC -volcanic	6	5	7	8	-
O	DELETERIOUS					
L	Chert	-	-	-	-	5
O	Concretions	2	3	1	-	2
G	Shale	-	1	-	-	-
Y	Weathered	-	-	-	-	-
%	Sample encrusted/cemented	54	55	84	97	13
%	SHALE (5-10mm fraction)	-	<1	<1	<1	-

* pC crystalline and volcanic grouped together

	Deposit Number	12066	12066	12066	12066	12066
	Sample Number	HB972	HB976	HB978	HB980	HB984
%	Carbonate	59	55	62	53	55
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	1	4	4	6	2
I	Greywacke, Argillite	1	-	6	1	5
T	pC -crystalline	34	33	22	31	32
H	pC -volcanic	3	5	3	8	6
O	DELETERIOUS					
L	Chert	1	-	1	-	-
O	Concretions	1	1	1	-	-
G	Shale	-	2	-	1	-
Y	Weathered	-	-	1	-	-
%	Sample encrusted/cemented	73	72	28	59	32
%	SHALE (5-10mm fraction)	-	<1	-	<1	-

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12066 HB990	12066 HB993	12066 HB995	12066 HB998	12066 HA103
%	Carbonate	61	58	59	52	52
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	1	-	1	1	1
I	Greywacke, Argillite	2	4	6	3	8
T	pC -crystalline	29	22	27	32	35
H	pC -volcanic	6	7	5	9	1
O	DELETERIOUS					
L	Chert	-	3	1	-	1
O	Concretions	-	3	1	1	1
G	Shale	-	3	-	2	-
Y	Weathered	-	-	-	-	-
%	Sample encrusted/cemented	58	33	32	59	15
%	SHALE (5-10mm fraction)	1	<1	<1	<1	-

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	12066 HA105	12066 HA106	12066 HA110	12066 HA111	NODEP HM162
%	Carbonate	54	52	58	60	56
	Sandstone, Arkose	-	-	-	-	-
L	Quartzite	2	4	3	2	1
I	Greywacke, Argillite	4	1	3	-	2
T	pC -crystalline	32	34	30	30	40
H	pC -volcanic	32	5	5	5	*
O	DELETERIOUS					
L	Chert	3	-	-	-	-
O	Concretions	3	2	1	1	1
G	Shale	2	1	-	2	1
Y	Weathered	-	1	-	-	-
%	Sample encrusted/cemented	36	53	59	91	82
%	SHALE (5-10mm fraction)	1	<1	-	1	4

* pC crystalline and volcanic grouped together

	Deposit Number Sample Number	NODEP HM217	NODEP HM247	NODEP HM262
%	Carbonate	59	45	58
	Sandstone, Arkose	-	-	-
L	Quartzite	3	1	2
I	Greywacke, Argillite	8	2	-
T	pC -crystalline	28	35	25
H	pC -volcanic	*	12	12
O	DELETERIOUS			
L	Chert	-	-	-
O	Concretions	1	5	3
G	Shale	1	-	-
Y	Weathered	-	-	-
%	Sample encrusted/cemented	11	61	84
%	SHALE (5-10mm fraction)	<1	-	<1

* pC crystalline and volcanic grouped together

APPENDIX D
BACKHOE TEST PIT LOGS

Deposit Number	Site Number s=sample	Log
12001	HB944	Ditch wall is 2 m sandy pebble gravel; base is 1.2 m sandy pebble gravel then into water
12002	HB945	base of small pit: 2 m sandy pebble gravel over till
	HB946	0.0 - >3.1 m cobble gravel (am=5-8";m=10")
		>3.1 water table
	HB947	1.2 m cobble over till
12004	HM297s	pit is 2-3 m deep; interbedded sandy coarse pebble gravel and sand
		backhoe at base:
		0.0 - 0.5 m sandy pebble gravel
		>1.5 till
	HB931	0.0 - 0.3 m soil
		0.3 - 1.0 pebbly sand
		1.0 - 2.0 interbeds of med. sand and pebbly sand
		>2.0 till
	HB932s	3.3m coarse pebble gravel (m=5") fining down to sandy pebble gravel at base;
		water table at base
	HB933	0.0 - 1.0 m coarse pebble gravel
		1.0 - 2.0 medium sand
		>2.0 till
	HB934	0.0 - 0.2 m soil
		0.2 - 1.0 sandy fine pebble gravel
		1.0 - 2.0 medium sand
		2.0 - 3.0 pebbly sand
		3.0 - >3.3 sandy fine pebble gravel
		>3.3 water table
	HB935	0.0 - 0.3 m soil
		0.3 - 1.0 sandy fine pebble gravel
		>1.0 till
	HB936	0.0 - >2.5 m cobble gravel, high coarse sand
		>2.5 water table
12006	HB941	0.0 - 0.3 m soil
		0.3 - 1.2 pebbly sand
		1.2 - 2.8 fine sand
		>2.8 pebbly sand
	HB943	in base of old pit:
		0.0 - 3.0 m sandy pebble gravel
		3.0 - >4.5 cobble gravel (am=5";m=10")
12007	HM227s	pit is 3 m sandy pebble gravel
		backhoe at base:
		0.0 - 1.0 m sandy fine pebble gravel
		1.0 - 3.0 cobbly coarse pebble gravel, sand content increases downward
	HB937	0.0 - 0.9 m cobble gravel
		>0.9 till
	HB938	0.8 m boulder and cobble lag over till
	HB939	0.3 m cobble lag over till
	HB940	0.0 - 0.2 m soil
		0.2 - 1.2 sandy fine pebble gravel
		1.2 - 2.7 cobble gravel
		>2.7 till

Deposit Number	Site Number s=sample	Log
12011	HA170	0.0 - 0.9 m alluvium 0.9 - 2.0 cobble gravel (m=7") >2.0 till
	HA171	0.0 - 0.2m soil 0.2 - 1.5 sandy coarse pebble gravel, some cobbles >1.5 till
	HA172	0.0 - 0.4 m soil 0.4 - 1.5 sandy cobble gravel with boulders at base >1.5 till
12013	HA175s	ditch depth: 1 m sandy pebble gravel base: 0.0 - 1.6 m sandy, very fine pebble gravel 1.6 - >2.0 med.-fine sand >2.0 water table
12020	HA143s	0.0 - 0.5 m soil 0.5 - 3.0 sandy pebble gravel 3.0 - 3.1 cobble bed (m=5") 3.1 - >3.5 pebbly coarse sand
	HA144	0.0 - 0.2 m soil 0.2 - >2.8 sandy pebble gravel (m=2")
12021	HA169	0.0 - 0.2 m soil 0.2 - >2.5 sandy coarse pebble gravel (m=7")
	HB963s	0.0 - 0.8 m diamicton 0.8 - 2.8 sandy coarse pebble gravel with small cobbles >2.8 till
12022	HB960	0.0 - 2.5 m sandy coarse pebble gravel, few small cobbles >2.5 silty fine sand; water table
	HB961	hole stopped at 1m due to extreme coarseness of material
12024	HB949s	ditch wall: 1 m sandy pebble gravel ditch floor: 0.0 - >2.2 m sandy fine pebble gravel
12026	HB950	0.0 - 1.8 m sandy pebble gravel; fines up from cobble gravel gravel at base to fine pebble gravel at top >1.8 till
	HB951	revegetated pit; 2 m sandy pebble gravel over till
	HB952s	0.0 - 1.5 m sandy coarse pebble gravel (am=3-4") >1.5 till
	HB953	0.0 - 1.6 m sandy pebble gravel (am=2") >1.6 till
	HB954	0.0 - 0.3 m sandy coarse pebble gravel >0.3 till
	HB955	0.0 - 0.8 m sandy fine pebble gravel >0.8 till
	HB956	0.0 - 0.3 m sandy coarse pebble gravel >0.3 till
12035	HB965	0.0 - 3.3 m cobble gravel; fines up from m=10" at base to m=4" at top >3.3 till
	HB966s	0.0 - 0.2 m soil 0.2 - 3.0 sandy coarse pebble gravel, cobbles (m=9") >3.0 till
	HB967	0.0 - 2.3 m sandy coarse pebble gravel, cobbles (m=7") >2.3 till
	HB968	0.0 - 2.8 m sandy coarse pebble gravel (m=4") >2.8 till

Deposit Number	Site Number s=sample	Log
	HB969	0.0 - 0.2 m soil 0.2 - 1.5 sandy coarse pebble gravel, cobbles (m=4") >1.5 till
	HB970	0.0 - 0.3 m soil 0.3 - 1.3 sandy pebble gravel >1.3 till
12037	HA138	0.0 - 0.2 m soil 0.2 - 1.7 sandy pebble gravel >1.7 till
	HA139s	0.0 - 0.2 m soil 0.2 - 1.2 sandy fine gravel 1.2 - >2.6 sandy pebble gravel (m=3")
	HA140	0.0 - 0.3 m soil 0.3 - >3.0 sandy coarse pebble gravel (m=4")
	HA141s	0.0 - 0.5 m soil (sand) 0.5 - >2.8 sandy coarse pebble gravel, cobbles (m=5, am=3")
	HA142	0.0 - 0.4 m soil 0.4 - >2.8 sandy pebble gravel, cobbles (m=6") in upper part
12041	HA137	0.0 - 0.6 m soil (fine sand) 0.6 - >2.5 pebbly sand to very sandy fine pebble gravel
	HA182	0.0 - 1.8 m medium sand over pebbly sand >1.8 till
	HA183	ditch wall: 1m sandy fine pebble gravel ditch floor: 0.0 - 0.6 m pebbly sand to sandy fine pebble gravel at base 0.6 - >1.8 medium sand
	HA184s	ditch wall: 2 m coarse pebbly sand ditch floor: 0.0 - 1.0 m medium coarse sand 1.0 - >2.0 pebbly sand, till balls and cobbles throughout
12042	HM188	pit is 2 m sandy pebble gravel backhoe at base: 0.0 - 1.5 m coarse sand, few pebble beds >1.5 water
	HM191s	pit is 4-6 m sandy pebble gravel with small cobbles backhoe at base: 0.0 - 0.6 m pebble gravel and water 0.6 - >0.8 clay, heavy, black, becomes stony downwards
	HM192	pit is 4-5 m sandy pebble gravel; floor is till in places and gravel in others backhoe at base: 0.0 - 2.0m sandy fine pebble gravel; water >2.0 till
	HA115s	0.0 - 3.0 m sandy fine pebble gravel at top grades down to coarse pebble gravel at base (m=3") >3.0 pea gravel; water table
	HA116	0.0 - 0.1 m soil 0.1 - 1.3 sandy fine pebble gravel 1.3 - 2.4 sandy pebble gravel (m=3") 2.4 - >3.3 medium fine sand
	HA117s	0.0 - 2.2 m sandy pebble gravel, coarsens to base 2.2 - >3.6 pebbly sand

Deposit Number	Site Number s=sample	Log
	HA118	0.0 - 0.2 m soil
		0.2 - 0.6 sandy fine pebble gravel
		0.6 - 1.4 pebbly sand
		1.4 - 3.5 cobble gravel (m=10")
		3.5 - >3.9 pebbly coarse sand
	HA119s	0.0 - 0.3 m soil
		0.3 - 1.3 coarse sand and granules
		1.3 - 2.0 cobble gravel
		2.0 - 3.0 sandy fine pebble gravel, small cobbles
		3.0 - >3.9 coarse sand
	HA120	0.0 - 0.7 m soil
		0.7 - 1.1 sandy pebble gravel
		1.1 - 1.9 pebbly coarse sand
		1.9 - 2.8 sandy pebble gravel
	HA121	0.0 - 0.3 m soil
		0.3 - 1.0 pebbly sand
		1.0 - >3.3 interbeds of cobble gravel (m=10") and sandy pebble gravel
	HA122s	0.0 - 0.2 m soil
		0.2 - 1.7 pebbly sand
		1.7 - >2.1 sandy coarse pebble gravel (m=3")
	HA123s	0.0 - >3.0 m sandy pebble gravel, some cobbles (m=6")
	HA124s	0.0 - 0.1 m soil
		0.1 - 3.0 sandy cobble gravel (m=10")
		3.0 - >3.9 sandy pebble gravel
	HA125s	0.0 - 0.1 m soil
		0.1 - 2.1 sandy pebble gravel interbedded with coarse sand and pebbles
		2.1 - >3.0 sandy cobble gravel (m=5")
	HA126	0.0 - 0.2 m soil
		0.2 - 1.3 medium coarse sand interbedded with granules
		1.3 - 2.8 sandy coarse pebble gravel (m=3")
		2.8 - >3.0 medium fine sand
	HA127	0.0 - 1.0 m ditch;sandy fine pebble gravel
		1.0 - 1.6 sandy coarse pebble gravel
		1.7 - >2.2 pebbly coarse sand
		>2.0 water table
	HA128s	0.0 - 0.3 m soil
		0.3 - 3.6 sandy coarse pebble gravel, small cobbles (m=7", am=3-5")
		>3.6 till
	HA129s	0.0 - 0.1 m soil
		0.1 - 2.8 sandy pebble gravel (am=3")
		>2.8 till
	HA130	0.0 - 0.4 m soil
		0.4 - 2.8 interbeds of coarse sand and sandy pebble gravel (m=5")
		2.8 - >3.9 coarse sand with pebbles and granules
	HA131s	0.0 - 0.1 m soil
		0.1 - 1.4 pebbly coarse sand grading down to sandy fine pebble gravel
		1.4 - >2.8 sandy coarse pebble gravel with small cobbles (m=5")
	HA132	0.0 - 0.3 m soil
		0.3 - 1.7 sandy coarse pebble gravel (m=4")
		>1.7 till
	HA133	0.0 - 0.2 m soil
		0.2 - 0.6 sandy fine pebble gravel
		0.6 - 1.8 pebbly sand coarsens down to sandy fine pebble gravel
		cobble layer at base
		1.8 - >2.9 pebbly coarse sand

Deposit Number	Site Number s=sample	Log
	HA134s	0.0 - 0.4 m soil 0.4 - 3.5 interbeds of sandy fine pebble gravel, pebbly coarse sand and sandy coarse pebble gravel with small cobbles (m=6") >3.5 medium coarse sand
	HA135s	0.0 - 0.2 m soil 0.2 - 1.2 sandy cobble gravel (m=5") 1.2 - 2.8 sandy pebble gravel, fines up from m=3" at base 2.8 - >3.0 pebbly coarse sand
	HA136	0.0 - 0.2 m soil 0.2 - 2.2 sandy fine pebble gravel 2.2 - >2.8 pebbly sand
	HA177	0.0 - 0.1 m soil (stony) 0.1 - 1.6 sandy fine pebble gravel >1.6 till
	HA178s	0.0 - 1.0 m interbeds of sandy fine pebble gravel and sand 1.0 - >3.0 sandy pebble gravel (m=3")
	HA179	0.0 - 0.1 m soil 0.1 - 1.3 sandy coarse pebble gravel 1.3 - 3.0 sandy pebble gravel, large increase in sand
	HA180	0.0 - 0.5 m soil (silty fine sand) 0.5 - 1.0 silty fine sand 1.0 - >3.0 sandy pebble gravel interbedded with pebbly sand and coarse sand
	HA181	Ditch: ≈1.5 m sandy coarse pebble gravel Bottom: 0.0 - >2.0m sandy coarse pebble gravel (m=5") sand increases with depth
	HA185	0.0 - 0.5 m fine silty sand 0.5 - >2.0 sandy pebble gravel
	HA186s	0.0 - 0.8 m coarse sand 0.8 - 1.8 interbeds of coarse sand and cobbly pebble gravel 1.8 - >2.5 pebbly coarse sand
	HA187	0.0 - 0.3 m soil 0.3 - 1.6 sandy pebble gravel with cobble 1.6 - >2.6 coarse sand and granules
	HA188s	0.0 - 0.2 m soil 0.2 - 1.7 sandy coarse pebble gravel 1.7 - >2.3 medium sand
	HA189	ditch: 0.8 m sandy pebble gravel floor: 0.1 sandy fine pebble gravel 0.1 - >2.3 medium to coarse sand, pebbly to base
	HA190	0.0 - 0.8 m sandy fine pebble gravel and coarse pebbly sand 0.8 - >2.0 coarse pebbly sand
12043	HA191	0.0 - 0.4 m soil 0.4 - 1.8 sandy fine pebble gravel becoming sandy coarse pebble gravel (m=5") >1.8 till
	HA192	0.0 - 0.4 m soil 0.4 - 2.5 sandy fine pebble gravel 2.5 - >2.8 coarse sand >2.8 water table
	HA193	0.0 - 0.4 m soil 0.4 - 1.0 sandy fine pebble gravel 1.0 - >2.5 pebbly sand to sandy very fine pebble gravel >2.5 water table
	HA194	0.0 - 0.2 m soil 0.2 - 0.6 fine sand 0.6 - >2.0 coarse sand fining down to medium sand

Deposit Number	Site Number s=sample	Log
	HA195s	0.0 - 0.2 m soil 0.2 - 1.7 sandy pebble gravel fining down to pebbly coarse sand >1.7 till
	HA196	0.0 - 0.2 m soil 0.2 - 2.5 interbeds of sandy fine pebble gravel and pebbly sand >2.5 water table in sandy pebble gravel
12046	HA168	ditch: 0.3 m sand / 0.3 pebble gravel/ till
12047	HA164s	0.0 - 0.2 m soil 0.2 - 1.7 sandy coarse pebble gravel (m=4") 1.7 - 2.2 sand and granules 2.2 - >3.1 sandy coarse pebble gravel
	HA166	0.0 - 0.2 m soil 0.2 - 1.5 sandy coarse pebble gravel >1.5 till
12052	HA162	ditch: 1 m high, covered base: 2 m sandy coarse pebble gravel (m=4, am=3") >2.0 till
12053	HA163s	ditch: 0.5 m high, covered base: 0.5 - >2.6 sandy coarse pebble gravel (m=6,am=3")
12055	HM271	pit is 4 m interbedded sandy fine pebble gravel and coarse sand backhoe at base: 0.0 - 0.6 m coarse sand, fine pebble beds >0.6 water
	HA156	0.0 - >2.5 m sandy coarse pebble gravel (m=3") interbedded with med. to med.-coarse sand
	HA157	0.0 - 0.1 m soil 0.1 - 0.7 sandy coarse pebble gravel 0.7 - >2.5 med. sand with some pebbles
	HA158	0.0 - 0.3 m sandy coarse pebble gravel 0.3 - 0.6 sand >0.6 bedded fine sand and silt
	HA159s	0.0 - 0.3 m soil (sand) 0.3 - 1.2 very sandy fine pebble gravel 1.2 - 1.5 bed of small cobbles (m=4") 1.5 - >2.8 pebbly coarse sand
	HA160	0.0 - 0.3 m soil (fine sand) 0.3 - 1.8 sandy pebble gravel (m=3") 1.8 - 3.9 sandy coarse pebble gravel (m=5")
12057	HA151	0.0 - 1.3 m sandy coarse pebble gravel >1.3 till
	HA152s	0.0 - 0.6 m soil into silty sand 0.6 - 2.3 interbeds of sandy fine and coarse pebble gravel >2.2 water table
	HA153	0.0 - 0.6 m soil 0.6 - >2.6 interbeds of sandy fine and coarse pebble gravel >2.2 water table
	HA154	0.0 - 0.3 m soil 0.3 - 0.7 fine sand 0.7 - 2.5 cobble gravel (m=7, am=3") 2.5 - >3.0 pebbly coarse sand
	HA155	0.0 - 0.3 m soil 0.3 - 0.8 sandy fine pebble gravel >0.8 till

Deposit Number	Site Number s=sample	Log
12062	HB986	0.0 - 0.2 m soil
		0.2 - 1.5 sandy coarse pebble gravel
		1.5 - >2.7 sandy pebble gravel fining down to pebbly sand
		>2.7 water table
	HA145	0.0 - 0.4 m soil
		0.4 - 1.7 sandy fine pebble gravel
		1.7 - >2.5 medium fine sand
	HA146	0.0 - 0.4 m soil
		0.4 - 1.5 sandy fine pebble gravel
		1.5 - 1.9 medium sand
		1.9 - >2.9 pebbly coarse sand
	HA147s	0.0 - 0.2 m soil
		0.2 - >3.7 interbeds of pebbly coarse sand and cobble gravel (m=5")
	HA148	0.0 - 0.2 m soil
		0.2 - 1.9 interbeds of pebbly coarse sand and coarse pebble gravel (m=4")
		1.9 - >2.7 pebbly sand
	HA149	0.0 - 0.2 m soil
		0.2 - 1.3 sandy pebble gravel, coarsens down (m=3")
		1.3 - 1.8 coarse sand
		1.8 - >2.2 sandy pebble gravel
	HA150s	0.0 - 0.2 m soil
		0.2 - 1.7 sandy pebble gravel
		1.7 - >2.5 medium fine sand
12063	HB987	0.0 - >0.5 m fine white sand
	HB988	0.0 - 0.5 m soil in fine sand
		0.5 - >2.6 sand, fines up from coarse sand
		>2.6 water table
12066	HM259s	pit is 2 m sandy pebble gravel
		backhoe at base:
		0.0 - 0.9 m medium coarse sand
		>0.9 water
	HM325s	pit is 3 m interbedded sandy pebble gravel and coarse pebbly sand
		backhoe at base:
		0.0 - >2 m interbedded coarse sand and pebbly sand
	HM332s	ditch is 1 m sandy coarse pebble gravel
		backhoe at base:
		0.0 - 1.5 m coarse pebbly sand
		1.5 - 1.7 cobble lag
		>1.7 till
	HB971	0.0 - 0.3 m soil
		0.3 - 0.9 sandy pebble gravel
		0.9 - 1.3 medium fine sand
		1.3 - 1.8 sandy pebble gravel
		1.8 - 2.4 pebbly sand
		>2.4 medium sand, damp
	HB972s	0.0 - 0.2 m soil
		0.2 - 0.9 sandy fine pebble gravel
		0.9 - 1.5 medium fine sand
		1.5 - 2.1 coarse pebble gravel with small cobbles
		2.1 - >3.0 coarse sand with some pebbles and cobbles
	HB973	0.0 - 0.3 m soil
		0.3 - 0.9 silt
		>0.9 till
	HB974	till

Deposit Number	Site Number s=sample	Log
	HB975	0.0 - 0.1 m soil 0.1 - 0.6 sandy fine pebble gravel 0.6 - 0.9 medium coarse sand 0.9 - 2.1 sandy pebble gravel >2.1 till
	HB976s	0.0 - 0.8 m sandy fine pebble gravel 0.8 - 0.9 coarse pebbly sand 0.9 - 2.0 sandy coarse pebble gravel (m=4") >2.0 till
	HB977	0.0 - 0.1 m soil 0.1 - 1.2 sandy coarse pebble gravel (m=3") 0.0 - >3.4 pebbly coarse sand and granules
	HB978s	0.0 - 0.2 m soil 0.0 - 2.0 sandy coarse pebble gravel with cobbles (m=6") >2.0 till
	HB979	0.0 - 0.1 m soil 0.0 - >2.3 sandy coarse pebble gravel with cobbles (m=4")
	HB980s	0.0 - 0.1 m soil 0.1 - 0.6 sandy fine pebble gravel 0.6 - 0.9 medium sand 0.9 - 2.2 sandy coarse pebble gravel (m=3") 2.2 - >3.7 coarse sand, some pebbles
	HB981	0.0 - 0.3 m soil 0.3 - 2.8 pebbly sand 2.8 - >3.0 medium sand
	HB982	0.0 - 3.0 m sandy cobbly gravel (m=6") >3.0 water table
	HB983	0.0 - 2.1 m sandy pebble gravel >2.1 till
	HB984s	0.0 - 0.1 m soil 0.1 - 0.6 sandy fine pebble gravel 0.6 - 1.2 sandy coarse pebble 1.2 - >3.1 sandy pebble gravel
	HB985	0.0 - 2.7 m sandy pebble gravel (m=3") >2.7 water
	HB989	0.0 - 1.0 m pebbly sand 1.0 - 3.0 sandy pebble gravel (m=3, am=2") 3.0 - >3.6 coarse pebbly sand
	HB990s	0.0 - 0.2 m soil 0.2 - 0.8 sandy fine pebble gravel 0.8 - 1.2 sandy coarse pebble gravel 1.2 - >2.4 coarse sand with pebbles >2.4 water table
	HB991	0.0 - 0.2 m soil 0.2 - 2.7 very sandy pebble gravel >2.7 fine sand, water table
	HB992	0.0 - 0.3 m soil 0.3 - 1.3 sandy fine pebble gravel 1.3 - 1.4 coarse pebbly sand 1.4 - 2.4 sandy coarse pebble gravel (m=3") >2.4 till
	HB993s	0.0 - 0.6 m soil (sand at base) 0.6 - 2.1 pebbly sand (large pebbles in med. sand matrix) 2.1 - >2.7 coarse sand (some pebbles) >2.7 water table

Deposit Number	Site Number s=sample	Log
	HB994	0.0 - 0.1 m soil
		0.1 - 1.6 interbeds sand and sandy pebble gravel
		1.6 - >3.0 sandy coarse pebble gravel, boulders to base (m=10")
		>3.0 water table
	HB995s	0.0 - 0.2 m soil
		0.2 - 1.6 sandy pebble gravel
		1.6 - >3.4 sandy coarse pebble gravel with cobbles (m=6")
	HB996	0.0 - 2.2 m sandy fine pebble gravel
		>2.2 till
	HB997	0.0 - >2.5 m interbeds of coarse sand and sandy pebble gravel (m=2")
	HB998s	0.0 - 0.2 m soil
		0.2 - 1.2 sandy fine pebble gravel
		1.2 - 1.5 coarse sand
		1.5 - 3.3 sandy coarse pebble gravel (m=2")
		>3.3 till
	HB999	0.0 - >2.0 m sandy pebble gravel with cobbles (m=6")
	HA101	0.0 - 0.5 m sand
		0.5 - >2.7 sandy coarse pebble gravel (m=4")
		>2.7 water table
	HA102	0.0 - 0.1 m soil
		0.1 - 0.9 sandy coarse pebble gravel
		0.9 - 1.0 pebbly sand
		1.0 - 3.0 gravelly sand fining down to sand
		>3.0 water table
	HA103s	0.0 - 0.3 m soil
		0.3 - 1.3 sandy fine pebble gravel
		1.3 - 3.0 sandy coarse pebble gravel (m=3")
		>3.0 pea gravel, water table
	HA104	0.0 - 0.3 m soil
		0.3 - 1.6 sandy coarse pebble gravel (m=3")
		1.6 - >3.0 pebbly coarse sand
		>3.0 water table
	HA105s	0.0 - 0.2 m soil
		0.2 - 2.8 sandy pebble gravel (m=3")
		>2.8 water table
	HA106s	ditch: 1 m cobbly coarse gravel (m=8")
		floor: 1.5 m sandy pebble gravel over till
	HA107	0.2 m sandy pebble gravel over clayey silt
	HA108	0.3 m pebble gravel over till
	HA109	0.0 - 0.2 m soil
		0.2 - 1.4 sandy fine pebble gravel
		1.4 - 2.7 pebbly coarse sand
	HA110s	0.0 - 0.1 m soil
		0.1 - 0.9 sandy pebble gravel
		0.9 - 1.5 sandy coarse pebble gravel, small cobbles
		1.5 - >3.3 pebbly coarse sand
		>3.3 water table
	HA111s	0.0 - 0.2 m soil
		0.2 - 1.1 sandy fine pebble gravel
		1.1 - >3.0 pebbly coarse sand
		>3.0 water table
	HA112s	0.0 - 0.3 m soil
		0.3 - 1.5 sandy fine pebble gravel
		1.5 - 2.0 pebbly sand
		2.0 - >3.6 medium fine sand

Deposit Number	Site Number s=sample	Log
	HA113	0.0 - 0.2 m soil
		0.0 - 1.3 interbeds of pebbly sand and sandy fine pebble gravel
		1.3 - >3.0 coarse sand, fines down
	HA114	0.0 - 0.3 m soil
		0.3 - 0.7 sandy fine pebble gravel
		0.7 - 1.8 coarse sand
	HA197	0.0 - 0.2 m soil
		0.2 - >2.5 interbeds of sandy fine pebble gravel and pebbly coarse sand
		>2.5 water table
	HA198	0.0 - 1.5 m sandy pebble gravel
		1.5 - 2.5 coarse sand with some beds of pebbly sand
		>2.5 water table
12070	HA202	0.0 - 0.3 m soil
		0.3 - 0.5 medium fine sand
		0.5 - 3.0 sandy fine pebble gravel
		>3.0 pebbly sand
BACKHOE PITS - NO DEPOSIT		
	HB930	0.0 - 0.3 m very sandy fine pebble gravel
		0.3 - >2.2 medium fine sand
	HB942	0.0 - 0.3 m soil
		0.3 - >3.0 coarse sand
	HB957	1 m sandy pebble gravel over till
	HB958	1.5 m silty sand over till
	HB959	<1 m silty sand over till
	HB962	till
	HB964	till
	HA165	till
	HA167	till
	HA173	0.0 - 0.2 m soil
		0.2 - 0.6 sandy pebble gravel
		>0.6 till
	HA174	ditch: 1 m sandy pebble gravel
		floor: 0.5 m sandy fine pebble gravel over till
	HA199	0.0 - 0.7 m soil (into fine sand)
		0.7 - 1.0 fine sand
		1.0 - >2.5 pebble layer then into pebbly sand
		>2.3 water table
	HA200	>2.5 m medium sand
	HA201	0.0 - 1.0 m fine sand
		1.0 - >2.3 medium sand

*m = maximum grain size;
am = most abundant in upper grain size range

APPENDIX E
INFORMATION FROM THE DEPARTMENT OF HIGHWAYS BLOCK FILE

Deposit Number	Sample Location	Inventory Type	Deposit Depth (m)	Number of Samples P=pit B=backhoe	% Stone > #4	End Use
12001	SW29-9-29W	P	1.8	3	40-60	Traffic
	NE30-9-29W	P	2.4	3	23-40	
12003	NW34-9-29W	P	3.5	6	4-80	Traffic
12004	NE6-9-28W	P	2.9	3	25-53	Traffic,
	SE7-9-28W	P	3.2	4	15-48	Pit run
12007	NW3-9-28W	P	3.0	5	25-55	Traffic
12008	NW3-9-26W	P	2.0	3	23-36	Traffic gravel
	NE4-9-26W	P	1.4	3	38-45	
12010	SE21-9-27W	B	1.7	21	24-72	
12011	SW28-9-27W	B	2.2	7	40-69	Base course
	SE29-9-27W	B	1.6	30	13-75	
12012	SE33-9-27W	P,B	1.2	15	2-71	Traffic
12013	NW30-9-26W	B	3.2	13	15-35	Traffic,
	SW31-9-26W	P,B	3.2	7	13-28	
	NE24-9-27W	P	3.5	1	49	
	SE36-9-27W	P	1.4	2	1-33	
12015	SW6-9-26W	P,B	1.2	17	10-60	
12020	NW5-8-27W	P	2.7	7	42-58	Pit run
12021	SE24-8-28W	P	3.0	1	33	Pit run
	NE24-8-28W	P	5.5	3	20-68	
12032	SW16-7-29W	P	2.9	4	39-52	C Base,pit run,
	NE17-7-29W	P	1.8	2	43-56	traffic
12034	NE19-7-28W	P	3.2	5	22-61	A & C Base,
	SW20-7-28W	P	0.9	1	29	Bituminous,
	NW20-7-28W	P	1.8	2	49-60	Pit run
	SW29-7-28W	B	2.9	10	15-65	
	NW29-7-28W	B	1.1	6	22-67	
	SE30-7-28W	P	2.7	4	23-54	
12035	SE8-7-28W	P		2	57-63	
	NE8-7-28W	P		1	53	
	NW9-7-28W	P	1.5	3	23-56	
12037	NW28-7-27W	P	1.8	2	57-75	Traffic,
	NE29-7-27W	P	3.0	4	32-61	Pit run
	SE32-7-27W	P	2.0	3	34-77	
12040	SE28-7-27W	P	2.1	3	34-60	
12042	SW17-7-28W	P	2.5	2	8-67	A Base,
	NE19-7-26W	P	4.0	8	37-64	Bituminous,
	NW19-7-26W	P	3.0	4	37-54	Traffic,
	SE30-7-26W	P	2.0	2	37-45	Pit run
	SW30-7-26W	P	4.3	14	38-64	
	SE13-7-27W	P	1.0	2	30	
	SW13-7-27W	P	2.0	5	25-47	
	SE25-7-27W	P	1.0	1	39	
	SW25-7-27W	P	4.0	6	47-80	
12044	NE19-6-26W	P	0.9	1	21	
	NW20-6-26W	P	1.8	5	8-23	
12051	SW22-6-29W	P	8.8	4	35-56	
12055	NW2-6-29W	P	1.4	2	49-66	Pit run
12057	SW21-5-29W	P	3.0	11	37-70	

Deposit Number	Sample Location	Inventory Type	Deposit Depth (m)	Number of Samples P=pit B=backhoe	% Stone > #4	End Use
12059	NE14-5-29W	P	1.8	6	19-49	Traffic,
	SE23-5-29W	P	3.4	6	36-71	Pit run
12066	NW18-5-26W	P	1.5	4	21-28	Traffic,
	SW19-5-26W	P	1.0	2	15-28	Pit run,
	NW19-5-26W	P	1.2	8	13-35	Seal coat
	NE13-5-27W	P	1.8	2	25-38	
	NE19-5-27W	P	3.0	5	30-50	
	SW20-5-27W	P	2.4	1	50	
	NW20-5-27W	P	1.5	1	35	
	NW25-5-27W	P	1.4	1	21	
	NE26-5-27W	P	1.5	1	21	
12067	SE19-6-27W	P	1.0	3	29-57	

PROVINCE OF MANITOBA
1988 AGGREGATE GRADING SPECIFICATIONS

*NOTE: N.S. = Not Specified
F.M. = Fineness Modulus

PASSING SIEVE SIZE		BITUMINOUS PLANT MIX			BASE COURSE					GRANULAR FILL	CULVERT GRAVEL	TRAFFIC TYPE						CONCRETE			SEAL COAT COVER				PASSING SIEVE SIZE	
					"A"	"A"	"B"	"C"	"C"									Fines	"A" COURSE							
Metric	Imp.	"A"	"B"	"C"	Gravel	Lime-stone	All	Gravel	Lime-stone			"A"	"A" Lime-stone	"B"	"C"	"D" Lime-stone	"D" Quarried rock		65%+ Lime-stone	Gravel	"A"	"B"	Cover "C"	Blotter "D"	Metric	Imp.
50 mm	2"								100	3" 100															50 mm	2"
37.5mm	1½"							100	N.S. 100		100														37.5mm	1½"
25 mm	1"			100										100	100	100				100					25 mm	1"
19 mm	3/4"				100	100	100					100	100			85-100	100		100	90-100					19 mm	3/4"
16 mm	5/8"		100		80-100																	100			16 mm	5/8"
12.5mm	1/2"	100										75-90		70-90	60-95			100			100	80-100	100	100	12.5mm	1/2"
9.5 mm	3/8"	70-95	70-90															96-100	20-55	20-55					9.5 mm	3/8"
4.75mm	#4	55-70	55-70	60-90	40-70	35-70	30-75	25-80	25-80		N.S. 25-80	45-70	35-60	40-70	30-70	35-60	30-60	90-100	0-10	0-10	0-60	0-65			4.75mm	#4
2.00mm	#10	35-55	35-55	35-80	25-55		25-65																		2.00mm	#10
1.18mm	#16																	50-80							1.18mm	#16
600um	#30																	25-60							600um	#30
425um	#40	17-29	17-29	20-50	15-30	10-30	15-35	15-40				10-35		10-35	5-35						0-15	0-15	0-25	0-50	425um	#40
300um	#50																	10-30							300um	#50
180um	#80	N.S. < 10	N.S. < 10																						180um	#80
75 um	#200	3-8	3-8	5-12	8-15	6-17	4-18	8-20 4-20	5-20	0-15	N.S. 4-20	8-15	6-17	0-15	0-15	0-17	0-10	0-3	0-2	0-2	0-4	0-5	0-5	0-10	75um	#200
MINIMUM CRUSH		50%	50%		35%		25%					35%	100%	35%	25%	100%	100%				30%	20%			MINIMUM CRUSH	
MAXIMUM SHALE		T 3% B 7%	T 3% B 7%		12%		12%	12%			N.S. 15%	12%		12%	15%						3%	4%			MAXIMUM SHALE	
MAXIMUM L.A.		35%	35 %		35%	35%	35%	35%	35%			45%	45%	45%	45%	45%			28%	28%	35%	35%			MAXIMUM L.A.	
MAXIMUM DELETERIOUS																		2%	1.5%	1.5%					MAXIMUM DELETERIOUS	
MAXIMUM IRONSTONE																		F.M. 2.3-3.5			5%	5%			MAXIMUM IRONSTONE	
MAXIMUM ABSORPTION																			2.25%	2.25%					MAXIMUM ABSORPTION	
SPEC NUMBER		920	920	920	900	900	900	900	900	520		910	910	910	910	910	910	930	930	930	940	940	940	940	SPEC NUMBER	

Figure E-1: Manitoba Highways and Transportation aggregate grade specifications.

APPENDIX F
LOCATION OF CROWN LANDS

MUN. OF ALBERT

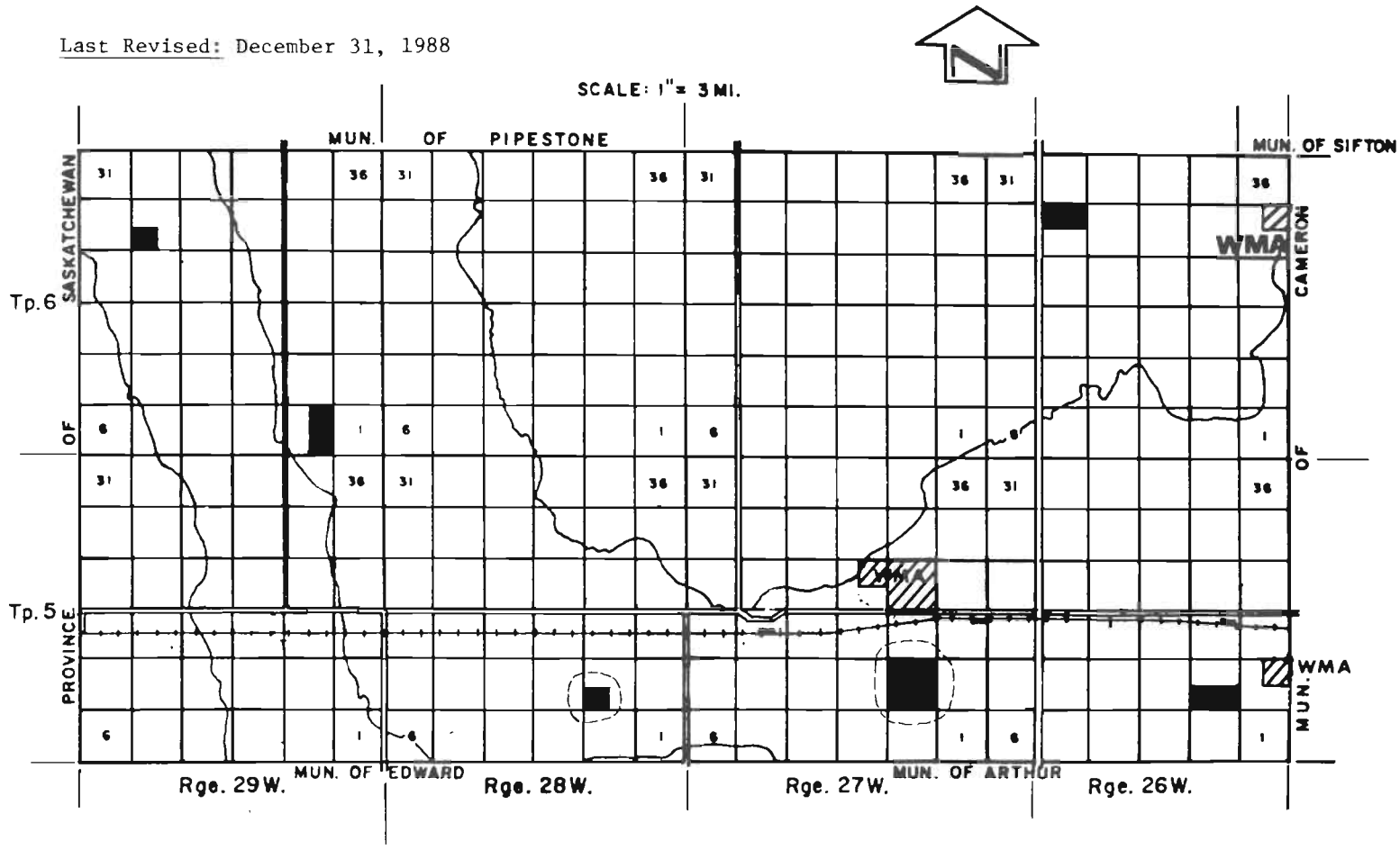


Figure F-1: Crown Lands in the R.M. of Albert.

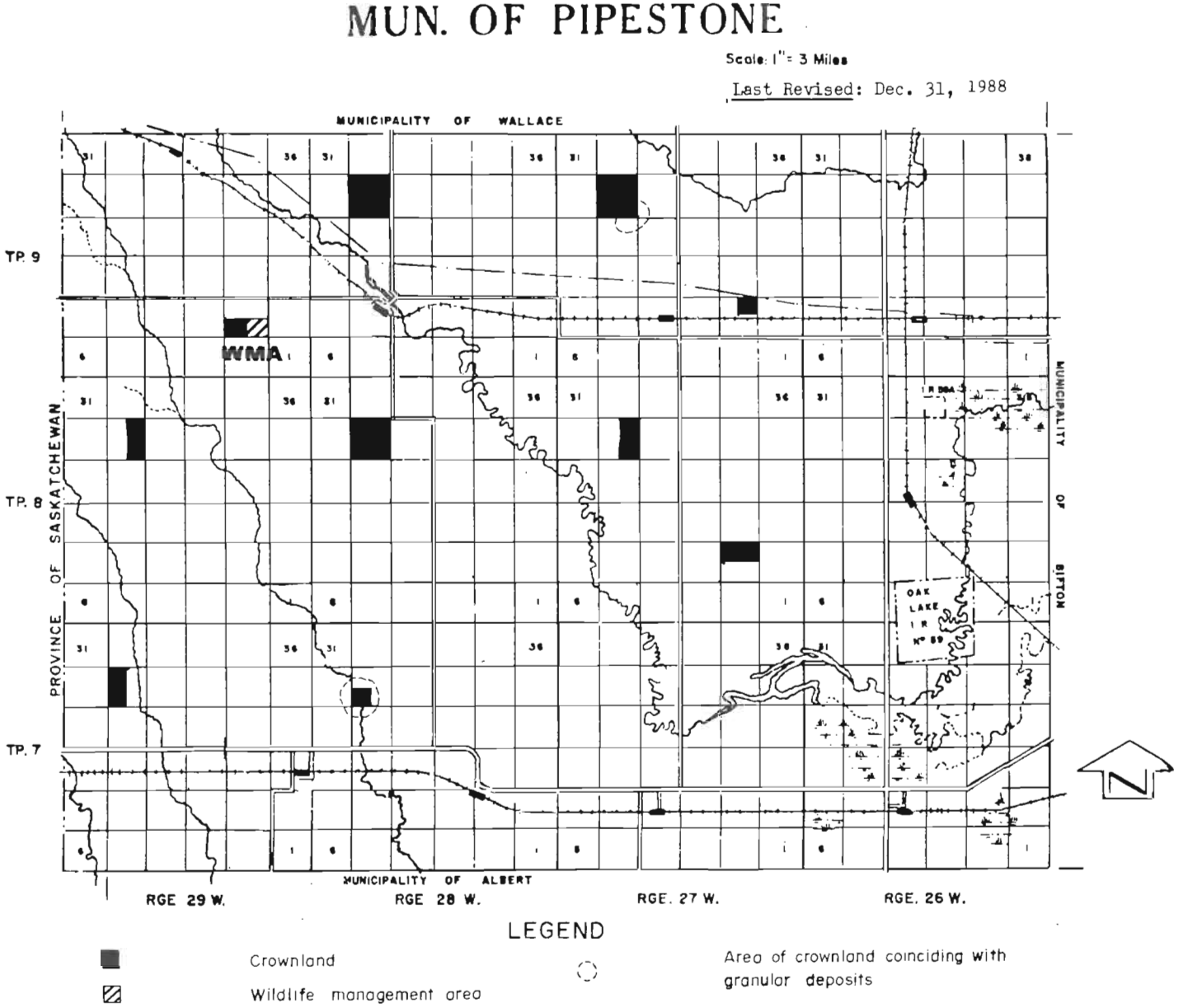


Figure F-2: Crown Lands in the R.M. of Pipestone.

APPENDIX G: GLOSSARY

AGGREGATE

Any inert, construction material (sand, gravel, slag, crushed stone or other mineral material).

AGGREGATE RESERVES

Aggregate in a deposit which is proven and is economically significant.

ALLUVIUM

Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream.

BEACH DEPOSITS

These are relatively narrow, linear features formed at the shores of glacial lakes that existed during deglaciation. Well developed beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates.

BEDROCK

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

BINDER

Material that produces or promotes consolidation in loosely aggregated sediments. Usually mud or clay, sometimes till is used for binder.

CARBONATE ROCKS

A broad term referring to those sedimentary rocks consisting chiefly of carbonate minerals, mainly limestone and dolostone.

CLAST

An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical weathering of a large rock mass. Synonyms include particle and fragment.

CROWN LAND

Land reserved and administered by the Crown. Sand and gravel usually administered by the Crown.

CROWN SAND AND GRAVEL

Sand and gravel reserved and administered by the Crown.

DELETERIOUS LITHOLOGY

A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone, and sandstone may deteriorate rapidly.

DEPOSIT

An accumulation of sediments left in a new location by a natural transportative agent such as water, wind, ice, or gravity.

DIAMICTON

Nongenetic term for non-or-poorly-sorted sedimentary deposit; grain size can range from clay to boulders.

DIRT

See fines.

DOLOMITE (DOLOSTONE)

A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolomite is also known as dolostone).

DRIFT

A general term for all unconsolidated rock debris transported from one place and deposited in another; distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

DURABLE ROCK

A rock fragment which is hard and inert and can be used as aggregate without breaking, crumbling or reacting with the cementing material.

EOLIAN

Pertaining to wind action.

EPOCH

A geological-time unit longer than an age and a subdivision of a period.

ESKERS

Eskers are narrow, sinuous ridges of sand and gravel. They vary greatly in size. Many eskers consist of a central core of poorly sorted and stratified gravel. The core material is often draped by better sorted and stratified sand and gravel.

FINES

A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.074 mm). Also described informally as "dirt", these particles are in the silt- and clay-size range.

FLUVIAL

Pertaining to rivers or streams.

GLACIOFLUVIAL DEPOSITS

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

GLACIOLACUSTRINE DELTAS

These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. Such deposits tend to consist mainly of sand and abundant silt. However, in near-ice or ice-contact positions, coarse material may be present.

GLACIOLACUSTRINE DEPOSITS

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

GRANULAR BASE COURSE

Components of a road placed on subgrade and designed to provide strength, stability, and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

GROUND MORAINE

A deposit of till with a flat or undulating surface.

HOLOCENE

An epoch of the Quaternary period covering the time period from the retreat of the continental glaciers to the present, about 10 000 years.

HUMMOCKY

An irregular or knob and kettle surface.

HUMMOCKY MORAINE

A landscape composed primarily of till with a hummocky surface.

ICE-CONTACT DEPOSIT

Material deposited in contact with glacier ice by meltwater; includes kames, eskers, kame terraces, etc.

ICE-CONTACT TERRACES

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure may be similar to outwash deposits.

KAMES

Kames are mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. The deposits consist mainly of irregularly bedded and cross-bedded, poorly sorted sand and gravel. Deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms.

LACUSTRINE DEPOSIT

Material deposited in a lake.

LITHOLOGY

The description of rocks on the basis of such characteristics as color, structure, mineralogic composition, and grain size. Generally, the description of the physical character of a rock.

MELTWATER CHANNEL

A drainage way produced by water flowing away from a melting glacier margin.

MORAINE

A distinct accumulation of glacial drift. Could represent an ice marginal position.

OUTWASH

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. They occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain-size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure.

PIT RUN

Unprocessed aggregate removed from pit. Generally consists of fine pebble gravel with minor amounts of material coarser than 38 mm (1 1/2"). It is used for road maintenance, upgrading and resurfacing.

PLEISTOCENE

An epoch of the recent geological past including the time from approximately 1.8 million years ago to 10 000 years ago. Much of the Pleistocene was characterized by extensive glacial activity.

QUATERNARY

The second period of the Cenozoic era, thought to cover the last 2-3 million years. It consists of two epochs: The Pleistocene and the Holocene.

RESOURCE

An aggregate deposit or environment which may or may not be proven and is presently not economically significant.

SHALE

A fine-grained, sedimentary rock formed by the consolidation of clay, silt, or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone, and mudstone.

SPILLWAY

Large drainage valley formed by meltwater flowing from a glacial lake. Spillways often have gravel terraces.

STONE

That component of aggregate coarser than 4.76 mm or the #4 sieve, includes pebbles, cobbles and boulders.

SURFICIAL GEOLOGY

A form of geological mapping dealing with all materials occurring at surface in an area: unlithified or lithified (sediments or bedrock).

TERRACE

A relatively flat, stair-stepped, depositional or erosional surface bounded by an ascending slope on one side and a descending slope on the other.

TILL

Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

WISCONSINAN

Pertaining to the last glacial stage of the Pleistocene Epoch in North America. It began approximately 100 000 years ago and ended approximately 10 000 years ago. The glacial deposits and landforms of southern Manitoba are predominantly the result of glacial activity during the Winsconsinan Stage.