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Quaternary Geology

of the

Orangeville Area
Southern Ontario

By

W. R. Cowan

Geoscience Report 141

TORONTO
1976

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Cowan, W. R.
1976: Quaternary Geology of the Orangeville Area, Southern Ontario; Ontario Div. of Mines, GR141, 98p. Accompanied by Maps 2326, 2327 and 2328, scale 1:50,000.

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Map 2326—Quaternary Geology of the Woodstock area, Southern Ontario. Scale 1:50,000.

Map 2327—Granular Resources of the Woodstock area, Southern Ontario. Scale 1:50,000.

Map 2328—Drift Thickness in the Woodstock area, Southern Ontario. Scale 1:50,000.

ABSTRACT

The Orangeville area is located west of Toronto astride the drainage divides between the Lake Huron, Lake Erie, Lake Ontario and Georgian Bay basins. Bedrock consists of Ordovician shales in eroded preglacial valleys, and Silurian sandstone, shale, and dolostone elsewhere. Drift up to 500 feet (150m) thick may overlie these rocks.

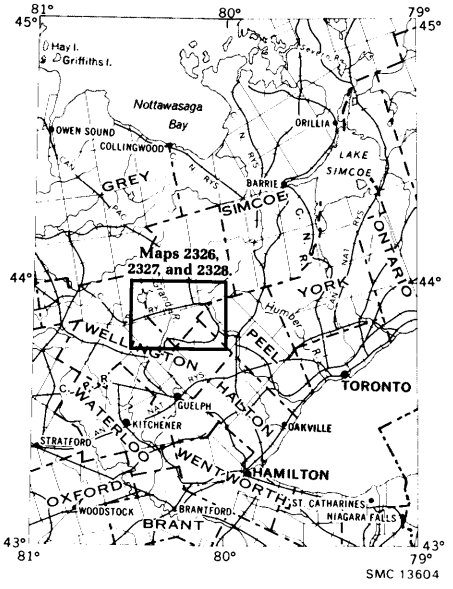


Figure 1–Key map showing location of Orangeville area. Scale 1 inch to 50 miles (1:3,168,000).

The exposed Pleistocene sequence is entirely of Lake Wisconsinan age. This sequence consists of Catfish Creek Till (Nissouri Stadial) deposited by ice flowing in a southerly direction, a poorly exposed silt till outcropping near Hillsburgh (Port Bruce Stadial), Tavistock Till deposited by the Georgian Bay lobe from the northwest and its Lake Simcoe sublobe from the northeast (Port Bruce Stadial), Port Stanley Till deposited from the east (Port Bruce Stadial), Newmarket Till deposited from the northeast (Port Huron Stadial), Wentworth Till deposited by Ontario lobe from the east (Port Huron Stadial), and Kettleby Till deposited in the Hockley Valley from the northeast (Port Huron Stadial). The Tavistock and Port Stanley Tills are of similar age and the Orangeville Interlobate Moraine was deposited in the area between these ice sheets. Port Stanley Till comprises the Guelph drumlin field.

Granular resources are primarily associated with the Port Stanley, Newmarket and Wentworth Tills and are largely located in Caledon, Erin, and Mono Townships. These townships have reserves in excess of local needs and comprise an important segment of the industrial mineral resources of southern Ontario. The remaining townships do not contain reserves exceeding future local needs.

Siltstone reduces the quality of granular materials located east of the Grand River.

Quaternary Geology

of the

Orangeville Area

Southern Ontario

By

W. R. Cowan[1]

INTRODUCTION

The Orangeville map-area (Figure 1) consists of National Topographic series sheet 40P/16 bounded by Latitude 43°45′ to 44°00′ north and Longitude 80°00′ to 80°30′ west. The area comprises about 430 square miles (1114 km^2) occurring largely in Dufferin and Wellington Counties, and to a lesser extent Peel County. The Town of Orangeville and the Villages of Hillsburgh, Grand Valley, Erin, and Alton are the principal centres within the area.

Road access to the area is provided by Provincial Highways 6, 9, 10 and 24; these are supported by a close-spaced network of township and county roads. The Canadian Pacific Railway provides freight service to much of the area however no passenger service is in effect at the time of writing.

Sand and gravel are the principal geological materials presently being extracted within the area on a commercial basis; reserves of these materials in Mono, Caledon, and Erin Townships form an important segment of the Toronto-Centred Region mineral reserve base. Dolostone, shale, sandstone, and clay have been extracted in the past and peat is extracted on a part-time basis at present. Gas showings have been encountered in exploratory wells drilled in Silurian and Ordovician rocks underlying the area.

Present Geological Survey

The present reconnaissance survey was initiated in 1971 and completed in 1972. Field data were obtained through the examination of roadcuts, stream and river banks, excavations, and by test pitting or hand augering. Additional information was obtained from well records maintained by the Ministry of the Environment and from the files of

[1]Geologist, Geological Branch, Ontario Division of Mines. Manuscript accepted for publication by the Chief, Phanerozoic Geology Section, March 4, 1974.

various municipal and governmental agencies. A preliminary map of the area has been published (Cowan and Sharpe 1973).

Mapping of the Quaternary geology is intended to provide information on the distribution, properties, stratigraphy, and history of surficial geologic materials for use in planning, engineering, hydrologic, geologic, and environmental studies.

Acknowledgments

Competent field assistance was provided in 1971 by D.R. Sharpe (Senior), J. Clue, and P. Rizzuto, and in 1972 by D.R. Sharpe (Senior), J. Clue, and J. Carr. Sharpe was responsible for mapping the area north and west of Highways 9 and 10 and for most of East Garafraxa Township. E.V. Sado assisted with office compilation of water well data and D.F. Hewitt and J.R. Trusler provided additional data on granular materials.

Water well records were provided by the Ministry of Environment; A.J. Tasker of the Water Quantity Management Branch provided additional assistance with these. Oil and gas records were provided by the Division of Mines. The Conservation Authorities Branch provided engineering data on the Orangeville Dam Site. Additional data on granular materials was provided by the Ministry of Transportation and Communications.

Gravel pit owners and operators and many private landowners kindly permitted access to their properties.

P.F. Karrow of the University of Waterloo, and Q.H.J. Gwyn and B.H. Feenstra of the Ontario Division of Mines provided lively discussion on geologic topics relevant to the present area.

Laboratory analyses were carried out by the Minerals Research Branch of the Ontario Division of Mines.

The writer extends his thanks to each of the above for their contribution to this project.

Previous Work

A number of report and papers discussing the geology of the Orangeville and peripheral areas are available; those of a more general nature are discussed here but more specific items will be discussed in the appropriate sections.

Early mapping of Paleozoic rocks was summarized by Logan (1863). Subsequent regional mapping was carried out by M.Y. Williams (1919) and J.F. Caley (1941); Sandford (1969) and Liberty (1969) have updated parts of these older maps. Remapping of the area adjacent to the Niagara Escarpment has been carried out by the Ontario Division of Mines (Telford *et al.* 1974). Stratigraphy and paleontology of the Silurian rocks occurring in the Escarpment has been revised by Bolton (1957). Data on subsurface stratigraphy is available in Beards (1967), Sandford and Quillian (1959), and Sanford (1961). Economic aspects of the Paleozoic rock occurring in the Orangeville area are considered briefly in the reports of Parks (1912), Goudge (1938), Hewitt (1960; 1964) and Vos (1969). A bedrock topography map of the area was compiled by Davies and McClymont (1962).

Sparse comments on the glacial deposits of the area were made by Logan (1863). This was followed by a considerable amount of work by F.B. Taylor whose early work is summarized in his 1913 paper. Chapman and Putnam (1943 *et seq.*) produced small scale maps of the major glacial features of southern Ontario and synthesized the glacial history of the area. Their work remains as the most comprehensive study available at a regional scale. Since that time the distribution of stratigraphy of glacial deposits in areas adjoining the Orangeville map-area have been carried out by Karrow (1968a, Guelph; 1971, Stratford-Conestogo), White (1971, Bolton) and Gwyn (1972, Dundalk). White (1970) mapped Caledon Township and Sharpe (1972) described the glacial deposits of parts of Amaranth, Mono and East Garafraxa Townships.

A recent survey of water resources of the Nottawasaga River basin is available for those parts of Amaranth and Mono Townships drained by this system (Sibul and Choo-Ying 1971). Soil survey reports have been published for the entire area (Hoffman, Mathews, and Wicklund 1963, Wellington County; Hoffman, Mathews, and Wicklund 1964a, Dufferin County; and Hoffman and Richards 1953, Peel County).

Relief and Physiography

The Orangeville area is located in the central high part of the Southern Ontario Peninsula. Though much of it is flat to gently rolling, maximum relief approaches 800 feet (240m). The highest point in the area is located three miles (5km) west-northwest of Orangeville where an elevation of 1725 feet (524m) a.s.l. is attained near the Amaranth Triangulation Station; this compares with the highest point in southwestern Ontario, 1779 feet (524m), located 10 miles (16km) northeast of Dundalk. The lowest point in the area occurs 10 miles (16km) northeast of the highest point where the Nottawasaga River leaves the map-area at about 950 feet (290m), a topographic gradient of nearly 80 feet per mile (15m/km). Local relief throughout the area is closely related to the physiographic regions mapped by Chapman and Putnam (1951). Relief adjacent to the major negative topographic features is as follows: Hockley Valley[1] bedrock channel area—up to 400 feet (120m); bedrock channels in the Cataract-Belfountain area—200 to 225 feet, (60 to 68m); southern part of the Grand River meltwater channel 100 to 175 feet (30 to 52m); Hillsburgh and West Credit River meltwater channels—100 to 150 feet (30 to 45m).

The most prominent positive topographic feature in the area is the Orangeville Moraine described by Chapman and Putnam (1951) as the Hillsburgh sand hills physiographic region. This comprises a three to five mile (5 to 8km) wide southwesterly trending band of stratified drift, mainly sand, in the Orangeville-Hillsburgh-Belwood area. It forms a nearly flat topped positive feature which has been strongly dissected by fluvial erosion. Elevations range between 1500 (450m) and 1650 feet (500m) with local relief ranging up to 100 feet (30m).

West and northwest of the Orangeville Moraine is the 'Dundalk till plain' of Chapman and Putnam (1951) which consists of a generally southeasterly sloping (in this map-area), poorly drained, flat to gently rolling region of fine-grained till which is locally fluted or weakly drumlinized. This surface is broken by isolated kames or eskers

[1]Hockley Valley refers to the valley occupied by the Nottawasaga River.

and the Grand River Valley. Local relief is usually less than 50 feet (15m) and elevations range between 1500 (450m) and 1600 feet (480m).

South and east of the Orangeville Moraine are the 'Guelph drumlin field' region which consists of low rolling streamlined hills separated from each other by numerous interconnecting meltwater channels and the Horseshoe Moraine region which contains the hummocky Singhampton and Paris Moraines. Elevations here range from 1300 (400m) to 1550 feet (470m) except in incised valleys where relief is generally less than 50 feet (15m) but may reach 100 feet (30m).

Drainage

The Orangeville area straddles the bedrock structural high known as the Algonquin Arch. This is strongly reflected in the surface drainage but glacial drift, particularly the Orangeville Moraine, disrupts this structural control. Consequently drainage is into four major basins: the Georgian Bay basin via the Nottawasaga River system; the Lake Ontario basin via the Humber and Credit River system; the Lake Huron basin via the Saugeen River system; and the Lake Erie basin via the Grand River system. In general the Orangeville Moraine, which itself is largely internally drained, serves to separate the easterly Ontario and Georgian Bay drainage from the southerly Erie basin drainage; the small area draining to Lake Huron is separated from Erie basin drainage by the regional drainage divide near Luther Lake.

Georgian Bay drainage encompasses less than 50 square miles (130km^2) in Mono and eastern Amaranth Townships. It primarily drains the preglacial bedrock valley known as Hockley Valley and some low lying terrain adjacent to and west of this. The Nottawasaga River and its principal tributary flow over bedrock through much of their length. Gradients exceeding 200 feet per mile (38m/km) occur on the tributary on which Cannings Falls is located but the steeper parts of the Nottawasaga River have gradients of 75 to 100 feet per mile (14 to 19m/km). Elsewhere gradients in this system range from 20 to 80 feet per mile (4 to 15m/km).

Lake Ontario drainage is primarily via the Credit River system, however the Humber River drains an area of less than five square miles (13km^2) a few miles east of Orangeville. Credit River headwaters rise on the east side of the Orangeville Moraine except for streams headed in breaches, such as that west of Caledon Lake. The system in this area consists of two branches, the Credit River in the Orangeville-Alton-Cataract area and the West Credit River[1] in the Hillsburgh-Erin-Belfountain area; the latter joins the Credit River at Credit Forks east of Belfountain. Both rivers are underfit through much of their length as they occupy abandoned meltwater channels containing numerous swamp areas. Credit River gradients are low, being less than 15 feet per mile (3m/km) until it reaches Cataract where it flows over bedrock at gradients exceeding 100 feet per mile (19m/km) as it drops over the Escarpment. Similarly, West Credit River gradients are generally less than 25 feet per mile (5m/km) above the Escarpment increasing to about 100 feet per mile (19m/km) in the breach in the Escarpment at Belfountain.

Huron Lake drainage is responsible for about five square miles (13km^2) of nearly flat, boggy terrain north of Monck in the extreme northwestern part of the map-area. Drainage here consists of ditches and short, low gradient stream segments which eventually enter the South Saugeen River north of the area.

[1]Referred to as Erin Branch on Map 2326 (back pocket).

More than two-thirds of the Orangeville area drains to Lake Erie via the Grand River System, one of the largest systems in southern Ontario. Grand River has its headwaters north of Dundalk; it enters the Orangeville area near Colbeck and flows southerly to Belwood Lake from which it flows to Lake Erie. It drains much of the low ground moraine area described as the 'Dundalk till plain' (Chapman and Putnam 1951) on which the drainage system is very immature. This is partially because the Grand River flows on resistant dolostone of the Guelph Formation, through most of the Orangeville area, which tends to impede further development of the natural drainage; this impedance has been reinforced by the introduction of an artificial base level at Belwood Lake following construction of the Shand Dam. Channel gradients range from 7 to 10 feet per mile (1.3 to 1.9m/km) for the trunk part of the Grand River in the Orangeville area.

North of Grand Valley tributaries consist of short stream segments, which are usually somewhat entrenched at their confluence with the Grand. They originate on flat ground moraine and are extended by headward drainage ditches. The extensive bog areas surrounding Luther Lake accentuate the poor drainage in this divide area between the Lakes Huron and Erie basins.

Below Grand Valley larger streams with low gradients such as Boyne Creek and Willow Brook are tributary to the Grand River. These in turn give way to larger trunk feeders including the Irvine Creek, Eramosa River, Speed River, and Conestogo River, all of which head in the Orangeville area but have their confluences to the south.

Irvine Creek drains much of West Garafraxa Township. It is a low gradient, meandering stream which is deeply incised where it crosses the Orangeville Moraine. South of this it parallels Grand River as it traverses a poorly drained area of outwash. It enters the Grand River system near Elora to the south.

Minor tributaries of Conestogo River head in the western parts of West Luther and West Garafraxa Townships. These flow west to the Conestogo and consist largely of ditches in the Orangeville area. Conestogo River enters Grand River at Conestogo in the Guelph area to the south.

Speed River drains a small area southwest of Orton where it occupies an abandoned meltwater channel. Gradients range from 10 to 25 feet per mile (2 to 5m/km) and its confluence with the Grand River is at Preston in the Galt area.

Similarly a small area of less than 10 square miles ($25km^2$) located south of Hillsburgh forms the headwaters of the Eramosa River which enters the Speed River at Guelph. These headwaters occupy low lying meltwater channels. Gradients range between 15 and 50 feet per mile (3 to 10m/km).

PALEOZOIC GEOLOGY

Regional mapping of Paleozoic rocks underlying the area was accomplished at least as early as 1863 when Logan prepared his geological map of Canada. Since then much has been done, however the maps prepared by Caley (1941) form the basis of most present day work and subsequent revisions by Sanford (1969) and Liberty (1969) did not significantly alter the geological contacts drawn by Caley in the Orangeville area. Telford *et al.* (1974) remapped the area in 1972-1973. Figure 2 shows this interpretation, though the distribution of the Salina Formation is from Caley (1941). The stratigraphy of the Niagara Escarpment rocks occurring in the eastern part of the area was revised by Bolton (1957) and his terminology is used herein. Information on the

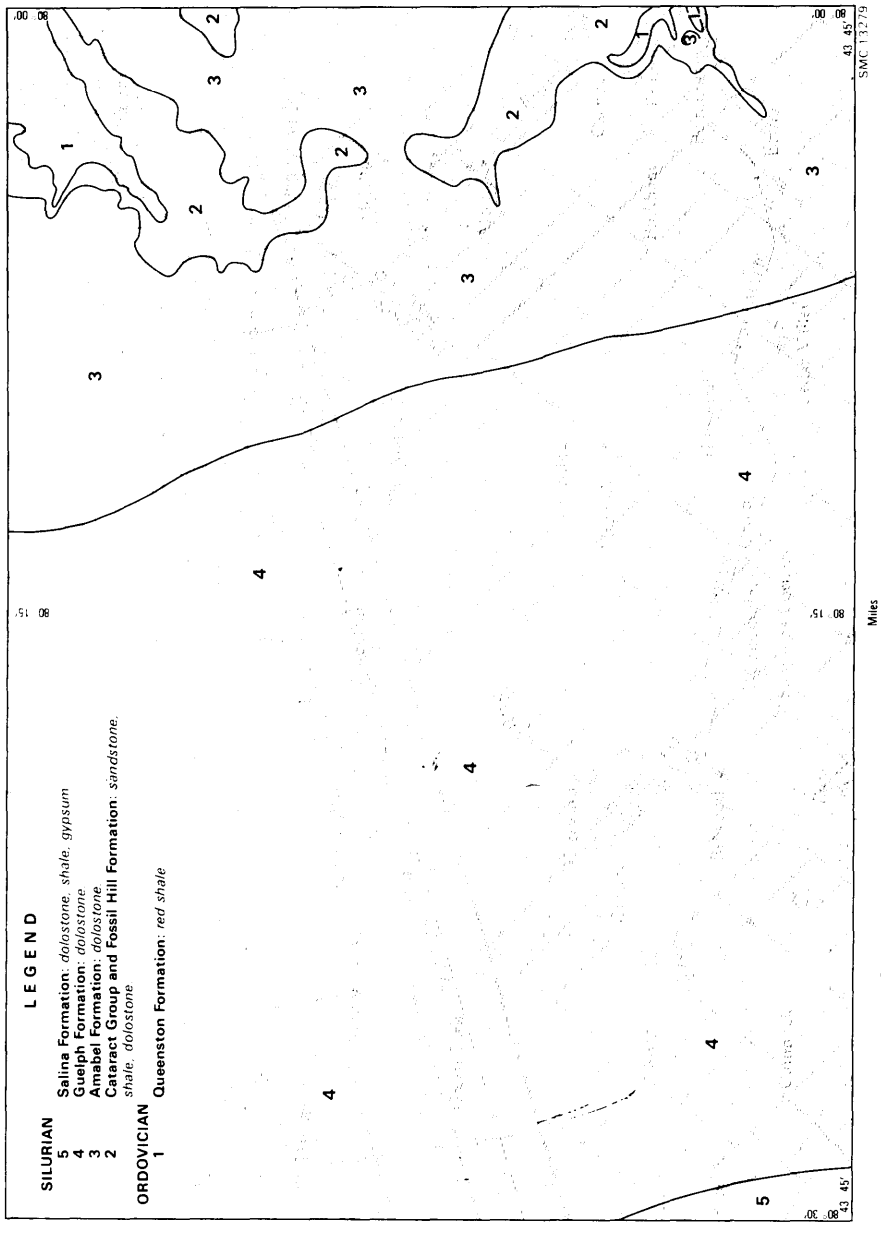


Figure 2–Paleozoic geology of the Orangeville area.

subsurface stratigraphy of Paleozoic rocks is available in Beards (1967) and publications of the Geological Survey of Canada (Sanford 1961 *et seq.*).

In general all Paleozoic rocks underlying the area have a low southwesterly dip. The principal structural feature is the Algonquin Arch which trends southwest-northeast across the area.

Ordovician

Red shales of the Queenston Formation are the only Ordovician rocks outcropping within the area (Figure 2). These occur in deeply incised reentrants in the Niagara Escarpment, now occupied by the Credit and Nottawasaga Rivers, where good exposures are available. The Queenston Formation is 300 to 400 feet (100-130m) thick within the map-area; however outcrops seldom exceed 20 to 40 feet (6-12m). The top of this formation occurs at about 1275 feet (522m) a.s.l. where the upper contact may be found in the Hockley and Credit Valleys.

Silbul and Kendrick (*in* Sibul and Choo-Ying 1971) have suggested that the Georgian Bay Formation underlying the Queenston Formation may extend up the Hockley Valley into the Orangeville area. The evidence for this interpretation is not compelling, however further drilling may verify this; if so the areal extent is probably less than as portrayed by them.

Silurian

Unconformably overlying the Queenston Formation are rocks of the Cataract Group of Lower Silurian Age. These include the Whirlpool, Manitoulin, and Cabot Head Formations in this area. Previously mapped by Caley (1941) as members of the Medina Formation these units have since been raised to formational status by Bolton (1957) who also redefined the Medina Formation (in Ontario) as the Cataract Group. The Cataract Group outcrops only in the face of the Escarpment and in the walls or floors of reentrants therein (Table 1).

The Whirlpool Formation is generally a white to grey, fine-grained, unfossiliferous, quartzose sandstone which is reddish brown in the Credit Forks[1] area. It outcrops near Belfountain and Cataract where it is about 15 feet (5m) thick and in the Nottawasaga River Valley and its tributary west of Glen Cross where it is 20 to 25 feet (6-7m) thick. As it is resistant it forms rapids near Belfountain and in Nottawasaga River and waterfalls where erosion has reached the underlying soft shales as in the Nottawasaga River tributary northwest of Glen Cross (Photo 1).

The Manitoulin Formation overlies the Whirlpool Formation with a sharp contact. It occurs along the West Credit River north of Belfountain, in the Cataract-Credit Forks area, and along the Nottawasaga River and its tributary west of Glen Cross. It consists of thin to thick bedded dolostone with minor shale and chert. Thicknesses are about 15 feet (5m) near Belfountain and 25 feet (7m) in the Nottawasaga River area west of Glen Cross.

[1]Credit Forks is located at the confluence of the Credit and West Credit Rivers about one mile (1.6km) northeast of Belfountain.

Table 1 SILURIAN ROCKS FORMING THE NIAGARA EXCARPMENT SECTION IN THE ORANGEVILLE AREA. SECTION, MEASURED BY BOLTON (1957, p97-98), IS LOCATED ON LOT 12, CONCESSION I EHS, MONO TOWNSHIP, DUFFERIN COUNTY.

Section 65: Nottawasaga tributary (from Bolton, 1957, p97-98)

FORMATION OR MEMBER	DESCRIPTION	THICKNESS
		Feet
Amabel Fm. Colpoy Bay Member	Dolomite; white to light grey, fine grained, massive, porous; 6 feet of thin bedded, grey, argillaceous dolomite 10 feet above base.	49
Fossil Hill Formation	Dolomite; grey, crystalline, massive, thin to thick bedded, buff weathered; corals and *Pentamerus oblongus* Sowerby throughout; Cephalopoda in upper 2 feet.	8
Cabot Head Formation	Fifty-two foot composite sequence from base of Cannings Falls down river to Queenston-Whirlpool falls; three major sections:	
	Section III. Shale; grey; interbedded with sandstone, calcareous and argillaceous, grey, dense; *Helopora fragilis* Hall, Pelecypoda.	9
	Section II. Sandstone; red, fine grained, with limestone, arenaceous, red, and red shale interbeds–upper 3.5 feet; remainder grey shale and argillaceous limestone, interbedded; thin red shale and sandstone beds 4 and 5 feet above base.	10
	Covered interval.	4
	Section I. Shale; grey; interbeds of sandstone, calcareous, grey, fine grained, and green limestone; fossiliferous; red shale and sandstone 15, 16, and 20-22 feet above base.	23
	Covered interval.	6
Manitoulin Formation	Dolomite; grey, dense, buff weathered and limestone, dolomitic, grey, crystalline; thin to thick bedded, argillaceous; white chert modules and lenses; fossiliferous; lower contact sharp lithological break.	26
Whirlpool Formation	Sandstone; whitish grey, fine grained, thick to thin bedded, crossbedded; rare greenish grey shale partings; lower contact sharp on Queenston red shale.	22

14 to 25 feet of Queenston Shale (Ordovician) underlies this section at this locality.

The Cabot Head Formation overlies the Manitoulin Formation with gradational contact. It outcrops along the line of Canadian Pacific Railway south of Cataract and along the Nottawasaga tributary on lot 12, concession 1 EHS, Mono Township, Dufferin County. It consists of grey shale containing thin interbeds of reddish brown shale and sandstone. It is about 70 feet (21m) thick at Cataract and 52 feet (16m) thick at the Nottawasaga tributary near Glen Cross (Bolton 1957).



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Photo 1–Canning's Falls at contact between Queenston and Whirlpool Formations.

Within the Silurian section of the Niagara Escarpment the Cataract Group is normally overlain by the Clinton Group consisting of a number of rock units which demonstrate rapid lithologic and faunal variations. Bolton (1957), in revising the stratigraphy of the Escarpment, found only one unit in the Orangeville area correlative with the Clinton Group. This was the Fossil Hill Formation named by him (Bolton 1953) from a locality on Manitoulin Island. In the Orangeville area this rock unit has been recorded at only one locality, on the Nottawasaga tributary, where it is about eight feet (2.5m) thick and is easily recognizable due to its rapid weathering relative to the overlying Amabel Formation. Fossil Hill rocks consist of fossiliferous, thin to thick bedded dolostone which overlies the Cabot Head Formation with sharp contact. On Caley's (1941) map they form part of the Lockport Formation but on subsequent maps they have been incorporated in the Amabel Formation because of their limited extent in the face of the Escarpment.

Overlying the Fossil Hill Formation and underlying the Guelph Formation is the Middle Silurian Amabel Formation (Bolton 1953; 1957) which is the cap rock of the Escarpment in this area. In the Orangeville area the Amabel Formation is represented by the Colpoy Bay Member which consists of massive, porous, fine-grained to aphanitic, buff weathering dolostone which is reefy. These rocks are 50 feet (15m) thick in the Nottawasaga tributary and exceed 100 feet (30m) in thickness along Highway 24 west of Cataract (Vos 1969). Outcrops occur in the Nottawasaga tributary, two miles (3.2km) east of Orangeville, in concessions 5 and 6 EHS, Mono Township southeast of

Glen Cross, in bedrock walls of the Credit Valley north and south of Melville at Alton and one-half mile (0.8km) southeast of Alton, in the Cataract-Belfountain area, in the West Credit River near Erin, and on lot 11, concession II WHS, Mono Township two miles (3.2km) north of Orangeville.

More than 50 per cent of the Orangeville map-area is underlain by reefy dolostones of the Guelph Formation. These overlie the Amabel Formation with gradational contact and indeed they are not lithologically distinct in well cuttings. It is a light yellowish grey to cream-coloured, porous, finely crystalline to granular dolostone. Outcrops occur on the Grand River north and south of Tarbert, near Waldemar and for about four miles (6km) south of Highway 9. Combined thickness of the Guelph and Amabel Formations ranges from 150-400 feet (45-120m) in the Orangeville area. The Guelph Formation grades upward into the Salina Formation with no unconformity.

The Salina Formation underlies a small area in the southwestern part of the map-area. These rocks are of Upper Silurian age and consist of grey to green calcareous shale with interbeds of buff to brown dolostone; locally gypsum or anhydrite may be present in the shale. No outcrops of these rocks occur within the area. Outliers of the Salina Formation may be interpreted in the Damascus-Monck area from water well records, however these are not confirmed. No estimates of thickness are available for the Salina in the Orangeville area, however Caley (1941, p.42) reports more than 475 feet (142m) of Salina rocks in Minto Township, a few miles northwest of the area.

Economic Geology

No mineral extraction from Paleozoic rocks is presently taking place in the Orangeville area, however sandstone, shale and dolostone have been quarried in the past. The Townships of Caledon, Erin, and Mono are designated lands under The Pits and Quarries Control Act, 1971.

SHALE

Queenston Shale was formerly quarried for the production of brick about one-half mile (0.8km) west of Credit Forks. The pit is still well exposed and is located on lot 10, concession IV W, Caledon Township, Peel County. The operation was described by Montgomery (1930).

This site and several others in the Credit and Nottawasaga reentrants are suitable for Queenston Shale extraction. Keele (1924, p.23-25) also described the properties of the Cabot Head Shale and found it suitable for tile, hollow building blocks, and possible roofing tile. Guillet (*in* Hewitt and White 1969, p.19) has since found this shale to be suitable for brick manufacturing as well. A chemical analysis of a 25-foot (7m) section near Cataract is given in Table 2.

Though good exposures of Cabot Head shale occur just below Cataract, the Queenston Shale is usually more accessible for extraction.

Table 2 CHEMICAL ANALYSIS OF A COMPOSITE SAMPLE OF CABOT HEAD SHALE FROM CATARACT (AFTER HEWITT AND WHITE, 169, p.19)

		Percent
SiO_2		53.6
Al_2O_3		16.4
Fe_2O_3		5.58
CaO		3.92
MgO		4.76
Na_2O		0.42
K_2O		5.27
TiO_2		0.80
CO_2		5.66
H_2O+		3.10
H_2O-		0.68
SO_3		nil
MnO		0.06
	Total	100.30
L.O.I.		8.86

SANDSTONE

Building stone, used primarily in the construction of the old Toronto City Hall, was formerly quarried from the Whirlpool Formation at two sites about two miles (3.2km) northeast of Orangeville. These quarries were described by Parks (1912, p.159-162) and Hewitt (1964).

Parks (1912, p.156) also reported that in the Orangeville map-area, about one and one-quarter miles (2km) below Cataract some small openings had been made on both sides of the ravine by D. Robertson and Company, Toronto, and others. Here seven feet (2m) of sandstone was exposed which Parks considered to be inferior to the material being quarried at Credit Forks farther downstream. Thick overburden (Manitoulin Formation) at this site led Parks to suggest that little output could be obtained without underground mining.

Future sandstone quarrying in the Orangeville map-area is unlikely as most of the outcrop areas of the Whirlpool sandstone occur in locations highly suitable for recreational purposes.

DOLOSTONE

No dolostone quarries are presently active within the Orangeville area though a considerable amount of activity took place in the past. The principal dolostone units are the Amabel and Guelph Formations; data on the stratigraphy and properties of these rock units are available in Bolton (1957), Goudge (1938), Hewitt (1960; 1964), and Hewitt and Vos (1972). Vos (1969) has recently outlined the most favourable areas for future extraction for the Amabel Formation in the Orangeville area. A number of chemical analyses for dolostones occurring in the Orangeville area are given in Table 3;

Table 3 CHEMICAL ANALYSES OF SOME SILURIAN CARBONATE ROCKS FOUND IN THE ORANGEVILLE AREA (ANALYSES FROM GOUDGE (1938), EXCEPT 1478). COMPONENTS IN WEIGHT PERCENT.

SAMPLE	FORMATION	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	TOTAL	S	CaO	MgO	RATIO CaO TO MgO
1478	Guelph	0.95	0.18	0.42	0.03*	53.54	43.09	98.21	0.01**	30.0	20.6	1.46:1
261	Guelph	0.16	0.36	0.08	Tr.	54.70	43.77	99.07	0.01	30.63	20.93	1.46:1
262	Amabel	0.38	0.38	0.38	0.02	55.55	42.35	99.06	Nil	31.12	20.25	1.53:1
262A	Amabel	0.90	0.37	0.55	0.04	55.02	41.66	98.54	Nil	30.83	19.92	1.55:1
279	Amabel	0.26	0.28	0.10	0.02	55.04	43.69	99.39	0.01	30.83	20.89	1.48:1
263	Amabel	0.72	0.50	0.54	0.02	55.16	42.85	99.79	0.01	30.90	20.49	1.51:1
264	Amabel	0.48	0.39	0.51	0.02	54.84	43.06	99.30	Nil	30.72	20.59	1.49:1
264A	Amabel	1.06	0.51	0.57	0.07	55.11	42.56	99.88	Nil	30.90	20.35	1.52:1
264B	Amabel	1.18	0.48	0.95	0.07	54.29	42.14	99.11	0.01	30.44	20.15	1.51:1
265	Manitoulin	12.46	2.22	1.10	0.11	47.39	35.72	99.00	0.30	26.60	17.08	1.56:1

Sample Locations

1478 East Garafraxa Township, lot 14, concession XI, bank of Grand River.
261 Waldemar; dolostone in west bank of Grand River at the village.
262 Orangeville (lot 1, concession IEHS, Mono Township); dolostone exposed in small quarry on top of ridge.
262A same location as 262; buff dolostone exposed lower down the sides of the same ridge.
279 Erin; lot 13, concession X, Erin Township.
263 Melville Junction; quarry formerly worked by Contractors' Supply Company on lot 27, concession I W, Caledon Township, Peel County.
264 Alton; top 15 of dolostone in abandoned quarry at the village.
264A Alton; next 12 feet of dolostone at same quarry.
264B Alton; bottom 20 feet of dolostone at same quarry.
265 Credit Forks; dolostone in abandoned quarry just west of the railway station.

* P_2O_5.
** SO_3.
Tr. trace.

these indicate that much of the Guelph and Amabel Formations consist of high purity dolomite.

The only recorded use of the Manitoulin Formation was reported by Goudge (1938, p.267) who described the production of crushed rock from a quarry located west of Credit Forks. Numerous quarries were operated for short periods in rocks of the Amabel Formation. Most of these produced lime, however, some crushed rock and cut stone was also produced.

Quarrying within the Guelph Formation was limited to the Grand River Valley where thick overburden has been eroded. Lime was produced. Goudge (1938, p.215) reported only one quarry from the area located just south of Waldemar Village. Here the dolostone was found to be very pure (sample 261, Table 3). Lime burning kilns were also located during the present survey on lot 13, concession XI, East Garafraxa Township, and in the area north of Waldemar.

Future quarrying in the Orangeville area will depend on demand. Within the Amabel Formation the best locality for future work is in the Cataract-Alton area as indicated by Vos (1969). Other areas of potential are adjacent to former quarry operations where overburden is minimal as indicated on the drift thickness map.

Overburden is generally thick in the subcrop area of the Guelph Formation except in the Grand River Valley.

OIL AND GAS

No exploratory wells have been drilled within the area. In adjoining areas, however, gas shows have been obtained from the Manitoulin and Gull River Formations in West Luther Township and from the Guelph Formation in Peel Township. Producing gas wells are located in Arthur Township to the west where the Ordovician Gull River and Shadow Lake Formations are the producing horizons.

BEDROCK TOPOGRAPHY

Topography of the bedrock surface was mapped by Davies and McClymont (1962) and this has recently been fitted into the regional picture by Karrow (1973). Sibul and Choo-Ying (1971) provided a bedrock topography map of the Nottawasaga drainage basin.

A generalized and revised portrayal of the bedrock topography is given in Figure 3. A gently south-sloping surface is present everywhere excepting the major Escarpment reentrants of the Hockley and Credit Valleys and their contiguous channel. Elevations range from about 900 feet (270m) a.s.l. in the Hockley Valley to 1600 feet (480m) over an apparent Salina Formation outlier or salient at Monck. Local relief adjacent to the bedrock valleys approaches 500 feet (150m) in the Hockley Valley and 300 feet (90m) in the Credit Valley; elsewhere local relief ranges from 5 to 20 feet (2 to 6m).

Low bedrock terraces are developed on the Guelph Formation along the Grand River north of Belwood. The low flat in the northwesternmost part of the map-area may be an extension of the Walkerton Valley (Karrow 1973).

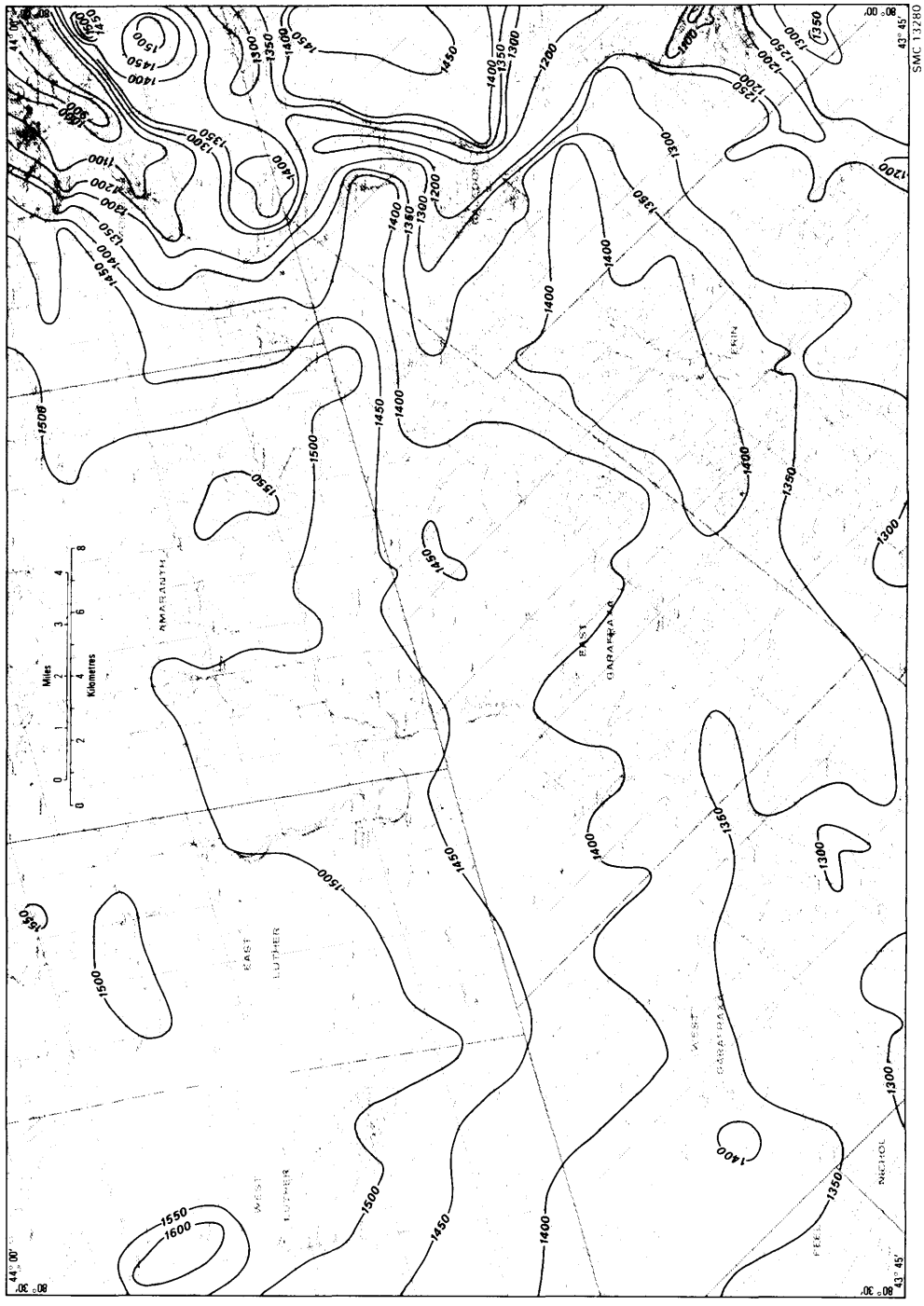


Figure 3–Sketch of bedrock topography, Orangeville area.

QUATERNARY GEOLOGY AND GEOMORPHOLOGY

Drift Thickness

Drift thicknesses within the map-area are shown on Map 2328 (back pocket). Greatest thicknesses occur within a buried channel adjacent to the modern Hockley Valley; here more than 450 feet (135m) of drift is present at one point while several others exceed 250 feet (75m). Elsewhere in the area drift usually varies from 50 feet (15m) to 150 feet (45m) in thickness excepting the Orangeville Moraine where 200 feet (60m) of drift is more common.

Till Stratigraphy

The Orangeville area has been affected by glacier incursions from the northwest (Georgian Bay lobe[1]), northeast (Lake Simcoe sublobe) and east or southeast (Ontario lobe). Consequently erratic materials of varied Precambrian provenance are present, as Logan (1863, p.894) noted when he observed Laurentian and Huronian erratics mixed with local rocks in the drift of Wellington and Grey Counties; this is especially true in the northern and west-central part of the area. The mixed provenance hinders the mapping of Quaternary rock units because distinct lobal affinities are masked. Similarly ice traversing Paleozoic terrain from the northeast or east cross essentially the same bedrock units precluding distinct lobal characteristics, e.g. ice of the Lake Simcoe sublobe entering the Hockley Valley traverses the same Paleozoic sequence as does Ontario lobe ice entering the Credit Valley.

All sediments mapped to date within the map-area are of Late Wisconsinan age though older sediments may be present. Multiple till sections are rare except in the walls of the Grand River Valley where a two till sequence is common. Stratigraphic terminology used herein follows that of Dreimanis and Karrow (1972).

PRE-CATFISH CREEK TILL SEDIMENTS

Only one exposure of Quaternary sediments that are possibly older than Catfish Creek Till was located. On the east side of Belwood Lake one-half mile (0.8km) south of Belwood (Grid Reference 546483) an exposure of possible Catfish Creek Till was found overlying stratified sand containing an interbedded grey, gritty, clayey silt till. As it occurred at lake level, excavation was restricted. This may represent a till older than Catfish Creek Till or it may be a lens within it.

[1]As used herein Georgian Bay lobe refers to ice moving from the north and northwest, i.e. the general vicinity of Georgian Bay.

Table 4 QUATERNARY DEPOSITS OF THE ORANGEVILLE AREA.

		Deposit	Materials	Landforms
Recent		modern alluvium bog deposits	sand, silt, gravel peat, muck, marl	present day flood plain and channel deposits filled depressions
Pleistocene	Late Wisconsinan	local glacial lakes and postglacial ponds	sand, silt, clay	veneer on ground moraine, depression fill
		KETTLEBY TILL	clayey silt till	buried
		glaciofluvial outwash	sand and gravel	terraces, outwash plains, channel fills
		WENTWORTH TILL	stony sandy silt till	Paris Moraine, hummocky topography
		NEWMARKET TILL	sandy silt till	hummocky end moraine
		ice-contact stratified drift	sand, and gravel	Orangeville Moraine, kames, eskers
		PORT STANLEY TILL	sandy silt till	Guelph drumlin field
		TAVISTOCK TILL	silt till	ground moraine plain, drumlins
		Middle till	silt till	mainly buried
		CATFISH CREEK TILL	stony sandy silt till	mainly buried ground moraine
	?	glaciolacustrine sediments	silt, clay, till?	buried



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Photo 2–Tavistock Till overlying Catfish Creek Till at Grand Valley.

CATFISH CREEK TILL

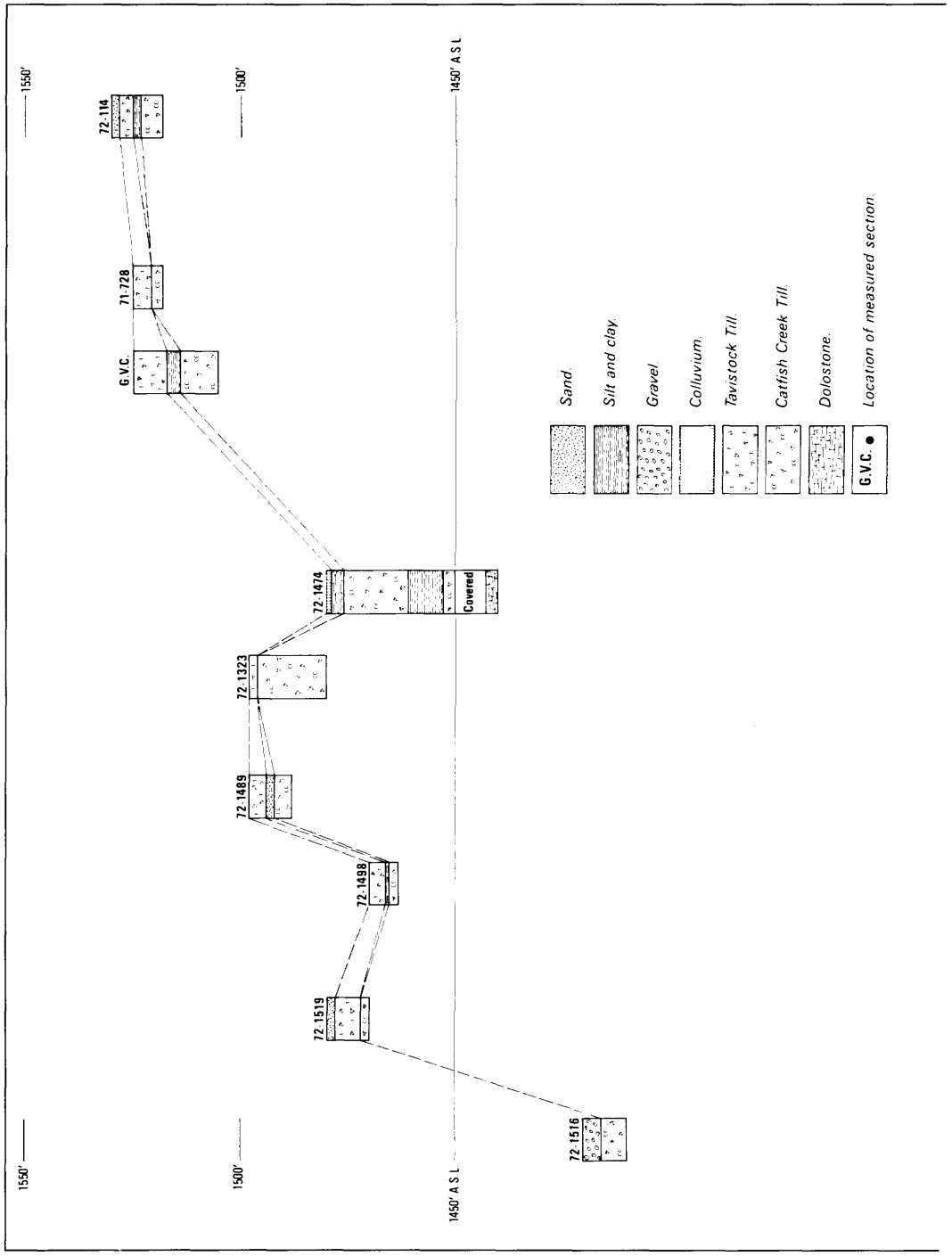
Catfish Creek Till takes its name from Catfish Creek near Lake Erie where it was first named (de Vries and Dreimanis 1960). It has since been traced northward as far as the Guelph area by Karrow (1968) and into the present area by the writer. It represents the initial Late Wisconsinan glacial advance which has been named the Nissouri Stadial (Dreimanis and Karrow 1972) and it is the oldest major till unit occurring in the map-area.

Within the Orangeville area Catfish Creek Till occurs along the banks of Grand River throughout most of its length (Figure 4). It appears to be present throughout the west half of the area only a few feet below the surface. In the east half possible occurrences were noted near The Maples and near Hillsburgh within deposits of ice-contact stratified drift. Up to 50 feet (15m) of this till has been observed.

The till is characteristically very compact, stoney to bouldery, and has a sandy silt texture (Table 5, Figure 5). It is a brown or yellowish brown (10 YR 4/4 to 10 YR 5/4)[1] to olive yellow (2.5Y 6.5/6) or light olive brown (2.5Y 5.5/4) when oxidized and greyish brown (2.5Y 5/2) or grey when unoxidized; depth of oxidation varies but 10 feet (3m) or more may be expected. As in other areas, easily abraded clastic materials are rare in the pebble grade and rock fragments are usually subrounded to rounded; flaggy materials are extremely rare. The very high dolomite content of the minus 200 mesh fraction suggests a northerly source with intense erosion of the Silurian carbonate

[1]Munsell Colour System

Orangeville Area



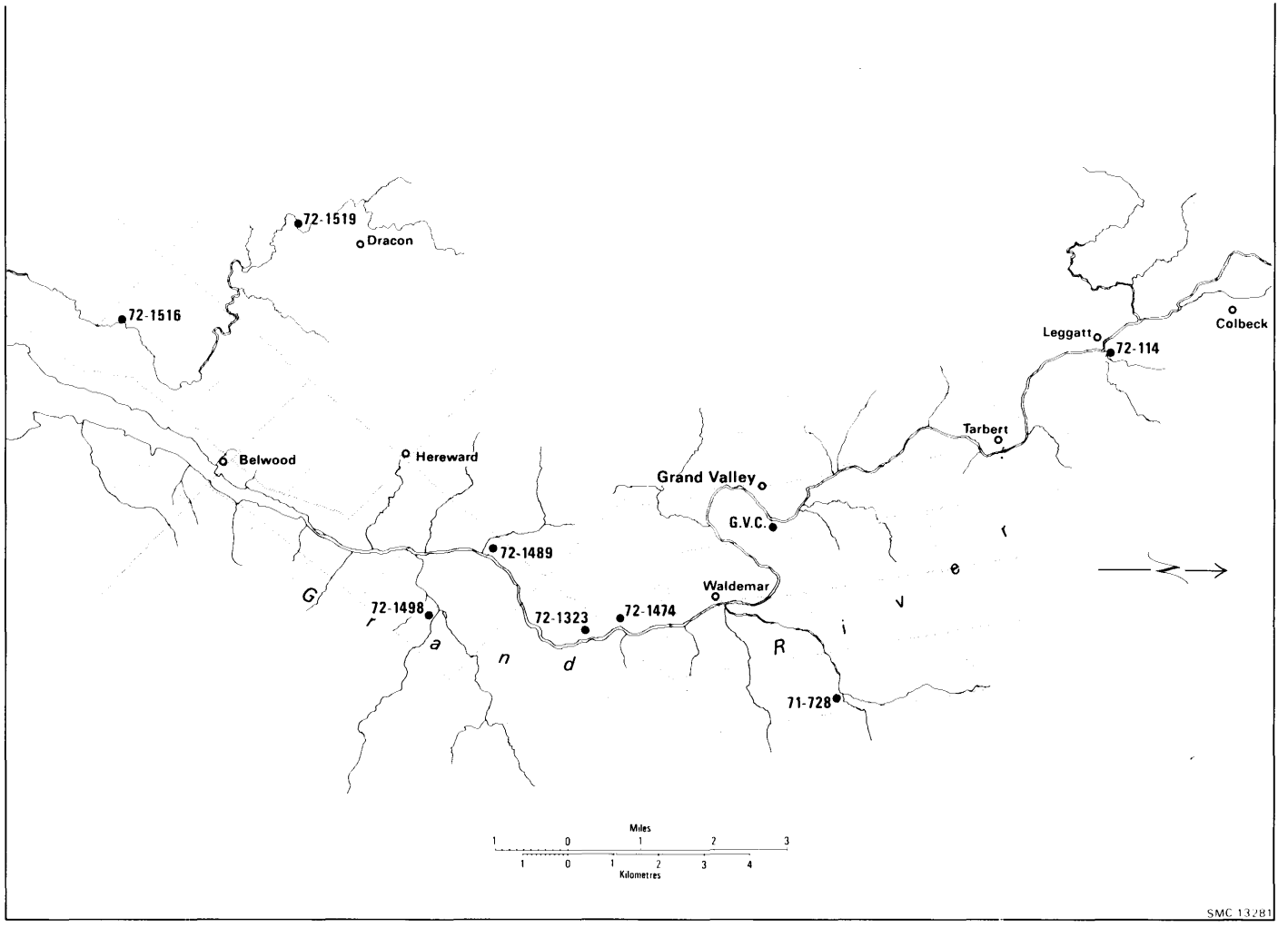


Figure 4–Stratigraphic sections along Grand River, Orangeville area.

Table 5 SUMMARY OF TILL ANALYSES FOR ORANGEVILLE AREA (R IS RANGE, M IS MEAN, N IS SAMPLE SIZE).

TILL	N	GRAIN SIZE—ANALYSIS CLAY % R	M	SILT % R	M	SAND % R	M	MD (MM) R	M	N	CARBONATES CALCITE % R	M	DOLOMITE % R	M	TOTAL % R	M	CALCITE/DOLOMITE R	M
Wentworth Till	2	10–12,	11	33–45,	39	45–55,	50	0.048 –0.080	0.054	2	13–17,	15	25–29,	27	38–46,	42	0.51–0.69,	0.60
Newmarket Till	3	9–11,	10	34–39,	36	51–55,	54	0.066 –0.081,	0.075	3	9–21,	16	12–32,	21	33–41,	36	0.27–1.69	0.98
Port Stanley Till	16	6–19,	12	26–53,	39	28–62,	49	0.0095–0.110,	0.061	16	5–22,	12	17–69,	37	36–75,	49	0.09–1.28,	0.45
Tavistock Till	49	10–52,	28	41–71,	53	3–38,	18	0.0019–0.034,	0.0099	49	10–33,	18	10–46,	25	30–58,	43	0.36–3.16,	0.85
Catfish Creek Till	10	10–21,	17	41–60,	47	30–42,	36	0.016 –0.038,	0.029	10	7–19,	13	24–57,	49	43–69,	61	0.13–0.79,	0.29

TILL	N	PEBBLE LITHOLOGY % LIMESTONE R	M	DOLOSTONE R	M	CHERT R	CLASTICS R	M	PRECAMBRIAN R	M	RATIO LS/DOL R	M	N	HEAVY MINERALS TOTAL % R	M	MAGNETICS % R	M
Wentworth Till	2	20–42,	31	53–70,	62	—	2–3 ,	3	3–7 ,	5	0.29–0.79,	0.54	2	4.2–5.5,	4.8	9.5– 9.6,	9.6
Newmarket Till	2	13–45,	29	36–83,	60	—	3–13,	8	1–6 ,	4	0.16–1.25,	0.70	3	3.8–6.2,	5.4	8.2–10.8,	9.5
Port Stanley Till	15	0–52,	20	39–99,	73	0–1	0–7 ,	3	0–10,	3	0.00–1.33,	0.36	16	1.8–6.2,	4.3	8.6–14.6,	11.4
Tavistock Till	44	1–46,	17	48–97,	74	0–3	0–9 ,	3	0–12,	5	0.01–0.96,	0.27	49	1.5–4.9,	3.1	2.9–16.6,	8.4
Catfish Creek Till	7	2–17,	5	78–98,	91	0–1	0–2 ,	0	0–10,	3	0.02–0.22,	0.06	10	1.6–4.3,	2.8	6.7–12.6,	9.6

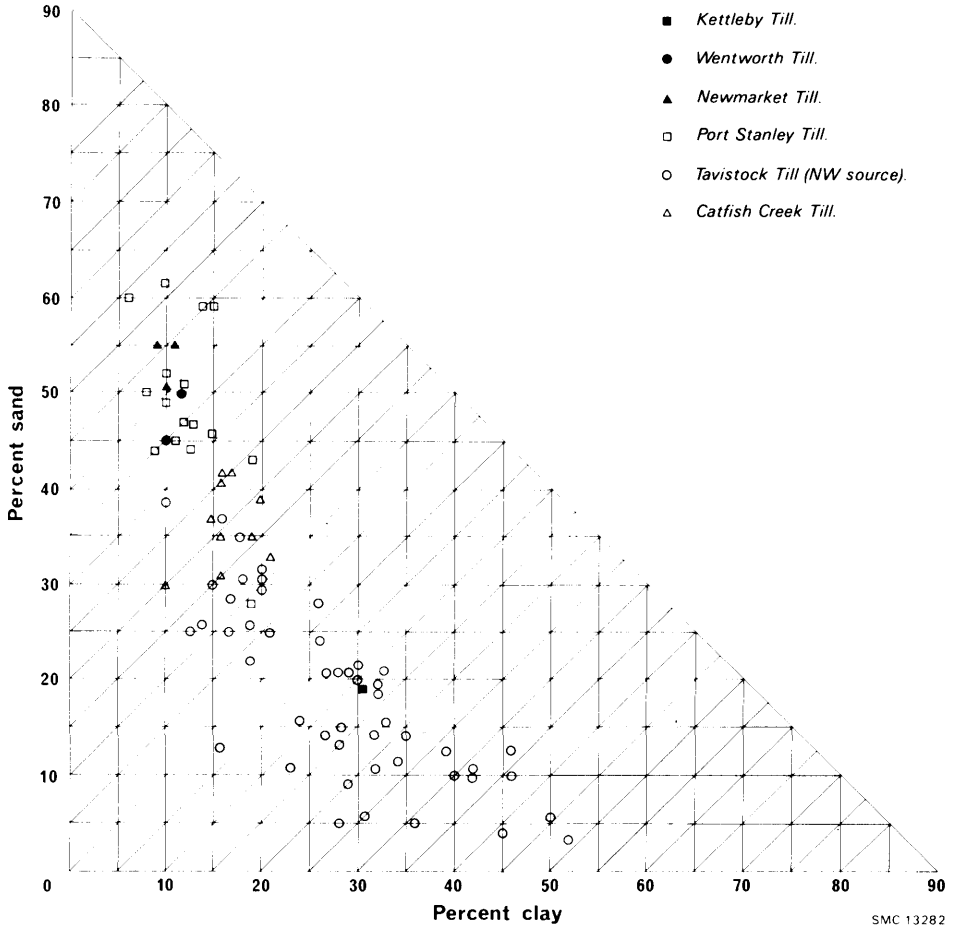


Figure 5–Textural diagram for Orangeville area till.

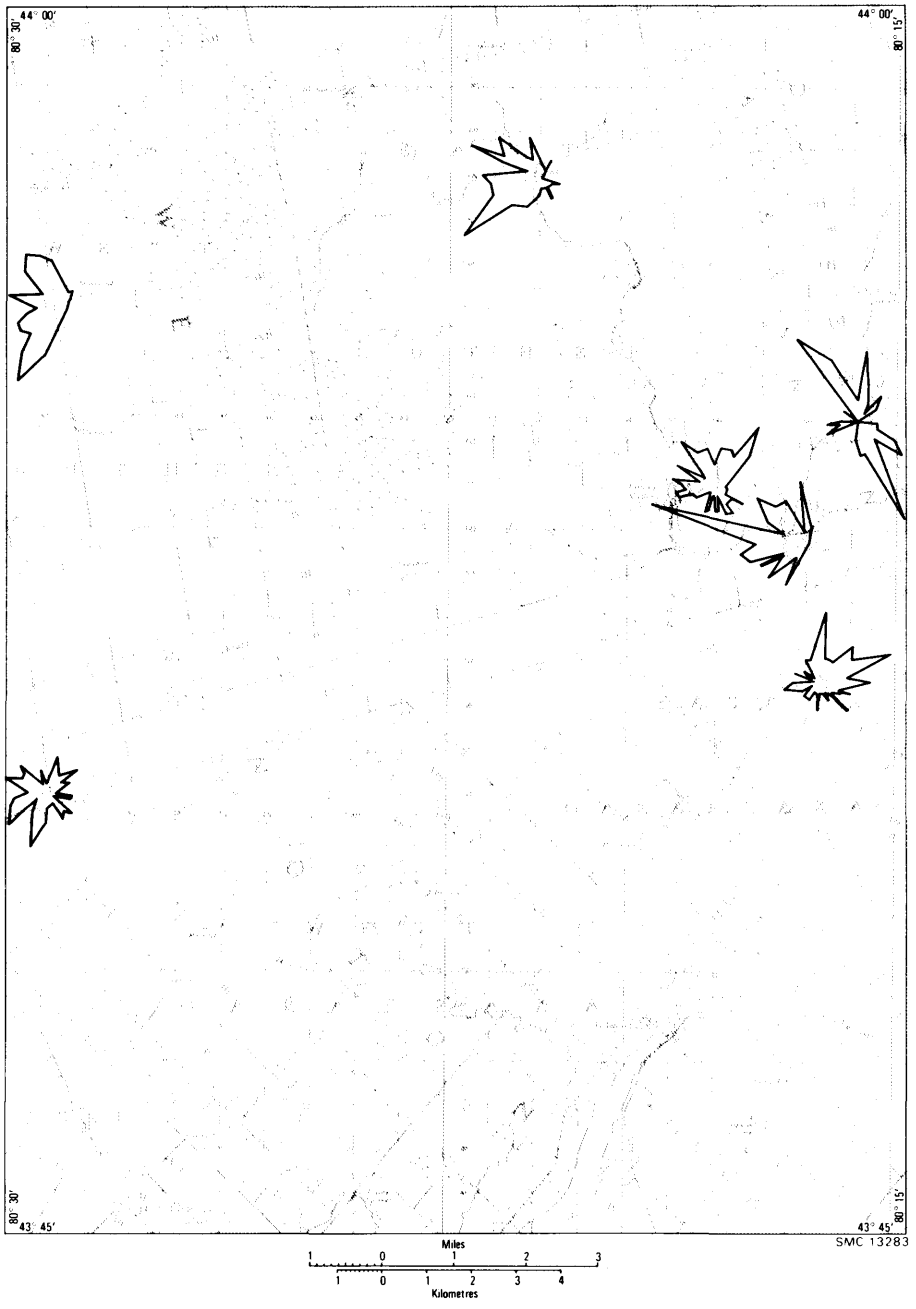


Figure 6–Rose diagrams of till fabric data (long axis orientation of pebbles) for Catfish Creek Till in Orangeville area. Locations are approximate.

rocks above the Escarpment. Springs commonly occur at the upper contact of this till.

Catfish Creek Till may be directly overlain by Tavistock Till or there may be intervening stratified sediments, usually lacustrine (Photo 2). In the Palmerston area to the west an intermediate till is present (Cowan 1972b) which is equivalent to the Stirton Till (Karrow 1974) or till 'B' of Karrow (1971). This till may be present in the westernmost part of the Orangeville area but it has not been observed to date. In most instances Catfish Creek Till probably overlies bedrock, but older glacial drift may be present locally. Interbedded lenses of lacustrine sediments have been observed within the Catfish Creek Till along the Grand River. Near Belwood, glaciolacustrine clay is commonly associated with this till.

Till fabrics (Figure 6) do not suggest a dominant directional trend though a strong northerly component is present. This in conjunction with the high dolomite content implies deposition from the north (Georgian Bay lobe).

MIDDLE TILL

A few occurrences of silt to clayey silt till located south of Hillsburgh are thought to be the 'middle till' of Karrow (1968). Some of these occurrences were associated with ice-contact stratified drift and may in fact be local till.

'Middle till' was described by Karrow (1968) in the Guelph area to the south where it occurs stratigraphically between the Catfish Creek Till and an overlying sandy silt till described as Wentworth Till (Karrow 1968) but since redefined as Port Stanley Till (Karrow 1974). 'Middle till' provenance is somewhat uncertain, however Karrow (1971) believes it to have an eastern source. To the south this till outcrops over a considerable area and has been formally named Maryhill Till by Karrow (1974). Extension of this term to the Orangeville area is not justified due to the nature of the outcrops. Sample 45 (Appendix B) is the only sample collected by the writer from this till; it is a yellowish brown silt till in which the pebble lithology suggests an easterly source.

Meager evidence suggests that the 'middle till' was deposited in a small area near Hillsburgh during an early Port Bruce Stadial glacial advance from the east. The associated deposits suggest that this may well be at or near the outer margin of this till sheet in the Orangeville map-area.

This till, or the lacustrine deposits related to it, was formerly used to manufacture bricks at Hillsburgh.

TAVISTOCK TILL

Tavistock Till takes its name from the village of Tavistock in the Stratford map-area to the south (Karrow 1974). It was formerly mapped as 'northern till' in the Guelph area by Karrow (1968) and as Till 'C' in the Conestogo map-area (Karrow 1971). Tavistock Till was informally referred to as 'Dundalk till' by Chapman and Putnam (1943b) who described it as a dolomitic sandy clay till occurring as till plain northeast of Arthur.



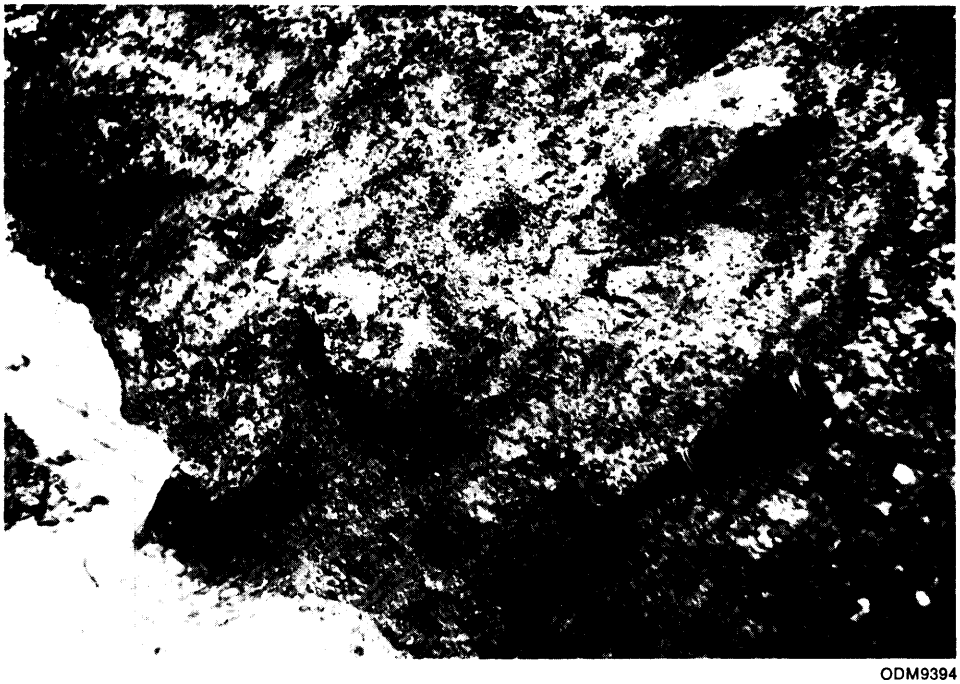
ODM9393

Photo 3–Tavistock Till overlying fine to medium sand, three miles (4.8 km) west of Alton in Orangeville Moraine.

This till occurs as ground moraine and fluted to drumlinized ground moraine on which the streamlined forms indicate a southeast direction of flow. It flanks and overlies the western part of the Orangeville Moraine (Photo 3) and ranges from one foot (0.3m) to 40 feet (12m) in thickness. It is generally observed in an oxidized state with colours ranging from brown (10YR5/3) to yellowish brown (10YR5/4) or dark yellowish brown (10YR4/4); the unoxidized colour is dark grey (10YR4/1) or dark grayish brown (10YR4/2).

Texturally the till is usually a silt or clayey silt till, however, it ranges to clay till locally and is often more sandy in the northwest or where it overlies sand as on the west flank of the Orangeville Moraine. At some localities the till is more clayey with depth, e.g. sample site 58, one-half mile southwest of Dracon, contains 39 percent clay 5 feet (1.6m) below the surface and 52 percent 18 feet (5.5m) below the surface; no stratigraphic break is present and the increase in clay content with depth is not pedogenic. The till contains numerous chips of red shale, as noted by Karrow (1971), and generally has a lower total heavy mineral content and fewer magnetics in the heavy minerals than does the Port Stanley Till. Lithologic data presented here (Table 5) shows the Tavistock Till in the Orangeville area to be similar to that described elsewhere (Karrow 1968; Karrow 1974).

Tavistock Till frequently directly overlies Catfish Creek Till in the Grand River area, though lacustrine sediments may intervene. To the west Stirton Till (Karrow 1974) occupies an intermediate position. In the vicinity of the Orangeville Moraine, Tavistock Till generally overlies sand though at one place, west of Orangeville, water laid till was found beneath it.



ODM9394

Photo 4–Glaciolacustrine bouldery silts underlying Tavistock Till (Lake Simcoe sublobe equivalent) one-half mile (0.8km) east of Orangeville.

Tavistock Till is a Georgian Bay lobe till, as indicated by streamline molded drift features, and results from glacial advance during the Port Bruce Stadial (Terasmae *et al.* 1972). The writer believes this till to be contemporaneous with the Port Stanley Till, however evidence exists to indicate that the Port Stanley ice overrode the outer margin of Tavistock Till at some time.

Till occurring at the head of the Hockley Valley between the east and west limbs of the Orangeville Moraine is now believed to be a Lake Simcoe sublobe equivalent or facies of the Tavistock Till. It was mapped previously as being of Ontario lobe affinity by Cowan and Sharpe (1973). The reinterpretation is based on distribution and pebble content which suggests an origin in the Hockley Valley. The till in this area is a sandy silt till and has been observed overlying glaciolacustrine silts which in places contain numerous dropstones (Photo 4). This implies a lake impounded in the Hockley-Credit bedrock channel area with the Credit Valley outlet blocked by Ontario lobe ice (Port Stanley Till).



ODM9395

Photo 5–Bouldery Port Stanley Till in Guelph drumlin field east of Binkham.

PORT STANLEY TILL

The drumlinized till flanking the east side of the Orangeville Moraine south of the Singhampton Moraine and west of the Caledon meltwater channel was referred to informally by Chapman and Putnam (1943b) as 'Eramosa till' which they described as a dolomitic, stony loam till occurring in the drumlin field between Guelph and Caledon; they have since referred to it as 'Guelph till' (Chapman and Putnam 1966, p.218). Karrow (1968) subsequently mapped this Guelph drumlin field as Wentworth Till and White (1970) described it as a phase of Wentworth Till older than the Port Huron Stadial. More recent work by Karrow and the work of White (1970) has led Karrow (1974) to redefine the Wentworth Till; consequently Wentworth Till in the Guelph drumlin field beyond the Paris Moraine is now referred to as Port Stanley Till which has been mapped over large areas to the south (Terasmae *et al.* 1972; de Vries and Dreimanis 1960; Dreimanis 1964; Karrow 1963; Cowan 1972).

Port Stanley Till in the Orangeville area is a stoney to bouldery (Photo 5) sandy silt till which is stiff to extremely stiff in compaction and having low plasticity. It is yellowish brown (10YR5/4) to light yellowish brown (10YR6/4) in colour, however, occurrences of reddish brown (2.5YR 4.5/4) phases are common—presumably from the incorporation of Queenston shale from below the Escarpment. As stated it occupies the broad track of rolling ground known as the Guelph drumlin field east of the Orangeville Moraine. Maximum thicknesses are unknown, however, this could be as much as 100 feet (30m); generally thickness would range from 3 to 50 feet (1-15m).

Detailed lithology (Table 5) indicates that Port Stanley Till is texturally similar to Wentworth and Newmarket Tills though it is more dolomitic and has greater total carbonate content. It is more coarsely textured than the Tavistock Till and is separable

from it to a degree on simple heavy mineral properties; the Simcoe sublobe facies of the Tavistock Till is very similar to Port Stanley Till.

Near its outer margin Port Stanley Till is frequently thin and may be seen overlying stratified drift of the Orangeville Moraine with which it is locally intercalated at the base. Its upper surface may be veneered with fine sands which are locally bouldery. These materials are ablation deposits which may be outwash or ablation till.

Port Stanley Till is of Late Wisconsinan age and was deposited by and advance of the Ontario lobe from the southeast during the Port Bruce Stadial about 14,500 years ago (Dreimanis and Karrow 1972; Karrow 1974). It is believed to be almost contemporaneous with the Tavistock Till, however, the Ontario lobe apparently retained its position longer and advanced over the outer part of the Tavistock Till southwest of Belwood in the Guelph map-area (Terasmae *et al.* 1972, p.62). A similar situation was noted in an excavation in the south half of lot 13, concession II, West Garafraxa Township, Wellington County in the Guelph map-area by the writer in 1972; a composite section of the observed materials is given below.

0-2′ (0-60cm)	pale brown laminated fine sand.
2-3′ (60cm-1m)	light yellowish brown pebbly sandy till-like materials (Sample 88c), black shale fragments.
3-6½′ (1m-2m)	yellowish brown silt till (Samples 88a, 88b, Port Stanley Till) containing lenses of reddish brown (5YR4/3) clay till (Sample 88b).
6½-8′ (2m-2.4m)	brown to dark grey (10YR5/1) compact clay till with numerous red shale chips (Sample 88c — Tavistock Till).

The sequence is thought to consist of Port Stanley Till and associated ablation materials overlying Tavistock Till. Additional data supporting this interpretation may be found on the northwest flank of the Orangeville Moraine where outwash sand, related to Port Stanley ice and indicating a northwesterly flow regime, overlies Tavistock Till.

NEWMARKET TILL

Newmarket Till was originally mapped as a separate till sheet by White (White 1970a; White and Karrow 1968) in the Bolton area where he referred to it informally as 'lower northern till'. Subsequently Gwyn (1972) formally named this till 'Newmarket Till' from the Newmarket area where the till outcrops over large areas. White also extended its limits into the Orangeville area while mapping Caledon Township (White 1970b).

With the Orangeville area this till is brown (10YR5/3) to yellowish brown (10YR5/4-6/4) sandy silt till. It is commonly observed overlying sand or gravel and numerous lenses of stratified drift are present within the till. Its outcrop area is primarily within a belt of rolling to hummocky topography which consists largely of the Singhampton Moraine as it occurs in Mono and Caledon Townships. Observed thicknesses were generally less than 10 feet (3m) and it probably does not exceed 40 feet (12m) in thickness. Newmarket Till varies from very stiff to soft in compaction; the latter condition prevails where it overlies stratified drift near the outer limit of its outcrop area.

Lithologically the till appears to vary considerably; this apparently relates to the degree of influx of dolostone at or above the Escarpment. Generally however, a notice-



ODM9396

Photo 6–Air photo showing hummock topography of Singhampton Moraine (upper right) crosscutting Guelph drumlin field four miles (6.5km) east of Orangeville. (Ontario Natural Resources photo 66-4337-83-42).

able percentage of materials from Ordovician rocks and from the Cataract Group are present. Carbonate content in the minus 200 mesh fraction range between 30 and 40 percent, though calcite to dolomite ratios are very variable. Total heavy mineral content in the fine sand fraction averages 10 percent of which an average of five percent are magnetic minerals.

Based on end moraine orientation the Newmarket Till represents an advance of the Lake Simcoe sublobe from the northeast along a line roughly parallel to the Hockley Valley. Relative ages may be obtained from crosscutting relationships. The Singhampton Moraine, which marks the outer limit of the Newmarket Till in the Orangeville area, crosscuts the Guelph drumlin field (Port Stanley Till) east of Highway 10 (Photo 6)

thus defining its maximum age. This relationship was reported by Chapman and Putnam (1951, p.49) and reiterated by White (1970a; 1971; White and Karrow 1968). In turn the southeastern end of the Singhampton Moraine is truncated by the Paris Moraine (Wentworth Till) and the Caledon meltwater channel east of Caledon (White and Karrow 1968; White 1970a). From this it may be concluded that the Singhampton Moraine and the Newmarket Till were deposited in the Orangeville map-area during the early part of the Port Huron Stadial or the latter part of the Port Bruce Stadial; the former is the usual interpretation of this moraine.

WENTWORTH TILL

Wentworth Till was originally defined by Karrow (1959) and takes its name from Wentworth County. In the Galt and Guelph areas Karrow (1963; 1968) mapped Wentworth Till west of the Paris Moraine though continually questioning the age relationships (Karrow 1971). Evidence such as that presented above (White and Karrow 1968; White 1970a; 1971; Chapman and Putnam 1951) clearly shows that Port Huron Stadial events occurred after the formation of the Guelph drumlin field and therefore Karrow (1974) has redefined the outer margin of the Wentworth Till to be the Paris Moraine.

In the Orangeville area Wentworth Till only occupies a few square miles in the southeastern most part of the map-area. Here it occurs in the hummock topography of the Paris Moraine where local relief ranges between 25 and 75 feet (7-23m). Thicknesses are unknown however it ranges from 3 feet (1m) to 15 feet (5m) in outcrops and probably does not exceed 50 feet (15m) in most instances. The till is generally a yellowish brown (10YR5/4), stony (15 to 25 percent), sandy silt till which dries to a light yellowish brown or pale brown colour. In the Paris Moraine lenses of stratified drift are not uncommon and in many places the Paris Moraine is cored by stratified drift though this is uncertain in the area south of Belfountain. The till is usually stiff to very stiff with little or no plasticity.

Lithologically Wentworth Till in the Orangeville area is similar to that in adjacent areas above the Escarpment (Karrow 1968; White 1970a; 1971). Pebble lithologies reflect the nearby Niagara Escarpment lithologies and total carbonates are typically high with low calcite to dolomite ratios. From Table 5 it is clear that Port Stanley, Newmarket and Wentworth Tills have many similarities which would be difficult to subdivide between without good stratigraphic control or morphologic discontinuities.

Wentworth Till is the result of a northwesterly glacial advance from the Ontario basin. Because the Paris Moraine has been related to the Port Huron Moraine System for many years (Chapman and Putnam 1951) the Wentworth Till has been considered to be of this age (Port Huron Stadial of Dreimanis and Karrow 1972). No evidence was uncovered during the present survey to refute this correlation.

KETTLEBY TILL

Kettleby Till was first mapped in the Bolton area by White (White and Karrow 1968) who described it as 'upper northern till'. Later Gwyn (1972) mapped it in the Alliston-Newmarket area and formally named it Kettleby Till; it takes its name from



ODM9397

Photo 7–Outwash sand and gravel overlying Kettleby Till, east of Glen Cross.

the Kettleby Cut described by White (1970a; 1971). Kettleby Till represent a southerly advance by the Lake Simcoe sublobe during the later part of Port Huron Stadial.

Within the Orangeville area the presence of this till is speculative. An outcrop of dark brown to dark grey, nearly stone-free clayey silt till (Sample 23) was located in 1971 in the Hockley Valley two miles (3.2km) east of Glen Cross beneath glacio-fluvial terrace gravels. At that time no other occurrences were known, however Gwyn (Ontario Division of Mines, personal communication 1973) now suggests that this outcrop is Kettleby Till based on his knowledge of its properties to the east.

The till is probably 10 to 20 feet (3-6m) thick at this site and appears to be interbedded with the lower part of the overlying outwash gravels (Photo 7). It is therefore suggested that a tongue of the Kettleby ice sheet extended up the Hockley Valley into the Orangeville area during the Port Huron Stadial. During retreat outwash gravels were deposited on top of the till, and these were later terraced.

GLACIAL LANDFORMS

END MORAINES

The oldest moraine within the area is the Orangeville Moraine. This was first described by Taylor (1910) who considered it to be a terminal moraine for the Ontario

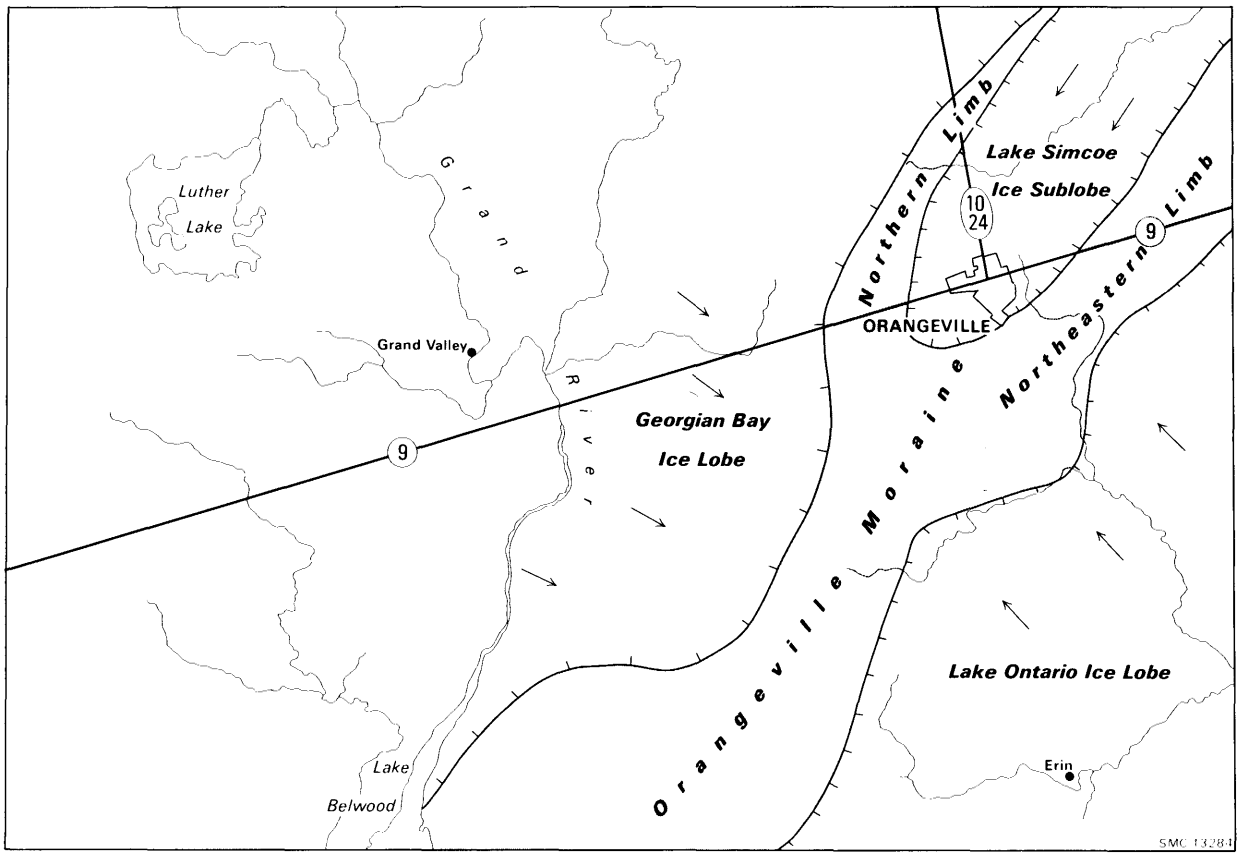
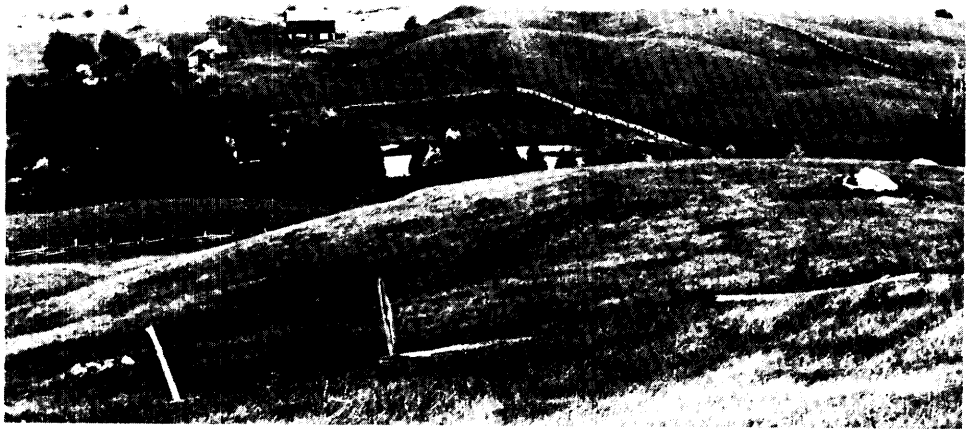


Figure 7–Approximate ice frontal positions at time of deposition of most of Orangeville Interlobate Moraine. Port Stanley Till, Tavistock Till and its Lake Simcoe sublobe equivalent were deposited at this time.



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Photo 8–Hummocky terrain in Orangeville Moraine, northwest of Orangeville.



ODM9399

Photo 9–Highly variable glaciofluvial sediments in the Orangeville Moraine at Simpsons Corners.



ODM9400

Photo 10–Dolostone boulder demonstrating degree of weathering since emplacement during the Port Bruce Stadial.

lobe and that it marked the eastern boundary of the interlobate area; he later named it the Orangeville Moraine (Taylor 1939, p.380). Chapman and Putnam (1949) established the interlobate nature of the moraine and they considered it to mark the first split of the Wisconsinan glacier in this area, i.e., Late Nissouri Stadial in terms of present nomenclature.

The moraine bifurcates in the north with one arm extending northeasterly from Caledon Lake and the other northerly (Figure 7). The northeasterly arm is overlain by the Singhampton Moraine east of Highway 10 and the northerly arm extends into the Dundalk map-area. South of Caledon Lake the moraine trends southwesterly and disappears beneath the Tavistock Till west of Belwood. The moraine may correlate with the Elmira Moraine to the southwest (Karrow 1968; 1971; Chapman and Putnam 1949; 1951).

The landform generally comprises a hummocky to dissected flat topped positive feature (Photo 8). It appears to consist of a lower glaciofluvial unit consisting of gravel and an upper glaciolacustrine unit consisting of fine sand, silt, and some varved sand and clay. Stratified drift may exceed 100 feet (30m) in thickness. Deformation structures are present throughout (Photo 9), textural variations are great, and surface boulders may be present (Photo 10).

Though part of the Orangeville Moraine may relate to the Catfish Creek Till the bulk of it is believed to have formed during the Port Bruce Stadial at the time of deposition of the Port Stanley and Tavistock Tills. Pebble lithologies (Table 6) indicate that much of the gravel has an easterly provenance as previously suggested by Chapman and Dell (1963). The glaciolacustrine sediments are thought to have been deposited in

Table 6 PEBBLE ASSEMBLAGES FOR PRINCIPAL GLACIOFLUVIAL DEPOSITS IN ORANGEVILLE AREA.

DEPOSIT	SAMPLE SIZE	LITHOLOGY MEAN RANGE								
		Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Felsic Igneous	Mafic Igneous	Metamorphic
GRAND RIVER Outwash north of Waldemar	5	7 (4–10)	89 (81–96)	1 (0–4)	—	0 (0–2)	—	2 (0–4)	1 (0–6)	0 (0–1)
GRAND RIVER Outwash south of Belwood	5	20 (7–35)	69 (50–86)	—	1 (0-3)	2 (0–3)	—	4 (1–5)	2 (0–4)	2 (1–4)
Outwash at head of Hockley Valley	5	61 (58–76)	24 (14–35)	—	2 (0–9)	4 (0–18)	present	3 (1–5)	3 (0–6)	3 (1–5)
Outwash in Credit Valley	5	64 (51–77)	14 (5–21)	—	1 (0–2)	9 (0–19)	—	5 (2–7)	3 (1–4)	4 (2–6)
Caledon Outwash fronting Paris Moraine	12	70 (51–84)	5 (0–14)	0 (0–1)	1 (0–2)	7 (0–24)	0 (0–1)	7 (2–12)	5 (0–9)	5 (2–13)
Caledon Lake— Waldemar Channel Outwash	5	45 (40–60)	35 (26–44)	1 (0–3)	2 (1–2)	6 (4–10)	—	6 (4–8)	4 (1–6)	2 (1–3)
ORANGEVILLE MORAINE North of Orangeville	9	68 (56–86)	18 (7–30)	—	2 (0–4)	1 (0–3)	0 (0–1)	2 (0–6)	3 (0–5)	5 (2–8)
ORANGEVILLE MORAINE Southwest of Alton	8	33 (15–46)	53 (19–76)	0 (0–1)	1 (0–4)	4 (0–11)	—	3 (0–7)	3 (0–6)	2 (0–5)
Mount View Esker complex	8	10 (5–14)	86 (80–92)	—	0 (0–2)	—	—	2 (1–3)	2 (0–5)	0 (0–2)
Egerton Esker	4	9 (5–12)	84 (81–86)	0 (0–1)	—	0 (0–1)	—	2 (0–3)	3 (0–4)	2 (0–3)

a large interlobal lake when the Georgian Bay and Ontario lobes were in contact south of Belwood. As the two lobes advanced to their maximum position the outer parts of the moraine were overrriden and the Hillsburgh meltwater channel was cut into the moraine in front of the Port Stanley ice.

The next oldest moraine is the Singhampton Moraine which overlies the Orangeville Moraine east of Highway 10. This was first mapped by Taylor (1913) and named by Chapman and Putnam (1949). In the Orangeville area this moraine is hummocky with local relief up to 50 feet (15m) in most places. It consists of Newmarket Till containing considerable stratified drift, in part derived from the underlying Orangeville Moraine. It is generally thought to represent the Lake Simcoe sublobe advance during the Port Huron Stadial though it is demonstrably older than the Paris Moraine.

Paris Moraine is the youngest in the area and occupies but a few square miles in the southeasternmost part of the map-area. First mapped and named by Taylor (summarized 1913) this moraine represents the outer limit of the Ontario lobe during the Port Huron Stadial. It consists of Wentworth Till and includes considerable stratified drift. Topography is hummocky with numerous boggy kettle holes; local relief is largely 25 to 50 feet (7-15m).

Chapman and Putnam maps (1951; 1972) indicate moraines near Dracon and Bowling Green; although these deposits are ablation materials no continuous moraine ridges were identified during the present survey. Sharpe (1972) described these deposits informally as the Laurel moraine; he also described a ribbed topography in the Farmington-Laurel area which he suggested was due to stagnation of the ice front.

GROUND MORAINE

Two large areas of ground moraine are present within the area. The first of these occupies most of the area mapped as Tavistock Till west of the Orangeville Moraine and is partly drumlinized or fluted. This area forms part of the Dundalk till plain described by Chapman and Putnam (1951, p.152). The area is basically flat and poorly drained with little surface relief. It is further smoothed by shallow lacustrine or bog deposits which have infilled depressions in the till surface.

The other area is primarily the drumlinized ground moraine of the Guelph drumlin field east of the Orangeville Moraine. Here the topography is rolling, relief is less than 100 feet (30m), and the area is dissected by a network of meltwater channels. Ground moraine in this area consists of Port Stanley Till which overlies stratified drift in the westerly sector.

STREAMLINED MOLDED DRIFT FORMS

Two areas of streamlined drift forms indicating direction of glacier flow are present within the area. The first is the Guelph drumlin field (Putnam and Chapman 1943a) located south of Orangeville. These drumlins trend in a northwest-southeast direction (130—140 degrees), have only weakly developed stoss and lee form, range from one-quarter to one mile in length, (0.4 to 1.6km) and range from a few hundred feet to one-half mile (0.8km) in width. They consist of Port Stanley Till for the most part,

however, those overlying the eastern part of the Orangeville Moraine may be cored with stratified drift. Meltwater channels have dissected the Guelph drumlin field into isolated groups in this area. These drumlins represent glacier flow from the southeast.

A second area of streamlined drift forms occurs primarily in East Luther Township northwest of Grand Valley. Here scattered glacial flutings trend at 120 to 130 degrees. These are believed to represent glacier movement from the northwest during deposition of the Tavistock Till. These flutings are very faint. Near Marsville a few weak flutings and drumlinoid features are present. These have a more westerly orientation (270—290 degrees) than the above flutings but are believed to represent the same glacial event.

GLACIOFLUVIAL FEATURES

MELTWATER CHANNELS

Glacial meltwater channels provide much information on glacial history; many of the principal channels are associated with outwash deposits. The Grand River channel contains the largest present-day stream. It is incised into surrounding drift as much as 150 feet (45m) and much of it flows on bedrock. This channel originated during retreat of the Tavistock ice from the Orangeville Moraine. Willow Creek was probably the original northerly limb of this channel.

The Hillsburgh channel is entrenched up to 150 feet (45m) into the southern limb of the Orangeville Moraine. It represents an ice marginal position of the Port Stanley ice, however it is not entirely certain whether it indicates a retreat position or a re-advance position. The former interpretation is preferred by the writer and it is believed that the Port Stanley ice probably did not advance much beyond the position of this channel and its southwesterly extension to the Speed River; the extension to the Eramosa River represents a later stage of retreat.

The channel from Caledon Lake to Waldemar is apparently slightly older than the Hillsburgh channel. The present interpretation for this channel is as follows: the Ontario lobe stood at a position near the Hillsburgh channel and along the northeasterly limb of the Orangeville Moraine while the Lake Simcoe sublobe occupied the Hockley Valley in a position between the two northern limbs of the Orangeville Moraine (Figure 7). Retreat of the Tavistock ice to the west permitted breaching of the moraine at Caledon Lake and drainage of the Ontario lobe and Lake Simcoe sublobe to the Grand River channel though flow may have been easterly at a later stage. Partial retreat at a later stage of the Ontario lobe allowed drainage to the south via the Hillsburgh channel.

Further retreat of the Ontario lobe resulted in numerous small channels being cut into the Guelph drumlin field. The northeasterly limb of the Orangeville Moraine was breached to initiate drainage via the Credit River channel from Orangeville to Alton and thence to the Hillsburgh channel. Continued retreat extended the Credit River channel to Cataract and permitted drainage to the south via Eramosa River. The Credit River channel was reoccupied during the Port Huron Stadial by waters flowing from the Newmarket ice in the Hockley Valley. This stage apparently coincides with the Violet Hill channel to the north of the area and much of the outwash related to the Credit River channel was deposited at this time.



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Photo 11–Stratified outwash sand and gravel two miles (3km) southwest of Belwood.

OUTWASH DEPOSITS

Glaciofluvial outwash deposits in the Orangeville area are economically important and are of great interest in deciphering the glacial history. The more important deposits occur along the Grand River, at the head of the Hockley Valley, along the Credit River, and fronting the Paris Moraine. Lesser deposits occur in the Hillsburgh meltwater channel, in the meltwater channel between Caledon Lake and Waldemar, and in smaller channels.

Terrace deposits along the Grand River consist of gravel and gravelly sand (Photo 11) which may directly overlie bedrock. These deposits range from less than five feet (1.5m) thick to more than 25 feet (8m) in thickness; one water well reports up to 65 feet (20m) of granular materials southwest of Belwood.

Pebble lithology (Table 6) shows that the outwash north of Waldemar consists mainly of locally derived dolostones but that to the south of Belwood contains more material derived from the east and northeast. The easterly component is thought to result from reworking of Orangeville Moraine sediments and from material entering Grand River via the Caledon Lake-Waldemar meltwater channel. Three sand samples taken from the outwash south of Belwood (Samples 10, 11, 12, Table 7) show mean sand sizes falling within the medium to fine sand range and distributions that are poorly sorted, strongly fine skewed to coarse skewed, and platykurtic to very leptokurtic (Folk 1968). Mineralogy of one sand sample (Sample 10, Table 8) from south of Belwood also implies a possible easterly source for this material.

These sediments represent deposition during the Port Bruce Stadial. They are largely the result of retreat of the Tavistock ice sheet though some material was derived from

Table 7 SEDIMENTOLOGICAL PROPERTIES OF GLACIOFLUVIAL OUTWASH SANDS FROM THE ORANGEVILLE AREA.

SAMPLE NO.	ORIGIN	GRAPHIC VALUES (FOLK & WARD 1957) Mz ϕ	σI ϕ	Sk I	K G	KG′	LOCATION LOT	CON.	TOWNSHIP
18	Caledon Outwash	1.02	0.53	−0.75	1.45	0.59	16	X	Erin
19A	Caledon Outwash	1.50	0.97	−0.80	1.00	0.50	15	I W	Caledon
19B	Caledon Outwash	1.18	0.97	−0.29	1.11	0.53	15	I W	Caledon
20	Caledon Outwash	2.23	0.59	0.17	1.07	0.52	14	III W	Caledon
22	Caledon Outwash	1.95	0.60	0.06	1.22	0.55	15	V W	Caledon
10	Grand River Outwash	2.57	1.31	+0.31	1.59	0.61	11	VI	W. Garafraxa
11	Grand River Outwash	2.07	1.17	0.19	0.76	0.43	11	V	W. Garafraxa
12	Grand River Outwash	1.59	0.98	+0.49	1.72	0.63	12	V	W. Garafraxa
13	outwash	2.23	0.53	0.29	1.21	0.55	31	II W	Caledon
14	outwash	1.34	1.13	+0.28	1.23	0.55	20	VIII	Erin
24	outwash?	1.45	1.13	−0.33	1.04	0.51	27	I W	Caledon

Table 8 MINERALOGICAL COMPOSITION OF GLACIOFLUVIAL OUTWASH SANDS IN ORANGEVILLE AREA (MINUS 60, PLUS 120 MESH FRACTION). MEASUREMENTS ARE GIVEN IN WEIGHT PERCENT.

Sample No.	10	13	14	18	19A	20	22	24
Quartz	27	36	40	40	33	33	36	30
Feldspar	13	10	11	14	14	17	12	15
Paleozoic Limestone	37	40	37	31	40	33	30	42
Grey Shale and Siltstone	10	9	7	11	8	9	15	7
Red Shale and Siltstone		2				1	1	1
Black Shale and Siltstone	4	1	1		2	2	4	
Garnet								1
Hornblende	2	1	1	1	2			
Mica								
Pyroxene								
Limonite/Hematite	1		1	1				
Precambrian l/s								
Magnetite								1
Sandstone	2		1	1	1			1
Acid Igneous Rocks	1		1	1		3	2	
Basic Igneous Rocks	2	1				2		2
Scapolite								
Epidote								
Chert	1							
Tourmaline								
Cemented Aggregates								
Dolomite								



ODM9402

Photo 12–Terraced outwash deposits in the Hockley Valley, east of Glen Cross.



ODM9403

Photo 13–Uniform outwash gravel in northwest part of Premier Concrete Products pit.



ODM9404

Photo 14–Small normal fault in outwash gravel two miles (3.2 km) north of Cataract.

the Port Stanley ice sheet to the east. Meltwaters flowed from north to south as does the present drainage.

The outwash deposits at the head of the Hockley Valley represent deposition from the Newmarket ice largely by south flowing meltwaters as the ice stood at the Singhampton Moraine during the Port Huron Stadial. These gravels range from 20 feet (6m) to more than 100 feet (30m) in thickness and are characterized by siltstone derived from the Georgian Bay Formation and clastics from the Cataract Group.

Ice-contact terraces (kame terraces) northeast of Blount were deposited by Newmarket ice when it stood in Hockley Valley. In contrast low level outwash terraces (Photo 12) were apparently deposited by the Kettleby ice as gravels east of Glen Cross are interbedded with underlying till interpreted as Kettleby Till.

Outwash along the Credit Valley from Orangeville to east of Alton was largely deposited during the Port Huron Stadial by waters derived from the Newmarket ice for the most part. The deposits are contiguous with the Caledon Outwash at Cataract (described below). Many of the gravels occur in low wet areas so little is known about them. Higher level deposits vary from sand and silty gravel to clean uniform stratified gravel (Photo 13). The deposits are less than 25 feet (8m) thick though one well record reports more than 50 feet (15m) of gravelly materials. The pebble lithology (Table 6) is similar to the Hockley Valley Outwash and the Caledon Outwash with siltstone being prominent. One sand sample (No. 24, Tables 7 and 8) is similar to other outwash deposits in the area.

The term Caledon Outwash is used here to describe a broad sheet of outwash gravel

fronting the Paris Moraine in the Bolton and Orangeville map-areas. These gravels were deposited during the Port Huron Stadial as the Ontario lobe stood at the Paris Moraine. The gravels are usually moderately well stratified with southerly currents indicated by internal structures; small scale faulting (Photo 14) has been observed. Thicknesses range from 19 feet (6m) to more than 50 feet (15m).

Pebble lithology of the Caledon Outwash is given in Table 6 and fine sand mineralogy is given in Table 8 (Samples 18, 19A, 20, 22). Siltstone and shale occur frequently in both the pebble and sand grades; red Queenston shale is more common in those deposits south of Cataract than to the north.

Grain size parameters for five samples from this deposit (Table 7) indicate mean grain sizes largely fall in the medium sand range and that the deposits are moderately sorted to moderately well sorted; distributions are finely skewed to strongly coarse skewed, and platykurtic to leptokurtic.

Gravels in the Hillsburgh meltwater channel are not well exposed though water well data suggest that thicknesses of 25 feet (7m) or more may be present. Lithologies would not vary greatly from those of the Hockley Valley and Credit River outwash deposits.

Outwash gravels between Caledon Lake and Waldemar are of some interest in determining the geologic history of the area. Flow directions at one poorly exposed site suggest northwest to southeast flow while pebble lithologies (Table 6) indicate the gravels were derived from Ontario or Lake Simcoe sublobe ice; it is felt these gravels were laid down by water flowing from east to west, but that later flow may have been towards the east. Thicknesses of 10 to 19 feet (3-6m) have been observed from these deposits though greater thicknesses may occur locally. Much of this material is modified ice-contact stratified drift which imparts a knobby topography to part of the deposit.

ICE-CONTACT STRATIFIED DRIFT

Large areas of ice-contact stratified drift were mapped during the present survey. Most of this was associated with the Orangeville Moraine and lesser morainal deposits; that part related to eskers is discussed in a later section.

As mentioned previously the Orangeville Moraine consists primarily of a lower unit of glaciofluvial gravels and an upper unit of glaciolacustrine sand and silt.

However, local variability (Photo 9) and internal collapse structures led to the mapping of these materials as ice-contact stratified drift; detailed mapping could refine this considerably. Interbedded till is rare in surface exposures. That area of the moraine located northwest of Orangeville contains stratified drift up to 160 feet (48m) thick, however less than 75 feet (23m) would be more typical. Much of the material is gravelly sand and extensive deposits of coarse gravel are rare.

The pebble lithology of this section (Table 6) indicates that much of the gravel was derived from below the Niagara Escarpment via the Hockley Valley: siltstone is more common in the cobble grade than is indicated in the pebbles. Eight sand samples from this area (Table 9) indicate that mean grain sizes range from coarse to fine; sorting ranges from poorly sorted to moderately well sorted and grain size distributions are near symmetrical to fine skewed and mesokurtic to leptokurtic (Folk 1968). Sand mineralogy (Table 10, Samples 1, 4, 6) also indicates the presence of considerable material from below the Escarpment cap rock. Boulders (Photo 10) representing final

Table 9 SEDIMENTOLOGICAL PROPERTIES OF SANDS IN ORANGEVILLE MORAINE. SAMPLES NUMBERED 1 TO 6 ARE FROM NORTH PART OF MORAINE AND REMAINDER ARE FROM SOUTH PART.

SAMPLE NO.	COMMENTS	GRAPHIC VALUES (FOLK & WARD 1957) Mz θ	σI ϕ	Sk I	K G	KG′	LOCATION LOT	CON.	TOWNSHIP
1 S	south part of pit	2.27	0.67	+0.14	1.08	0.52	3	III	Mono
1 N	north end of pit	1.67	0.54	+0.15	1.18	0.54	4	III	Mono
2 S	south end of pit	2.80	1.70	+0.14	1.54	0.61	5	3 W	Mono
2 N	north end of pit	0.20	0.51	+0.04	0.89	0.47	5	3 W	Mono
3		1.76	0.97	+0.22	1.42	0.59	4	III	Mono
4′		1.70	0.56	+0.25	1.31	0.57	4	II W	Mono
5		1.93	0.92	+0.08	1.05	0.51	5	II W	Mono
6		2.21	1.41	+0.03	1.07	0.52	5	I	Amaranth
	Means	1.82	0.91	+0.13	1.19	0.54			
15		1.31	0.86	+0.05	0.98	0.49	28	IX	Erin
16	overlain by till	1.68	0.53	+0.19	1.26	0.56	1	XIX	E. Garafraxa
17		2.24	1.10	+0.14	1.04	0.51	30	VIII	Erin
25A	roadcut	3.05	0.69	+0.39	1.21	0.55	27	VII	Erin
25B	roadcut	1.67	0.71	+0.06	1.10	0.52	27	VII	Erin
25C	roadcut	4.53	0.79	+0.20	1.06	0.51	27	VII	Erin
26	overridden	2.54	0.79	+0.16	1.23	0.55	21	VIII	Erin
	Means	2.43	0.78	+0.17	1.13	0.53			

Table 10 MINEROLOGICAL COMPOSITION OF SANDS TAKEN FROM ICE-CONTACT GLACIOFLUVIAL DEPOSITS IN ORANGEVILLE AREA (ALL PERCENTAGES ARE TAKEN TO NEAREST 1 PERCENT).

SAMPLE NO.	1	4	6	15	17	25B	7	21	9	8
Quartz	33	48	7	25	29	41	27	39	53	38
Feldspar	13	13		13	10	18	15	28	13	15
Paleozoic Limestone	42	25	88*	47	46	31	42	20	33	31
Grey Shale and Siltstone	9	3		2	6	5	12	16	1	14
Red Shale and Siltstone			5							
Black Shale and Siltstone		1		5	2	1		5		1
Garnet										
Hornblende	1	5		1						
Mica										
Pyroxene										
Limonite/Hematite		1			1	1				
Precambrian l/s										
Magnetite					1					
Sandstone				5	2	3	2			
Acid Igneous Rocks				1			2			
Basic Igneous Rocks	1	3		1	1			1		1
Scapolite										
Epidote										
Chert	1				2					
Tourmaline										
Cemented Aggregates		1								
Dolomite										

*dolomitic.

Table 11 SEDIMENTOLOGICAL PROPERTIES OF MISCELLANEOUS SAND SAMPLES TAKEN FROM ICE-CONTACT GLACIOFLUVIAL DEPOSITS, ORANGEVILLE AREA.

SAMPLE NO.	ORIGIN	GRAPHIC VALUES (FOLK & WARD 1957) Mz ϕ	σI ϕ	Sk I	K G	KG′	LOCATION LOT	CON.	TOWNSHIP
7	ice-contact, kame	0.47	0.68	−0.06	0.98	0.49	11	XVII	E. Garafraxa
21	ice-contact, kame	2.57	0.65	+0.27	0.98	0.49	13	VIII	Erin
23	ice-contact, kame	1.85	0.75	+0.15	0.97	0.49	14	IX	Erin
9	ice-contact	1.97	0.55	−0.04	1.02	0.50	14	VI E	Mono
8	ice-contact, esker	2.80	0.80	+0.23	1.28	0.56	6	XV	E. Garafraxa

ablation are common on the surface.

The northeastern limb of the Orangeville Moraine contains stratified drift having indicated thicknesses in excess of 100 feet (30m). Much of this was overridden by the Newmarket ice and has a till veneer.

The bulk of the Orangeville Moraine trends southwesterly from Alton toward Belwood. Stratified drift in this segment may exceed 150 feet (45m) locally but 50 to 100 feet (15-30m) is more common. The eastern part of this material extends beneath the Port Stanley Till and the outermost part of the Tavistock Till overlies the western part of the drift (Photo 3). Pebble lithologies (Table 6) indicate a greater dolostone component contributed by the Tavistock ice from the northwest though considerable easterly source siltstone remains. Sand mineralogy (Table 10, Samples 15, 17 25B) is similar to that in the northern segment. Sieve analyses of sands (Table 9) gives the following results: mean grain sizes—medium sand to coarse silt range; sorting—poorly sorted to moderately well sorted; skewness—near symmetrical to strongly fine skewed; kurtosis—mesokurtic to leptokurtic (Folk 1968). Glaciolacustrine sediments are more pronounced in this segment and much of the sediment consists of fine sand varying to silt or varved sand.

Further deposits of ice-contact stratified drift occur as isolated kames or minor recessional moraine deposits. One such deposit occurs north of Grand Valley where several square miles are overlain by thin deposits of sand and gravel which in places constitute little more than a veneer over Tavistock Till. These deposits represent stagnant conditions during retreat of the Tavistock ice.

Eroded glaciofluvial materials in the walls of the Hockley Valley and Credit Valley near Belfountain were mapped as ice-contact deposits. These are poorly exposed and strongly slumped but consist mainly of sand gravel with some lacustrine silt and minor till. Thicknesses up to 75 feet (23m) may be expected.

Sedimentological properties of sand samples from scattered ice-contact deposits are given in Table 11.

Eskers

Several esker segments are present in the area. Perhaps the first mention of these was made by Logan (1863, p.908) who described a belt of loose gravel ('Artemesia Gravel') entering Luther Township from the northwest. Taylor (1909; 1910; 1912) mentioned eskers in the Orangeville area and commented on the large size of the one described by Logan. This esker is the largest one in the area and is referred to here as the Mount View Esker. Mount View Esker or esker complex rises up to 50 feet (15m) above the surrounding terrain, though exposures seldom reveal more than 25 feet (8m) of stratified drift. In general it consists of an inner core of pebble or cobble gravel flanked by sand which may be quite bouldery. Much of the esker has been removed for road building. Pebble lithologies indicate the Georgian Bay lobe origin of this esker (Table 6).

The Egerton and Brice Hill Eskers (Chapman and Putnam 1951) occur north of the Mount View Esker and trend parallel to it. The former originates in Glenelg Township to the northwest and ends in Luther Lake and the latter rises in Proton Township to the north and ends near Campania in the Orangeville area. These eskers consist of central granular cores flanked by sand, as with the Mount View Esker, and pebble

content is primarily dolostone. The Mount View, Egerton, and Brice Hill Eskers[1] were deposited during retreat of the Tavistock ice toward the northwest; all are believed to be subglacial in origin.

A few esker segments in East Garafraxa are generally aligned in a northwest-southeast direction. Current bedding in the one immediately north of Reading is variable and pebble counts suggest an easterly source in part. The segment south of Marsville has a pebble lithology suggesting a northwesterly source though poorly exposed current bedding suggests a flow toward the northwest. These eskers are believed to be related to the Tavistock ice though the ambiguities pointed out remain; better exposures could resolve this.

LACUSTRINE SEDIMENTS

Sediments indicating the presence of proglacial lakes or postglacial pondings occur in four main situations: the Grand River area in association with Catfish Creek Till, the Orangeville Moraine area but particularly the southern part, the Hockley Valley area, and on the surface of the Tavistock Till in the western part of the area. The oldest of these consist mainly of silts and clays related to the Catfish Creek Till. The most extensive outcroppings of these occur in eroded tracts near Belwood where stratigraphic relationships are uncertain. However lenses of lacustrine sediments are known to be present within the Catfish Creek Till and lacustrine sediments immediately overlie the till in several places near and west of the Grand River. These sediments are believed to represent proglacial lakes which were present during the retreat of the Catfish Creek ice and perhaps during earlier fluctuations of the ice sheet margin. The upper part of these sediments probably are not distinguishable from sediments deposited in proglacial lakes fronting later advances.

The next oldest lacustrine sediments occur in the Orangeville Moraine. These are believed to represent an interlobal lake, here called Glacial Lake Garafraxa, formed at a time of confluence or contact of the Ontario and Georgian Bay lobes south of Belwood during the Port Bruce Stadial. The sediments are mainly near shore and deltaic silty fine sands forming an upper unit over much of the Orangeville Moraine, however, near Belwood these contain grey to reddish grey clay bands of laminae suggesting deep water sedimentation; though not well exposed the latter sediments may be partially varved.

In the Hockley Valley glaciolacustrine sediments are well exposed in the valley wall at Glen Cross and near the head of the Hockley Valley in concession I WHS, Mono Township. These sediments may be 30 feet (9m) or more thick, though they are generally less than this. They consist mainly of compact laminated silt with minor fine sand. At the Glen Cross outcrop, occasional bands of clay and clayey silt one to six inches (2-15cm) thick are present, though these comprise less than five percent of the total. Figure 8 demonstrates the grain sizes of these materials at Glen Cross and Tables 12, 13 and 14 show the chemistry and mineralogy. These data show analytical differences from different size fractions and provide background data for environment studies. Springs commonly occur at the upper contact of these sediments. The proglacial lake into which these sediments were deposited resulted from ice blocking the Hockley Valley to the northeast; the sediments themselves may originate from ice to the north-

[1]Referred to as Keldon Esker by Gwyn (1971).

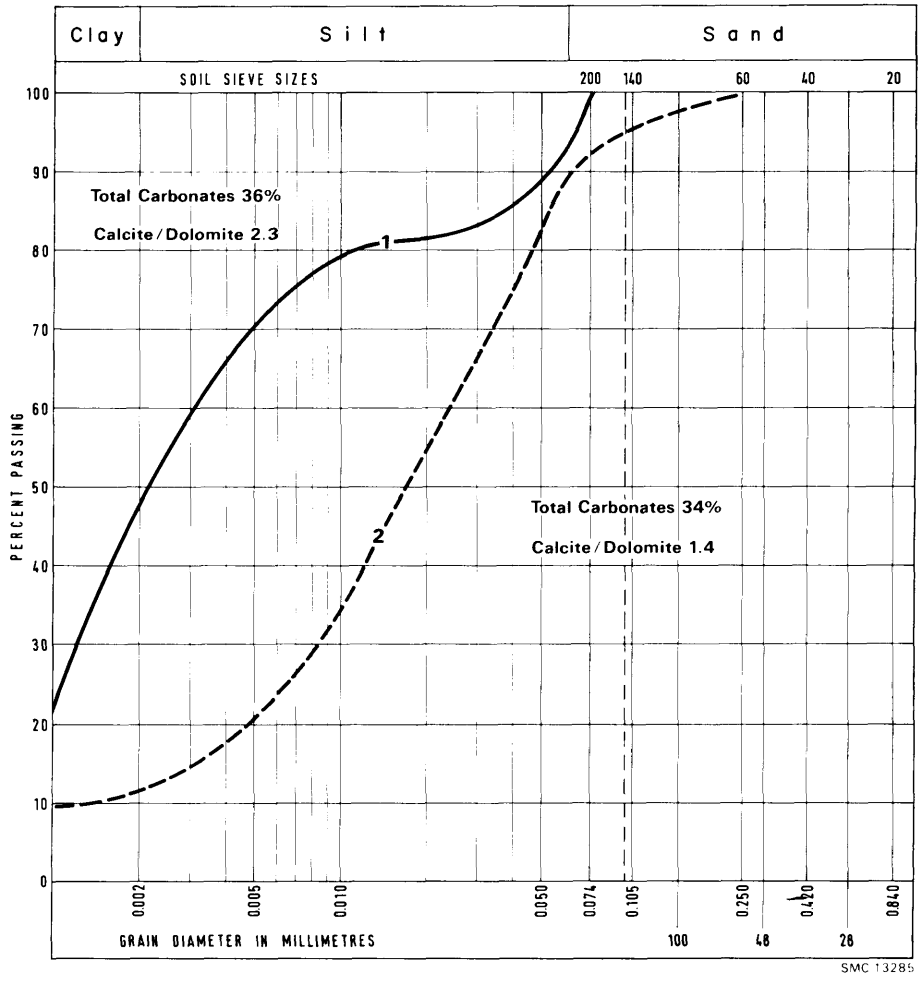


Figure 8–Grain size distribution for stratified lacustrine sediments in wall of Hockley Valley at Glen Cross, Orangeville area. 1 is for clay bands within general silt unit (2). Carbonates on –200 mesh fraction.

Table 12 X-RAY DIFFRACTOMETRY MINERALOGY FOR LACUSTRINE SEDIMENTS FROM GLEN CROSS, ORANGEVILLE AREA. SAMPLES AS FOR FIGURE 8.

	−2μ FRACTION		BULK	
	CLAY 1	CLAY 2	CLAY 1	CLAY 2
Illite*	A	A	B	C
Chlorite	AB	A	B	BC
Quartz	C	—	B	A
Plagioclase	—	—	C	BC
K Feldspar	—	—	—	C
Calcite	A	A	A	A
Dolomite	—	—	C	BC

A—Abundant.
B—Moderate.
C—Minor.
*The illite appears to contain minor expanding layer mineral (probably montmorillonite) in its lattice.

Table 13 TRACE ELEMENT ANALYSIS OF CLAYS FROM GLEN CROSS, ORANGEVILLE AREA. SAMPLES AS FOR FIGURE 8.

	TRACE ELEMENT ANALYSIS (−400 MESH FRACTION)	
	#73-CLAY-1	#73-CLAY-2
Mn	700 ppm.	620 ppm.
Cu	85 ppm.	25 ppm.
Pb	<25 ppm.	<25 ppm.
Zn	80 ppm.	50 ppm.
Ni	25 ppm.	20 ppm.
Co	10 ppm.	7 ppm.
Cr	60 ppm.	40 ppm.
Ba	350 ppm.	230 ppm.
Fe	3.30%	2.45%



ODM9405

Photo 15–Contorted lacustrine sediments in small pond deposit, west of the Grand River.

Table 14 CHEMICAL COMPOSITION OF LACUSTRINE CLAY FROM GLEN CROSS. SAMPLES AS FOR FIGURE 8. COMPONENTS ARE IN WEIGHT PERCENT.

	ANALYSIS OF BULK MATERIAL	
	#73-CLAY-1	#73-CLAY-2
SiO_2	38.7	47.8
Al_2O_3	10.9	8.32
Fe_2O_3	5.20	3.00
MgO	3.63	3.39
CaO	18.7	17.4
Na_2O	1.05	1.73
K_2O	2.58	1.95
H_2O^+	2.46	0.95
H_2O^-	1.24	0.33
CO_2	15.1	14.4
TiO_2	0.37	0.32
SO_3	0.15	0.25
	100.1	99.8
L.O.I.	18.9	15.6

east or to the west. Their age is not certain; correlation with the bouldery lacustrine sediments underlying the Lake Simcoe sublobe equivalent of the Tavistock Till at Orangeville would suggest a Port Bruce Stadial age however they may be younger and related to the Newmarket Till.

The youngest lacustrine sediments in the area represent small local pondings during deglaciation of the area. These occupy shallow basins, largely on the Tavistock Till surface, and sediments range from three to 10 feet (1-3m) thick. Sediments consist of laminated to varved sand, silt, and clay which are commonly contorted (Photo 15). Locally mollusc-bearing postglacial pond sediments occur in the upper part of these materials.

NONGLACIAL SEDIMENTS

Bog and Swamp Deposits

Tracts of poorly drained land containing organic materials occur in low meltwater channels, which may also be groundwater discharge areas, and in numerous shallow depressions on the west side of the Orangeville Moraine where postglacial drainage is not yet fully developed. Most of the material consists of black muck though peat and shell-bearing marl occur in many deposits; locally peat and marl may be quite prominent. Most organic sequences range from three to five feet (1-2m) in thickness but may range to 20 feet (6m). A well log at Caledon Lake (lot 29, concession IV, Caledon Township) shown below indicates 87 feet (26m) of black muck: 0–1 foot (0–0.3m) topsoil; 1–3 feet (0.3–1m) gravel; 3–90 feet (1–27m) black muck; 90–146 feet (27–44m) gravel. The upper three feet (1m) of material is fill brought in for recreational development of the lakeshore. The thickness of muck suggests that Caledon Lake is an infilled kettle hole.

A radiocarbon date on gyttja collected by T.W. Anderson[1] from the base of Wylde Lake Bog (640cm below surface) is 10,800 ± 180 years B.P. (GSC-1028) (Lowdon and Blake 1970).

Alluvium

Alluvial deposits occur along most water courses. They range in texture from well washed gravels to silty materials containing much organic matter and consist mainly of reworked till, sand, or gravel from nearby stream banks. Major streams usually contain meandering channels which give rise to a lower channel gravel facies and an upper flood plain sandy silt facies, often superposed. Along the Grand River low level terraces mapped as outwash may be postglacial alluvium in part. Alluvial deposits in the Orangeville area range from three to five feet (1–1.5m) in thickness.

[1]Palynologist, Canada Centre for Inland Waters, Burlington.

PLEISTOCENE HISTORY

Pleistocene glacial events prior to the Late Wisconsinan Substage undoubtedly occurred in the Orangeville area, however sediments relating to these were not discovered during the present geological survey. A synthesis of known glacial events in the Late Wisconsinan is as follows.

Reactivation of glaciers following Middle Wisconsinan withdrawals led to inundation of the Orangeville area by ice from the north and the deposition of the Catfish Creek Till (Nissouri Stadial). Onset of these events was about 24,000 years ago and the ice spread southward to its maximum position in Ohio about 18,000 years ago (Goldthwait *et al.* 1965). Local fluctuations apparently took place and these were accompanied by glacial lakes in the Grand River valley. Retreat followed and the Catfish Creek ice withdrew beyond the limits of the Orangeville area. Perhaps during the decay of this ice sheet, part of the Orangeville Moraine was deposited and glaciolacustrine sediments were laid down in the Grand River valley and in the Conestogo River valley to the west. These lacustrine sediments are approximately correlative with those of the Erie Interstadial in the Lake Erie basin to the south estimated to be about 15,500—16,500 years old (Morner and Dreimanis 1973).

A minor fluctuation of the Georgian Bay lobe to the northwest incorporated some of these lacustrine sediments into a fine-grained till known as Stirton Till (Karrow 1974) which was deposited in the Palmerston area to the west. The writer believes this advance entered the Orangeville area but did not advance as far east as the Grand River. The 'middle till' reported south of Hillsburgh is probably of a similar age as this till i.e. late Nissouri Stadial or Early Port Bruce Stadial. This minor fluctuation and its accompanying lacustrine sediments was followed by major Port Bruce Stadial advances of the Georgian Bay lobe from the northwest, Lake Simcoe sublobe from the northeast, and the Ontario lobe from the east about 15,000 years ago. These advances resulted in the deposition of the silty Tavistock Till in the west, its Simcoe sublobe sandy facies in the Hockley Valley area, and the Port Stanley Till in the east with the formation of the Guelph drumlin field. Glaciofluvial sediments deposited in the interlobate areas provided the bulk of the Orangeville Moraine as seen today. An interlobal lake (Glacial Lake Garafraxa), formed when the Ontario lobe advanced to block drainage south of Belwood, resulted in glaciolacustrine sedimentation and further building of the Orangeville Moraine. The Georgian Bay lobe then retreated to the Grand River meltwater channel; further retreat resulted in the formation of the Mount View, Egerton, and Brice Hill Eskers, and shallow lacustrine deposits were laid down on the surface of the Tavistock Till. The Ontario lobe held its position somewhat longer and advanced over the outer part of the Tavistock Till south of Belwood. Meltwaters flowed to Grand River along the Caledon Lake-Waldemar meltwater channel and retreat of the Ontario lobe then led to incision of the Hillsburgh meltwater channel, dissection of the Guelph drumlin field and initiation of the Credit River channel before the ice retreated beyond the area. Thus about 13,500 years ago, (Mackinaw Interstadial) the area was ice free and periglacial and eolian processes dominated.

Following the Mackinaw Interstadial the ice lobes again advanced about 13,000 years ago giving rise to the Port Huron Stadial. The main Georgian Bay lobe did not enter the area, however the Lake Simcoe sublobe advanced into the Hockley Valley damming a proglacial lake before it. This advance was to the Singhampton Moraine, which crosscuts the Guelph drumlin field northeast of Highway 10, and the Newmarket

Till was laid down. Outwash was deposited at the head of the Hockley Valley and the Credit River meltwater channel was reoccupied. At about the same time the Ontario lobe was advancing and depositing the Wentworth Till; it reached its outermost position at the Paris Moraine which crosscuts the Singhampton Moraine and apparently correlates with the Gibraltar Moraine to the east (White 1970b). The Mono Mills-Caledon meltwater channel was cut and the Caledon Outwash was deposited in front of the Paris Moraine. Both ice sheets then retreated well beyond the area to the east and northeast. The Ontario lobe did not reenter the Orangeville area again during the Pleistocene, however, the Lake Simcoe sublobe again reached the northeastern part of the area when it entered the Hockley Valley to deposit the Kettleby Till during a late phase of the Port Huron Stadial. Outwash was also deposited in the Hockley Valley at this time.

Retreat of the Kettleby ice from the Hockley Valley ended glacial activity in the Orangeville area for the Pleistocene Epoch. Postglacial geological processses have not appreciably changed the glacial landscape to date. Mass wasting and fluvial erosion are actively proceeding in the Hockley Valley, Credit Valley, Grand River Valley and elsewhere, while infilling of wet depressions with organic matter continues.

ECONOMIC GEOLOGY

Sand and Gravel

Extensive outwash gravel deposits in the eastern part of the Orangeville area comprise an important part of the mineral resource base of Southern Ontario, particularly that part centred on the municipality of Metropolitan Toronto. Because of land use stress generated by these deposits the Townships of Caledon, Erin and Mono have been designated under the 'Pits and Quarries Control Act' of 1971. The major deposits of granular materials in the Orangeville area are briefly described below. Information on lesser deposits is given in Appendix 'C'. Additional data is available in Hewitt and Karrow (1963) and in Hewitt and Cowan (1969a, b).

CALEDON OUTWASH

The Caledon Outwash (Figure 9) is a sheet of gravel and gravelly sand largely deposited by meltwater flowing southerly in front of the Paris Moraine during the Port Huron Stadial; contiguous deposits between Cataract and Alton were laid down by meltwaters flowing south from the head of the Hockley Valley. These gravels are usually well stratified and crossbeddings imply a southerly flow; minor faulting may be present (Photo 14). Generally the gravel is medium to coarse textured with stone content ranging from 25 to 75 percent; large boulders are not common, however, near the Paris Moraine materials are more variable and may contain larger boulders. Overburden ranges from zero to five feet (0-2m) and the water table has been encountered in several pits in the area at depths of 30 to 50 feet (9-15m). Thicknesses range from 10 to 75 feet (3-23m).

Siltstone occurs throughout the deposit (Table 6) and near Belfountain shale derived from the Queenston Formation may be locally quite pronounced in the pebble and sand

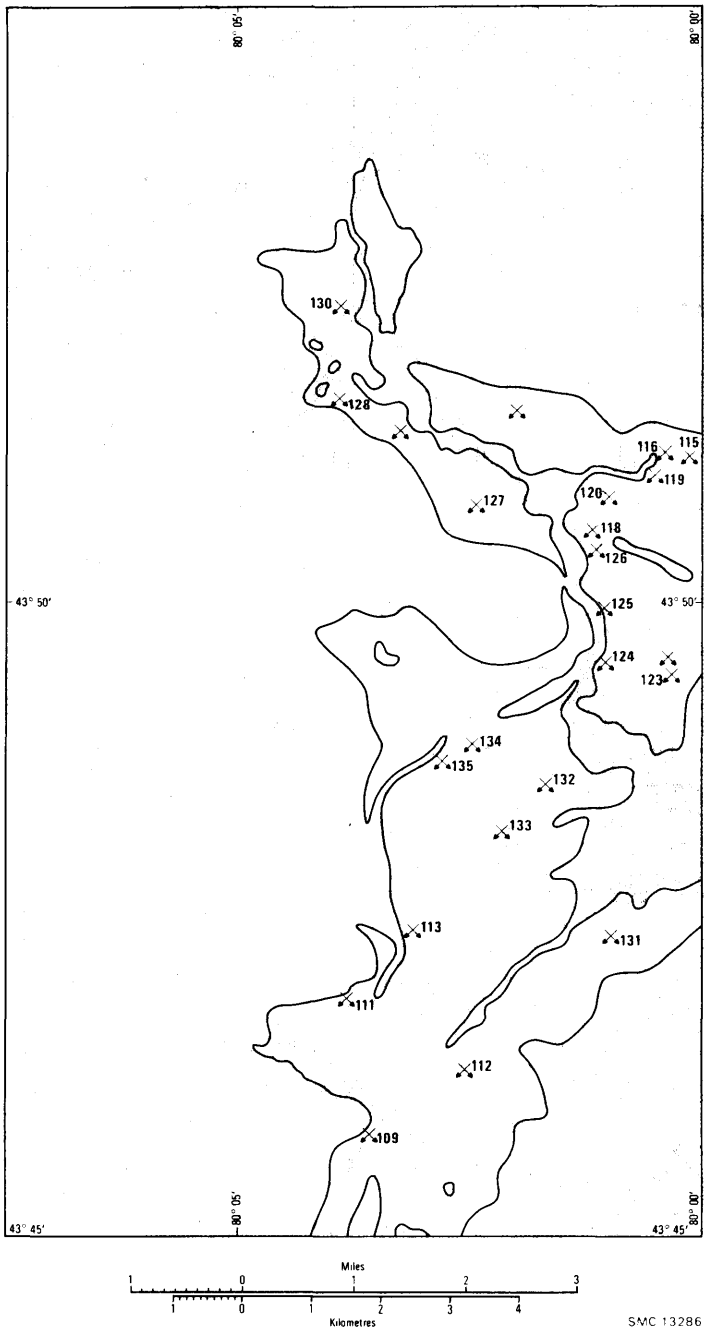


Figure 9–Sketch map showing location of gravel pits in Caledon Outwash and contiguous deposits of Credit River meltwater channel as far north as Melville.

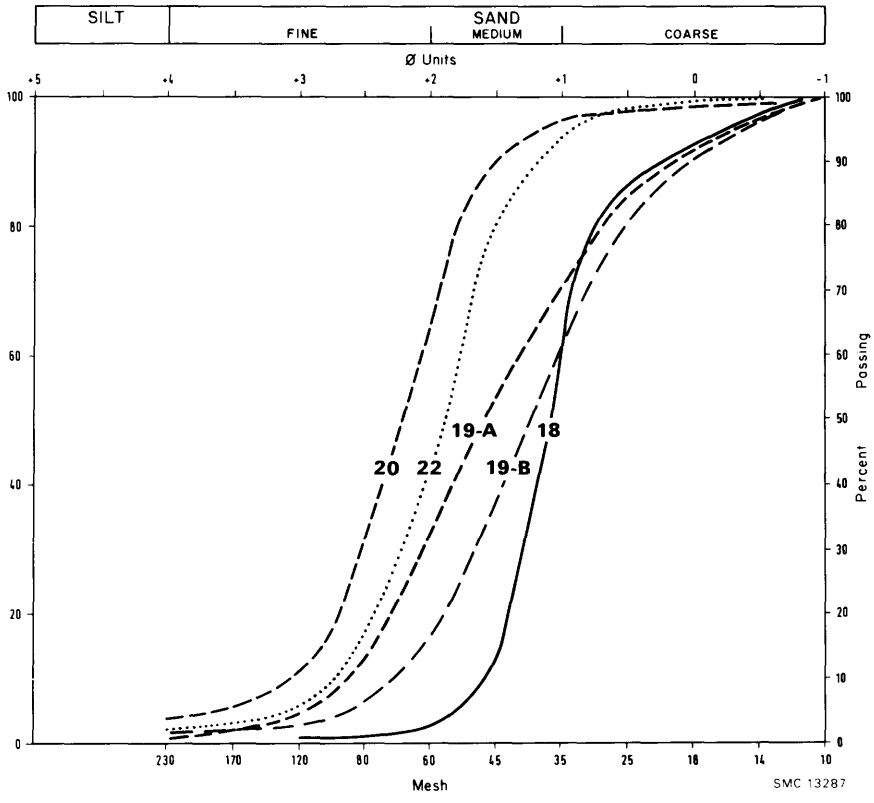


Figure 10–Sieve analyses for sands from Caledon Outwash. Locations and sedimentological properties are given in Table 7.

Table 15 SUMMARY OF DATA ON SAND AND GRAVEL PITS LOCATED IN CALEDON OUTWASH INCLUDING CONTIGUOUS CREDIT RIVER OUTWASH SOUTH OF MELVILLE.

	Location								Composition						Pebble Lithology (percent)								
Property Number	Township	Concession	Lot	Owner or Operator	Thickness of Overburden	Observed Thickness of Dep.	Reported Thickness of Dep.	Estimated Reserves (S—small, L—large, U—unknown)	% Stone (estimated)	% Sand (estimated)	% Stone Greater than 1"	% Stone Greater than 4"	Maximum Boulder (feet)	Origin of Deposit	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian Felsic Rocks	Precambrian Mafic Rocks	Precambrian Metamorphic Rocks	Sand Sample No.
109	Erin	IX	13	C. Chambers		18		S	50	50	65	5	1.0	outwash	67	14	—	2	—	—	2	2	13	—
111	Erin	X	16	P. Armstrong		20		S	20	80				outwash	84	6	—	—	—	—	3	5	2	18
112	Erin	XI	12			10		S-M	40	60	30	10	0.7	outwash	71	6	—	2	—	—	12	6	3	—
113	Erin	XI	16		1	10		S	50	50			0.7	outwash	73	3	—	1	8	—	5	6	4	—
115	Caledon	I W	15	Franceschini Bros.	3	18		M	60	40	30	5	2.0	outwash	67	6	—	—	6	—	10	6	5	19
115	Caledon	I W	15	Franceschini Bros.		20		M	70	30	60	30	0.5	outwash	67	5	—	2	8	—	11	—	6	—
116	Caledon	I W	16	Armstrong Holdings Ltd.	2–4	8		S	40	60	25	5	0.5	outwash	—	—	—	—	*	*	—	—	—	—
118	Caledon	II W	16	Armstrong Holdings (Flaherty Pit)		10		M	30	70	40	5	0.7	outwash	—	—	—	—	*	—	—	—	—	—
119	Caledon	II W	16	Warren Bitulithic Ltd.	2	15		M	30	70	25	5	1.5	outwash	—	—	—	—	*	—	—	—	—	—
120	Caledon	II W	16	Warren Bitulithic Ltd.	1	13		M	25	75	30	2	0.6	outwash	—	—	—	—	*	—	—	—	—	—
123	Caledon	III W	12	Credit Valley Cons. Auth.	2	15		M?	50	50	50	10	1.0	outwash	60	2	—	1	24	—	6	2	5	—

124	Caledon	III W	14	Armstrong Holdings Ltd.	2	25		L	50	50	50	5	0.7	outwash	—	—	—	—	*	—	—	—	—	—
125	Caledon	III W	15	Twp. of Caledon	2	25		S	60	40	40	5	1.0	outwash	64	5	—	1	16	1	6	3	4	—
126	Caledon	III W	16	Armstrong (Flaherty Pit)	2	18		S-M	50	50	20	2	0.5	outwash	68	5	—	—	*	1	6	9	11	—
128	Caledon	III W	22			15		S	20	80				outwash	68	17	—	—	10	—	2	1	2	—
130	Caledon	III W	24	B. Horan	2	16		S	40	60	30	5	1.0	outwash	62	20	—	1	3	—	7	4	3	—
130	Caledon	III W	24	B. Horan	2	15		S	30	70			0.5	outwash										
131	Caledon	V W	9			20		S	30	70			2.0	outwash	—	—	—	—	*	*	—	—	—	—
132	Caledon	V W	13	Franceschini Bros.		6		L	60	40				outwash	74	—	—	2	10	—	7	4	3	—
133	Caledon	V W	13	W. J. Pinkney	2	18	35	M?	60	40	30	10	1.0	outwash	78	2	1	1	5	*	5	4	4	—
134	Caledon	V W	15	Pinchin	2–4	25		S						outwash	—	—	—	*	*	—	—	—	—	—
135	Caledon	V W	15	Franceschini Bros.	2	20		M	50	50	30	2	0.7	outwash	72	6	—	—	6	—	6	8	2	22

fractions. The siltstone gives rise to Petrographic Numbers (Ministry of Transportation and Communications Specifications) generally ranging from 120 to 175 however numbers exceeding 200 may occur in the minus one inch grade in which siltstone is most common. Beneficiation in the Caledon area is accomplished in two ways: firstly a pulverizing technique is used which reduces much of the incompetent siltstone to very fine sizes which are then removed as dust or in the washing and classifying procedure; a second technique consists of screening out the minus three-quarter inch or one inch (12mm or 2.5cm) fraction and crushing the over-size for stone. The products obtained are then suitable for certain grades of structural concrete or asphaltic concrete.

Mineralogy of four sand samples from this deposit (samples 18, 19A, 20, 22, Table 8) show that shale and siltstone comprise 10 to 20 percent of the fine sand fraction. Several sieve analyses are shown in Figure 10 (minus 2mm fraction) and sedimentological properties of these were given in Table 7.

Reserves for that part of the Caledon Outwash occurring in the Orangeville area are estimated to considerably exceed 300 million cubic yards ($2.3 \times 10^8 m^3$) and therefore comprise an important resource.

While a number of pits are located within the deposit only one pit was operating on a continuous commercial basis during the present survey. This is described below while data on the remaining pits are tabulated in Table 15. A number of these pits have been described previously by D.F. Hewitt (Hewitt and Karrow 1963; Hewitt and Cowan 1969a, b).

Premier Concrete Products (127)[1] operates a pit located in lots 17 to 20, concession III WHS, Caledon Township, two miles (3.2km) southeast of Alton. The property was described previously by D.F. Hewitt (Hewitt and Karrow 1963, p.67; Hewitt and Cowan 1969a, p.69). Reserves on this property are rapidly depleting.

When visited, material was being extracted from two areas on the property. The northwest part of the pit consisted of 10 to 12 feet (3m) of stratified, uniform medium outwash gravel (Photo 13) dipping slightly toward the south. It consisted of about 50 percent stone having a maximum size of eight inches, (20cm); 50 percent of the stone exceed an inch (2.5cm) in diameter and 5 per cent exceed four inches (10cm).

At the southern working area 10 feet (3m) of gravelly sand containing 20 to 40 percent stone was being extracted. This material was poorly sorted and most of the stone was in the one-half to two-inch (12mm-5cm) size range. The property averages 25 to 30 percent stone. Three pebble counts from this property gave the following ranges: limestone, 51-77 percent; dolostone, 5-21 percent; sandstone, 1-2 percent; siltstone, 0-19 percent; Precambrian felsic igneous rocks, 2-7 percent; Precambrian mafic igneous rocks, 1-4 percent; and Precambrian metamorphic rocks, 3-6 percent.

The prominence of siltstone in parts of the pit would necessitate beneficiation for the production of certain products however no beneficiation is carried out due to the low average stone content. The principal products are concrete sand and crushed stone for the production of premix concrete.

Overburden ranges from one to four feet (0.3-1.3m) in thickness and the water table occurs near the base of the present pit; a suction dredge was previously used to work 20 feet (6m) of material below the water table (Hewitt and Karrow 1963, p.67).

A permanent crushing, screening, and washing plant is located on the property.

[1]Property number as shown on Map 2327 (back pocket).

Table 16 | SUMMARY OF DATA FOR SAND AND GRAVEL PITS IN THE HOCKLEY VALLEY OUTWASH, ORANGEVILLE AREA

	Location								Composition						Pebble Lithology (percent)									
Property Number	Township	Concession	Lot	Owner or Operator	Thickness of Overburden	Observed Thickness of Dep.	Reported Thickness of Dep.	Estimated Reserves (S—small, L—large, U—unknown)	% Stone (estimated)	% Sand (estimated)	% Stone Greater than 1"	% Stone Greater than 4"	Maximum Boulder (feet)	Origin of Deposit	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian Felsic Rocks	Precambrian Mafic Rocks	Precambrian Metamorphic Rocks	Sand Sample No.
42	Mono	I W	4	Baker	2	20		S	50	50	50	5	3.0	outwash	69	14	—	1	2	—	5	6	3	
43	Mono	I W	5	Baker	2	20		S	50	50	25	5	0.8	outwash	—	—	—	—	*	—	—	—	—	—
44	Mono	I W	6	Leader Bros.	2	9		S	40	60	50	5	1.0	outwash										
45	Mono	I W	7		1	6		S	40	60	40	1	0.5	outwash	76	20	—	—	1	—	2	—	1	—
53	Mono	I E	6	Hyco	1	20		S	50	50	50	20	0.7	outwash	40	35	—	—	18	—	1	3	3	—
	Mono	I E	8	road cut										outwash	58	26	—	9	1	—	3	1	2	—
	Mono	II E	9	road cut		8	100+	L	60	40	50	10		outwash	61	27	—	2	—	—	2	3	5	—
	Mono	II E	9	road cut cobbles		8			60	40	50	10		outwash	6	8	—	1	15	—	7	6	3	—
	Mono	II E	10	road cut		6								outwash	64	16	—	8	2	—	—	6	4	—

HOCKLEY VALLEY OUTWASH

Outwash gravels located at the head of the Hockley Valley in Mono Township are perhaps the second most important gravel reserve in the Orangeville area. These were laid down by meltwaters from the Newmarket ice when it stood at the Singhampton Moraine during the Port Huron Stadial. Available information indicates that these meltwaters flowed in a southerly direction.

These gravels are medium to coarse textured and stone content generally ranges from 40 to 60 percent. Observed thicknesses do not exceed 20 feet (6m) however water well and boring data indicate thicknesses in excess of 100 feet (30m). The writer believes that material occurring at greater depths is probably not of as good quality as the uppermost 30 feet (9m). Overburden is generally three feet (1m) or less thick but on the pitted northern part of the deposit considerable thicknesses of fine sand and silt may occur in pockets overlying the gravel.

Much of the gravel is crushable material, and, as with the Caledon Outwash, siltstone is the prominent deleterious lithology (Table 6). Petrographic numbers for this deposit range from 120 to 165 and some beneficiation would be necessary to produce high quality aggregate. Reserves are estimated to exceed 85 million cubic yards (6.5 x $10^7 m^3$). Much of the undeveloped part of this outwash occurs immediately north of the Hockley Valley in Concessions I and II EHS, Mono Township. Available data for these deposits is given in Table 16.

GRAND RIVER OUTWASH

Outwash deposits laid down in the Grand River Meltwater channel provide important sources of granular materials. These are primary local sources and are not sufficient to support commercial export beyond the area.

North of Waldemar these gravels are medium to coarse textured and observed thicknesses range from 10 to 25 feet (3-8m) with stone content ranging from 40 to 60 percent. Deleterious material is rare in this area (Table 6) and available Petrographic Numbers are less than 125. Data on pits located in this area are tabulated in Table 17. Estimated resources exceed 10 million cubic yards (7.5 x $10^6 m^3$). Overburden is generally less than three feet (1m) thick. Portable crushers are brought to the deposits as required.

South of Waldemar the gravel deposits are 15 to 25 feet (5-7m) thick though one water well reports 65 feet (20m) of material. Overburden is generally one to three feet (0.1-1m) thick. Stone content ranges from 25 to 75 percent and much of it is fine for crushing purposes. Siltstone (Table 6) is present and locally may be a problem. One fine sand sample (Sample 10, Table 8) contains up to 15 percent siltstone and shale in this location. Petrographic numbers range from 110 to 155. Grain size distribution of three sand samples from south of Belwood are given in Figure 11 while sedimentological properties of these are found in Table 7. Up to 15 percent fines may be present in these sands. Reserves remaining in this area are estimated to exceed 25 million cubic yards (2.0 x $10^7 m^3$). A narrow terrace deposit located one mile (1.6km) northeast of Belwood has not been opened up but comprises a reserve for future local needs.

Table 17 SUMMARY OF DATA FOR SAND AND GRAVEL PITS IN THE HOCKLEY VALLEY OUTWASH, ORANGEVILLE AREA.

Location									Composition						Pebble Lithology (percent)									
Property Number	Township	Concession	Lot	Owner or Operator	Thickness of Overburden	Observed Thickness of Dep.	Reported Thickness of Dep.	Estimated Reserves (S—small, L—large, U—unknown)	% Stone (estimated)	% Sand (estimated)	% Stone Greater than 1"	% Stone Greater than 4"	Maximum Boulder (feet)	Origin of Deposit	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian Felsic Rocks	Precambrian Mafic Rocks	Precambrian Metamorphic Rocks	Sand Sample No.
	North of Waldemar																							
21	E. Luther	II	31	Hillis Pit	3	20		S?	60	40	50	20	2.0	outwash	10	84	—	—	2	—	3	—	1	—
22	E. Luther	II	32	D. Black		15		S?	40	60	40	5	1.5	outwash	10	87	—	—	—	—	1	2	1	—
—	E. Luther	II		Grand Valley Excavation	2	3+		—	60	40		20	2.0	outwash	5	95	—	—	—	—	—	—	—	—
25	E. Luther	III	31	Greenwood Const.		10+	25	U	40	60	20	5		outwash										
26	E. Luther	VI	30		2	15		S	60	40	70	40	3.0	outwash	4	96	—	—	—	—	—	—	—	—
	Belwood Area																							
59	W. Garafraxa	V	9		1	15		S	70	40	40	5	1.0	outwash	7	86	—	—	2	—	4	—	1	—
60	W. Garafraxa	V	11			12		S	25	75			0.7	outwash	17	71	—	—	—	—	4	4	3	—
61	W. Garafraxa	V	11	Carlow-Cox Const.		25		S	10	90	20	5	0.5	outwash	—	—	—	—	—	—	—	—	—	11
62	W. Garafraxa	V	12	Cross	1	25			50	50	40	5	0.7	outwash	22	72	—	—	2	—	1	2	1	12
63	W. Garafraxa	V	12	Cross	3	19		M	25	75		5	2.0	outwash	—	—	—	*	*	*	—	—	—	—
64	W. Garafraxa	V	12	Cross	1	15			40	60	40	5	0.5	outwash	—	—	—	—	*	—	—	—	—	—
71	W. Garafraxa	VI	11			20		S	30	70	30	5	0.7	outwash	18	68	—	3	2	—	5	3	1	—
72	W. Garafraxa	XI	11			18		S	25	75	40	5	0.5	outwash	35	50	—	3	3	—	4	1	4	10
73	W. Garafraxa	VI	12	Wm. Thompson		10		S	40	60	30	5	0.7	outwash	—	—	—	*	*	—	—	—	—	—
	E. Garafraxa	IX	125	river cut		20		S	60	40				outwash										

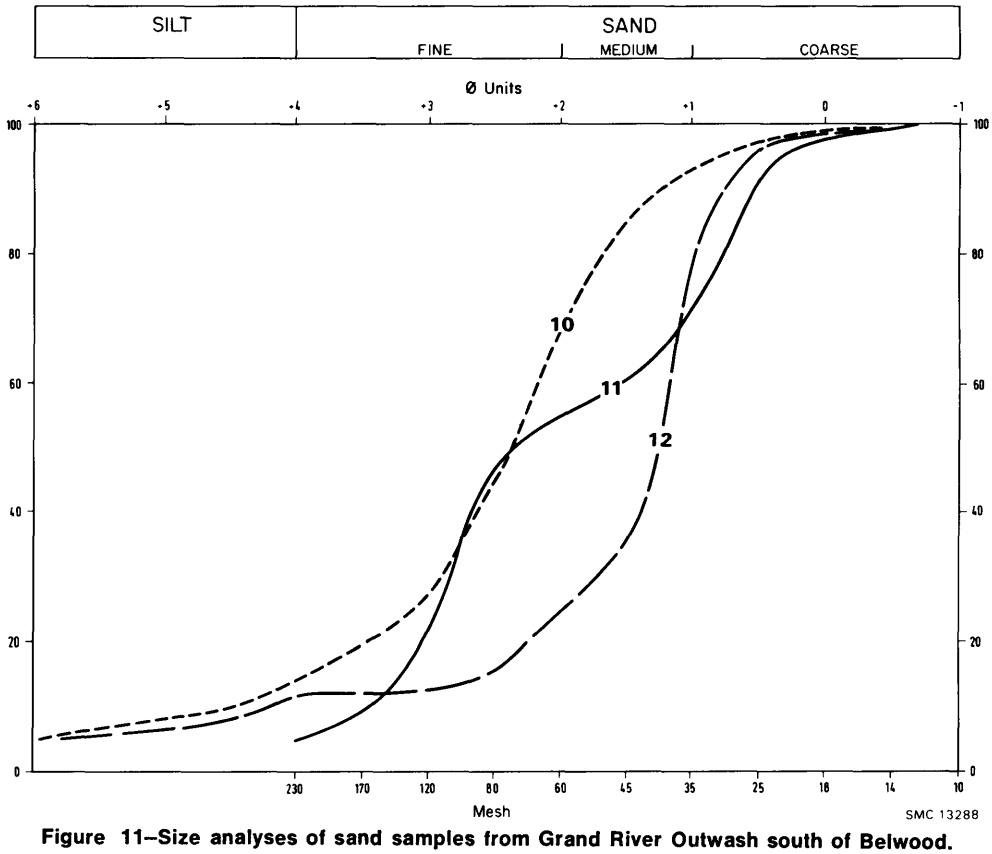


Figure 11–Size analyses of sand samples from Grand River Outwash south of Belwood.

MISCELLANEOUS OUTWASH DEPOSITS

Numerous outwash deposits of lesser extent than those described above are present in the area. These provide local sources of granular materials from time to time. The Caledon Lake-Waldemar meltwater channel has supported numerous pit operations for local use, however none are operated on a continuing basis. Reserves in this area are not well defined.

Gravel in the Hillsburgh meltwater channel is largely unexploited though up to 25 feet (8m) was encountered in well borings. The water table is close to the surface along parts of this deposit.

One deposit of possible commercial interest is a sheet of outwash fronting the Orangeville Moraine about one mile (1.6km) south of Orangeville, however, little data is available. The deposit appears to merit exploration. Pit data from miscellaneous outwash deposits are given in Appendix C.

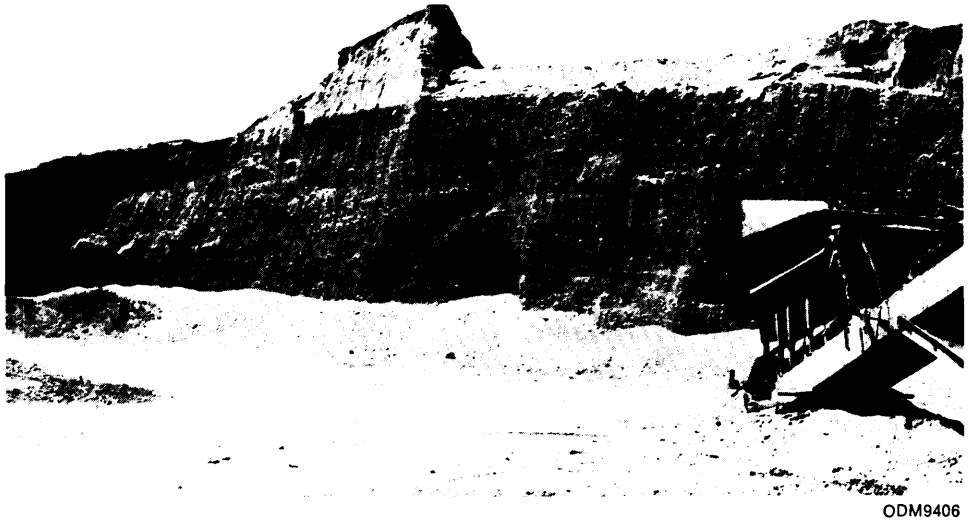
ORANGEVILLE MORAINE

The Orangeville Moraine consists of glaciofluvial and glaciolacustrine sediments deposited as an interlobate moraine during the Port Bruce Stadial. Pebble lithology (Table 6) of the gravels indicates that much of the material was derived from the east and northeast by the Ontario lobe and the Lake Simcoe sublobe. At present, extraction from glaciofluvial units (Photo 16) is centered in Mono Township immediately northwest of Orangeville and in Erin Township near Hillsburgh.

The north limb of the Orangeville Moraine is located in Mono and Amaranth Township north of Orangeville and in East Garafraxa Township north of the Caledon Lake-Waldemar meltwater channel. Water well data in this area indicate thicknesses of granular materials ranging between 50 and 150 feet (15-45m). Considerable sand may overlie useable material. Stone content may range from 10 to 60 percent and much of this not suitable crushing material. Petrographic numbers range from 130 to 250 and beneficiation is necessary for the production of high specification products. Several size analyses of sand from this deposit are shown in Figure 12 and sedimentological properties of these were given in Table 9. Mineralogy of sand, (Samples 1, 4 and 6, Table 10) indicates the presence of five to 10 percent shale and siltstone in the fine sand fraction. Reserves in ice-contact areas are difficult to estimate due to variability of thicknesses, composition, and lateral extent, however large resources remain in this area; these are estimated to exceed 25 million cubic yards ($2.0 \times 10^7 m^3$).

Only one operation is licensed in this area at the time of writing, that of Lockyer Brothers Limited (50). The property is located on lots 3 and 4, concession III WHS, Mono Township and operates on a full-time basis. The north pit had a 25-foot (8m) face consisting of two feet (0.6m) of gravel underlain by six feet (2m) of uniform horizontally bedded medium to medium fine sand, 12 feet (3.5m) of crossbedded sandy gravel and 5 feet (1.5m) of slumped material. The material averaged 60 percent stone having a maximum size of 1.5 feet (0.5m); 15 percent of the stone exceeded one inch (2.5cm) in diameter and five percent exceeded four inches (10cm) in diameter. Sand sample 1N (Figure 11) was taken from this pit.

At the south pit the upper level consisted of 15 feet (4.5m) of southeasterly dipping crossbedded fine to medium sand with thin gravel stringers. Ten percent of this material



ODM9406

Photo 16–Uniform gravelly sand of glaciofluvial origin at north end of Lockyer Brothers' pit.

was gravel of which 40 percent exceeded one inch (2.5cm) in diameter and five percent exceed four inches (10cm) in diameter. The lower working level consisted of 16 feet (4.9m) of bedded fine to medium sand and medium gravel. Sand sample 1S was taken from the south pit. Sand sample 1 in Table 10 gives mineralogical data on sand from the Lockyer Pit.

Two pebble counts from the Lockyer Pit area give the following assemblage range in percent: limestone, 56-61; dolostone, 24-20; sandstone 1-3; siltstone, present; shale, 0-1; Precambrian felsic igneous rocks, 2-4; Precambrian mafic igneous rocks, 1-5; Precambrian metamorphic rocks, 5-6.

Remaining reserves on this property are small. Other pits occurring in this part of the Orangeville Moraine are summarized in Table 18.

The northeastern limb of the Orangeville Moraine trends northeasterly from Caledon Lake and was overridden in part by the Newmarket ice, thus part of the potential reserves are buried. Few pits are located in this area and only one is licensed (McPherson Pit (140)). Sparse water well logs in this area indicate granular materials do not exceed 35 feet (10m) in thickness. Available pit data are summarized in Table 18. Reserves are large in this area, however, delineating the most useable properties is a problem because of overburden thicknesses and the variability of the deposits.

The southwestern limb of the Orangeville Moraine extends southwesterly from Caledon Lake to Belwood. Considerable fine sand forms the uppermost stratigraphic unit through much of this area and granular materials are best exposed where erosion has taken place; for instance, numerous gravel showings are present in the walls of the entrenched Hillsburgh meltwater channel. Up to 150 feet (45m) of granular materials is reported in water well records, however, sand is the principal component in many of these. Up to 25 feet (7m) of overburden may also be present.

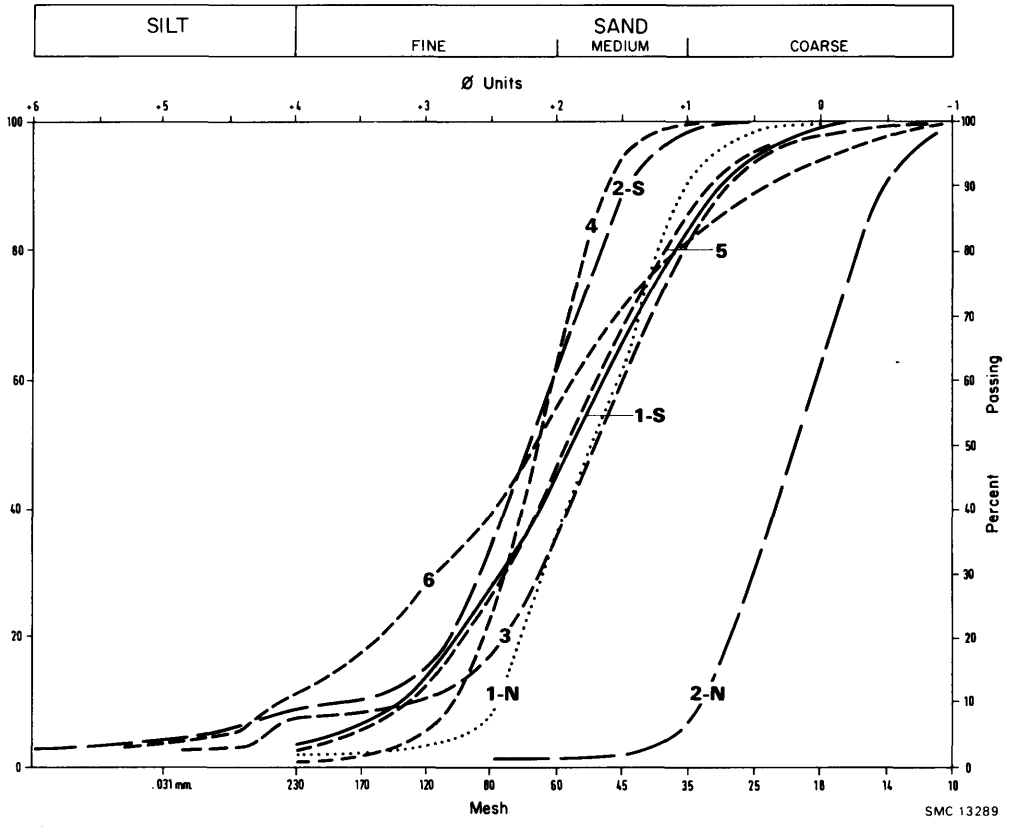


Figure 12–Size analyses of sands from Orangeville Moraine north of Orangeville. All samples from gravel pits.

Table 18 SUMMARY OF DATA FOR PITS IN GRAND RIVER OUTWASH, ORANGEVILLE AREA.

Location					Composition									Pebble Lithology (percent)									
Property Number	Township	Concession	Lot	Owner or Operator	Thickness of Overburden	Observed Thickness of Dep.	Reported Thickness of Dep.	Estimated Reserves (S—small, L—large, U—unknown)	% Stone (estimated)	% Sand (estimated)	% Stone Greater than 1"	% Stone Greater than 4"	Maximum Boulder (feet)	Origin of Deposit	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian Felsic Rocks	Precambrian Mafic Rocks	Precambrian Metamorphic Rocks	Sand Sample No.
	Northern Limb																						
30	Amaranth	I	3		5	25		U	30	70	20		0.5	ice-contact										
31	Amaranth	I	5	Trimble	2	15		U	20	80			2.0	ice-contact	—	—	—	—	—	—	—	—	—	6
48	Mono	II W	4	J. D. Dinnick south end north pit		15		S	60	40	50	10		ice-contact	55	26	—	4	3	—	1	3	8	—
48	Mono	II W	4	J. D. Dinnick north end north pit		15		S		95				ice-contact	—	—	—	—	—	—	—	—	—	4
48	Mono	II W	4	south pit		15		S	40	60			1.0	ice-contact										
49	Mono	II W	5		0	25		S	64	40	75	20	1.0	ice-contact	75	11	—	1	1	*	6	5	2	5
51	Mono	III W	4	south		18		S	15	85	5	2	1.5	ice-contact	69	19	—	1	1	—	1	—	8	3
51	Mono	III W	4	north		25		S	35	65				ice-contact										
52	Mono	III W	5	Batson Pit—north	1–5	20		S	70	30	60	20	2.5	ice-contact-outwash	67	23	—	3	—	1	—	—	5	2N
52	Mono	III W	5	Batson Pit—south		25		S	90	10	10	70	2.0	ice-contact-outwash	75	16	—	—	—	—	2	3	4	2S
	Mono	II W	6	roadcut	2	30			20	80			1.5	ice-contact	71	10	—	1	2	—	2	3	6	—

Table 18—Continued

	Mono	II W	6	roadcut	5	30		40	60			3.0	ice-contact	86	7	—	—	—	—	—	4	3	—
95	E. Garafraxa	A	2	Black	2	20	S	10	90				ice-contact										
	Northeastern Limb																						
121	Caledon	II W	22		2	15	S	30	70	30		0.4	ice-contact	—	—	—	—	*	—	—	—	—	—
129	Caledon	III W	23			10	S	20	80				ice-contact										
136	Caledon	V W	25			25	U	25	75				ice-contact	59	19	—	—	11	—	4	4	3	—
137	Caledon	V W	26		3	11	U	30	75	20	0	0.4	ice-contact										
	Caledon	II W	27	road cut		30		40	60				ice-contact										
139	Caledon	II E	27		2	15	S	15	85	40	5	2.0	ice-contact	68	15	—	—	6	1	3	4	3	—
140	Caledon	III E	26		2	8	S	30	70	40	5	1.0	ice-contact										
141	Caledon	IV E	26	D. R. McPherson	3	27	S	60	40			3.5	ice-contact										

Table 19 PIT DATA FOR ORANGEVILLE MORAINE SOUTHWEST OF CALEDON LAKE, ORANGEVILLE

Location					Composition										Pebble Lithology (percent)									
Property Number	Township	Concession	Lot	Owner or Operator	Thickness of Overburden	Observed Thickness of Dep.	Reported Thickness of Dep.	Estimated Reserves (S—small, L—large, U—unknown)	% Stone (estimated)	% Sand (estimated)	% Stone Greater than 1"	% Stone Greater than 4"	Maximum Boulder (feet)	Origin of Deposit	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian Felsic Rocks	Precambrian Mafic Rocks	Precambrian Metamorphic Rocks	Sand Sample No.
58	W. Garafraxa	I	22		3	15		S	25	75				ice-contact										
67	W. Garafraxa	VI	9		2	20		S		100				ice-contact										
68	W. Garafraxa	VI	9			12		S	60	40	50		1.0	ice-contact										
70	W. Garafraxa	VI	10			6		S	50	50				ice-contact										
74	W. Garafraxa	VII	10		1	15		S	25	75				ice-contact										
75	W. Garafraxa	VII	12			10		S	15	85	30		0.5	ice-contact										
76	W. Garafraxa	VIII	6		1	12		S	20	80			0.2	ice-contact										
85	E. Garafraxa	XVI	1			10		S	50	50	30		0.5	outwash	52	36	—	4	1	—	1	2	4	—
91	E. Garafraxa	XIX	2			20		S	25	75	50	10	2.0	ice-contact	47	36	—	2	3	—	5	5	1	—
96	Erin	I	32			15		S	25	75	50	10	0.5	ice-contact	18	75	—	3	1	—	2	1	—	—
97	Erin	III	29			8		S	40	60			4.0	ice-contact	15	76	1	—	4	—	2	1	—	—

Table 19—Continued

98	Erin	IV	27			18	S	60	40				ice-contact											
99	Erin	V	23			8	S	10	90				ice-contact											
100	Erin	V	25	R. G. Kennedy		20	S	40	60	30	5	1.0	ice-contact	28	54	1	2	5	—	4	3	3	—
101	Erin	VI	22	F. Cox		20	S	15	85	10	5	0.7	ice-contact	46	34	—	4	6	—	7	—	3	—
102	Erin	VI	28			12	S	60	40	30	5	1.0	ice-contact	43	46	—	2	4	—	1	3	—	—
103	Erin	VII	28			15	S	30	70	40	2	0.5	ice-contact										
104	Erin	VII	30			8	S	10	90				ice-contact										
106	Erin	VIII	21			15	S	10	90				ice-contact	—	—	—	—	—	—	—	—	—	26
107	Erin	VIII	22			25	S	20	80				ice-contact										
108	Erin	VIII	30	R. Huxley	5	18	M?	30	70	35	5	1.0	ice-contact	25	64	—	—	2	—	3	5	1	17
138	Caledon	V W	27		2	11	S	10	90	15	0	0.4	ice-contact	—	—	—	—	*	—	—	—	—	—

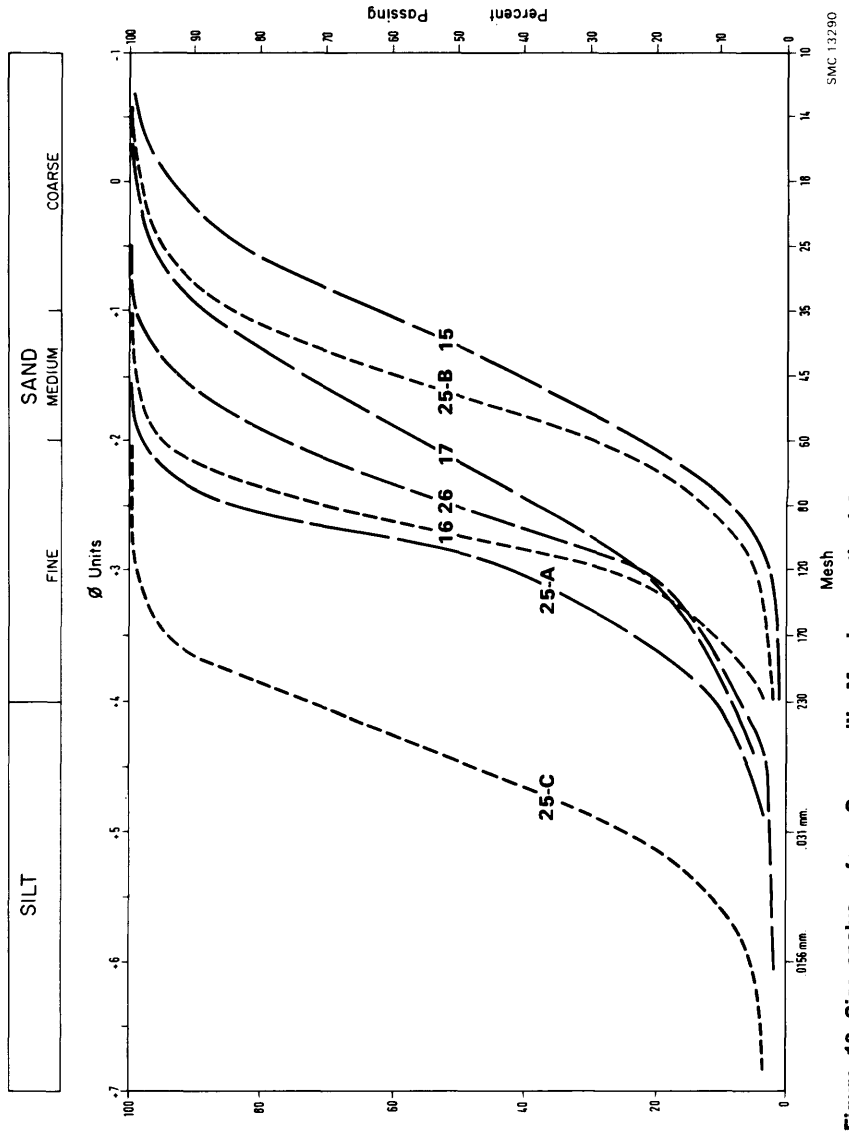


Figure 13–Size analyses from Orangeville Moraine south of Caledon Lake. Samples 15, 17 and 26 are from sand or gravel pits and 16 and 25 are from roadcuts.

Pebble counts from gravel units (Table 6) again suggest that much of the material in this area was derived from an easterly direction. Sand mineralogy (Samples 15, 17 and 25B, Table 10) also contains 10 to 15 percent shale and siltstone material. Figure 12 shows sand size distributions; samples 15 and 17 are glaciofluvial sediments from gravel pits while 16 and 25 are from road cuts which are in part of glaciolacustrine origin.

Evaluation of resources in this area is difficult because of overburden and lack of continuity of the granular deposits. It is probable that resources are large, however, without considerable subsurface exploration sequential land use planning to allow future exploitation of these is difficult.

No major commercial operations are present in this part of the moraine at this time, however one pit near Hillsburgh warrants discussion because it occurs in an eroded section of the moraine exposing a considerable thickness of gravel. This pit, the Barbour Pit (110), is located on lots 27 and 28, concession IX, Erin Township, one mile (1.6km) north of Hillsburgh. Up to 50 feet (15m) of material is exposed and overburden varies from one to three feet (0.3-1.0m) of weathered sand and gravel. The west face of the pit exposed 50 feet (15m) of sand and gravel comprising 50 percent stone and 40 percent sand; 40 percent of this material exceeds one inch (2.5cm) in diameter, 10 percent exceeds four inches (10cm) in diameter, and the largest boulder observed was one foot (0.3m) in diameter. The north face exposed 25 to 40 feet (7-12m) of stratified gravel and gravelly sand as follows: (from the surface) 0-11 feet (3.5m)—seven feet (2.1m) of stratified pebbly sand underlain by four feet (1.2m) of cobble gravel; 11-15 feet (3.5-4.5m)—coarse cobble gravel; 15-25 feet (4.5-7.5m)—southwesterly dipping cross-stratified pebble gravel containing 30 percent stone; 25-40 feet (7.5-10m)—poorly sorted, substratified, coarse cobble gravel containing 70 percent stone having a maximum diameter of one foot (0.3m). Slump features occur in the pit, and crossbedding varies from northwesterly to southwesterly in dip. Up to five percent fines are present in some units. One pebble count from this pit gives the following percentage composition: limestone—27; dolostone—59; Precambrian felsic igneous rocks—3; Precambrian mafic igneous rocks—6; Precambrian metamorphic rocks—5.

A sand sample was collected from a graded sample (15) is given in Figure 13 and the mineralogy of the fine sand fraction in Table 10. Crusher run and pit run gravel are the principal products.

Reserves on this property are probably large. Other pits in this part of the Orangeville Moraine are listed in Table 19.

ESKERS

Eskers within the area have been important local sources of granular materials and in many instances are largely worked out. Generally they consist of gravel cores flanked by sand which may be quite bouldery. Thickness, continuity, and composition are highly variable. Material remaining in these should be considered as local resources necessary for future road maintenance and construction. Pit data for these deposits are summarized in Appendix C; these data are quite incomplete as most of the pits are inactive and slump covered. Petrographic numbers for the eskers located in East and West Luther Townships are usually less than 125.

MISCELLANEOUS ICE-CONTACT DEPOSITS

Kames and small areas of ice-contact stratified drift occurring in the area generally do not contain sufficient resources as individual deposits to support large scale commercial processing plants. However, they are important local sources of road and construction gravel. These deposits are usually very variable in composition, lateral extent, and thickness, and frequently contain masses of till or silt. Pit data on these resources are tabulated in Appendix C.

SUMMARY

The Orangeville area contains resources of granular materials which exceed local needs in the foreseeable future. The writer believes that those parts of Caledon, Erin, and Mono Townships lying within the Orangeville area are capable of supporting considerable commercial extraction for export beyond the area. The remaining townships, or parts thereof, do not contain reserves exceeding future local needs: one possible exception would be the development of presently unknown buried resources in the Orangeville Moraine in East Garafraxa Township.

Siltstone is deleterious through much of the area and sand blending is required for the production of certain products from many deposits.

Clay

No pits for the production of brick or tile from Quaternary clays are presently operating in the Orangeville area though several past producers have been recorded. Baker (1906, p.61) reported the production of about 300,000 red stock bricks per year by one Thomas Cook of Orangeville. These were made from the Red-Top (leached) clay. The pit was not located during the present survey, so it is not known whether the clays were fine-grained till or lake deposits. Production of brick and tile by G. Fuller from a clay pit near Dracon was reported by the Ontario Bureau of Mines (1914, p.24); the pit was presumably located in Tavistock Till, however, lacustrine clays associated with the Catfish Creek Till may have been used. A pit for the production of tile operated at Hillsburg in former years; this production was apparently from the 'middle till'.

Clays suitable for clay products are not abundant in the Orangeville area. Potential sources are surficial lacustrine clays and Tavistock Till which would both require stone and grit removal, buried clays near Belwood and in the Hockley Valley which would require overburden removal, and the 'middle till' which would require stone and grit removal as well as overburden stripping in many instances. Generally bedrock sources are more suitable and better Quaternary sources are available outside the area. Calcium carbonate is a major component of all of these except where leached. Some chemical properties of buried Hockley Valley silts and clays were given in Tables 12 to 14.

Marl

Marl is associated with many organic deposits in the area. At Caledon Lake these marl deposits are extensive and at one time were mined for the production of Portland Cement. The largest marl deposits were located on lot 31, concession B, East Garfraxa Township, Dufferin County. Published information on the deposits may be found in Gibson (1901), Ells (1902), Gillespie (1905), Hewitt (1968), and Guillet (1969).

Gibson (1901) first described the deposit and the organization of the Orangeville Cement Company. He also provided chemical analyses of the marl and clay at this time. Ells (1902) referred to the deposit and in 1905 Gillespie described the deposit and the proposed processing equipment to be used by the company which had reorganized as the Superior Portland Cement Company Limited. Production trials were made in 1907, production began in 1908, but the equipment was again idle by 1914. Production was about 500 barrels per day (Hewitt 1968).

Guillet (1969) recently described the deposit and suggested that it may have been largely depleted. He assessed the deposit as follows:

> Orangeville marl is of fair quality. A 2-foot [60cm] section averaged 90.3 percent $CaCO_3$, 3.3 percent $MgCo_3$, 0.49 percent Fe_2O_3, and 0.82 percent insoluble. The dry powder is buff-cream in colour with a relatively good brightness. Oil absorption is moderate. Natural grain size averages 81 percent finer than 325 mesh, 33 percent finer than 10 micron. The crude marl is 53.6 percent water; 770 pounds of dry marl are contained in one cubic yard of the crude (Guillet 1969, p.85).

Additional data is available in Guillet's report.

The production of mineral filler offers the most likely market for marl at present. The specifications and properties of mineral fillers are given by Hewitt (1973).

Peat

Amaranth Peat Products extracts peat for agricultural purposes from properties located on lots 16 and 17, concession X, and lot 19, concessions VIII and IX, Amaranth Township. Extraction is by a front-end loader from depths of three to five feet (1-1.5m). Marl is not mixed in with the organic material.

Chapman and Putnam (1951) also reported old peat workings from the Luther Lake area, however, these were not found during the present survey.

Numerous bogs are present in the Orangeville area which could support small operations such as the one mentioned above. Most of the organic materials are less than 10 feet (3m) thick, though the well record mentioned previously indicates up to 90 feet (27m) of muck in the Caledon Lake bog.

ENGINEERING GEOLOGY

General

Pleistocene sediments of the Orangeville area generally do not present severe engineering problems. The Catfish Creek Till is extremely compact; excavation in this material may require blasting or ripping which would incur unexpected costs. Springlines

commonly occur at the upper contact of this till. These may provide undesirable construction conditions and accelerated mass wasting of overlying units has been observed along the Grand River due to ground water flow.

Tavistock Till is susceptible to frost heaving; low cost roads built on this material are frequently impassable in the spring. Though no tests were carried out, this till may be assumed to have low to intermediate plasticity and to be relatively inactive. Along the Conestogo River to the west of the area numerous slope failures have been noted where this till overlies glaciolacustrine silt and clay or clay till (Stirton Till), however, these conditions have not been observed in the Orangeville area.

Port Stanley, Newmarket and Wentworth Tills generally have low plasticity and provide good foundation materials. Boulders and lenses of stratified drift provide highly variable conditions for local excavation in these materials.

Stratified sand and gravel does not provide problems for the most part. These are usually well drained except in channel bottoms. Hummocky terrain of morainal areas necessitates considerable cut and fill work during road construction and uniform fine sand of the Orangeville Moraine may pose compaction problems.

Hockley Valley Landslide Scar

During 1971 a large landslide scar (Photo 17) was identified on lot 6, concession I EHS, Mono Township, on the south side of the Hockley Valley two miles (3.2km) northeast of Orangeville. Subsequently a preliminary report was prepared by the writer (Cowan 1971a) which discussed the landslide hazard possibilities of the area and recommended further geological investigation; Terra-Scan Limited (Gartner 1971) then made an engineering reconnaissance of the slide site and concluded that no present day hazard for large scale landslides exists adjacent to the site. No other scars were observed by the writer though small scale slumping is common throughout the valley. Gartner (1971) suggested a further landslide scar may exist about one-quarter mile (0.5km) to the northeast of the known scar.

MORPHOLOGY

Approximate maximum dimensions of the semicircular scar are 800 yards (800m) in the east-west direction, 350 yards (350m) in the north-south direction, and a maximum depth of about 25 yards (23m); these dimensions are from air photographs and topographic maps only. The disturbed material, mainly gravelly sand and gravel, has a somewhat hummocky topography with local relief less than 25 feet (8m) which is exceeded in gullied areas. The backslope of the scar forms a smooth arcuate break with the flat outwash apron to the south. The cross-sectional (north-south) profile is concave though a central high area occurs near the lip of the slide where materials piled up. Backward rotation of the slide materials is indicated in the surface morphology of the slide area. Post-landslide gullying is considerable and the presence of mature trees growing within the gullies indicates that the slide is probably not post-settlement.



ODM9407

Photo 17–Part of air photo showing landslide scar on south side of Hockley Valley (Ontario Natural Resources photo 66-4339-82-93).

STRATIGRAPHY

Slumping of the steep walls of the Hockley Valley, prevents the examination of undisturbed exposures. A further complication arises from the presence of considerable material classified as ice-contact stratified drift which by definition implies great variability of materials. Nevertheless a stratigraphic section, comparable to the slide site, was measured less than one-half mile (0.8km) from the slide area. The section consists of: (from the surface in feet)

0-2 (0-60cm)	Weathered fine sand containing minor gravel.
2-37 (60cm-11m)	Uniform rounded medium gravel of glaciofluvial outwash origin. Mainly slump covered. Springline occurs at contact with underlying unit.
37-67 (11-20m)	(to ditch on south side of road). Yellowish grey to yellowish brown laminated silt of glaciolacustrine origin. May be very compact. Thin grey to pink, clay bands (½-1½", 12-36mm) suggest part of unit is varved. Top 6 feet (1.8m) covered. (see tables 12, 13, and 14 for properties of similar materials at Glen Cross).
67-88 (20-27m)	(north side of road). Slump covered.
88-92 (27-28m)	(river) thin bedded grey dolostone (Manitoulin Formation).

The immediate engineering significance of this section is the presence of the impermeable, compact silt unit underlying the thick surface gravels. Bedrock under the slide area itself is Queenston Shale.

Water well records from the Ministry of the Environment indicate that the gravel unit is 50 to 72 feet (15-22m) thick on lots 5 and 6, concession I EHS, Mono Township. Borehole information, provided by the Conservation Authorities Branch (Ontario Ministry of Natural Resources) from engineering studies carried out on the Orangeville Dam Site, indicates that on lot 5, concession II EHS, Mono Township, up to 60 feet (19m) of gravel and sand overlies more than 20 feet (6m) of loose to medium dense silt with minor clay and sand layers. In summary, up to 75 feet (23m) of porous granular materials overlies an impermeable unit of glaciolacustrine silt 20 to 50 feet (6-15m) thick. The latter generally occurs at elevations of 1300 to 1350 feet (395-410m) a.s.l. in the slide area though at Glen Cross the probable equivalent unit occurs at about 1075 feet (325m) a.s.l.

Considerable seepage may be observed along the contact between these two units; below the slide scar this seepage has resulted in the deposition of several feet of calcareous tufa.

ORIGIN

The slide site was preconditioned by gross structure consisting of permeable gravels with relatively low internal friction overlying impermeable silts (Varnes 1958). Shearing resistance was probably then decreased by positive pore water pressures; the source of the water creating these excessive pore water pressures is not known. The writer originally considered that the water was derived from internal drainage of excessive surface water,

Table 20 SOIL CLASSIFICATIONS APPLIED TO GEOLOGICAL UNITS OF ORANGEVILLE AREA

GEOLOGICAL UNIT	SOIL CATENA	SOIL SERIES DRAINAGE		
		Good	Imperfect	Poor
Alluvium	—	—	Bottom Land	Bottom Land
Bog and Swamp	—	—	—	Muck, Peat
Outwash Sand	Fox	Fox	Brady	Granby
Outwash Gravel	Burford	Burford	Brisbane	Gilford
Outwash Gravel	Caledon	Caledon	Camilla	—
Ice-contact sands	Hillsburgh	Hillsburgh	—	—
Ice-contact sands	Pontypool	Pontypool	—	—
Ice-contact gravels	Donnybrook	Donnybrook	—	—
Lacustrine silty sands	Brant	Brant	Tuscola	Colwood
Lacustrine clay and silt	Brantford	Brantford	Beverly	Toledo
Wentworth Till (very stony)	Dumfries	Dumfries	Killean	Lily
Newmarket Till (very stony)	Dumfries	Dumfries	Killean	Lily
Newmarket Till	Harriston	Harriston	Listowell	Parkhill
Port Stanley Till	Guelph	Guelph	London	Parkhill
Port Stanley Till	Harriston	Harriston	Listowell	Parkhill
Tavistock Till (clayey silt texture)	Huron	Huron	Perth	Brookston
Tavistock Till (clayey silt texture with silt veneer)	Bennington	Bennington	Tavistock	Maplewood
Tavistock Till (silty texture)	Harriston	Harriston	Listowel	Parkhill
Tavistock Till (silty texture with silt veneer)	Honeywood	Honeywood	Embro	Crombie

e.g. rainfall, though no factor contributing to a high shear stress initiating the slide was proposed beyond the loading due to surcharge of moisture. Gartner (1971) suggested that the water was supplied by a glacial lake dammed in the Hockley Valley and that shear stress generated by rapid drainage of the lake and loss of lateral support may have initiated the slumping. If the latter is the case, then the slide occurred during the Port Huron Stadial, probably related to advance of the Kettleby ice. However, no lacustrine sediments known to be younger than those underlying the slumped gravels were mapped by the writer.

AGRICULTURAL SOILS

Agricultural soils in the Orangeville area are developed on Quaternary sediments for the most part as exposed bedrock occurs in areas of excessive slope or in stream or river channels. Soil development has taken place since deglaciation, about 13,000 to 14,000 years duration, and profiles are not strong in a geological sense; B horizons seldom exceed a depth of two feet (0.6m) below the surface in tills, however, these may exceed three feet (1m) in sands. Table 20 relates the present geology to soil catenas used by the Ontario Soil Survey (Hoffman and Richards, 1953; Hoffman *et al.* 1963, 1964). The grey-brown Podzolic is the predominant Great Group and the dark grey Gleysolic and Organic Great Groups of the less well drained areas form the remainder.

APPENDIX A

MEASURED PLEISTOCENE SECTIONS

Description of measured sections. Footage from surface down is approximate due to variation in unit thicknesses. (Metric conversion: 1 foot = 30.5cm).

GRAND VALLEY CUT (Photo 2) Elevation: 1525 feet. Lot 32, Concession II, East Luther Township, GR 557609

0-8	Brown silt till (Sample 21), appears to be stonier in upper part (Tavistock Till); fabric vector
8-11	Yellow fine sand and silty sand (thins to west); cobbly near lower contact; glaciolacustrine
11-20	Compact, stoney, yellowish brown, sandy silt till; up to 30 per cent stone, maximum boulder 2 feet; Sample 21A, Catfish Creek Till; fabric vector

ORANGEVILLE CUT, Elevation: 1400 feet. Lot 1, Concession I WHS Mono Township. GR 738635

0-8	Yellowish brown, sandy silt till; Tavistock Till-Simcoe sublobe; close to till Sample 34.
8-12+	Massive to substratified, compact, grey silt with numerous included cobbles and small boulders (dropstones); lacustrine (Photo 4).
71-728,	Elevation: 1525 feet, Lot 6, Concession VIII, Amaranth Township. GR 596624.
0-4	Compact, dark brown (7.5YR4/4) silty clay till; Tavistock Till; (Sample 18).
4-7	Pebbly outwash sand and gravel; to east upper till overlies compact, stoney, blocky, light red (2.5YR6.5/6), sandy silt till; Catfish Creek Till; (Sample 18A).
71-870,	Elevation: 1500 feet. Lot 16, Concession XIII, East Garafraxa Township. GR 584585.
0-6	Very compact, dark yellowish brown (10YR4/4) clayey silt to silt till; weak fissility; few stones; Tavistock Till; (Sample 20).
6-10	Compact, stony, yellowish brown, sandy silt till; Catfish Creek Till; (Sample 20A). Probably an inclusion as this unit is now missing.
71-1151,	Elevation: 975 feet. Lot 11, Concession VI, Mono Township. (Photo 7). GR 789719.
0-4	Gravel and coarse sand; intercalated thin beds of clayey silt and clayey silt till at base.
4-15	Dark brown, stone-poor silt to clayey silt till; Kettleby Till; (Sample 23).
71-1985,	Lot 23, Concession VII, Erin Township, south of Hillsburgh. (Poorly exposed). GR 696475.
0-2.5	Brown stony, sandy silt till; few laminae of silt; (Sample 41).
2.5-5.5	Poorly sorted gravel, subrounded to well rounded; pebble lithology-limestone 34, dolostone 49, sandstone 8, Precambrian 8, chert 2.
5.5-8	Compact, very stony, gritty, sandy silt till; (Sample 41A).
	To north gravel and lower till replaced by silt. Section is not reliable for stratigraphic purposes.
72-114,	Elevation: 530 feet. Lot 28, Concession VIII, East Luther Township. GR 519682.
0-2	Weathered pebbly sand.
2-5	Blocky, brown silt till; Tavistock Till.
5-7	Massive, mottled silt.
7-12	Stony, sandy till; Catfish Creek Till.
	Adjacent cut shows four feet of varved silt and clay and four feet of compact, stony, sandy silt till; Catfish Creek Till; (Sample 80).
72-1323	Elevation: 1500 feet. Lot 14, Concession XII, East Garafraxa Townships. GR 583568.
0-2	Brown silt to clayey silt till (Tavistock Till).
2-30	Yellowish brown stoney to bouldery, sandy silt till; (Catfish Creek Till).
72-1474,	Elevation: 1480 feet. Lot 16, Concession XIV, East Garafraxa Township. GR 580576.

0-1	Pebbly silt; colluvium.
1-4	Greyish yellow to yellowish brown silt; slightly contorted; thin interbeds of dark brown clay and sandy silt in lower one foot.
4-19	Yellowish brown to brown, very stiff, stoney, sandy silt to silt till (Catfish Creek Till).
19-27	Compact, contorted, brown, massive clayey silt and interbedded yellow silt; few dropstones; lacustrine, probably.
27-30	Yellowish brown sandy silt till (Catfish Creek Till).
30-37	Covered interval.
37-40	Thin bedded, vuggy, grey dolostone (Guelph Formation).
72-1489,	Elevation: 1500 feet. Lot 15, Concession XI, East Garafraxa Township. GR 563549.
0-4	Brown (10YR4/3) slightly pebbly silt till; silt inclusions; Tavistock Till; (Sample 85A).
4-4.5	Coarse sand.
4.5-6	Pebbly, poorly sorted fine sand.
6-10	Light yellowish brown (2.5Y6/4) pebbly sandy silt to silt till; Catfish Creek Till; (Sample 85B).
72-1498,	Elevation: 1470 feet. Lot 12, Concession XI, East Garafraxa Township. GR 577535.
0-4	Dark yellowish brown (10YR4/4) silty clay till; rare grits and pebbles; Tavistock Till; (Sample 86A).
4-4½	Very pale brown (10YR7/4) laminated silt and fine sand; brown clay lamina.
4½-6+	Stoney, yellowish brown (10YR5/3.5), sandy silt till; Catfish Creek Till; (Sample 86B).
72-1516,	Elevation 1420 feet. Lot 13, Concession V, west Garafraxa Township, northwest side of stream. GR 515465.
0-4	Outwash sand, minor gravel.
4-10	Compact, stoney, yellowish brown sandy silt till (Catfish Creek Till).
72-1519,	Elevation: 1480 feet. Lot 19, Concession VI, West Garafraxa Township. GR 493504.
0-2	Fine sand, gravelly at base.
2-8	Gritty brown, clayey silt till; reworked at top; (Tavistock Till).
8-10	Very stiff, stony, gritty, yellowish brown, sandy silt till; Catfish Creek Till.

APPENDIX B

Till analyses (sample locations are plotted on Map 2326 in back pocket).

NOTES:

(1) Except for pebble counts all laboratory analyses were carried out by the Mineral Research Branch of the Ontario Division of Mines.

(2) Sand-silt boundary, 0.062mm; silt-clay boundary 0.002mm; Md is median diameter in mm.

(3) Pebble counts on 8-32mm grade.

(4) Carbonate analyses on minus 200 mesh fraction using Chittick apparatus.

(5) Heavy mineral separations on −60 to +120 mesh fraction using tetrabromethane (S.G. 2.96).

(6) Till identification.

- CC – Catfish Creek Till
- m – middle till
- P – Port Stanley Till
- K – Kettleby Till
- N – Newmarket Till
- T – Tavistock Till (northwesterly source)
- Ts – Tavistock Till (Lake Simcoe sublobe equivalent)
- W – Wentworth Till

(7) Till samples which are asterisked were not used in calculation of means.

		Texture					Pebble Lithology %								Carbonates				Heavy Minerals		Color Fresh	Remarks
Sample No.	N.T.S. Grid Ref.	Till	Clay %	Silt %	Sand %	Md. mm.	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian	Ratio Ls/Dol	Calcite %	Dolomite %	Total %	Ratio Ca/Dol	Total %	Magnetics %		
1	658674	T	17	58	25	0.0109	22	73	—	—	—	—	5	0.30	20.9	18.9	39.8	1.10	4.8	8.8	—	
2	657623	T	10	52	38	0.034	41	50	—	—	2	—	7	0.82	18.7	14.9	33.6	1.25	3.9	9.3	—	
3	644610	T	14	60	26	0.022	39	54	—	2	—	6	5	0.72	20.6	13.5	34.1	1.52	4.1	12.1	—	
4	639638	T	13	62	25	0.0208	22	73	—	—	—	2	3	0.30	18.0	17.0	35.0	1.06	3.4	8.5	10YR5/4	
5	687680	T	17	55	28	0.0175	14	82	—	—	—	—	3	0.17	32.9	10.4	43.3	3.16	2.2	8.2	light brown	silt veneer
6	712627	Ts	19	64	17	0.0097	35	53	—	—	—	8	3	0.66	21.4	12.9	34.3	1.66	2.8	9.4	10YR5/4	
7	706646	Ts	21	49	30	0.0193	10	80	—	—	3	—	7	0.12	17.2	25.3	42.5	0.68	2.9	8.4	—	overlies sand
8	703670	Ts	20	64	16	0.012	20	70	—	1	6	—	3	0.29	19.2	13.5	32.7	1.42	3.9	7.8	10YR5/45	sand veneer
9	634663	T	19	59	22	0.012	34	56	—	—	2	2	5	0.61	22.0	11.1	33.1	1.98	4.9	8.4	10YR5/4	
10	694718	T	16	71	13	0.0090	23	74	—	—	1	—	1	0.31	19.9	17.3	37.2	1.15	4.5	9.5	2.5Y6/4	
11	697700	T	19	55	26	0.0138	11	77	—	1	6	—	4	0.14	19.0	23.7	42.7	0.80	3.0	10.2	—	sand veneer
12	596719	T	29	62	9	0.0052	19	77	—	—	1	1	1	0.25	18.3	20.7	39.0	0.88	1.8	8.6	—	overlies silt
13	592687	T	24	60	16	0.007	46	48	—	—	—	—	6	0.96	19.2	18.4	37.6	1.04	3.4	6.6	10YR4/2.5	
14	654700	T	27	59	14	0.0040	22	73	—	2	1	—	3	0.30	19.8	16.4	36.2	1.21	4.4	8.2	10YR4/4	sand veneer
15	596640	T*	26	36	38	0.016	8	89	—	—	2	—	1	0.09	19.5	30.8	50.3	0.63	5.1	9.5	7.5YR5/4	
16	585623	CC	17	41	42	0.036	2	98	—	—	—	—	—	0.02	7.0	54.2	61.2	0.13	2.7	9.6	10YR4/4	sand veneer
17	626713	T	36	59	5	0.0038	—	—	—	—	—	—	—	—	24.0	14.5	38.5	1.66	4.2	7.9	light greyish brown	
18	596624	T	46	41	13	0.0026	1	97	—	—	1	—	1	0.01	18.5	23.9	42.4	0.77	2.7	7.6	7.5YR4/4	
18a	596624	CC	20	41	39	0.031	2	97	—	—	—	—	1	0.02	14.4	54.8	69.2	0.26	2.7	6.7	2.5YR6.5/6	
19	640514	T?	15	55	30	0.022	32	51	—	2	7	—	8	0.63	16.4	19.0	35.4	0.86	4.5	7.3	—	sand veneer

		Texture					Pebble Lithology %							Carbonates				Heavy Minerals		Color Fresh	Remarks
Sample No.	N.T.S. Grid Ref.	Till	Clay %	Silt %	Sand %	Md. mm.	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian	Ratio Ls/Dol	Calcite %	Dolomite %	Total %	Ratio Ca/Dol	Total %	Magnetics %		
20	584585	T	35	51	14	0.0041	18	76	—	—	2	—	4	0.24	18.8	36.0	54.8	0.52	3.3	7.6	10YR4/4	
20a	584585	CC	21	46	33	0.021	4	91	1	1	—	—	2	0.04	13.5	52.1	65.6	0.26	2.3	8.3		yellowish brown Probably an Inclusion
21	558609	T	32	54	14	0.0044	68	17	—	—	10	—	5	4.0	13.0	22.2	35.2	0.59	4.1	6.1	10YR4/4	
21a	558609	CC	16	43	41	0.034	12	78	—	4	—	1	5	0.15	9.2	57.4	66.6	0.16	2.4	8.6	2.5Y5.5/4	
22	758672	N	9	36	55	0.078	45	36	—	11	2	—	6	1.25	16.9	17.3	34.2	0.98	6.2	9.4		yellowish brown
23	789718	K	31	50	19	0.0070	68	6	—	—	—	16	10	11.3	21.6	13.1	34.7	1.65	3.2	8.2	10YR3/2	
24	786662	N	11	34	55	0.081	—	—	—	—	—	—	—	—	20.8	12.3	33.1	1.69	6.0	10.8		brown
25	803571	P	10	41	49	0.053	20	71	—	—	—	—	1	0.28	7.4	44.9	52.3	0.16	1.8	9.8		greyish brown
26	769604	P	10	38	52	0.068	14	81	—	3	—	—	2	0.17	7.9	42.4	50.3	0.19	2.5	12.2		greyish brown
27	741481	P	13	40	47	0.054	—	99	—	—	1	—	—	0.00	5.9	69.3	75.2	0.09	2.2	8.6	10YR6.5/3.5	stony sand veneer
28	745487	P	15	39	46	0.046	8	91	—	—	—	1	—	0.09	7.3	48.0	55.3	0.15	3.7	9.0	2.5YR4.5/4	sand veneer
29	729516	P	8	42	50	0.062	22	74	—	—	1	—	3	0.30	12.8	25.7	38.5	0.50	6.0	13.0	10YR5/4	sand lenses
30	747511	P	11	44	45	0.050	6	91	—	—	—	1	2	0.07	7.1	51.1	58.2	0.14	3.4	9.6	yellowish brown	borrow pit
31	728567	P*	8	37	55	0.075	37	49	—	4	4	—	6	0.76	13.0	19.5	32.5	0.67	6.1	11.9	10YR5/3	sand veneer
32	689564	T	13	43	44	0.045	33	56	—	—	1	1	9	0.59	17.4	15.8	33.2	1.10	4.5	7.0	brown	overlies sand
33	707526	P	12	37	51	0.065	11	81	—	—	3	1	4	0.14	4.9	38.6	43.5	0.13	4.0	12.0	yellowish brown	sand veneer
34	743635	Ts*	3	25	72	0.095	53	42	—	2	—	—	4	1.26	13.2	16.9	30.1	0.56	2.5	3.7	yellowish brown	sand inclusions
34a	743635	Ts	14	32	54	0.082	—	—	—	—	—	—	—	—	12.7	17.6	30.3	0.72	5.7	10.3	yellowish brown	
35	736671	Ts?	28	42	30	0.013	14	76	—	—	9	1	—	0.18	8.9	29.5	38.4	0.30	4.4	8.4		yellowish brown
36	782690	N	10	39	51	0.066	13	83	—	2	1	—	1	0.16	8.8	32.2	41.0	0.27	3.8	8.2	—	

37	798459	W	10	45	45	0.048	20	70	—	1	2	—	7	0.29	17.3	29.0	46.3	0.69	4.2	9.6	—	brown
38	777576	P	6	34	60	0.090	24	66	—	—	2	2	5	0.36	13.4	22.5	35.9	0.60	6.2	11.5	—	yellowish brown
39	805489	W	12	33	55	0.080	42	53	—	—	2	—	3	0.79	12.8	25.1	37.9	0.51	5.5	9.5	—	½ mile east of area
40	737443	P	14	27	59	0.105	38	50	1	3	4	—	4	0.76	17.3	30.3	47.6	0.57	5.9	10.4	—	yellowish brown
41a	696474	?	15	49	36	0.019	28	55	—	1	6	—	9	0.51	15.2	25.6	40.8	0.59	4.8	8.8	—	brown
41c	696474	?	10	39	51	0.064	44	51	—	—	2	—	3	0.86	15.0	28.3	43.3	0.53	5.2	12.5	—	yellowish brown
42	644472	P	19	38	43	0.031	—	—	—	—	—	—	—	—	22.5	22.8	45.3	0.99	5.8	11.1	—	yellowish brown
43	442719	P	10	28	62	0.110	18	68	1	3	1	—	10	0.26	12.0	35.5	47.5	0.34	6.2	12.8	10YR6/3.5	
44	629467	P	19	53	28	0.0095	31	63	—	1	2	—	3	0.49	20.5	19.5	40.0	1.05	6.0	11.7	—	overlies fine sand
45	693470	M	24	65	11	0.0060	51	36	—	—	2	5	5	1.41	24.8	14.0	38.8	1.77	4.5	6.9	10YR5/4	
46	713466	P	9	47	44	0.041	52	39	—	1	—	—	7	1.33	21.5	16.8	38.3	1.28	6.2	12.6	10YR5.5/4	
47	754463	P	15	26	59	0.096	40	46	—	3	4	—	7	0.87	13.7	36.9	50.6	0.37	4.0	10.3	10YR5.5/5	
48	78861	P	12	41	47	0.056	14	83	—	—	1	—	2	0.17	10.2	45.3	55.5	0.22	2.2	12.7	10YR6/4	
49	694539	P*	10	34	56	0.076	—	—	—	—	—	—	—	—	13.0	16.7	29.7	0.78	2.3	9.2	—	
50	553578	T	32	57	11	0.0044	23	66	3	—	4	1	4	0.35	20.6	25.9	46.5	0.80	2.2	7.7	10YR5.5/4	overlain by silt
51	563550	T	45	51	4	0.0025	6	86	1	2	—	—	5	0.07	20.2	14.5	34.7	1.39	4.3	8.5	10YR5.5/3	
52	540523	T	31	63	6	0.0040	—	—	—	—	—	—	—	—	20.1	28.5	48.6	0.71	2.3	6.2	10YR5.5/4	
53	527507	T	33	51	16	0.0047	18	69	—	4	1	—	8	0.26	11.9	25.1	37.0	0.47	3.9	7.3	10YR4/3	
54	509484	T	28	51	21	0.0073	11	71	2	8	—	—	7	0.01	8.8	21.0	29.8	0.42	4.5	11.0	10YR4/3.5	
55	455466	T	28	51	21	0.0070	25	68	1	—	2	—	4	0.37	15.3	22.7	38.0	0.67	3.6	8.3	—	yellowish brown

		Texture					Pebble Lithology %								Carbonates				Heavy Minerals		Color Fresh	Remarks
Sample No.	N.T.S. Grid Ref.	Till	Clay %	Silt %	Sand %	Md. mm.	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian	Ratio Ls/Dol	Calcite %	Dolomite %	Total %	Ratio Ca/Dol	Total %	Magnetics %		
56	469485	T	32	49	19	0.0078	23	66	—	3	1	—	8	0.35	16.0	27.9	43.9	0.57	2.9	8.1	10YR5/4	
57	523550	T	34	54	12	0.0042	13	78	1	—	—	—	8	0.17	18.7	29.5	48.2	0.63	2.7	8.1	10YR5.5/4	jasper conglomerate present
58	491513	T	39	48	13	0.0038	18	78	2	—	—	—	2	0.23	12.7	27.9	40.6	0.46	2.9	6.3	10YR5.5/4	5′ below surface
58a	491513	T	52	45	3	0.0019	—	—	—	—	—	—	—	—	24.7	16.6	41.3	1.49	4.0	5.1	10YR5/3	18′ below surface
59	450509	T	50	44	6	0.002	—	—	—	—	—	—	—	—	17.7	19.8	37.5	0.89	2.8	7.4	10YR5/3	slightly weathered
60	430484	T	28	59	13	0.0065	34	59	—	3	3	—	3	0.58	17.8	25.5	43.3	0.70	4.1	9.3	10YR5/4	
61	404514	T	20	49	31	0.0225	16	75	1	1	—	—	7	0.21	10.7	32.1	42.8	0.33	2.9	5.9	10YR5/4	
62	423524	T	27	58	15	0.0081	29	54	—	3	2	—	12	0.54	17.5	25.2	42.7	0.69	4.6	9.5	10YR5.5/4	
63	412596	T	26	50	24	0.010	17	78	2	—	—	—	3	0.22	10.5	38.1	48.6	0.28	2.0	6.7	10YR5.5/5	
64	411653	T	18	47	35	0.026	8	88	1	—	—	—	3	0.09	11.6	46.2	57.8	0.25	1.8	8.0	10YR5/4	jasper present
65	403698	T	30	48	22	0.0068	10	84	1	—	—	—	5	0.12	13.3	35.9	49.2	0.37	2.1	8.6	10YR5/4	
66	446717	T	20	48	32	0.029	9	85	—	—	1	—	4	0.11	13.8	43.9	57.7	0.31	1.5	6.6	10YR5/4	
67	459694	T	16	47	37	0.031	12	86	—	—	—	—	2	0.14	14.7	43.5	58.2	0.34	1.6	9.8	10YR5/4	
68	481699	T	20	50	30	0.018	9	80	1	1	4	—	4	0.11	14.7	36.4	51.1	0.40	1.9	8.7	10YR5/4	
69	499678	T	40	50	10	0.0033	14	73	2	—	3	—	8	0.19	15.1	32.6	47.7	0.46	2.0	6.8	10YR5/4	
70	532629	T	26	46	28	0.0091	13	81	1	1	—	—	4	0.16	12.3	36.7	49.0	0.34	2.9	2.9	—	mottled
71	512655	T	21	54	25	0.011	13	75	2	1	3	—	6	0.17	14.2	34.4	48.6	0.41	2.6	7.0	10YR5.5/4	
72	487646	T	18	51	31	0.020	16	73	—	1	2	—	8	0.22	17.1	33.1	50.2	0.52	1.5	10.0	10YR5/4	
73	512607	T	27	52	21	0.0061	15	80	—	1	1	—	3	0.19	17.4	23.7	41.1	0.73	2.8	10.4	10YR5/4	
74	534603	T	46	44	10	0.0024	9	79	—	—	3	1	8	0.11	22.0	23.7	45.7	0.93	1.8	13.0	10YR4-5/4	inclusions of sandy till

75	481587	T	32	50	18	0.0059	14	82	—	—	—	—	4	0.17	13.9	34.3	48.2	0.40	2.0	4.4	10YR5/4	
76	442584	T	33	46	21	0.0070	7	85	—	—	2	—	6	0.08	13.3	36.7	50.0	0.36	1.8	7.1	10YR4.5/4	
77	446558	T	42	47	11	0.0031	14	70	3	1	7	—	5	0.20	19.9	19.7	39.6	1.01	2.0	8.1	10YR4/4	overlain by gravel
78	475541	T	30	50	20	0.0066	12	81	1	1	—	—	5	0.15	18.2	28.1	46.3	0.65	2.0	9.3	brown	mottled
79	407648	CC	16	49	35	0.034	—	—	—	—	—	—	—	—	9.7	55.9	65.6	0.17	1.6	10.6	—	
80	519682	CC	16	42	42	0.038	17	78	—	—	—	—	5	0.22	17.6	51.6	69.2	0.34	3.0	12.6	—	
81	513699	CC	19	46	35	0.027	—	90	—	—	—	—	10	0.0	11.6	54.7	66.3	0.21	1.6	12.2	10YR6/2	
82	578610	CC	16	53	31	0.016	—	—	—	—	—	—	—	—	9.7	45.8	55.5	0.21	4.3	11.3	—	
83	551484	T	23	66	11	0.0063	11	80	—	1	1	—	7	0.14	21.5	18.8	40.3	1.14	3.6	11.9	—	
84	539457	P	13	43	44	0.036	18	80	—	—	1	—	1	0.22	13.4	35.3	48.7	0.38	2.8	14.6	—	
85a	563549	T	28	67	5	0.0041	9	91	—	—	—	—	—	0.10	21.0	18.7	39.7	1.12	4.1	16.6	—	
85b	563549	CC	10	60	30	0.038	8	90	—	—	—	—	2	0.09	12.7	37.7	50.4	0.34	3.1	8.2	—	
86a	577535	T	42	48	10	0.0030	—	—	—	—	—	—	—	—	21.5	12.8	34.3	1.68	4.4	13.7	10YR7/4	
86b	577535	CC	15	48	37	0.019	—	—	—	—	—	—	—	—	19.2	24.4	43.6	0.79	4.1	7.6	10YR5/3.5	
87	G513435	P	14	45	41	0.037	14	84	—	—	—	—	2	0.17	17.3	30.6	47.9	0.56	3.7	12.0	10YR5/4	Guelph area
88a	G489434	PS	28	49	23	0.0067	—	—	—	—	—	—	—	—	21.7	16.8	38.5	1.29	5.8	15.7	10YR5/3	Guelph area
88b	G489434	T	55	39	6	0.0015	—	—	—	—	—	—	—	—	18.8	17.3	36.1	1.09	4.1	13.8	7.5YR5/2-5YR4/3	
88c	G489434	?	14	67	19	0.016	—	—	—	—	—	—	—	—	15.0	27.0	42.0	0.56	3.7	13.0	10YR5/4	
83d	G489434	PS	30	53	17	0.0051	—	—	—	—	—	—	—	—	22.2	17.9	40.1	1.24	4.7	17.5	10YR5/1	
88e	G489434	T	57	37	6	0.0015	—	—	—	—	—	—	—	—	21.7	16.1	37.8	1.35	4.7	15.5	—	

APPENDIX C

Descriptive data on gravel or sand pits not included in text.

Notes:

(1) Estimated or inferred reserves as follows;
Small less than 1,500,000 cubic yards (1.1 x $10^6 m^3$)
Medium 1,500,000 to 5,000,000 cubic yards (1.1 x 10^6 to 3.8 x $10^6 m^3$)
Large more than 5,000,00 cubic yards (3.8 x $10^6 m^3$)

(2) Asterisks in pebble counts indicate presence at pit but not recorded in sample.

	Location								Composition						Pebble Lithology (percent)									
Property Number	Township	Concession	Lot	Owner or Operator	Thickness of Overburden	Observed Thickness of Dep.	Reported Thickness of Dep.	Estimated Reserves (S—small, L—large, U—unknown)	% Stone (estimated)	% Sand (estimated)	% Stone Greater than 1"	% Stone Greater than 4"	Maximum Boulder (feet)	Origin of Deposit	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian Felsic Rocks	Precambrian Mafic Rocks	Precambrian Metamorphic Rocks	Sand Sample No.
1	W. Luther	IV	15	Benham			5–35	S	60	40	60	15	3.0	Ice-contact	7	90	—	—	—	—	2	1	—	—
2	W. Luther	IV	15	H. White	1–6		10–50	S	20	80	25	5	0.5	ice-contact										
3	W. Luther	IV	15	M.T.C.		17		S	70	30	20	5		ice-contact	14	80	—	2	—	—	1	2	2	—
4	W. Luther	IV	18			10		S	30	70	50	10	0.5	ice-contact	7	92	—	—	—	—	1	—	—	—
5	W. Luther	V	9			15		S			40	5	1.5	esker	13	80	—	—	—	—	1	5	1	—
6	W. Luther	V	10			20		S	60	40	25	5		esker	9	86	—	—	—	—	2	2	1	—
7	W. Luther	V	12	Willoughby		25		S	50	50			2.0	esker	5	90	—	—	—	—	3	2	—	—
8	W. Luther	V	12	P. Rackel		6	8	S	40	60	10	1		esker										
9	W. Luther	V	14			15		S	60	40	25	1		esker										
10	W. Luther	VI	10			5		S						esker										
11	W. Luther	VII	9					S	60	40	50	5		esker	10	87	—	2	—	—	2	—	—	—
12	W. Luther	VII	10			20		S	50	50	60	30	1.0	ice-contact	12	85	—	—	—	—	—	3	—	—

13	W. Luther	X	15			12		S	80	20	50	15		esker											
14	W. Luther	XI	11			10		S	50	50	75	40		esker-delta	9	85	1	—	—	—	—	3	—	—
15	W. Luther	XI	12			5		S	5	95				esker											
16	W. Luther	XII	10	Jackson		30		S	50	50	40	10	1.0	esker	5	86	—	—	—	—	3	4	2	—
17	W. Luther	XII	11			30		S	20	80				esker	9	85	—	—	1	—	2	—	3	—
18	W. Luther	XII	16	Jackson	3	17		S	40	60	60	15	1.0	ice-contact	4	96	—	—	—	—	—	—	—	—
18	W. Luther	XII	16												8	84	1	—	—	—	2	—	5	—
19	W. Luther	XIII	9			30		S	70	30	75	40	2.0	esker	12	81	—	—	1	—	1	4	1	—
20	E. Luther	II	20			7		S	5	95				esker										
23	E. Luther	III	20			11		S	10	90				ice-contact										
24	E. Luther	III	21			5		S		100				ice-contact										
27	E. Luther	VIII	32			10		S	30	40				ice-contact	13	80	—	—	—	—	3	4	—	—
28	E. Luther	IX	24			4		S						outwash								•		
29	E. Luther	X	30			5		S	75	25	40	20	1.0	esker?										
32	Amaranth	II	10			12		S			50	15	1.0	outwash	36	52	—	—	2	—	2	5	3	—
33	Amaranth	II	18			5		S					0.5	outwash										
34	Amaranth	III	16			6		S	30	70				outwash										
35	Amaranth	VI	1			5		S	30	70			0.5	esker										
36	Amaranth	VI	10	J. Lodder		30		S	35	65				ice-contact										
36	Amaranth	VI	10	J. Lodder	4	20			60	30	80	40	3.0		5	90	—	—	—	—	1	4	—	—
36	Amaranth	VI	10	J. Lodder	0	25			40	60	80	20	1.0											
37	Amaranth	VII	11		1	10		S	50	40			1.5	ice-contact	5	93	—	—	—	—	—	2	—	—
38	Amaranth	VIII	2	Gamble	1	8		S	40	60			1.0	outwash	38	44	—	1	6	—	4	5	2	—
39	Amaranth	IX	1	Thompson and Tuintjer	1	14		S	60	40		50		outwash	40	35	3	1	10	—	4	6	1	—

Property Number	Location			Owner or Operator					Composition					Pebble Lithology (percent)																
	Township	Concession	Lot		Thickness of Overburden	Observed Thickness of Dep.	Reported Thickness of Dep.	Estimated Reserves (S—small, L—large, U—unknown)	% Stone (estimated)	% Sand (estimated)	% Stone Greater than 1"	% Stone Greater than 4"	Maximum Boulder (feet)	Origin of Deposit	Limestone	Dolostone	Chert	Sandstone	Siltstone	Shale	Precambrian Felsic Rocks	Precambrian Mafic Rocks	Precambrian Metamorphic Rocks	Sand Sample No.
40	Amaranth	IX	22	E Patton		15		S	25	75				esker										
41	Amaranth	X	3			10		S	40	60	30	1		outwash										
46	Mono	IW	10			8		S	30	70	30			ice-contact	78	6	—	1	2	—	5	4	3	—
47	Mono	IW	13			8		S	60	40	70	30	2.0	ice-contact					*					
54	Mono	IE	11	Overland Pit	1–3	10		S	20	80	15	5	0.5	ice-contact	65	9	—	8	13	—	2	1	2	—
55	Mono	IIE	2	D. G. Hand	1	20		S	10	90				ice-contact										
56	Mono	IIIE	6	E. White	1–4	25		S	30	70	30	5	1.5	ice-contact	78	9	—	1	2	*	1	4	4	—
57	Peel	A	10			20		S	5	95				ice-contact										
65	W. Garafraxa	V	25			8		S	5	95				ice-contact										
66	W. Garafraxa	V	25			15		S	20	80				ice-contact										
69	W. Garafraxa	VI	9			8		S	25	75				ice-contact										
77	E. Garafraxa	X	17	Henderson	0–4	35		S	25	75	40	10	1.0	ice-contact	7	91	—	—	—	—	—	2	—	—

78	E. Garafraxa	XIII	6	Bayne				S	20	80				esker	26	66	—	—	—	—	3	1	3	—
79	E. Garafraxa	XIII	11	Taylor	2	30		S	20	80	20	5		ice-contact	4	92	—	—	—	—	1	1	2	—
80	E. Garafraxa	XIV	13			8		S	40	60	40	5	1.0	esker										
81	E. Garafraxa	XV	5	D. Everson				S	30	70				esker										
82	E. Garafraxa	XV	6			20		S	30	70			1.0	esker										
83	E. Garafraxa	XV	6 & 7					S	75	25			0.6	esker	42	49	—	—	—	—	5	1	3	—
84	E. Garafraxa	XV	9			18		S	20	80				esker	21	55	1	7	7	—	—	2	7	—
86	E. Garafraxa	XVI	15	McKetrick		10		S	30	70				outwash										
87	E. Garafraxa	XVII	11	Orangeville S & G				S	60	40	40	10	1.0	ice-contact	41	41	—	—	8	—	2	6	—	7
87	E. Garafraxa	XVII	11	Orangeville S & G		14			20	80			6.0	ice-contact										
88	E. Garafraxa	XVII	12	F. Corbett		25		S	50	50				esker										
	E. Garafraxa	XVII	12											kame	31	25	—	4	11	—	4	15	9	—
89	E. Garafraxa	XVIII	11			20		S	30	70	40	10	1.0	esker	33	48	1	2	5	—	7	4	2	—
90	E. Garafraxa	XVIII	11	Orangeville S & G		10		S-M	20	80			0.5	ice-contact										
90	E. Garafraxa	XVIII	11	Orangeville S & G		20			30	70			2.0	ice-contact-outwash	34	52	—	1	7	—	2	3	2	—
92	E. Garafraxa	XIX	4			10		S	20	80			1.0	outwash	60	26	—	2	4	—	4	4	—	—
93	E. Garafraxa	XIX	4			10		S	50	50	60	15	1.0	outwash	45	32	—	2	6	*	8	5	2	—
94	E. Garafraxa	XIX	5	W. J. Hunter		10	25	S					1.5	outwash	44	38	2	2	4	—	7	1	3	—
105	Erin	VIII	20			20		S	40	60	60	10	3.0	outwash	35	54	—	—	2	—	5	2	2	14
114	Erin	XI	20			8		S	60	40				ice-contact										
117	Caledon	IW	24		2.5	22		S	15	85	15		0.4	ice-contact										
	Caledon	IIW	28	roadcut		8		U						outwash	47	34	—	7	2	—	6	2	2	—
122	Caledon	IIW	31	Rayburn Const.		12		S?	20	80				outwash	—	—	—	—	—	—	—	—	—	13

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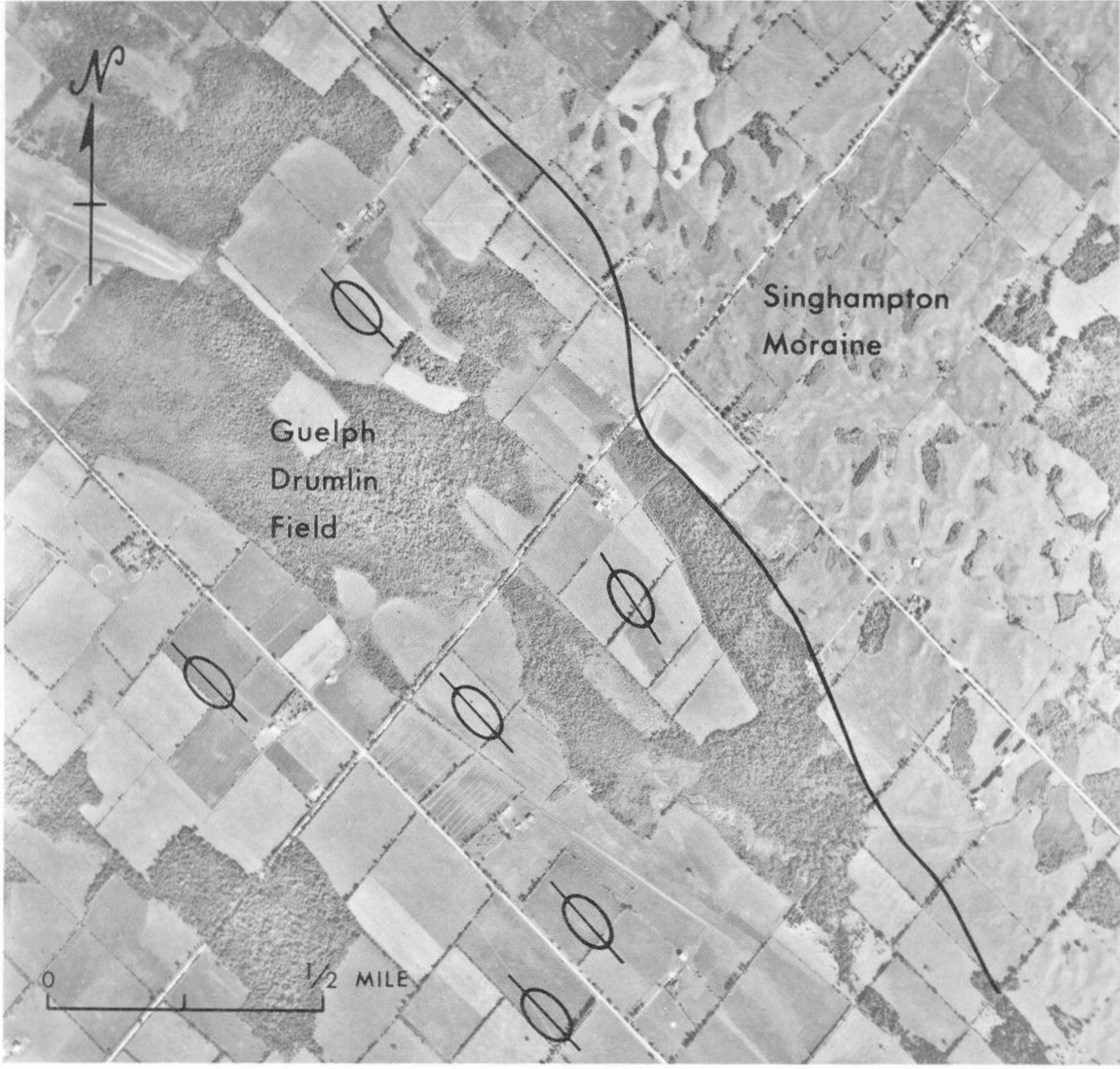
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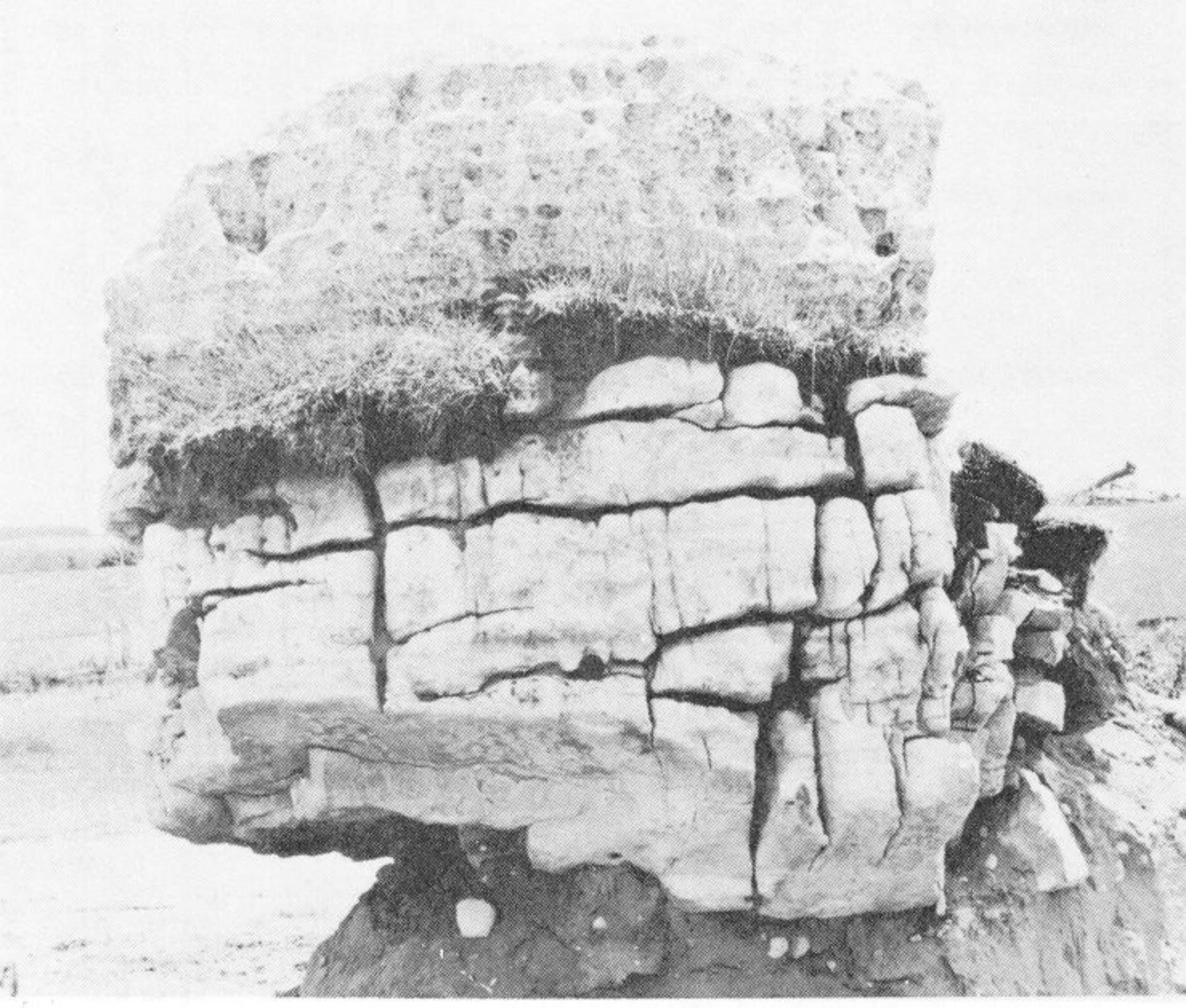



N
Singhampton
Moraine
Guelph
Drumlin
Field
0
1/2 MILE







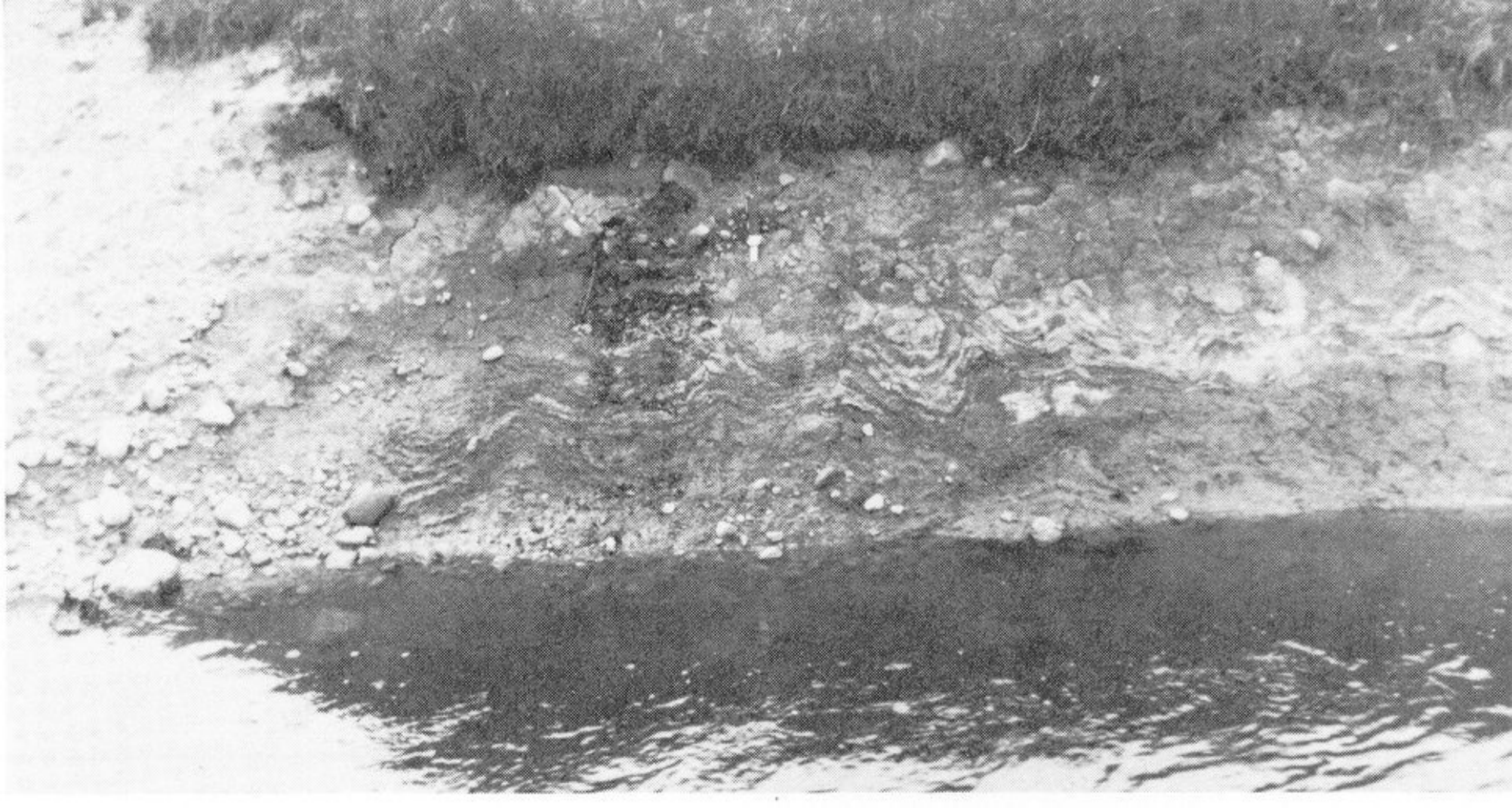















Landslide Scar
0
1/2 MILE

DUFFERIN COUNTY

WELLINGTON COUNTY

DUFFERIN COUNTY

REGIONAL MUNICIPALITY OF PEEL

WELLINGTON COUNTY ERAMOSA TOWNSHIP

LUTHER LAKE

WEST LUTHER

EAST LUTHER

AMARANTH

MONO

ORANGEVILLE

CALEDON

EAST GARAFRAXA

WEST GARAFRAXA

ERIN

PEEL

NICHOL

Monticello

Monora

Stongwood

Monoca

Mount View

Grand Valley

Campania

Washington

Cardwell

Laurel

Bowling Green

Leggott

Torbolton

Dracon

Hereward

Marsville

Reading

Creighton

Hillsburgh

Erin

Caledon East

Inglewood

Cataract

Belfountain

Terra Cotta

Glen Williams

Norval

Georgetown

Limehouse

Campbellville

Milton

Acton

Brampton

Streetsville

Meadowvale

Malton

Port Credit

Mississauga

Oakville

Burlington

Hamilton

London

Lake Erie

Lake Ontario

Lake Simcoe

Georgian Bay

Owen Sound

Barrie

Toronto

Niagara Falls

Windsor

Sarnia

Kitchener

Guelph

Stratford

Goderich

Orangeville

Map 2326

ONTARIO

Scale 1:50,000

Published 1978

Ministry of Natural Resources

Ontario

Hon. Leo Bernier, Minister

Dr. J. K. Reynolds, Deputy Minister

Division of Mines

G. A. Jewett, Executive Director

E. G. Pye, Director, Geological Branch

ONTARIO DIVISION OF MINES

Map 2326

ORANGEVILLE

Southern Ontario

Quaternary Geology

NTS 40 P/16

Scale 1:50,000

MAP COVERAGE: INDUSTRIAL MINERALS, QUATERNARY OR PLEISTOCENE GEOLOGY SERIES (EXCLUDING PRELIMINARY MAPS)

LEGEND

CENOZOIC

QUATERNARY

RECENT

15 — *15 Alluvium, unsubdivided: silt, sand, gravel.*

14 — *14 Bog deposits: peat, muck, marl.*

PLEISTOCENE

LATE WISCONSINAN

13 — *Glaciolacustrine or local pond sediments:*
13a Mainly silt and clay.
13b Mainly fine to very fine sand.

12 — *12 Glaciofluvial outwash sand, minor gravel.*

11 — *11 KETTLEBY TILL: clayey silt till.*

10 — *10 Glaciofluvial outwash gravel and gravelly sand, frequently overlain by several feet of sand or silt.*

9 — *9 WENTWORTH TILL: stony, sandy silt till.*

8 — *8 NEWMARKET TILL: sandy silt till.*

7 — *7 Ice-contact stratified drift, unsubdivided: sand and gravel including some till or silt.*
7a Mainly gravel.
7b Mainly sand.

6 — *6 PORT STANLEY TILL: sandy silt till.*

5 — *TAVISTOCK TILL*
5a Sub: clayey silt till; Georgian Bay Sub.
5b Sandy silt till; Lake Simcoe subbdw.

4 — *4 Middle till: silt till.*

3 — *3 CATFISH CREEK TILL: stony, sandy silt till.*

UNCONFORMITY

PALEOZOIC

SILURIAN

2 — *2a Guelph Formation: dolostone.*
2b Amabel Formation (includes Fossil Hill Formation at base): dolostone.
2c Cataract Group: sandstone, dolostone, shale.

ORDOVICIAN

1 — *1 Queenston Formation: red shale.*

Deposits on this sheet are mapped where they reach three feet or more in thickness. Thinner deposits are not shown.

SYMBOLS

- *Drumlin.*
- *Glacial fluting.*
- *Esker; (direction known, unknown).*
- *Ice-contact slope; enclosed area indicates kettle hole.*
- *Terrace escarpment.*
- *Glacial meltwater channel; (direction of flow inferred, uncertain).*
- *Gravel or sand pit.*
- *Abandoned quarry or shale pit.*
- *Till sample locality.*
- *Peat pit.*
- *Landslide scar.*
- *Hummocky topography.*
- *Geological boundary, actual or interpreted.*
- *Bedrock outcrop.*
- *Topographic contours.*
- *County boundary.*
- *Township boundary.*

For other conventional signs refer to 1:50,000 National Topographic System maps.

SOURCES OF INFORMATION

Geology by W. R. Cowan, D. R. Sharpe and assistants, Geological Branch, 1971, 1972.

Aerial photography: Ministry of Natural Resources, Toronto and National Air Photo Library, Ottawa.

Water well records of the Water Quantity Management Branch, Ministry of the Environment, Toronto.

Preliminary map, P. 848 Quaternary Geology of the Orangeville Area, scale 1:50,000 issued 1972.

Cartography by M. J. Colman and assistants, Surveys and Mapping Branch, 1975.

Topography from map 40P/16 of the National Topographic System, with additional information by W. R. Cowan.

Magnetic declination in the area was approximately 8° West in 1970.

Scale 1:50,000

Metres 1000 0 1 2 3 4 5 6 7 Kilometres

Chains 80 40 0 1 2 3 Miles

Ministry of Natural Resources
Ontario

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Deputy Minister

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ONTARIO DIVISION OF MINES

Map 2327

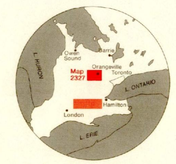
ORANGEVILLE

Southern Ontario

Granular Resources

NTS 40 P/16

Scale 1:50,000



MAP COVERAGE: GRANULAR RESOURCES SERIES (EXCLUDING PRELIMINARY MAPS)

SYMBOLS

- Area known to contain usable granular materials; frequently overlapping active or inactive pits. Probability of locating economic deposits is moderate to high.
- Area underlain by stratified drift containing materials of value; possibly overlain by material of no value. Development costs may be high. Probability of locating economic deposits is moderate to low.
- Area containing buried granular materials of which useable material is very localized. Prospecting and development cost high. Probability of locating economic deposit is low.
- Area containing stratified drift of limited thickness or extent. Probability of locating useable materials is low.
- Area having little or no potential for the location and production of granular materials.
- 56 Location of property: (see report).
- Sand or gravel pit.
- Peat and muck pit.
- Abandoned quarry or shale pit.
- 8/52 Water well location: indicating thickness of overburden overlying reported thickness of granular materials; (x indicates material is sand).
- Additional information location: (see report).
- Geological boundary, approximate.
- Bedrock outcrop.
- Regional Municipality or County boundary.
- Geographic township boundary.

For other conventional signs refer to 1:50,000 National Topographic System maps.

LEGEND

CENOZOIC
QUATERNARY
RECENT

15 *Alluvium, unsubdivided: silt, sand, gravel.*

14 *Bog deposits: peat, muck, marl.*

PLEISTOCENE
LATE WISCONSINAN

13 *Glaciolacustrine or local pond sediments.*
12a *Mainly silt and clay.*
12b *Mainly fine to very fine sand.*

12 *Glaciofluvial outwash sand, minor gravel.*

11 KETTLEBY TILL: clayey silt till.

10 *Glaciofluvial outwash: gravel and sand, minor silt and clay; locally kame to minor bed of sand or silt.*

9 WENTWORTH TILL: stony, sandy silt till.

8 NEWMARKET TILL: sandy silt till.

7 *Ice-contact stratified drift, unsubdivided: sand and gravel including some till or silt.*
7a *Mainly gravel.*
7b *Mainly sand.*

6 PORT STANLEY TILL: sandy silt till.

5 TAVISTOCK TILL
5a *Silt to clayey silt till; Georgian Bay lobe.*
5b *Sandy silt till; Lake Simcoe sublobe.*

4 *Middle ER: silt till.*

3 CATFISH CREEK TILL: stony, sandy till (b).

UNCONFORMITY

PALEOZOIC
SILURIAN

2 *Guelph Formation: dolostone.*
2a to 2c *Amabel Formation (includes Fossil Hill Formation at base): dolostone. Cataract Group: sandstone, dolostone, shale.*

ORDOVICIAN

1 *Queenston Formation: red shale.*

LIST OF PROPERTIES

WEST LUTHER TOWNSHIP
1. Con. IV, lot 15.
2. Con. IV, lot 15.
3. Con. IV, lot 15.
4. Con. IV, lot 18.
5. Con. V, lot 8.
6. Con. V, lot 15.
7. Con. V, lot 15.
8. Con. V, lot 12.
9. Con. V, lot 14.
10. Con. VI, lot 10.
11. Con. VII, lot 9.
12. Con. VII, lot 10.
13. Con. X, lot 15.
14. Con. XI, lot 11.
15. Con. XI, lot 12.
16. Con. XII, lot 10.
17. Con. XII, lot 11.
18. Con. XII, lot 16.
19. Con. XIII, lot 9.

EAST LUTHER TOWNSHIP
20. Con. II, lot 20.
21. Con. II, lot 21.
22. Con. II, lot 20.
23. Con. III, lot 20.
24. Con. III, lot 21.
25. Con. III, lot 21.
26. Con. VI, lot 30.
27. Con. VII, lot 20.
28. Con. IX, lot 24.
29. Con. X, lot 20.

AMARANTH TOWNSHIP
30. Con. I, lot 3.
31. Con. I, lot 7.
32. Con. II, lot 10.
33. Con. II, lot 16.
34. Con. III, lot 16.
35. Con. VI, lot 1.
36. Con. VI, lot 7.
37. Con. VII, lot 11.
38. Con. VIII, lot 2.
39. Con. IX, lot 1.
40. Con. IX, lot 2.
41. Con. X, lot 5.

MONO TOWNSHIP
W.H.S.:
42. Con. I, lot 4.
43. Con. I, lot 5.
44. Con. I, lot 6.
45. Con. I, lot 7.
46. Con. I, lot 10.
47. Con. I, lot 13.
48. Con. II, lot 4.
49. Con. II, lot 5.
50. Con. III, lots 2, 4.
51. Con. III, lot 4.
52. Con. III, lot 6.

E.H.S.:
53. Con. I, lot 6.
54. Con. I, lot 11.
55. Con. II, lot 5.
56. Con. III, lot 6.

PEEL TOWNSHIP
57. Con. A, lot 10.

WEST GARAFRAXA TOWNSHIP
58. Con. I, lot 27.
59. Con. V, lot 8.
60. Con. V, lot 11.
61. Con. V, lot 11.
62. Con. V, lot 15.
63. Con. V, lot 15.
64. Con. V, lot 15.
65. Con. V, lot 25.
66. Con. V, lot 25.
67. Con. VI, lot 9.
68. Con. VI, lot 9.
69. Con. VI, lot 9.
70. Con. VI, lot 10.
71. Con. VI, lot 11.
72. Con. VI, lot 11.
73. Con. VI, lot 12.
74. Con. VII, lot 12.
75. Con. VII, lot 12.
76. Con. VIII, lot 6.

EAST GARAFRAXA TOWNSHIP
77. Con. X, lot 12.
78. Con. XIII, lot 6.
79. Con. XIII, lot 11.
80. Con. XIV, lot 13.
81. Con. XV, lot 6.
82. Con. XV, lot 6.
83. Con. XV, lot 6 or 7.
84. Con. XV, lot 9.
85. Con. XVI, lot 1.
86. Con. XVI, lot 15.
87. Con. XVII, lot 11.
88. Con. XVII, lot 13.
89. Con. XVII, lot 17.
90. Con. XVII, lot 17.
91. Con. XVII, lot 18.
92. Con. XVIII, lot 11.
93. Con. XIX, lot 4.
94. Con. XIX, lot 6.
95. Con. A, lot 2.

ERIN TOWNSHIP
96. Con. I, lot 30.
97. Con. III, lot 26.
98. Con. IV, lot 27.
99. Con. V, lot 23.
100. Con. V, lot 26.
101. Con. VI, lot 22.
102. Con. VI, lot 28.
103. Con. VII, lot 30.
104. Con. VIII, lot 30.
105. Con. VIII, lot 30.
106. Con. VIII, lot 31.
107. Con. VIII, lot 32.
108. Con. VIII, lots 29, 30.
109. Con. IX, lot 13.
110. Con. IX, lots 27, 28.
111. Con. X, lot 16.
112. Con. XI, lot 10.
113. Con. XI, lot 10.
114. Con. XI, lot 25.

CALEDON TOWNSHIP
W.H.S.:
115. Con. I, lot 15.
116. Con. I, lot 16.
117. Con. I, lot 24.
118. Con. II, lot 16.
119. Con. II, lot 16.
120. Con. II, lot 21.
121. Con. II, lot 22.
122. Con. II, lot 31.
123. Con. III, lot 12.
124. Con. III, lots 13, 14.
125. Con. III, lot 15.
126. Con. III, lot 16.
127. Con. III, lots 17-20.
128. Con. III, lot 22.
129. Con. III, lot 23.
130. Con. III, lot 24.
131. Con. V, lot 12.
132. Con. V, lot 13.
133. Con. V, lot 13.
134. Con. V, lot 15.
135. Con. V, lot 15.
136. Con. V, lot 25.
137. Con. V, lot 26.
138. Con. V, lot 27.

E.H.S.:
139. Con. I, lot 27.
140. Con. III, lot 30.
141. Con. IV, lot 26.

SOURCES OF INFORMATION

Geology by W. R. Cowan, D. R. Sharpe and assistants, Geological Branch, 1971, 1972.

Aerial photography: Ministry of Natural Resources, Toronto and National Air Photo Library, Ottawa.

Water well records of the Water Quantity Management Branch, Ministry of the Environment, Toronto.

Preliminary map, P. 846 Quaternary Geology of the Orangeville Area, scale 1:50,000 issued 1972.

Cartography by M. J. Colman and assistants, Surveys and Mapping Branch, 1975.

Topography from map 40P/16 of the National Topographic System, with additional information by W. R. Cowan.

Magnetic declination in the area was approximately 9° West in 1970.

Scale 1:50,000

Metres 1000 0 1 2 3 4 5 6 7 Kilometres

Chains 80 40 0 1 2 3 Miles

Published 1975

Ministry of Natural Resources
Ontario

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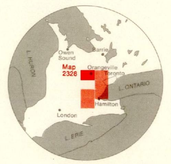
Map 2328

ORANGEVILLE

Southern Ontario

Drift Thickness

NTS 40 P/16 Scale 1:50,000



MAP COVERAGE: DRIFT THICKNESS OR BEDROCK TOPOGRAPHY SERIES (EXCLUDING PRELIMINARY MAPS)

DUFFERIN COUNTY

WELLINGTON COUNTY

REGIONAL MUNICIPALITY OF PEEL

WELLINGTON COUNTY

ERAMOSA

DUFFERIN COUNTY

Published 1978

Scale 1:50,000

Metres 1000 0 1 2 3 4 5 6 7 Kilometres

Chains 80 40 0 1 2 3 Miles

LEGEND

- 90 — Spot drift thickness, in feet, from water well log.
- 58 + — Spot drift thickness, in feet, in excess of depth indicated.
- 225 — Drift thickness contour, inferred.
- Small bedrock outcrop.
- Area of bedrock outcrop.
- Regional Municipality or County boundary.
- Geographic township boundary.
- 1400 — Topographic contours.

For other conventional signs refer to 1:50,000 National Topographic System maps.

SOURCES OF INFORMATION

Compiled by W. R. Cowan, 1975, from water well records provided by the Ministry of the Environment.

Cartography by M. J. Colman and assistants, Surveys and Mapping Branch, 1975.

Topography from map 40P/16 of the National Topographic System, with additional information by W. R. Cowan.

Magnetic declination in the area was approximately 8° West in 1975.