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CANADA
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PAPER 51-12

PLEISTOCENE AND RECENT DEPOSITS OF THE CORNWALL-CARDINAL AREA, STORMONT, DUNDAS, AND GRENVILLE COUNTIES, ONTARIO

(Report and Map)

By

E. B. Owen

OTTAWA

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(with an appendix containing compiled data on gravel deposits in the area)

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Appendix

Compilation of data pertaining to gravel deposits in the map-area arranged in order of lots and concessions according to the individual townships.

Illustration

Preliminary map - Cornwall-Cardinal area, Ontario.

PLEISTOCENE AND RECENT DEPOSITS
OF THE
CORNWALL-CARDINAL AREA,
ONTARIO

INTRODUCTION

This report and the accompanying map present the results of an investigation of the superficial deposits in five adjacent townships located along the St. Lawrence River in the area that is described as the International Section of the St. Lawrence Seaway Project.

The following townships are included in the report: Cornwall and Osnabruck townships, Stormont county, Williamsburgh and Matilda townships, Dundas county, and Edwardsburgh township, Grenville county, all in the province of Ontario.

The report is based on work done during the field seasons of 1949 and 1950. The writer was ably assisted in the field by K. F. Pallett, L. W. Bebensee, and F. Savard in 1949, and by W. L. Christie, R. S. Axford, N. Spino, D. G. Benson, and G. Sicard in 1950, all of whom performed their duties in a satisfactory manner. He is indebted for many courtesies to numerous farmers in the area and to the owners of various sand and gravel deposits.

A geological map by Messrs. Joseph Keele and L. Heber Cole[1], which

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[1]Keele, J., and Cole, L. H.: Structural Materials along the St. Lawrence River between Prescott, Ont., and Lachine, Que.; Mines Branch, Department of Mines, Canada, Pub. No. 549, 1922.

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accompanies their report on the occurrence of structural materials along the St. Lawrence River, proved extremely useful.

Because of the great importance of underground waters to farmers and to the inhabitants of communities who depend on wells for their supply, a study was made of ground-water conditions in the area mapped, and considerable information obtained on the occurrence, quantity, and quality of the ground-water available. It is proposed to publish separate water supply papers for the five townships at a later date.

PHYSICAL FEATURES

The area extends along the northwest side of the St. Lawrence River from a point approximately 1 mile east of the town of Prescott to 2 miles east of the eastern limits of the city of Cornwall. It extends from 8 to 13 miles back from the river, depending upon the length of the individual townships. The area comprises about 525 square miles.

The topography of the map-area is complex, representing in part the original irregularities of the Pleistocene deposits, and in part the erosional effects of Recent time. During the advance and retreat of the last ice-sheet great quantities of loose rock debris, which had been picked up by the ice and transported in some cases over considerable distances, were deposited at the base of the ice, and along its outer margin during pauses in its retreat. Although these materials appeared to be heaped in irregular hills and ridges, there was a definite trend parallel to the direction of ice movement that had a marked influence on the deposition of later unconsolidated deposits. During the retreat of the ice, melt waters carried outwash material away from the front and deposited it in the low ground between and up to the lower slopes of the previously formed till ridges. The deposition of this material tended somewhat to subdue the relief pattern of the area. Further subduing of the relief was accomplished during the invasion of the marine waters of the Champlain Sea. The result of this inundation was to form a topography consisting in many localities of elongated, boulder strewn 'islands' of till projecting slightly above the surrounding level tracts of flat-lying marine sediments. Since that time the softer, sedimentary material has been dissected by numerous streams, which, aided by run-off from the higher till areas, have in some instances eroded down to bedrock.

The map-area can be divided into three physiographic divisions: (1) till plains; (2) clay plains; and (3) sand plains. These are not those broad separations to which the term "physiographic" is commonly applied, indeed the whole region constitutes only part of one such unit. It is a much finer division based on the topographic form, depth, and character of the surface deposits, and the kind and configuration of the bedrock, where it outcrops[1].

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[1]Putman, D. F., and Chapman, L. N.: The Physiography of Eastern Ontario; Scientific Agriculture, 20: 7, March 1940 (p. 436).

The till plains division includes all those areas where any appreciable depth of glacial till forms the surface deposit. It extends across Cornwall, Osnabruck, and Williamsburgh townships and occupies the east part of Matilda township. Its total area is approximately 350 square miles. The topography varies from gently rolling to hilly with elevations from 200 to 350 feet above sea-level.

The clay plains division occupies the north-central part of Matilda township. It is by far the smallest physiographic division in the map-area, with a total area not exceeding 45 square miles. The topography is flat with elevations ranging from 225 to 275 feet above sea-level. Small isolated patches of clay are found at many places in the lower parts of the till plains division.

The sand plains division extends across Edwardsburgh township and into the west part of Matilda. Its area is approximately 130 square miles. The topography varies from hilly to flat with elevations from 250 to 375 feet above sea-level. Numerous, small areas of till with elevations up to 375 feet occur throughout this division.

TABLE OF PHYSIOGRAPHIC DIVISIONS

Division	Area in sq. mi.	Elevation in feet above sea-level	Topography
Till plains	350	200-350	Gently rolling to hilly
Clay plains	45	225-275	Flat
Sand plains	130	250-375	Flat to hilly

Approximately 325 square miles of the map-area drains into the St. Lawrence River and the remaining 200 square miles drains northeast into the Ottawa. The height of land between the St. Lawrence and Ottawa Rivers is located only about 3½ miles north of the St. Lawrence River in Edwardsburgh and Matilda townships. Farther east, it crosses Williamsburgh and Osnabruck townships in a general northeasterly direction and leaves the map-area in the vicinity of the community of Newington. The large swamp areas of central Williamsburgh township lie on the divide. The west part of the map-area is drained chiefly by South Nation River, which, with its numerous small tributaries, flows in a northeast direction across

Edwardsburgh township north of the divide. These waters finally empty into Ottawa River at the community of Wendover, 32 miles downstream from the city of Ottawa. The east part of the map-area, south of the divide, is drained by many creeks, the largest of which is Raisin River. This stream, which originates in the swampy areas of northeast Osnabruck township, crosses the central part of Cornwall township in an easterly direction, and finally empties into the St. Lawrence River at the village of Lancaster, some 14 miles downstream from the city of Cornwall.

Because of the nearness of the height of land to the St. Lawrence River, not only in the map-area but also in the area to the west, the St. Lawrence receives only a small part of the total run-off in the west part of the map-area. The greater part of this area is drained by South Nation River and its tributaries north to the Ottawa. South Nation is a young stream that formed after the recession of the Champlain Sea to carry the run-off on the north side of the divide. Commonly, it flows over unconsolidated deposits, but in a few localities it has eroded down to bedrock. The predominant, unconsolidated material in the area drained by it is clay till, which is relatively impervious to the passage of ground water, overlain in places by irregular deposits of Champlain clay and sand, and scattered ridges and knobs of kame sand. Because of the underlying till, the fairly level topography, and the lack of steep, confining banks, floods along the course of the South Nation in the map-area are almost an annual event. A large part of the flat area overlain by marine clay immediately north of Brinston and Toyehill, Matilda township, is inundated almost every spring. Considerable erosion takes place in the loose, unconsolidated deposits of sand in the upper reaches of the watershed in Edwardsburgh township.

Although no attempt was made to locate actual sites for flood control dams along the part of the South Nation in the map-area, the only locality where such a project would seem feasible is in the vicinity of the community of Spencerville. The large, low swamp lands bordering the river upstream from this community might be made into a satisfactory reservoir with the dam located at or near the site of the small mill dam at Spencerville. The presence of bedrock at the surface in this locality may or may not be a factor favourable for the construction of a larger dam. Ground-water investigations within the community

indicate the possibility of open fissures occurring in the rock at depth, and this condition would have to be explored before any decision could be reached.

Large deposits of recent wind-blown sand occur in scattered areas in Edwardsburgh township. These areas, which were once wooded, were cleared for cultivation, but have since been rendered useless by drifting sand. The sand is derived from local sand hills, which appear to be of kame origin. In some localities, the entire centre of a hill has been scooped out by the wind, exposing the underlying till. Reforestation, which has been carried on to a limited extent, appears to be the most satisfactory method of preventing the continued drifting of the sand.

GEOLOGY

BEDROCK FORMATIONS

The map-area is almost all underlain by flat-lying or gently undulating Palaeozoic rocks, which, with the possible exception of the earliest formation, are of Ordovician age[1].

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[1]Wilson, A. E.: Geology of the Ottawa-St. Lawrence Lowland, Ontario and Quebec; Geol. Surv., Canada, Mem. 241, p. 7 (1946).

One small outcrop of white quartzite of Precambrian age is located in lot 33, con. IV, Edwardsburgh tp. This probably represents the top of a high ridge projecting through the Palaeozoic cover and does not necessarily mean that Precambrian rocks exist at shallow depths over any large area.

Table of Formations

Era	Period	Sub-epoch	Formation	Thickness (feet)	Lithology
Palaeozoic	Ordovician	Trenton and Black River	Ottawa	690-700	Limestone with a little shale and some sand at its base
		Disconformity			
		Chazy	St. Martin Rockliffe	20-155 150-165	Impure limestone. Shale with sandstone lenses
		Disconformity			
		Beekmantown	Oxford March	240(±) 30(±)	Dolomite with a little shale at the top. Interbedded sandstone and dolomite
	Ordovician or Cambrian		Nepean	Up to 500	Sandstone
Great unconformity					
Precambrian Archaean(?)			Grenville		Crystalline limestone, quartzites, and metamorphic rocks; associated granite and granite-gneiss

UNCONSOLIDATED DEPOSITS

The superficial deposits of the map-area are predominantly Pleistocene in age. As no interglacial deposits were noted, all the material was accepted as being deposited either during or immediately following the retreat of the last ice-sheet. They include glacial, glacio-fluvial, lacustrine, marine, and Recent deposits. Because of the limited extent and isolated character of the lacustrine deposits they have been included with marine deposits in the area.

Glacial Till Deposits

Glacial till, which was deposited directly by the ice-sheet, occupies not only the surface of a large part of the map-area, but also extends over much of the area beneath the covering of glacio-fluvial material and marine sediments.

The unweathered till varies from a bluish grey, compact, unstratified, clay till to a dark brownish, less compact, sandy clay till. Because the boundaries between the various till types are gradational and indefinite all the glacial till areas have been mapped as clay till, which actually occupies approximately 95 per cent of the total till-covered areas. In some localities, the upper part of the till has been reworked during the subsequent invasion of marine water and occurs as an extremely loose, gravelly sandy till that has the appearance of a coarse, bouldery, unstratified gravel.

Clay till occurs extensively on the surface throughout Cornwall, Osnabruck, and Williamsburgh townships. It is composed largely of material derived from the underlying Palaeozoic rocks, containing many boulders and rock fragments of local origin. Boulder counts in the clay till conducted in several localities throughout the area showed an average of 7 per cent crystalline rocks foreign to the area. These varied from 10 per cent in the north part of Osnabruck township to 4 per cent at a point in the south part of Edwardsburgh township approximately 36 miles to the southwest. As the gravel deposits located along the emerged marine beaches of the Champlain Sea were derived partly from the adjacent glacial till, and as the quality of a gravel depends to a large extent upon the quality of its constituent pebbles and boulders, it is considered that boulder counts in the till might prove useful in outlining general areas where gravel of better quality might be deposited. Although in any given section, boulder counts are frequently used to differentiate between till sheets, no evidence was obtained that would suggest more than one till in the map-area.

The best sections of clay till in the map-area were noted along stream valleys and in road cuts. An excellent section of clay till occurs along the east bank of Hoasic Creek, in Williamsburgh township, about one-tenth mile south of the Canadian National Railway tracks. Here the creek has cut a 15-foot vertical face in the till disclosing limestone and crystalline boulders, up to 12 inches in diameter, embedded in a clayey matrix. On the outskirts of the municipalities of Cornwall and Morrisburg, numerous artificial excavations have exposed clay till at various depths. Evidence of the relative impermeability of clay till is indicated by the fact that it underlies a large part of the swamp areas in Osnabruck and Williamsburgh townships, which are the sources of numerous small creeks.

The topography of the part of the map-area covered with glacial till is that of ground moraine. No terminal moraines, which mark minor re-advances during the general retreat of the last ice-front, were observed. It is suggested that some of the larger undulations in the till plain could be called drumlins. These low, elongated hills, which rise from 10 to 50 feet above the surrounding country, have a length that varies from ½ mile to 3 miles and a width that ranges from ¼ to ½ mile. These structures are especially pronounced in Matilda and Edwardsburgh townships, where they stand out as 'islands' of clay till rising above the relatively flat plains covered with marine sediments.

Areas mantled with thin layers of reworked till occur chiefly on the higher ground and are usually associated with accumulations of large boulders. In some cases reworked till occurs in areas where the glacial drift is thin, with bedrock outcropping nearby, or existing only a few feet below the surface. It is commonly exposed in the upper parts of some gravel pits where the overlying marine beach gravel has been stripped off.

Glacio-fluvial deposits

There are two classes of glacio-fluvial deposits in the map-area, outwash and kame. Outwash deposits are formed by streams of melt water flowing out from the glacier and depositing their load some distance away, and kames are ice-contact deposits, being formed in immediate contact with the melting ice.

The outwash deposits, which consist of well-stratified and crossbedded sand and gravel, appear to be confined mainly to valleys located between the higher clay till ridges. They do not appear on the surface, being buried beneath a covering of marine sand, silt, and clay. One well, located in lot 6, con. IV, Edwardsburgh tp., was reported to have encountered 6 feet of gravel overlying bedrock and buried beneath 60 feet of marine clay, and numerous wells in Matilda township reported 3 to 5 feet of gravel beneath various thicknesses of marine sediments. Two wells dug in lot 25, con. VIII, Williamsburgh tp., were reported to have encountered gravel buried beneath 10 feet of marine clay. The water in these wells is of excellent quality and is usually under considerable hydrostatic pressure. It is thought that these gravel deposits could be developed into important, local sources of ground-water.

Except in the case of Lachapelle pit, outwash materials occur in most gravel pits as long, narrow, irregular deposits situated along the lower edges of the larger clay till drumlins. Because of the reworking of the top part by the waters of the Champlain Sea it is difficult to identify outwash deposits from surface indications. However, they can be easily observed underlying the marine deposits in the lower part of the faces of some gravel pits. The material forming the marine beach deposits along the sides of the larger drumlins was, in part, derived from these outwash deposits, and it was noted that the most satisfactory gravel pits are constructed on marine beach deposits in localities where large quantities of outwash material were at one time present.

Excellent sections exposing glacio-fluvial sand and gravel occur in the Lachapelle pit in lots 20 and 21, cons. VIII and IX, Osnabruck tp., and in the MacIntosh pit in lot 25, con. V, Edwardsburgh tp., about 1½ miles southeast of Spencerville. The Lachapelle pit is on an esker-like ridge of glacio-fluvial material the relief of which has been modified by the subsequent invasion of marine waters. From 8 to 10 feet of outwash material overlain by 2 to 4 feet of marine sand and gravel is exposed in the pit. A well drilled on top of the ridge is reported to have encountered 95 feet of sand and gravel and to be yielding a large supply of water. The contact between the two deposits is well defined. In places, it can be identified by an accumulation of fairly large boulders, chiefly of crystalline rocks, ranging up to 12 inches in diameter. Marine fossils occur in the overlying material that occupies the surface but not in the underlying deposits of glacio-fluvial origin. The marine sand and gravel are apparently beach deposits formed during the withdrawal of the Champlain Sea. The deposits in the MacIntosh pit are comparable to those in the Lachapelle, except that here the outwash material occurs along the north and northwest flank of a clay till drumlinoidal structure and bedrock is exceedingly close to surface. Sections in MacIntosh pit show 3 to 4 feet of marine fossil-bearing sand and gravel overlying 8 to 12 feet of outwash material. The contact between the two deposits presents a distinct disconformity, with the overlying marine beach deposits sloping gently to the northwest and the crossbedded glacio-fluvial deposits arranged with their fore-set beds dipping in a general southwest direction.

Kame deposits are extensive throughout Edwardsburgh township and extend across the northwest corner of Matilda. They occur as scattered knolls and irregular ridges of sand and fine gravel, the relief of which has been considerably lowered by the planing action of the waves. The greater part of the marine sand deposited in the low, flat areas between the kame deposits in Edwardsburgh township and extending into the west part of Matilda, north of Cardinal, was probably derived from the kame deposits. Because of the loose, unconsolidated character and low resistance to wave action of the material, no emerged, marine, beach bluffs, with their accompanying deposits of sand and gravel, were formed in the kame area. The trees have been cleared from a considerable part of the kame area and attempts have been made to cultivate the soil. These efforts have only met with partial success and large areas are now covered with drift sand. In some places, great hollows have been scooped out by the wind exposing the underlying clay till and forming large recent dunes that are gradually inundating the adjacent lower ground. Reforestation, which has been carried on to a limited extent in the area, appears to be the only means of preventing further destruction.

Champlain (marine) Deposits

The invasion and subsequent withdrawal of the Champlain Sea, which followed the retreat of the ice-sheet in the region, formed (marine) deposits of various types. The most extensive of these are deposits of sand, silt, and clay that occur in many of the low, flat areas between the higher ridges of glacial material in the east part of the map-area. They form a broad, flat plain crossing the north and central parts of Matilda township and extend west into Edwardsburgh township where they cover the low ground between the hills and ridges of kame material.

Marine Clay

Marine clay forms an extensive plain in the northwest and central parts of Matilda township. The deposit extends a considerable distance farther west but is covered by a thin layer of marine sand, and except for a few small areas, one in lot 20, con. VIII, and others in lots 25 and 34, con. I,

Edwardsburgh tp., can only be seen along the banks and in the bottoms of small creeks. Farther east, marine clay occurs in lots 25 to 30, con. VIII, Williamsburgh township, and in numerous, small, scattered areas in Osnabruck and Cornwall townships. The colour of the clay is a uniform, dull, lead grey. It appears to be massive in the upper part, although becoming sandy and commonly well laminated toward the base. Good sections of marine clay are rare in the map-area. The following logs supplied by well owners in Matilda township give some idea of the thickness of the marine clay deposits in various localities in that township.

Lot 22, con. V	Lot 23, con. VI	Lot 26, con. VII
Feet	Feet	Feet
0 to 55 - clay	0 to 34 - clay	0 to 2 - sand
55 to 56 - gravel	at 34 - gravel	2 to 39 - clay
at 56 - bedrock		39 to 42 - gravel
		at 42 - bedrock

In Edwardsburgh township, a well located in lot 29, con. I, was reported to have passed through 80 feet of clay underlying 3 feet of sand, and another well, in lot 6, con. IV, was reported to have encountered 60 feet of clay. In lot 25, con. VIII, Williamsburgh township, two dug wells were reported to have penetrated 10 feet of marine clay overlying "water gravel". The general elevation of marine clay throughout the map-area is close to 250 feet above sea-level.

An excellent section of varved clay occurs at the extreme east end of Sheek Island at a point about 200 yards south of the bridge leading to the mainland. Here the river bank consists of 10 feet of poorly stratified sand overlying 15 feet of laminated, silty clay. A layer of fine gravel from 2 to 8 inches thick, containing only limestone pebbles, is interbedded with the silty clay. The elevation of the top of this varved clay deposit is approximately 185 feet above sea-level. However, the surface at which the elevation was taken is an erosional one, covered with alluvial sand, and the elevation measured does not necessarily indicate the maximum altitude at which the clay was deposited. Two sections of clay showing indistinct varving occur in a low bank along the

St. Lawrence River about 1,000 feet west of the Pavilion in Riverside Park, Cornwall, and 6 miles downstream in a northeast direction from the varved clay deposit on Sheek Island. It is thought that the varved clays were deposited during the time of Lake Frontenac[1], which covered the area in the interval

[1]Antevs, Ernst: Retreat of the Last Ice-sheet in Eastern Canada; Geol. Surv., Canada, Mem. 146, pp. 64-66 (1925).

following the retreat of the last ice-sheet and before the invasion of the Champlain Sea.

Marine Sand

Marine sand overlies a much larger area than the clay. It covers a considerable part of Edwardsburgh township and the west part of Matilda, and occupies smaller areas in north Williamsburgh and Osnabruck townships. In most cases the sand appears to overlie the clay and to have been deposited in shallower water near the shore whereas the clay was deposited in somewhat deeper water. The sands belong chiefly to the period of emergence of the land, being formed largely by wave and current erosion along the emerging shoreline. In this manner, the wide areas of marine sand occurring in Edwardsburgh and Matilda townships were derived from the loose, easily eroded kame deposits in the same area. The marine sand occurring in the extreme north part of Osnabruck township may have been derived from similar kame deposits located in the area north of the township. The depth of these marine sands varies from a few inches to a few feet. The thickest deposits occur in the east part of the map-area where hills and ridges of glacial till with deep intervening valleys formed the shores and provided an abundance of material. Here, the marine sand deposits were not spread over wide areas but tended to accumulate near the shore, and in many cases to be built up into offshore bars and terraces roughly paralleling the shoreline. It is in near-shore deposits such as these that the shell Saxicava rugosa and other marine Pleistocene fossils are found in great abundance.

The marine sands vary in texture from very fine to coarse and in colour from dark reddish brown in the upper oxidized zones to a light grey at depth. They are very fine in the wide, flat areas, but become gradationally

coarser as an emerged, marine bluff is approached. Bedding is poor except in deposits adjacent to a beach where the deposits are usually well stratified with excellent crossbedding.

Marine Beaches

Raised beaches with their accompanying deposits of marine sand and gravel occur in numerous localities at elevations ranging from 241 to 363 feet above sea-level. They are best developed on the north and northwest flanks of clay till drumlins. The location of these deposits in relation to the higher ground against which they were formed suggests that the winds were prevailingly westerly during their formation. The best developed beaches occur where the winds had the widest sweep from the west and northwest. It is difficult to trace individual beaches for more than a few hundred yards, as most of them were developed locally around 'islands' of till that emerged as the sea withdrew.

There appear to be few elevations at which the raised beaches are stronger and better developed than at others. This would suggest that the withdrawal of the marine waters was a slow, continuous process with few pauses during their retreat, and that the elevations of the emerging beaches depended more upon the relief of the emerging land and the resistance of the material to wave erosion than to any lengthy pause in the retreat of the marine waters.

The following table indicates the groups of elevations within which most of the beaches are located.

Township	Groups of elevations (feet above sea-level)							
Cornwall	241-243	255-260	274-287				324-334	
Osnabruck			281-283		303-309	313-319		331-342
Williamsburgh			271-277	294-301				
Matilda				288-300	292-304			
Edwardsburgh			281-289			312-321		363

It is often a difficult task to determine the location of the former water plane of an emerged beach. The above elevations, which were calculated using a beaman arc alildade, were taken only on well-preserved bluffs along which, in every case, marine fossils have been identified.

The material ranges from coarse sand and fine gravel in the terraces to extremely coarse, bouldery gravel higher up on the beach. The finer material is well stratified and mostly contains numerous, whole, marine shells, whereas the bedding in the coarser gravel is poor and the shells in fragments. The floor and back of the deposits are of clay till or reworked clay till with bedrock often only a few feet below the till.

Long narrow ridges, the surfaces of many of which are covered with numerous, large, well-rounded boulders, occur along the tops of many of the emerged marine bluffs. The matrix surrounding the boulders, which normally do not extend more than 2 to 3 feet below the surface of the ground, resembles a reworked till. It grades into clay till at depth. These accumulations of large boulders were probably formed in part by wave or current action carrying away the finer material from the till composing the bluff, and leaving the larger stones behind. However, it is considered that most of the boulders were carried and deposited by ice floating in the Champlain Sea. Boulder counts conducted along a number of ridges, whose elevations were above 300 feet, indicated from 90 to 100 per cent crystalline rocks, and boulder ridges at lower elevations and in localities where limestone bedrock occurs at or near the surface contained up to 74 per cent limestone. It is considered that the crystalline boulders were chiefly obtained by the ice from glacial outwash material deposited, previous to the invasion of the marine waters, near or along the base of the ridge, whereas the limestone was plucked from bedrock outcropping in shallow water off-shore. Boulder ridges where it constitutes a large percentage of the boulders, are also found on higher ground that had been previously submerged but where no bluff had formed.

Recent Deposits

Dune Sand

Sand dunes are at present forming in local areas throughout Edwardsburgh township. They occur adjacent to kame areas, chiefly, where deforestation and attempts at cultivation have exposed the soil to wind action. The material consists of a fine, white sand that is useless for farming. The dunes, formed by the prevailingly westerly winds, are bow-shaped, with their concave steep sides to the east. They usually form along the east side of the kame deposits, which are, without doubt, the sources of the material. A large number of older dunes, in many instances covered with a considerable amount of vegetation, also occur in the same general area. Many of these take the form of longitudinal ridges, trending in a general easterly direction and joined by a number of transverse ridges. According to Lobeck[1], land forms such as these

[1]Lobeck, A. K.: Geomorphology, an Introduction to the Study of Landscapes, 1939, p. 383.

indicate winds of intermediate strength blowing from the west.

A long, narrow deposit of recent dune sand occurs in Williamsburgh and Osnabruck townships, immediately north of the C.N.R. tracks between the communities of Morrisburg and Aultsville. The deposit never extends more than a mile north of the present St. Lawrence River. The dunes have formed along the bottom part of a former bluff of the river that roughly parallels the St. Lawrence in this locality. The dunes appear to have been created by southerly winds, with the sand originating in the alluvium covering the terrace below the bluff. This dune area can be traced for a distance of 7 miles, although it never reaches a width greater than ½ mile.

Peat

Two deposits of peat occur in the area. The larger deposit is about 1½ miles southeast of the community of Newington in lots 1 and 2, con. V, Osnabruck tp., and extends east into adjacent Roxborough township. It has been

fully described by Leverin[1]. The other, which is considerably smaller, occurs

[1]Leverin, H. A.: Peat Moss Deposits in Canada; Bur. Mines, Canada, Pub. 817, 1946, p. 65.

in lots 22 and 23, cons. IV and V, Osnabruck tp. The elevation of the former is approximately 325 feet above sea-level and that of the latter is about 300 feet. Both deposits are underlain by clay till that is considered to be relatively impervious to the passage of water.

Alluvium

Except for shallow deposits of alluvium now being formed along both sides of South Nation River from Ventnor northeast to the point where the river leaves the map-area, and earlier deposits occurring at irregular intervals along the St. Lawrence River, alluvial or flood-plain deposits are not common in the map-area. The material along the South Nation consists of silt, sand, and gravel mixed with considerable organic material, whereas along the St. Lawrence it consists of fine to medium sand overlying marine or lacustrine clay or clay till.

A number of bluffs formed during a higher stage of the river can be recognized along the northwest side of the St. Lawrence. In Edwardsburgh township, one such bluff occurs immediately east of Port Johnstown, paralleling the north side of No. 2 highway for 1 mile. A second occurs in the same township in lots 17-18, con. I, between highway No. 2 and the river. The elevation of the former is 262 feet above sea-level and of the latter 255 feet. These two bluffs probably represent two stages during the lowering of the St. Lawrence River to its present level. No comparable bluffs were recognized in Matilda township. A low bluff along which a number of recent sand dunes have formed occurs in Williamsburgh township about 1 mile north of the St. Lawrence River. The elevation of this bluff is approximately 248 feet. In Osnabruck township, farther east, about ¼ mile north of the C.N.R. tracks and roughly parallel with them, a similar bluff with an elevation of 237 to 240 feet can be traced for over 3 miles. A lower bluff, whose elevation is approximately 211 feet, occurs

at irregular intervals across the south part of the township. It was nowhere found to be more than $\frac{1}{10}$ mile from the present river bank.

The terraces below the bluffs are covered with a thin layer of fine- to medium-grained sand directly overlying marine or lacustrine clay or clay till. From their appearance in the field and their texture, it is difficult to distinguish between the marine sand and alluvium. Except for the absence of marine shells and the lack of bedding on the part of the alluvial sand, the two materials appear to be the same.

It is thought that the sands below the bluffs are alluvial deposits acquired chiefly from Champlain sands by the St. Lawrence River and its numerous small tributaries. The source of much of the material is thought to be the area adjoining the river in Edwardsburgh township where extensive marine sand deposits occur adjacent to the St. Lawrence. If these deposits are the actual source of the alluvial sand, this, along with the relatively short distance over which the material was carried, would account for the great similarity of the material in the two deposits. In Osnabruck township between Farran's Point and Dickinson's Landing, and again east of Dickinson's Landing, "islands" of clay till surrounded by alluvial sands occur on the terrace located below the bluffs.

Elevations taken along the former bluffs between Prescott and Dickinson's Landing, a distance of some 36 miles, indicate a drop of approximately 1.2 feet a mile. The gradient of the present St. Lawrence River over the same distance was calculated to be about 1.3 feet a mile. The similarity of these gradients serves as an indication of the apparent association of the bluffs with a moving body of water similar to the present St. Lawrence River and not to some lower stage of the Champlain Sea.

DIRECTION OF ICE MOVEMENT

Glacial striae were seen at only two localities, and at both belonged to a single set. At the MacIntosh pit in lot 24, con. V, Edwardsburgh tp., glacial striae occur in dolomitic limestone of the Oxford formation. The direction of ice movement was south 23 degrees west. In the other locality, striae, occurring in limestone of the Ottawa formation, are exposed at a quarry

in lot 35, con. VIII, Williamsburgh tp. They indicate that the direction of ice movement at that point was south 29 degrees west.

The trend of the topographic feature formed by the glacial deposits in an area generally reflect the direction of ice movement. In the east part of the map-area, the general trend of the topography is approximately north-south; in the west part it varies from south 15 degrees west to south 30 degrees west. This indicates a change in direction of the ice movement toward the west that agrees with the findings of Putman and Chapman[1], who state: "that the

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[1]Chapman, L. J., and Putman, D. F.: The Physiography of Eastern Ontario; Scientific Agriculture, 20, 7 March 1940, p. 426.

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direction of ice movement in the Kingston vicinity was roughly parallel to the St. Lawrence, while further east the direction was more nearly north and south". The city of Kingston is approximately 61 miles southwest of the west edge of the map-area. The trend of the topography in the east part of the map-area appears to change slightly as the St. Lawrence River is approached. This change suggests that the valley of the St. Lawrence exerted some influence on the direction of ice movement as the ice-sheet crossed the area, causing it to turn in a direction more parallel to the direction of this major topographic feature.

GLACIAL HISTORY

The entire map-area has been subject to glaciation. As no interglacial formations were observed, it is assumed that the glacial deposits all belong to the latest or Wisconsin age of glaciation. The types of unconsolidated material occurring in the map-area, classified according to their origin and arranged in order of their deposition, are as follows: glacial, glacio-fluvial, lucustrine, marine, and Recent deposits.

The glacial deposits, which were the first unconsolidated deposits to be laid down in the map-area, were deposited directly upon bedrock in the form of ground moraine during the advance of the ice-sheet. The resultant topography was very uneven, although no great extremes in relief occurred. In some localities, the glacial material was heaped up into elongated ridges or drumlins that projected above the surrounding country.

As climatic conditions changed and the ice began to retreat, the resultant melt-waters issuing from the ice carried with them considerable amounts of glacio-fluvial material that was deposited both upon the till of the ground moraine and upon bedrock. This outwash material, which was deposited by streams in the low areas out beyond the limits of the glacier, tended to subdue the relief, whereas kame deposits, formed when the melt-waters discharged part of their load in immediate contact with the ice, added to the relief of the map-area.

Immediately following the withdrawal of the ice, a small lake, resulting from the temporary ponding of the melt-waters, covered much of the lower part of the map-area. This lake, known as Lake Frontenac, existed only until the lower St. Lawrence became free of ice, permitting the marine waters of the Champlain Sea to cover the entire map-area. During the period of marine submergence, great thicknesses of clay and sand were deposited both upon the glacial and glacio-fluvial material.

Subsequent to this, after the ice had thawed back to a greater distance and the excess load due to the weight of the ice-sheet was removed, the land began to emerge from beneath the sea and deposits that had been formed along the strandlines of the Champlain Sea were lifted up and warped out of their horizontal positions. As the uplifting continued, new beaches were formed along the shores on the land newly emerged from the sea. These in turn were uplifted, with the result that a series of emerged strandlines were formed throughout the entire map-area, each with their accompanying deposits of marine sand and gravel and accumulations of large boulders.

Streams commenced to form on the newly emerged land and to cut into the loose material along their new courses. At the same time, Recent deposits of various types commenced forming in favourable localities and have continued up to the present time.

BEDROCK TOPOGRAPHY

A considerable number of spot elevations of the surface of bedrock were obtained while conducting ground-water surveys throughout the map-area. These elevations, compared with the results from a large number of holes drilled

adjacent to the St. Lawrence River in relation to the St. Lawrence Seaway Project, and supplied by the General Engineering Branch, Department of Transport, give some idea of the relief of bedrock in the map-area.

CORNWALL TOWNSHIP

In 1946, A. E. Wilson[1] described a former channel of the St. Lawrence

[1]Wilson, A. E.: A Buried Channel of the St. Lawrence River; Am. Jour. Sci., vol. 244, Aug. 1946, pp. 557-562.

about one-half mile south of the present course of the river and extending from Messina Point west through Robinson Bay. The west end of this buried channel joins up with the present channel of the river in the vicinity of the southwest corner of Barnhardt Island, and its eastern end apparently connects with the present channel between Cornwall Island and the New York State mainland. A second, narrower trench extends west from a point north of the east end of Barnhardt Island to where it appears to join with the present channel of the St. Lawrence between Sheek and Barnhardt Islands.

A third valley, apparently deeper than the others, extends from the west tip of Cornwall Island toward the city of Cornwall. This may be the termination of an ancient stream valley whose waters emptied into the St. Lawrence from the north or northwest or it may be a former channel of the St. Lawrence River. If it is the buried channel of a former tributary stream, the fact that bedrock surface is at lower elevations here than below the St. Lawrence would indicate that the tributary was flowing over unconsolidated material that could possibly be pre-Wisconsin.

Separating these buried stream channels in the bedrock are a number of ridges, all of which have an approximate southwest strike. The larger ridges are located beneath the unconsolidated deposits covering the east end of Barnhardt Island and the northwest corner of Cornwall Island. The greatest relief in the bedrock surface is in the vicinity of the northwest corner of Cornwall Island where it approaches 70 feet.

The limited information available suggests that the bedrock surface, upstream in a southwest direction from Moulinette to Dickinson's Landing is relatively flat with no major topographic features.

OSNABRUCK TOWNSHIP

In Osnabruck township, information derived from the owners of a few water wells drilled to bedrock indicates the presence of a broad ridge on the surface of bedrock extending in a southwest direction from North Lunenburg to the vicinity of Woodlands. A valley in the bedrock with a relief of about 30 feet is indicated beneath the south corner of Long Sault Island. There are no indications of the proximity of bedrock to surface in the section adjacent to the Long Sault Rapids. It is thought that here the St. Lawrence River is flowing over unconsolidated material, principally compact clay till very resistant to erosion, and that bedrock exists at considerable depths below. Evidence as to the resistance of the till is also suggested by the slow rate of erosion along the till bluffs located at the southwest end of Sheek Island and against which a large part of the force of the water passing through the Long Sault Rapids is exerted.

WILLIAMSBURGH TOWNSHIP

In the north part of Williamsburgh township, there are a number of broad, flat areas where bedrock exists at depths of less than 20 feet. With the exception, however, of a buried ridge extending in a southwest direction from the vicinity of Froatsburn and passing through the area immediately north of the town of Morrisburg, bedrock is much deeper in the south part. This ridge crosses the St. Lawrence River at the Rapid Plat and has been identified on the northwest side of Ogden Island as a small buried hill on bedrock surface with a relief of approximately 20 feet. The presence of this ridge on the surface of bedrock no doubt assisted in the formation of the Rapid Plat.

MATILDA TOWNSHIP

Comparison of elevations derived from numerous holes drilled to bedrock for water indicate that there are at least two major depressions in the surface of the bedrock underlying the north part of Matilda township. These

cross the township in a general southwest direction. Associated with these depressions are a relatively large number of water wells in which the water appears to be under sufficient hydrostatic pressure to raise it a considerable distance above the point where it was first encountered. With the exception of two small ridges, both of which occur in the southwest corner, the surface of bedrock in the south part of Matilda township appears to be relatively flat and to be buried beneath a considerable thickness of drift.

EDWARDSBURGH TOWNSHIP

The surface of bedrock in Edwardsburgh township is considerably more uneven than in the townships farther to the east. From the location of bedrock outcrops, together with the information obtained as the result of a large number of drilled wells, it appears that the surface of bedrock underlying the township consists of a series of long, narrow, parallel ridges striking in a general southwest direction and separated by wide, deep valleys filled with glacial drift. The relief of the bedrock surface is approximately 195 feet, ranging from 375 feet above sea-level in the vicinity of Groveton to a minimum of 180 feet or less, as indicated by a 117-foot well drilled in lot 8, con. VIII. A number of flowing-artesian wells in the Pittston area appear to be located on the side or flank of a buried valley. A ridge of rock crossing the southeast corner of the township and extending to the St. Lawrence River is the probable cause of the Galop Rapids located about 1 mile upstream from the town of Cardinal.

Age of the St. Lawrence River

Although there is no evidence that the St. Lawrence River existed prior to Pleistocene time, it seems fairly evident that the river was flowing in much the same channel as at present before the invasion of the last ice-sheet and possibly at an earlier date. This is suggested by the presence of drift-filled, former stream channels of the river and by the occurrence of a number of buried valleys in the adjoining areas, which apparently were formed by ancient streams flowing into the St. Lawrence valley. The slight change in the trend of

the topography in the east part of the map-area as the valley of the St. Lawrence is approached would also indicate that this topographic feature was present before the advance of the last ice-sheet.

ECONOMIC GEOLOGY

The most important unconsolidated material in the map-area from the economic standpoint is gravel. It is obtained chiefly from the emerged marine beaches that are found scattered throughout almost the entire map-area, usually on the northwest flank of a clay till ridge or along a north-facing slope. Pertinent data concerning these deposits has been compiled and will be found at the end of this report arranged according to lots and concessions in the individual townships. Many of the deposits have been opened and used only locally by the farmer-owner, hence only limited information is known regarding them. In some cases much more development work is needed before accurate estimates as to quality and quantity of the material in the individual deposit can be obtained. All the beach deposits were considered to have formed during the withdrawal of the Champlain Sea. The larger, but not necessarily the best, deposits are located at the higher elevations. These were formed at a time when a relatively small amount of land had emerged and the waves forming the deposit had their greatest sweep.

The best gravel, and that which can normally be used directly from these beach deposits without further processing, occurs in the terraces built up below the emerged bluffs. A well-developed terrace may be up to 200 feet in width with a gentle slope away from the bluff. Those that are less developed may be as narrow as 50 feet. The terraces usually contain large numbers of whole shells, which appear to be an excellent criteria for the better types of gravel. The depths of these deposits range from 3 to 12 feet. Farther up on the bluffs, the gravel becomes much coarser, containing a large percentage of cobbles and boulders too large to be used in a concrete mixture. The floors of many of the smaller pits contain large heaps of these "rejects". The sand and gravel occurring in marine bars is of somewhat better quality. The material usually extends across the entire surface of the ridge, but the deposits are usually shallow and unimportant. The best gravel is obtained from glacio-outwash

deposits, of which there are only three being worked in the map-area at the present time. The location of these can be obtained from the compilation sheets.

Sand deposits are not common in the east part of the map-area. One small pit is constructed on a spit located on the extreme southwest end of a long marine beach deposit in lot 28, con. V, Cornwall tp. A second deposit occurs in lot 7, con. I, Osnabruck tp., about ½ mile south of the community of Wales. Neither of these deposits is of any great size and contains only limited supplies of sand. A number of small sand pits have been opened up in kame deposits in Edwardsburgh township for local use by the farmer who owns it.

A complete description of the boulder accumulations in the south part of the map-area has been published by R. H. Picher[1]. Since its publication only

[1]Picher, R. H.: Road Materials along the St. Lawrence River from the Quebec Boundary to Cardinal, Ontario; Mines Branch, Department of Mines, Canada, No. 530, 1920, pp. 23-33.

a few unimportant changes have occurred, and the reader who desires further information on the subject is referred to it.

Peat deposits in the map-area are small and are not considered important. The largest, which is in lots 1 and 2, con. V, Osnabruck tp., has been fully described by Leverin[2]. A small, new deposit was observed in lots 23

[2]Leverin, H. A.: Peat Moss Deposits in Canada; Bur. Mines, Canada, Pub. 817, 1946, p. 65.

and 24, cons. IV and V, Osnabruck tp.

Although a number of small plants for the manufacture of tile and brick are reported to have operated in the past, at present there is no such plant within the map-area. The material chiefly used was the marine clay exposed along the banks of the St. Lawrence River and smaller streams, and which occupy

the surface in many of the low-lying localities throughout the map-area. These clays have been described in detail by Keele[1].

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[1]Keele, J.: Preliminary Report on the Clay and Shale Deposits of Ontario; Geol. Surv., Canada, Mem. 142, pp. 53-57 (1924).

APPENDIX

Compilation of data pertaining to gravel deposits in the map-area arranged in order of lots and concessions according to the individual townships.

Township CORNWALL County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
1	H. E. Winters.	22	5	Fairly well-developed marine beach; small terrace	Northwest facing slope		Coarse, poorly bedded gravel; some sand; overlies clay till, grades up into a water-worked till; large boulder ridge extends along top of slope	27,000	30,000 concrete aggregate; local road repairs	Concrete aggregate, local road repairs	Small crushing and screening plant
2	I.Grant	25	5	Well-developed marine beach; broad terrace	Northwest flank of a clay till drumlin	260	Clean, well-sorted gravel and sand; many shells; good bedding; boulder ridge extends along top of slope	1,000	50,000	Cornwall open air theatre; local road repairs	Pit opened June 1949
3	Coleman-Munro Construction Co.	26	5	Fairly well-developed marine beach; small spit	Northwest facing slope		Coarse sandy gravel; predominantly limestone cobbles; few shells	5,000	60,000	Local road fill	Pit located near the southwest end of a 2-mile long marine beach bluff; it is the best of 4 pits located on this deposit

Township CORNWALL County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
4	H.Lague	28	5	Marine beach; well-developed spit	Extreme south-west end of a long marine beach bluff		Fine to medium, stratified, sand; few lenses of sandy gravel; many shells	10,000	20,000	Fine material for local coarse concrete aggregate	Largest sand pit in Cornwall township
5	G. Rae	34	5	Marine beach; well-developed terrace	Northwest flank of clay till drumlin		Clean, medium, stratified gravel; few lenses of medium sand; few shells	900	59,000+	Local farm use	Large deposit; needs further development
6	Cornwall town-ship	12	6	Marine beach fairly well developed terrace	Northwest facing slope		Coarse, poorly bedded gravel; some sand; few shells; overlies clay till; grades up into a water-worked till, large boulder ridge along top of slope	12,000	100,000	Local road fill and repairs	Extremely large deposit
7	G. Payo	23-24	6	Marine beach; fairly well-developed terrace	Northwest flank of clay till drumlin		Medium to coarse, poorly bedded gravel; predominantly limestone pebbles; few shells; boulder ridge along top of slope	4,000	100,000	Concrete aggregate; local road fill and repairs	Large deposit

Township CORNWALL County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
8	Coleman-Munro Construction Co.	33	6	Marine beach	Northwest flank of a clay till drumlin		Very coarse stratified gravel; predominantly limestone pebbles; grades up into a water-worked till; very few shells	Large	Large	Road metal; crushed stone; concrete aggregate	Large crushing and screening plant
9	G. Losey	24	6	Marine beach; broad, well-developed terrace	Below marine beach bluff on which main Coleman-Munro pit located	277	Clean, well-stratified sand and gravel; many shells	Large	Large	Local road metal; concrete aggregate	Very extensive deposit; main reserves on north side of road
10	M. Miller	38	6	Marine beach	Northwest flank of small, clay till drumlin	260	Fine stratified sand at northeast end grading into coarse gravel at southwest end; few shells	100	30,000	Local farm use	Small sand pit at extreme northeast end of deposit; further development necessary
11	A. Decaire	19	7	Marine beach poorly developed terrace	Northwest facing clay till bluff	276	Coarse, stratified gravel grading into sandy gravel at west end of pit; many shells large boulder ridge along top of bluff; clay till exposed in bottom of pit	4,000	20,000	Local road repairs; concrete aggregate	Small crushing and screening plant

Township CORNWALL County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds)	Use	Remarks
12	-	36-37	7	Poorly developed marine beach	Northwest flank of small, clay till drumlin	308	Coarse, bouldery, poorly bedded gravel; few broken shells	None	2,000	Not used	No pit; deposit too small to be developed except for local use
13	D. St.-Louis	13	8	Marine beach; broad terrace	Northwest flank of a large, clay till drumlin	329	Coarse, poorly bedded gravel grading into a stratified, sandy gravel at the southwest end of deposit; predominantly limestone pebbles; many shells	2,000	large	Local roads; concrete aggregate	Continuation of large, worked out pit on east side of highway; needs further development
14	A.Beandette	15	8	Marine beach;	Northwest flank of clay till bluff		Coarse, bouldery gravel; no bedding; few shells	500	10,000	Local farm use	A small deposit; not a good gravel
15	A. Bender	32	8	Marine beach	North flank of a clay till bluff		Coarse, bouldery gravel; no bedding; few broken shells	1,000	7,000	Local farm use	Continuation of large New York Central Railway pit, ¾ mile to west; material too dirty and bouldery to be used for anything but fill

Township CORNWALL County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu. yds.)	Use	Remarks
16	New York Central Railway	34-35	8	Marine beach	West end of north facing clay till bluff		Coarse, poorly bedded gravel; few shells	Large	Small	Railway ballast, some concrete	Deposit almost worked out
17	Fisher	17	9	Small well-developed marine beach and terrace	Northwest flank of small, clay till drumlin		Medium, stratified sandy gravel; many shells	None	Large	None	Promising deposits; needs further development
18	R. Alguire	26	9	Marine beach; fairly well developed	North-facing clay till bluff	324	Medium, stratified sand interbedded with coarse gravel; predominating granite and gneissic pebbles; few broken shells	2,000	12,000	Local road repairs	Material contains a larger than usual number of hard, durable pebbles
19	Arbuthnot Bros.	37	9	Marine beach; fairly well developed terrace	North-facing clay till bluff		Coarse, poorly bedded gravel; few shells	3,750	80,000	Local road fill and repairs	Small screening and crushing plant a continuation of the deposit to the west of the road contains approximately 25,000 cu. yds. gravel

Township OSNABRUCK County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
1	H. Masse	2	1	Well-developed marine beach; terrace	Northwest facing clay till bluff		Very coarse, poorly sorted gravel on the flank of the bluff with finer sandy gravel on the terrace; predominantly limestone pebbles; boulder ridge extends along top of bluff	Very large	Little	Railway ballast; local roads and farm use	A large pit almost worked out
2	F. Ezard	13	3	Marine beach; poorly developed terrace	Northwest flank of a clay till drumlin	281	Very coarse, bouldery gravel; poor sorting; predominantly limestone pebbles; few shells	4,000	50,000	Road fill; crushed for concrete aggregate	Material contains many large boulders
3	A. MacMillan	2	4	Fairly well-developed marine beach; poor terrace	Northwest facing clay till bluff	303	Coarse bouldery gravel; poor sorting; predominantly limestone pebbles; very few shells; a ridge of washed cobbles extends along top of bluff	1,000	5,000	Local roads and farm use	Small deposit
4	Mrs. G. Shaver	7	4	Marine beach poorly developed terrace	Northwest flank of clay till drumlin	283	Coarse, bouldery gravel; poor sorting; few broken shells	None	9,000	-------	Large deposit; probably not possible to be fully exploited because of a cemetery at northeast end

Township OSNABRUCK County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
5	F. Martin	9	4	Marine beach; poorly developed terrace	Northwest flank of a clay till drumlin		Coarse, bouldery gravel; poor sorting; few broken shells	750	2,000	Local farm use	Small deposit; material could be used only as fill
6	A.Swerdfeger	18	4	Marine beach; no terrace	Northwest flank of a clay till drumlin		Very coarse, bouldery gravel; poor sorting; predominantly limestone pebbles; few broken shells; small boulder extends along top of bluff	200	Large	Local road metal	Lack of a terrace means lack of fine material
7	R. Shaver	19-20	4	Marine beach; fairly well-developed terrace	Northwest flank of a clay till drumlin		Coarse, bouldery, stratified gravel; predominantly limestone pebbles; cobble ridge extends along top of bluff; many shells in terrace, which contain about 15,000 cu. yds. sandy gravel	2,500	Large	Local road metal and farm use; not used recently	Three old pits on the same deposit; material suitable only for fill
8	W. Primeau	25-26	4	Fairly well-developed marine beach; poor terrace	Northwest flank of a clay till drumlin	309	Coarse, bouldery gravel; predominantly limestone pebbles; considerable shale present; very few shells; cobble ridge extends along top of bluff	4,000	40,000	Local road fill and farm use	Shallow deposit 5-foot working face

Township OSNABRUCK County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
9	W. Hollister	27	4	Marine beach; fairly well-developed terrace	Northwest flank of clay till drumlin		Coarse, bouldery, stratified gravel; predominantly limestone pebbles; many shells	15,000	Large	Local road metal	Large shallow deposits
10	R. Gallinger	36	4	Marine beach; no terrace	Northwest flank of clay till drumlin	306	Very coarse, bouldery gravel; resembles a water-worked till	600	3,000	Local farm use; not used recently	Material suitable only as fill
11	G. McGill	16	5	Marine beach; poorly developed terrace	Northwest flank of a clay till drumlin		Coarse, bouldery gravel; predominantly limestone pebbles; some Beekmantown dolomite; few broken shells	4,500	Large	Local farm use; road fill	Large shallow deposit; material suitable only for fill
12	---	19	5	Marine beach; no terrace	Northwest flank of a clay till drumlin		Very coarse, bouldery gravel; few shells	Small	Small	Local farm use; not used recently	A small shallow deposit

Township OSNABRUCK County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
13	W. Gallinger	31	5	Marine beach; fairly well-developed terrace	West end of east-west striking clay till ridge		Coarse, stratified gravel; predominantly limestone pebbles; many shells in finer materials	12,000	Large	Local farm use; road metal	Needs more development; probably not extensive
14	A. Patenaude	30-31	6	Marine bar with low sloping sides	Top and flanks of a low clay till drumlin		Poorly bedded, sandy gravel; predominantly limestone pebbles; many shells	2,500	60,000	Local farm use; road metal and fill	Large shallow deposit; further development needed to determine lateral extent
15	R. Ohff	10	7	Marine beach; fairly well-developed terrace	North flank and top of an east-west striking clay till ridge		Coarse, bouldery, stratified gravel; resembles a water-worked till; few shells; material becomes finer east along deposit	60,000	Large	Local road metal and fill; crushed for concrete aggregate	Large deposit extending along ridge for approximately ½ mile; at present worked by Osnabruck tp

Township OSNABRUCK County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
16	A. Zeran	12	7	Marine beach; no terrace	Northwest flank and top of clay till drumlin		Coarse, bouldery gravel; resembles a water-worked till; predominantly limestone pebbles; few shells	1,000	Large	Local farm use	Extensive, shallow deposit; material too bouldery to be used for anything but fill; two small pits on this deposit
17	W. Gallinger	19	7	Marine beach	Northwest flank of long, narrow, clay till drumlin		Coarse, bouldery gravel; resembles a water-worked till; few shells; boulder ridge extends along top of bluff	None	Large	Not used	Deposit would have to be developed by test pitting; it is doubtful if gravel would be suitable for anything but fill
18	- - -	20	7	Marine beach	Northwest flank of long, narrow, clay till drumlin		Coarse, bouldery gravel; resembles a water-worked till; predominantly limestone pebbles; large boulder ridge extends along top of bluff	1,000	Large	Local farm use	Extensive, shallow deposit; material too bouldery for anything but fill; two small pits on deposit

Township OSNABRUCK County STORMONT Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
19	Brownell	32	7	Marine bar	Flanks and top of long, low, clay till ridge		Coarse, sandy, poorly sorted gravel; few shells	4,500	25,000	Local farm use; road fill	Shallow deposit with a working face of 3-4 feet
20	A. Winters	32	7	Marine bar	Flanks and top of long, low, clay till ridge		Coarse, sandy, poorly sorted gravel; considerable limestone with shaly partings; few shells	1,350	27,000	Local farm use; road fill; not used recently	Shallow deposit with a working face of 3-5 feet
21	A. Mattice	13-14	8	Marine beach; poorly developed terrace	Northwest flank of a clay till drumlin		Coarse, bouldery, poorly sorted gravel; resembles a water-worked till; few shells	6,000	Large	Local farm use; road fill; not used recently	Extensive, shallow deposit with a 3-foot working face; needs further development

Township OSNABRUCK County STORMONT Province ONTARIO

NO.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds)	Estimated material available (cu.yds.)	Use	Remarks
22	S. Carbino	30	8	Marine beach; poorly developed terrace	Northwest flank of a small clay till drumlin		Coarse, poorly sorted gravel; predominantly limestone pebbles; small sand spit on the southwest of deposit	4,500	6,000	Local farm use; some road metal	Small deposit
23	S. Lachapelle	20-21	8-9	Marine beach; well developed terrace overlying outwall sand and gravel	Northeast-southwest extending ridge		Marine beach; coarse, bouldery, stratified gravel; 3-6 feet thick, marine terrace; stratified sandy gravel; many shells; outwash; cross-bedded silt, sand, and gravel	100,000	Very large	Road metal; large amounts for concrete aggregate without crushing	Large deposit extending along ridge for approximately ½ mile; working face of 5-20 feet

Township WILLIAMSBURG County DUNDAS Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
1	E. Whittaker	29	4	Marine beach	Northwest flank of a low, clay till drumlin		Coarse, bouldery gravel; resembles a water-worked till; poor sorting; very few shells	30,000	Little	Local farm use; road fill	Deposit almost worked out
2	N. A. Hunter	30	4	Marine beach	Northwest flank and top of large clay till drumlin	295	Very coarse, bouldery gravel; resembles a water-worked till; predominantly limestone pebbles; many large igneous boulders on the slope of the bluff	1,600	Large	Local farm use; road fill	A small pit on a large deposit; a similar pit is located on the opposite side of the road; same deposit as Nos. 3, 6, and 7
3	G. MacIntosh	33	4	Marine beach fairly well developed terrace	Southeast flank of a clay till drumlin		Fine to medium-grained, stratified, grey sand; few, scattered, igneous boulders in sand; large boulder ridge extends along top of bluff	500	Large	Local farm use	Shallow, extensive deposit

Township WILLIAMSBURG County DUNDAS Province ONTARIO

NO.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds)	Estimated material available (cu.yds.)	Use	Remarks
4	C. Monette	35	4	Marine beach poorly developed terrace	Northwest flank of a large clay till drumlin		Coarse, boulders, stratified sandy gravel; predominantly limestone pebbles; approximately 5 per cent Beekmantown dolomite; irregular boulder ridge extends along top of bluff	1,000	Very large	Local farm use	Pit located on southwest end of a long, gravel deposit; material becomes finer toward southwest part of deposit; another small pit on south side of road; same deposit as Nos. 2, 7, 8
5	Mrs. F MacMillan	22	5	Marine beach	Southwest end of a long, narrow, clay till ridge		Coarse, bouldery gravel; resembles a water-worked till; poor sorting; considerable shale; very few large boulders.	775	4,000	Local farm use	Small deposit
6	- - -	26	5	Marine beach well developed terrace	Northwest flank of a clay till drumlin	301	Medium, stratified gravel; considerable shells	15,000	Large	Local farm use; road fill	Large deposit; needs developing; same deposit as Nos. 2, 3, 6

Township WILLIAMSBURG County DUNDAS Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
7	Garlough	29	5	Well-developed marine beach	Northwest flank of a clay till drumlin	301	Coarse, bouldery gravel; poor sorting; predominantly limestone pebbles; considerable shale; many shells	7,500	Large	Local farm use; road fill	Wide, shallow deposit; needs developing; same deposit as Nos. 2, 3, 7
8	W. Garlough	31	5	Marine beach; poorly developed terrace	Southwest end and top of a large, low clay till drumlin	271	Coarse, bouldery gravel; resembles a water-worked till; poor sorting; very few shells	8,000	Large	Local farm use; road fill	Shallow, extensive deposit; needs developing on northwest flank and top of drumlin; material exposed suitable only for fill
9	L.Whittaker	5	6	Marine beach; poorly developed terrace	Northwest flank and top of a clay till drumlin		Coarse, bouldery gravel; poor sorting; predominantly limestone pebbles; few broken shells	4,500	20,000	Local farm use; road fill	Small deposit
10	---	10	6	Marine beach; fairly well-developed terrace	Northwest flank and top of a clay till drumlin		Coarse, bouldery gravel; predominantly limestone pebbles; many shells; material finer at southwest end of deposit; material in terrace is a fine, sandy gravel	None	30,000	- - -	No pit on deposit; needs developing

Township WILLIAMSBURGH County DUNDAS Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
11	Williamsburgh tp.	12	6	Marine beach; well-developed terrace	Northwest flank and top of a long, narrow, clay till ridge	294	Coarse, stratified gravel; fair sorting; predominantly limestone pebbles; many shells	20,000	50,000	Road metal; concrete aggregate	Large deposit extends northwest into farm of R. Castleman
12	I. MacIntosh	31	6	Marine beach	Northwest flank and top of a clay till drumlin	256	Coarse, bouldery gravel; poor sorting; very few shells	7,500	Large	Local farm use; road fill	Large deposit; material suitable only for fill; pit located on southwest tip of drumlin
13	W. Farrel	2	7	Marine bar	Long, narrow ridge with a north-south strike		Medium, well-bedded, sandy gravel overlain by 3 feet of coarse, stratified gravel, predominantly limestone pebbles; many shells	2,500	Large	Local farm use; road fill	Long, narrow deposit; average working face of about 9 feet; test pitting needed along its entire length for development; same deposit as No. 14

Township WILLIAMSBURGH County DUNDAS Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
14	Williamsburgh tp.	2	7	Marine bar	Long, narrow ridge with a north-south strike		Coarse, stratified gravel; fair sorting; predominantly limestone pebbles	7,500	Large	Local farm use; road fill	Same deposit as No. 13; shallower with a 5-foot average working face
15	W. Beckstead	9	7	Marine beach and bar	Long, narrow ridge with N. 10°E. strike		Coarse, bouldery gravel; poor sorting; predominantly limestone pebbles; few shells	3,750	45,000	Local farm use; road fill; some concrete aggregate	Extensive deposit; large pit on south side of road on farm of L. Froats
16	G. H. Armstrong	18	7	Marine beach and bar	Top and flanks of a low ridge with N. 20°E. strike		Coarse, bouldery gravel; resembles a water-worked till; predominantly limestone pebbles	Large	Little	Local farm use; road fill	Several small pits or thin deposit that is almost worked out; same deposit as No. 17
17	W. A. MacMillan	19	7	Marine beach; fairly well-developed terrace	Southeast flank and southwest end of a long, low clay till ridge		Coarse bouldery gravel; poor sorting; predominantly limestone pebbles; many shells	Large	Little	Local farm use; road fill	Shallow, extensive deposit; pit located on southwest end of deposit; working face 2-4 feet; clay till exposed in pit bottom; same deposit as No. 16

Township MATILDA County DUNDAS Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
1	W. La-Pierre	1	1	Marine beach and/or bar	Flanks and top of a long, narrow, clay till drumlin		Coarse, bouldery gravel poor sorting; predominantly limestone pebbles; few broken shells; several large boulders scattered along the ridge	Large	Large	Local farm use; road fill; some concrete aggregate	Numerous small pits have been opened up along the top of the ridge on this deposit
2	E. Shaver	20	2	Marine beach and/or bar; well-developed terrace	Flanks and top of a clay till drumlin		Coarse, stratified gravel; fair sorting; few shells; considerable Beekmantown dolomite	11,000	100,000	Local farm use; road fill; some concrete aggregate	Pit is located on west end of deposit; another similar pit located immediately west; test pits put down along road running north from deposit indicate terrace gravel extends a considerable distance northwest of marine bluff; best deposit noted in township

Township MATILDA County DUNDAS Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
3	G. Mullin	6	3	Marine beach	Northwest flank of a clay till drumlin	296	Coarse, bouldery gravel; poor sorting; predominantly limestone pebbles; few broken shells	4,000	6,000	Local farm use; road fill	Small deposit; material suitable only for fill; pit located on southwest end of deposit
4	S. McGrewer	23	4	Kame sand reworked by marine waters			Fine-to medium-grained, grey, stratified sand; few shells	1,000	Large	Plastering; fine cement work	This deposit marks the farthest eastern limit of the great kame area that covers a large part of Edwardsburgh township

Township MATILDA County DUNDAS Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
5	W. Whitteker	3	5	Marine beach and/or bar	Northwest flank and top of a long, narrow, clay till drumlin		Coarse, stratified, sandy gravel; good sorting; predominantly limestone pebbles; many shells; very few large boulders	8,000	8,000	Local farm use; road metal	Shallow deposit with an average working face of 6 feet; the deposit can be traced for a considerable distance to the northwest where it can be located by the presence of several small gravel pits
6	A. E. Bell	15-16	5	Marine beach and/or bar	Northwest flank and top of a clay till drumlin	270	Coarse, bouldery gravel; resembles a water-worked till; poor sorting; no shells	300	Small	Local farm use	Small, shallow deposit; extends northeast across the road onto the farm of R. S. Luck
7	Bert McQuigg	14	8	Marine beach (?)	On northwest flank of a low clay till drumlin		Coarse, grey sand interbedded with coarse, sandy gravel; fair sorting; predominantly limestone pebbles; no shells; no boulders over 12 inches	7,500	15,000	Local farm use; road fill	Small deposit with a 5-7 foot working face; clay till exposed in bottom of pit

Township EDWARDSBURGH County GRENVILLE Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
1	Chas. McInnes	4	1	Fairly well-developed marine beach and/or bar	Northwest flank and top of low, clay till drumlin	289	Coarse, bouldery gravel; resembles a water-worked till; poor sorting; considerable Beekmantown dolomite pebbles; no shells	50,000	Large	Local farm use; road metal; some concrete aggregate	Shallow deposit; material resembles that in larger deposits farther east in Cornwall township
2	R. Spencer	26	1	Marine beach; fairly well-developed terrace	Northwest flank of clay till drumlin		Fine to coarse, stratified, sandy gravel; fair sorting; predominantly limestone pebbles; few broken shells	25,000	25,000	Local farm use; road metal; some concrete aggregate	Deposit probably extends northeast across road and under farm-house
3	Reddon	24	2	Marine beach; outwash	Northwest flank and top of low clay till drumlin	312	3-4 feet of coarse, bouldery, marine beach gravel overlying crossbedded outwash sand and gravel; good sorting; no shells	20,000	Large	Road metal; concrete aggregate	Large deposit with a 9-foot working face; needs further development; probably extends along entire ridge
4	A. Eaton	12	3	Poorly developed marine beach and terrace	Northwest flank of clay till drumlin	281	Coarse, bouldery gravel, resembles a water-worked till; poor sorting; no shells; small boulder ridge extends along top of bluff	6,000	6,000	Local farm use; road fill	Very small deposit; material suitable only for fill

Township EDWARDSBURGH County GRENVILLE Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
5	Riddle	25	3	Marine beach (?)	Northwest flank of clay till drumlin	312	Coarse, bouldery gravel; resembles a water-worked till; poor sorting; considerable Beekmantown dolomite pebbles; no shells	8,000	24,000	Road fill; some concrete aggregate	Small deposit; material suitable mainly for fills
6	P. A. Mac-Intosh	25	5	Marine beach and terrace; outwash	Northwest flank of clay till drumlin	324	3-6 feet of low-dipping, coarse, bouldery, marine gravels overlying steeply dipping outwash sand and gravel; no shells; a distinct unconformity between the two deposits	40,000	40,000	Road metal; concrete aggregate	Large deposit extending east of No.16 highway; maximum working face of 20 feet; bedrock exposed at east end of pit
7	E. Lawrence	34	6	Well-developed marine beach	Northwest flank of a large, clay till drumlin		Coarse, bouldery gravel; poor sorting; few shells	10,000	Large	Local farm use; road fill	Large deposit; needs further development along edge of bluff
8	H. Spencer	12	7	Marine beach; fairly well-developed terrace	Northwest flank of a low, clay till drumlin	284	Fine to medium, stratified, sandy gravel; fair sorting; predominantly limestone pebbles; few shells	3,600	80,000	Local farm use; road fill; some concrete aggregate	Extensive deposit; becoming finer toward west end; small sand pit located at west end of deposit

Township EDWARDSBURGH County GRENVILLE Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
9	B. Moore	18	7	Fairly well-developed marine beach	Northwest flank and top of long, clay till drumlin		Coarse, bouldery gravel; resembles a water-worked till; poor sorting; few shells; becomes sandy toward northeast end of deposit	None	13,000	- -	Small deposit; one test pit recently put down from which description of material obtained
10	Ontario Department of Highways	30	7	Large, well-developed marine beach and terrace	Below and on northwest flank of a clay till bluff	321	Medium, stratified gravel; fair sorting; few shells	Large	Large	Crushed to form concrete aggregate for No.16 highway	Deposit partly in terrace below emerged bluff; highest bluff in area 50-60 feet high
11	M. F. Cleary	30	7	Large, well-developed marine beach and terrace	Northwest flank and top of a clay till bluff		Coarse, bouldery gravel; resembles a water-worked till; poor-sorting; predominantly limestone pebbles; no shells	Large	Large	Concrete aggregate for Prescott elevator	Deposit located high on the bluff; needs further development northeast along ridge; clay till exposed in pit bottom; bedrock believed near surface; C.P.R. passes beside pit

Township EDWARDSBURGH County GRENVILLE Province ONTARIO

No.	Owner	Lot	Con.	Type deposit	Location	Elev. beach	Description of material	Estimated material removed (cu.yds.)	Estimated material available (cu.yds.)	Use	Remarks
12	A. Campbell	12	9	Marine beach and/or bar; fairly well-developed terrace	Northwest flank and top of a small clay till drumlin	281	Coarse, bouldery gravel; resembles a water-worked till; poor sorting; predominantly limestone pebbles; few broken shells; boulder ridge extends along top of bluff	8,000	Large	Local farm use; road fill	Reported to test satisfactorily for concrete aggregate
13	Ontario Department of Highways	25	9	Marine beach	Northwest flank of a clay till drumlin	363	Coarse, bouldery gravel; resembles a water-worked till; no sorting; predominantly limestone pebbles; no shells; very little Beekmantown dolomite or igneous pebbles present	17,000	Large	Local farm use; road fill; concrete aggregate for No. 16 highway	Very large deposit; predominance of limestone pebbles due to nearness of bedrock northwest of bluff