GLACIAL LAKE SHORELINES IN NORTHERN WENTWORTH COUNTY, ONTARIO.

by James H. Horton

A thesis submitted to the Department of Geography, McMaster University, Hamilton, Ontario, in partial fulfilment of the requirements for the degree, Bachelor of Arts.

March, 1961.

A C K N O W L E D G M E N T S

The writer would like to express his sincere appreciation to Dr. H. A. Wood of the Department of Geography, McMaster University, for his invaluable assistance in supervising this work. A debt of gratitude is owed for his many helpful suggestions and criticisms, and especially for his patience in reviewing the first draft of this thesis. In addition, thanks is also due to the personnel of the Burlington and Suburban Area Planning Board, and the Hamilton Wentworth Area Planning Board for allowing the author access to literally hundreds of aerial photographs, as well as recent land use information. A similar word of appreciation is also expressed to the Soils Department staff at the Ontario Agricultural College in Guelph for their kindness in allowing the author access to, as yet, unpublished material on the soils of Wentworth County. Finally, the author would particularly like to thank Mrs. J. S. Manson for giving so freely of her time to type this thesis.

TABLE OF CONTENTS

C O N T E N T S (Cont'd.)

C O N T E N T S (Cont'd.)

C O N T E N T S (Cont'd.)

* * *

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

LIST OF MAPS

GENERAL INTRODUCTION

During recent geologic times in North America, four distinct glacial ages occured within the Pleistocene epoch. Evidences of the first three glaciations, the Nebraskan, Kansan, and Illinoian have been largely obscurred by the effects of the most recent glaciation known as the Wisconsin. Measured on the vast scale of geologic time it was only a few moments ago that the great continental ice sheet of the Wisconsin glaciation covered all of Southern Ontario. In absolute terms the ice sheets first began to recede between 15,000 and 20,000 years ago under the impress of a warming climate. Some 8,000 to 10,000 years have passed since the last vestiges of ice receded from the landscape of Southern Ontario. Today the great variety of glacial landforms which cover virtually all of Southern Ontario represent the legacy of the Wisconsin glaciation. Because of its extreme geologic youthfulness the physiography of Southern Ontario has been essentially undisturbed since its formation. The infinitely slow but inexorable agents of landform denudation have not yet had time to modify or change the "Wisconsin" landscape to any appreciable degree. From this landscape with its marked clarity of original features, one group of elements related to a particular set of circumstances has been selected as the subject of investigation in this thesis.

During the 10,000 years or so that it took for the Wisconsin ice sheets to recede completely from Southern Ontario, a number of large glacial lakes were formed in the basin areas now occupied by

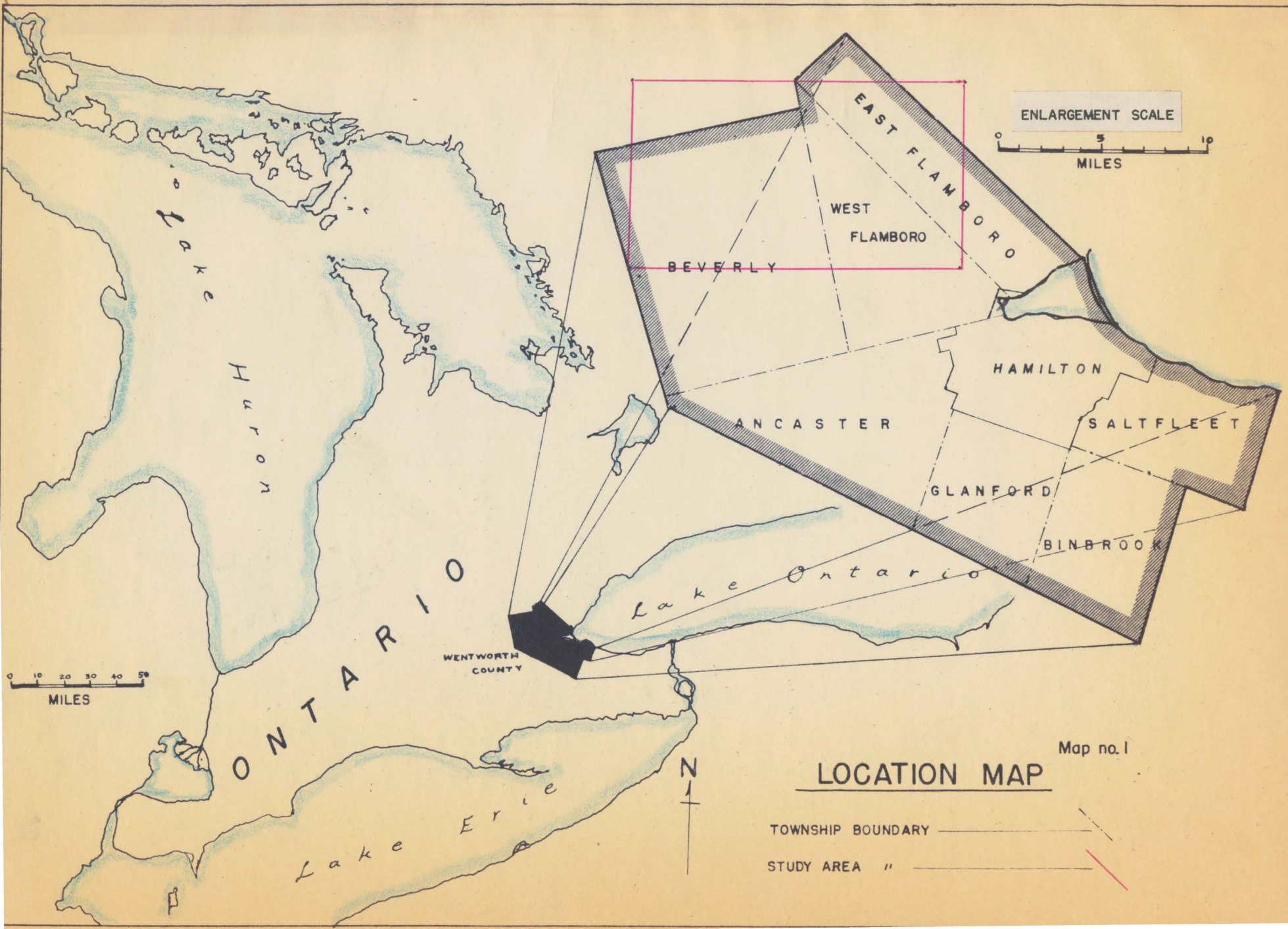
the present Great Lakes. These ancient predecessors of the modern Great Lakes have left fossil shorelines throughout many areas of Southern Ontario at elevations often much higher than the present lakes.

It is the purpose of this thesis to investigate two such shorelines in northern Wentworth County.* In this investigation the approach will be essentially geographic. It will include the delineation and mapping of the shorelines and their attendant features, a discussion of their physical characteristics both in time and space, and their formation in relation to the ancient lake environments. In addition, the relationships between the shorelines and certain physical elements such as soils, drainage, erosion, etc., will be investigated, as well as the relationships between the shorelines and certain cultural elements. The study will be divided into two main parts. In part one, which forms the major section, the physical geography of the shorelines will be systematically analyzed. James Hutton's famous geologic principle of uniformitarianism** provides the perspective for this first section in which "the present is regarded as the key to the past." The shorter but equally important second part will be concerned with the present cultural geography of the shoreline

*The study area lies just north of the western terminus of Lake Ontario and constitutes most of the northern portions of Beverly, West Flamboro and East Flamboro Townships in northern Wentworth County. (see map No. 1)

**Hutton, James
1795: Theory of the Earth, Edinburgh

areas. The point of departure for this second section is a complete reversal of the Huttonian principle as the major consideration shifts to the influence of the physical elements of the shorelines upon the land use and settlement pattern. Hence "the past becomes the key to the present". Although both sections are written from opposite perspectives, they are fused within the overall geographic approach. It is the writer's hope that this fusion will be such that it will provide a balanced systematic study elucidating both the physical and cultural aspects of the ancient shorelines that have been preserved upon the landscape of northern Wentworth County.


ENLARGEMENT SCALE
0 5 10
MILES
EAST FLAMBORO
WEST FLAMBORO
BEVERLY
HAMILTON
ANCASTER
SALTFLEET
GLANFORD
BINBROOK
Lake Ontario
WENTWORTH COUNTY
Lake Huron
ONTARIO
Lake Erie
0 10 20 30 40 50
MILES
N
Map no. 1
LOCATION MAP
TOWNSHIP BOUNDARY
STUDY AREA "

PART 1

PHYSICAL GEOGRAPHY

SECTION 1

DESCRIPTION OF THE STUDY AREA

CHAPTER 1

BEDROCK GEOLOGY

FORMATIONS

Bedrock throughout the study area is comprised mostly of crystalline dolomites of Middle Silurian age. Beds dip gently to the southwest to form the dip slope of the Niagara escarpment. Bedrock elevations decrease accordingly. In the west, over about 60% of the area, the surface strata are cream to buff coloured dolomites of the Guelph formation. Beds are uniform and display thicknesses from two to eleven inches. (see fig. 1) Most of the eastern portion of the study area is underlain by the somewhat older grey-buff dolomites of the Lockport-Amabel formation. Bedding is similar to that of the Guelph formation. In a small area of the northeast, a re-entrant in the Niagara escarpment, now occupied by the Bronte Creek, has been cut down into the still older grey-buff sandstones, shales, and dolomites of the Clinton-Cataract group which forms most of the escarpment face.

BEDROCK SURFACE

Because of the covering mantle of glacial drift information regarding the bedrock surface is limited. However, certain generalizations are apparent. In the southwest portion of the study area a few small escarpments outcrop through the thin drift breaking an otherwise smooth

Fig. 1: Outcrop of thin, evenly bedded Guelph dolomite south of Sheffield on No. 8 Hwy. Note: the shallow overburden of this limestone plain area.

bedrock surface of the Guelph dolomites. The general direction of these outcrop ridges is northeast - southwest approximately at right angles to the strike of the beds and subparallel to the Dundas re-entrant in the Niagara escarpment. Younger strata of the Guelph dolomites also break through the surficial Pleistocene deposits farther north in the central portion of the study area. The location of these outcrops, plus a few areas of outcropping Lockport-Amabel strata in the east-central zone, suggests there may be a series of generally northeast-southwest trending escarpments of low relief throughout the study area subparallel to the northern scarp face of the Dundas re-entrant into the Niagara escarpment.

The far northeast corner of the study area, where elevations increase, is characterized by exceedingly rugged bedrock. It has been suggested this zone of rough bedrock surface may be related to reeflike structures of the Lockport-Amabel formation.[1]

The Bronte creek valley south of the rough bedrock zone represents a drift filled pre-glacial re-entrant cut into the Niagara escarpment. The upper reaches of this pre-glacial valley are completely buried west of Flamboro Station. Nevertheless, it seems likely that the head of the valley does not extend more than two or three miles to the west of this point. Borings indicate a probable depth of 60 feet and steep walls in the Carlisle area.[2]

[1] Karrow, P.F.
1959: Pleistocene Geology of the Hamilton Map-Area; (Preliminary Report) Ont. Dept. Mines, Circular No. 8

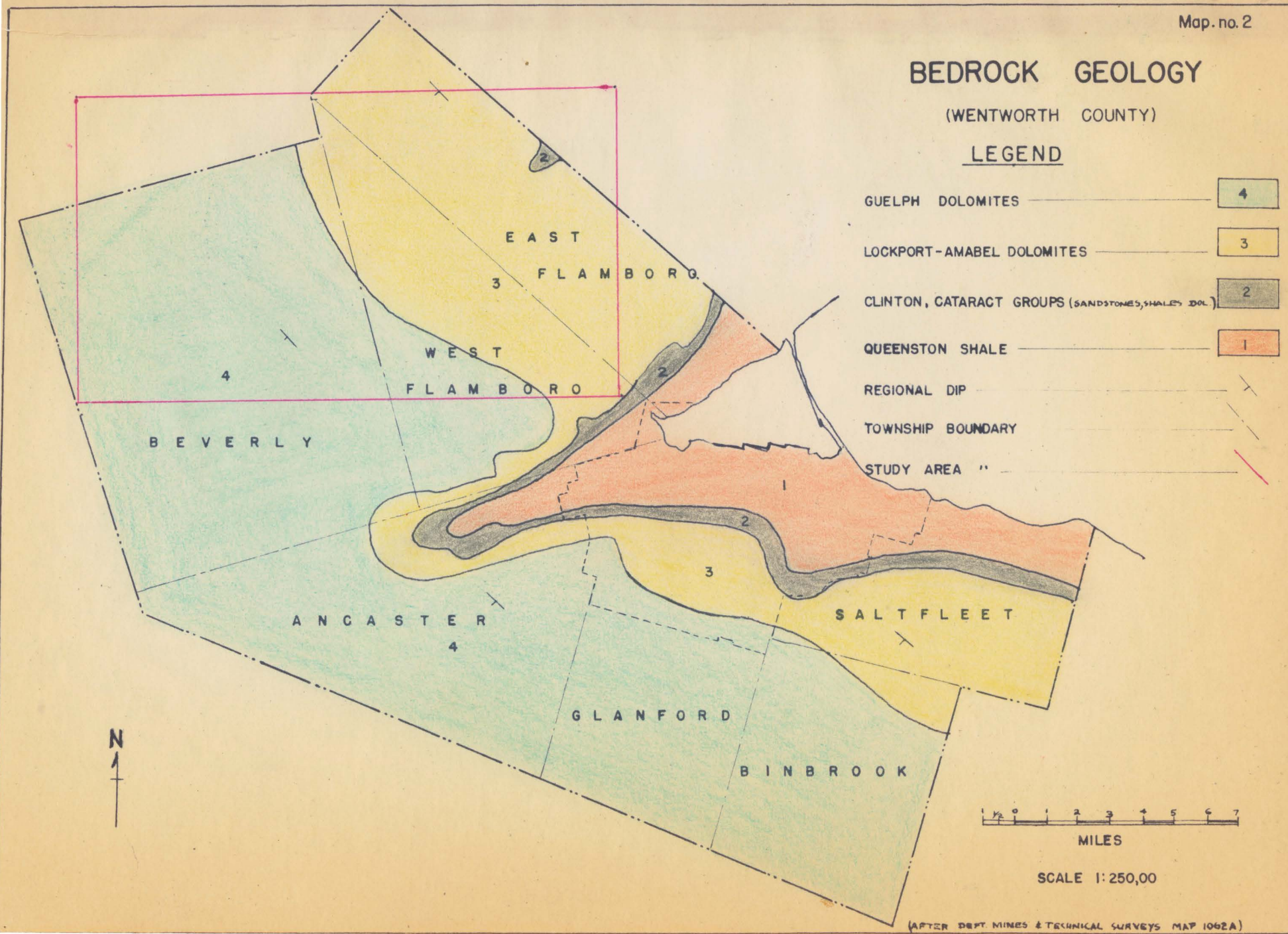
[2] (ibid.)

Two miles west of Millgrove, steep outcropping walls reveal a similar buried pre-glacial valley oriented north-south. Extraction of peat and muck from this bedrock depression has revealed a depth of at least twenty feet or more.

Map. no. 2

BEDROCK GEOLOGY

(WENTWORTH COUNTY)



(AFTER DEPT. MINES & TECHNICAL SURVEYS MAP 1062A)

CHAPTER 2

GLACIAL GEOLOGY AND PHYSIOGRAPHY

INTRODUCTION

Land forms throughout the study area are primarily the result of Pleistocene glaciation and, to a lesser extent, post-glacial erosion and deposition. Surficial deposits are of glacial, glaciofluvial, and glaciolacustrine origin, and are genetically related to movements of the Lake Ontario lobe of the Wisconsin ice sheet. At least two or more advances of the Ontario lobe moved in a westerly direction across the area giving rise to the present physiography. The oldest tills occur in the most westerly part of the study area, whereas the youngest tills occur in the east.

EVOLUTION OF THE PRESENT LANDSCAPE

During its earliest advance the westward moving ice of the Ontario lobe scoured off most of the bedrock in northern Beverly, West Flamboro, and East Flamboro Townships and formed a large morainic system just west of Wentworth County. A small portion of the Galt moraine representing the eastern margin of this system cuts northwest across the western part of Wentworth County.

Either during the first advance, or more probably during a later advance, the Ontario ice lobe deposited a number of generally east-west trending drumlins and drumlinized till ridges on the shallow overburden

of the limestone plain and the lower edges of the Galt moraine's east margin to form the present day Westover drumlin field. Stagnant wasting of the ice sheet left ice contact materials around the lower flanks of the drumlins, particularly around the ends. At the same time outwash gravels, fans, eskers and kame deposits were laid down in the central and western portions of northern Wentworth County. As the ice receded, meltwater channels cut down to bedrock through the shallow till deposits north of Sheffield, and formed a few, small, bare rock floored, spillways in this area.

The last major advance of the Ontario ice lobe laid down the youngest till deposits in the area throughout most of East Flamboro, and West Flamboro Townships, and formed a low gently undulating morainic system on the dip slope of the Niagara escarpment near, and parallel to, the scarp face. During the advance and recession of the last ice sheet outwash sands and gravels, derived principally from the northeast beyond Campbellville, were deposited throughout the Carlisle-Harper Corners area. Stagnant wasting of the last ice sheet is indicated by the presence of Kame deposits and eskers in the Carlisle area. Meltwater channels developed parallel to the receding ice front and carved shallow sandy spillways between the strands of the Flamboro morainic system.

PRESENT PHYSIOGRAPHY (see map No. 3)

Moraines

Galt Moraine. The topography of the Galt moraine which cuts across the northwest corner of the study area is typically rough and hummocky.

Elevations rise from about 865 ft.* at the base of the moraine north of Sheffield to slightly over 1000 ft. at Clyde and 1050 ft. near Crieff in Puslinch Township just north of Wentworth County. The till in this moraine is probably the oldest Pleistocene deposit in the study area. It is typically an oxidized red-buff to grey, loose stoney till of sandy to loamy composition, and was probably derived in part from the dolomite cap rocks of the Niagara escarpment by westward movement of the Lake Ontario ice lobe.

Flamboro Moraine. The moraines in East Flamboro and West Flamboro Townships differ markedly from the Galt moraine in morphology, age, and composition. Three strands of this moraine and two intervening meltwater channels extend across the southeast corner of the study area in a southwesterly direction. The most easterly strand barely cuts across the lower righthand corner of the accompanying physiographic map (see map No. 3). Unlike the Galt moraine these moraines are low and smoothly indulating with no rugged, hummocky, topography. Elevations decrease along the strands to the southwest and across the strands towards the Niagara escarpment to the southeast. The most westerly strand attains an elevation of slightly over 925 ft. at the Wentworth-Halton County line but decreases to 875 ft. along most of its crest, while along the northwestern flank elevations are slightly less than 850 ft. The two more southeasterly moraines have crests at 850 ft. and 800 ft. and are separated by spillway channels just below 825 ft. and 800 ft. respectively.

* Datum Plane for all elevations given is mean sea level.

Recent investigations have shown that the Flamboro moraines are composed of a younger till than that in the drumlins and the Galt moraine to the west. This till is typically of a stony, reddish-brown, silty clay composition in the oxidized zone and is covered with a very sandy mantle throughout most of the study area. The same investigations have also shown that the recession of the last ice sheet was marked by a number of minor advances, at least in the north where three similar tills of this younger age are separated by beds of sands near Lowville.[3] The author has found similar evidence at the southern end of the second most westerly moraine in a road cut near the intersection of the Brock road and No. 5 Highway. Here about five feet of till on top of the moraine is separated from the main body of till by about two to three feet of sand. The implication is that fluctuations probably occured along the entire ice front between Greensville and Lowville.

The Limestone Plain

East of the Galt moraine most of the central part of the study area is occupied by a broad drumlinized limestone plain. Except where there are drumlins and associated areas of deeper drift, most of this ice scoured limestone plain is covered by less than two feet of overburden. (see fig. 1) Most of the shallow overburden consists of lacustrine sands and silts in the southwest and thin glaciofluvial materials in the northeast deposited during, and subsequent to, the ice retreat from the area. Attention has already been drawn to the small northeast-southwest trending

[3]Karrow, P.F. (op. cit.) pg. 4

escarpments which cross this shallow drift plain, as well as to the rough bedrock surface which outcrops in places through the extremely thin drift in the northeast. Elevations of this limestone plain reflect the regional dip and increase from about 850 ft. in the southwest to slightly over 900 ft. in the northeast.

The Westover Drumlin Field

By far, the most striking physiographic features in the study area are the drumlins of the Westover drumlin field which occupy much of northern Beverly, and parts of East Flamboro, and West Flamboro Townships. Well over fifty drumlins of variable size occur in this field with the largest, most well developed, members occuring in the eastern and central portions of the study area. Generally speaking, west of highway 52 the drumlins are poorly developed. Orientation of the drumlins is nearly east-west throughout most of the central area*, whereas approaching the Galt moraine in the north and northwest, the orientation shifts to a general northwesterly direction approximately at right angles to the moraine. The till of these drumlins has been described by Karrow[4] as sandy in texture with a pink-buff coloured oxidized zone. It seems probable that this till is either of a similar age and origin to that of the Galt moraine or just slightly younger.

* Glacial stria 2 1/2 miles north west of Westover indicate ice passed over the area along a bearing 28^{0} north of west. (see fig. 2)

[4]Karrow, P.F. (op. cit.) pg. 3

Fig. 2: Ice-scoured Guelph dolomite 2 1/2 miles northwest of Westover. Average striae orientation is 298° Azimuth indicating ice moved over the area in a direction slightly north of west. Arrow indicates direction of ice movement.

The main drumlin field (Westover area). Most of the largest drumlins in the field occur in the type area just north of Westover in the vicinity of the West Flamboro-Beverly Townline. Here a few of the drumlins attain lengths of one to 1 1/2 miles and heights of 150 ft. to 175 ft. above the surrounding land. Elevations at the base of the drumlins rise from around 875 ft. in the south to around 900 ft.-925 ft. in the north, over a distance of some three to four miles. On the other hand, the crests of most of the drumlins in the main group are all around 950 ft.-980 ft. in elevation.

The majority of the drumlins north of Westover and east of Kirkwall have been formed on a tabular till ridge above the surrounding limestone plain. The curious feature, however, is that many of the drumlins in the main group have been formed so close together that they have been fused into composite masses of till representing groups of two or three roughly formed drumlins. A good example occurs just south of Carlisle where two drumlins have fused to form a V-shaped mass of till pointing east. Except for the fused groups, however, most of the drumlins in the main Westover area are fairly well spaced about one half mile apart. Some two miles west of Westover the drumlins become more widely spaced and are about one mile apart. East of the Brock Road the few drumlins that exist are widely spaced with one or two miles between most of them.

One other unusual feature of the main drumlins is their disproportionate width compared with their length. Many of this central group exhibit a width equal to at least half their length, giving them a more rounded appearance than is characteristic of most drumlins. The average

length is about one half mile. Due to their unusual width the slopes of these drumlins are less steep than in most drumlin fields. One point is very apparent, however, in almost every case the southern slopes of the drumlins are steeper than the northern sides.

The southernmost drumlins around Westover and those farther west most closely approximate the normal drumlin form and proportions. Here most of the drumlins average about one half mile in length and are about one quarter of this dimension in width. Nevertheless these drumlins also exhibit a much steeper slope along their southern side than along their northern exposures.

Throughout the entire drumlin field a large quantity of kame material has been deposited around the lower flanks of the drumlins. This is particularly true of the main Westover group. The kame is particularly prevelant around the ends of the drumlins where steeply dipping fans of semi-sorted ice contact material is almost consistently splayed out in a northerly direction. (see figs. 3, 4, & 18) Unless locally the ice melted first on the higher ground to the north, the reason for this northerly trend of the glaciofluvial deposits is not immediately clear since bedrock dips to the southwest. In only a few cases are these deposits found splayed out in a southerly direction. Diagnostically, however, the presence of these ice-contact materials suggests that the recession of the ice which formed the drumlins took place by the melting of a stagnant ice sheet.

Drumlins west of the main field. Beyond the main Westover group to the west there is a large gap in the drumlin field between highway 52 and

Fig. 3: Gravel pit exposure of ice-contact material dipping north to form a glaciofluvial fan around the northwest end of the Westover drumlin.

Fig. 4: Close-up of semi-sorted ice contact material seen in Fig. 3. "Apparent" dip is approximately 30°.

Sheffield. This gap is characterized by an almost uninterrupted stretch of limestone plain west of which the drumlins again become apparent. In contrast with the Westover group, however, the drumlins in the Sheffield area are much smaller and are only a few tens of feet in local relief. In the north central part of the area a fairly broad, low, drumlinized ridge of till seems to be associated with a north-south trending bedrock escarpment which outcrops in a few places. Despite the fact that the drumlins west of highway 52 are much smaller than those to the east, there is still a marked tendency for their southern slopes to be appreciably steeper than their northern sides.

The drumlins on the margin of the Galt moraine farther north and along the drumlinized till plain north of highway 97 are somewhat higher than most of those in the Sheffield area but are in every respect smaller than the main drumlins around Westover. They represent the poorly developed tail end of the field formed as the ice moved west and northwest over the area. Only a few of these drumlins exhibit appreciably steeper southern slopes compared with their northern sides.

Glaciofluvial Deposits

Except for the ice contact material around the drumlins, glaciofluvial deposits laid down during the advance and the retreat of the ice sheets are located primarily in northern East Flamboro, and West Flamboro Townships.

Kame. Kame deposits occur principally in the Freelton-Strabane area and the Carlisle-Flamboro Station district, as well as on the floor of the

Bronte Creek re-entrant at the east boundary of Wentworth County. The deposits in the Carlisle and Bronte Creek areas have been described by Karrow as poorly sorted, irregularly stratified gravels.[5] The kame deposits of the Strabane-Freelton area are similar to those at Carlisle and are typically poorly sorted sands and gravels displaying irregular stratification.(see fig. 5) A few localized areas of highly sorted sands and gravels have been uncovered northeast of Strabane. Here, gravel pit operations have exposed slumped deposits which strongly suggest the ice sheet retreated by the melting of stagnant blocks. Throughout the areas of kame deposition elevations range from approximately 875 ft. to slightly over 900 ft. North of Freelton at the intersection of the Beverly-West Flamboro Townline and the southeast corner of Puslinch Township, kame and kettle topography near the Galt moraine occurs at elevations from just below 925 ft. to about 1000 ft. above datum. In most cases the topography of the kame areas is typically erratic and irregular although relief is seldom severe.

Eskers. A number of small eskers occur in association with the kame deposits in northern East Flamboro and West Flamboro Townships. In the Carlisle area a small esker trends west from Flamboro station for a couple of miles. Several small, but well formed, eskers of short length are also associated with the kame deposits east and west of Freelton. They trend in a northwest-southeast direction and appear to have been formed by water moving southeast under the ice.

[5]Karrow, P.F. (op. cit.) pg. 3 & map legend symbol No. 4.

Fig. 5: Poorly sorted kame gravels northeast of Strabane. Irregular, contorted sand bed cuts across the centre of the exposure. (Camera case in lower left corner gives scale.)

Fig. 6: Well developed cross bedding in the sands and gravel of the spillway along the eastern margin of the drumlin field.

Outwash Gravels. In addition to the kame and esker deposits, outwash gravels were also deposited in northern East Flamboro and West Flamboro Townships during the retreat of the ice sheet which formed the drumlin field and during the lesser advance of the last ice sheet which formed the Flamboro moraines. These gravels occur principally around the Harper Corners area and northeast of Carlisle. In contrast with the kame deposits, these gravels are generally well sorted, rounded and stratified, with well developed foreset bedding indicating a general northern origin.[6] Associated with these outwash gravels is a well defined spillway channel which extends southwest along the east front of the main drumlin field from the junction of No. 6 highway and the Carlisle concession to the concession immediately southeast of Westover. Extensive gravel workings in the bottom of this spillway at the intersection of the Brock road and the 6th concession road in West Flamboro have revealed well sorted horizontally bedded sands and gravels. Well developed cross bedding in the northeastern exposures indicates a northeasterly source. (see fig. 6) It seems probable that this spillway was formed during the recession of the ice sheet which formed the drumlins and that its deposits are contemporaneous with the outwash gravels immediately to the northeast.

Outwash fans. At least one outwash fan has been positively identified within the study area and the presence of a second one seems probable. The first is a well developed fan built south from the mouth of a narrow gap between two drumlins in the north central portion of the 6th con-

[6]Karrow, P.F. (op. cit.) pg. 4

cession just west of the Beverly-West Flamboro Townline. This fan which is dissected by the present Spencer Creek valley stands out with exceptional clarity on aerial photographs. Materials in this fan are poorly sorted, stratified, sandy to loamy, subangular gravels. An exposure in the western part of the fan indicates a gentle dip to the south at approximately ten degrees. (see figs. 7 & 8) A feature of similar morphology and orientation occurs just west of Mountsberg and is probably of a similar origin. It seems likely that these fans were built out during the retreat of the ice sheet which formed the drumlins.

Spillways

Brief mention has already been made of the spillway channels in the study area. They occur in three separate areas and are related to both the earlier and later ice recessions. In the 7th and 8th concession blocks north of Sheffield, three small spillway channels have been cut down through the shallow till to form rock floored drainage outlets to the south. These shallow channels,plus the gravel floored spillway along the east front of the main drumlin field, were formed during the recession of the earlier ice sheet which formed the drumlins. The shallow spillways between the strands of the Flamboro moraines on the other hand where formed during the recession of the last ice sheet and are typically sandy in nature.

Swampland

A quantitatively important element of the present physiography is the large area of swampland between the main drumlin field and the drumlinized till deposits north of highway 97. The Beverly swamp comprises most of this poorly drained land; however, a number of other

Fig. 7: Gently dipping stratified outwash gravel exposed in the large outwash fan north of Westover.

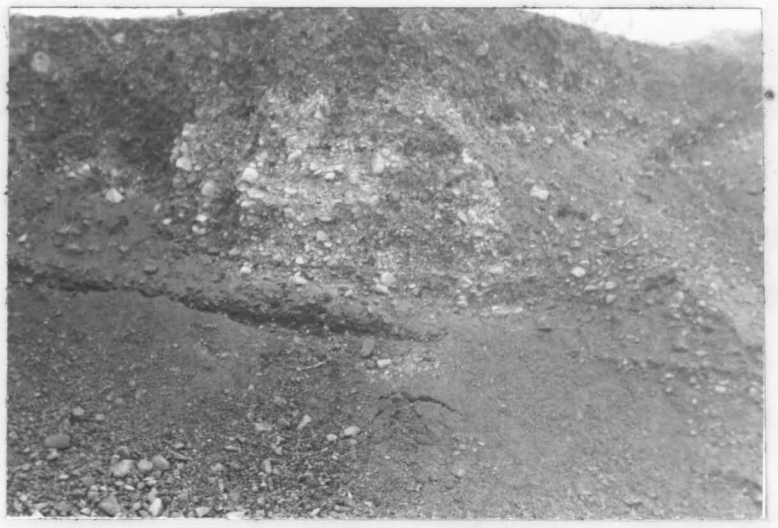


Fig. 8: Close-up of the outwash gravels seem in Fig. 7 showing the sub-angular nature of the gravel and its loamy matrix.

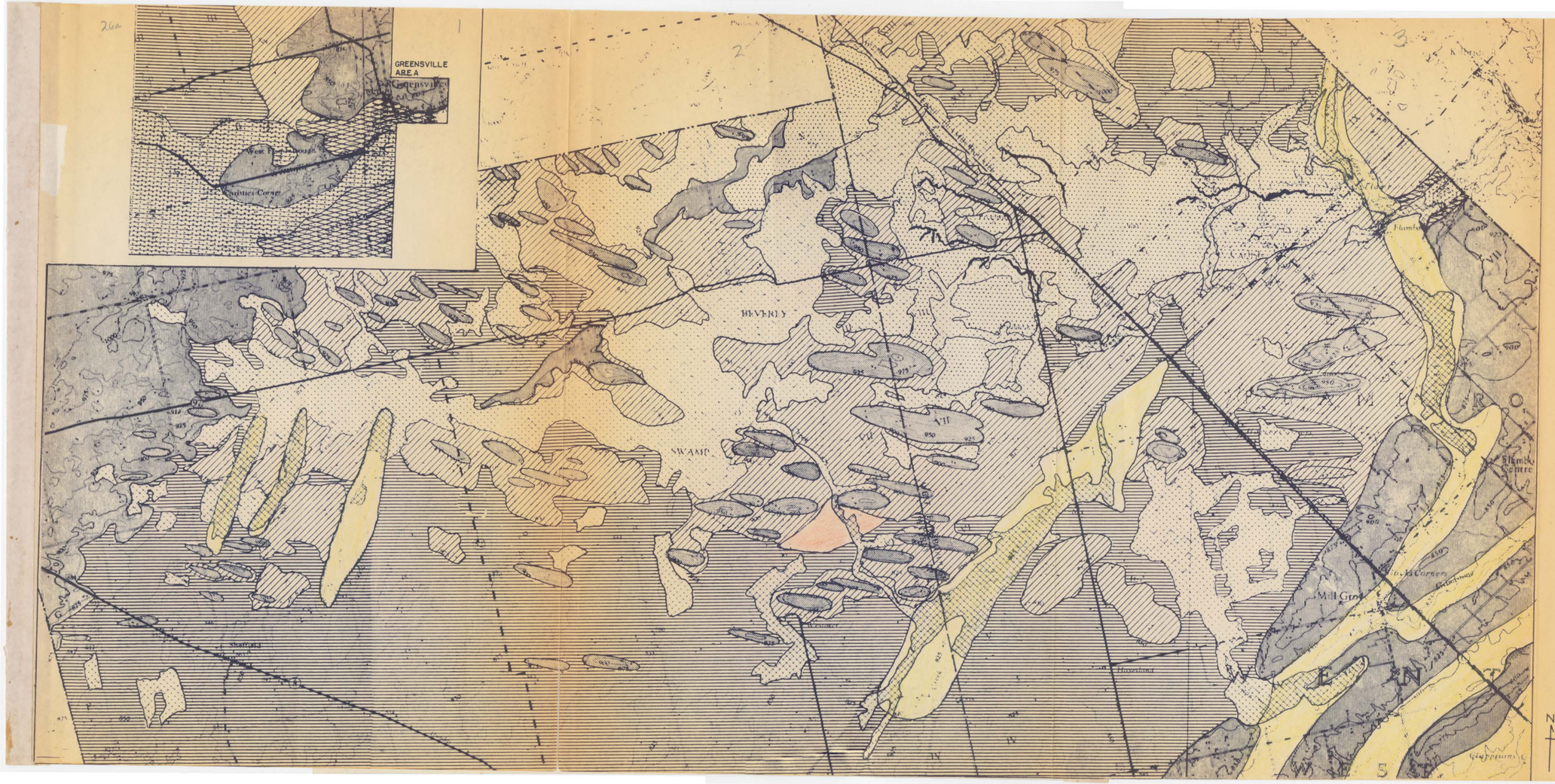
smaller areas of swampland also exist throughout northern Wentworth County. Most of the major areas of swamp are covered with muck and peat deposits usually less than five or six feet in depth.[7]

Raised Shorelines

At sometime during the slow fluctuating recession of the last ice sheet two glacial lakes were formed in the Lake Erie basin. These lakes were dammed between the ice front on the east and the Galt moraine and higher ground to the west and northwest, thus covering most of northern Wentworth County during their existance. The highest level lake covered most of the drumlin field leaving only the highest crests above water as a group of islands. The second lake, which existed at a lower level, extended mostly below the drumlin field. Raised shorelines at both levels occur on the most north westerly Flamboro moraine thus indicating that the ice front must have receded to some position southeast of this point during the existance of these lakes. Field evidence indicates there was probably a low level period between existance of the two lakes.* Both of these glacial lakes have left various raised shoreline features ranging from erosional to constructional forms throughout the area. The subsequent sections of this work will be concerned with a detailed analysis of these various shoreline features as elements in the total geographic entity of northern Wentworth County.

[7]Summary Report No. 285, Mines Branch, Dept. of Mines, Ottawa. 1913

*Differential upwarping of the two water planes suggests a low-level period of extensive eastward retreat of the ice front between the lowering of the upper (oldest) lake and the formation of the lower lake. See, "Elevation and Attitude of the Shorelines", Chapter 3 of this work.



Map no. 3

PHYSIOGRAPHY; NORTHERN WENTWORTH COUNTY.

SCALE 1:50,000

1 1/2 0 1 2

MILES

LEGEND

- LIMESTONE PLAIN
- TILL PLAIN
- TILL MORAINE
- KAME MORAINE & SEVERELY DISSECTED TILL MORAINE
- KAME DEPOSITS & CREVASSE FILLINGS
- ESKERS
- OUTWASH FAN
- DRUMLINS
- SPILLWAYS
- " (MARSH COVERED)
- SWAMP & MUCK
- ESCARPMENTS & DISSECTED SHALE
- COUNTY BOUNDARY
- TOWNSHIP "

COMPILED & DRAWN BY J. HORTON 1960-61

BASE MAP FROM NATIONAL TOPOGRAPHIC SERIES 1:50,000

SECTION 2

RAISED SHORELINES IN NORTHERN WENTWORTH COUNTY

CHAPTER 3

GENERAL INFORMATION

PREVIOUS WORK

At the time of this writing very little has been written regarding the existance of raised shorelines in northern Wentworth County. Indeed, the presence of these shorelines seems to have been overlooked almost entirely by most investigators. Leverett and Taylor indicated the probable extension of glacial lakes Whittlesey and Warren shorelines through the area on small scale maps as early as 1915.[8] They did not, however, support their assumptions with field observations in the area, thus no beaches were mapped, but rather an assumed general shoreline position was indicated. Writers after Leverett and Taylor have almost consistently ignored the possibility of shorelines this far north. Chapman and Putnam[9] suggest there was probably an extension of the Lake Warren shoreline through the area at an elevation of about 850 ft., but state that the highest recognizable Warren beaches occur on the Galt moraine to the southwest between Paris and St. George at elevations between 830 ft. and 840 ft. They make the comment that these elevations are some-

[8] Leverett, F., and Taylor, F.B., 1915: The Pleistocene of Indiana and Michigan and the history of the Great Lakes; U. S. Geol. Survey, Monog. 53.

[9] Chapman, L.J., and Putnam, D.F., 1951: The Physiography of Southern Ontario; Univ. of Toronto Press.

what higher than would be expected of a Warren beach. Their assumed extension of the Warren shoreline across northern Wentworth County at 850 ft. lies considerably below the lowest beaches found in the area by the author.

The question of highest "expected" elevations seems to have been the blindfold which has prevented the discovery of raised shorelines higher than Chapman and Putnam's assumed 850 ft. maximum level. Even works as recent as Hough's "Geology of the Great Lakes"[10] map the area as being mostly covered by the Ontario ice lobe during the existance of glacial lakes in the Huron and Erie basins. On the otherhand a B.A. thesis on Beverly Township written in the Department of Geography at McMaster University in 1958[11] briefly alludes to the existance of raised beaches in the Westover drumlin field. Staff members of the Geography Department at McMaster have also been aware of the presence of these beaches and this has led the author to undertake the present study. At the time of this writing the only published material showing any of the raised beaches in the area is Karrow's preliminary report on the "Pleistocene Geology of the Hamilton Map Area"[12], which covers a small section of the raised shorelines in Wentworth County. In this work Karrow indicates raised beaches on the drumlin east of Carlisle at approximately 875 ft. and 925 ft. He also suggests probable beaches at 875 ft. on the moraine southwest of Millgrove.

[10] Hough, J.L.
1958: Geology of the Great Lakes; Univ. of Illinois Press.

[11] McQueen, R.
1958: Beverly Township; Typed as manuscript, McMaster University.

[12] Karrow, P.F. (op. cit.) (accompanying map)

ELEVATION AND ATTITUDE OF THE SHORELINES

During the Pleistocene glaciation of North America the weight of the overriding ice caused deformation and depression of the earth's crust. Following the withdrawal of the Wisconsin ice sheets from Southern Ontario, isostatic rebound of the earth's crust occured, resulting in a general rise of the land to the northeast. As a result of this isostatic rise, the raised shorelines throughout northern Wentworth County have been upwarped to the northeast along an axis very close to the orientation of a line drawn through the hamlets of Freelton and Rockton. Unfortunately it is not within the scope of this thesis to precisely investigate the amount of upwarping the shorelines have undergone. It will be possible only to give a general statement of beach elevations throughout the study area. Although the lack of precisely measured elevations necessitates approximations, it is the author's opinion that the elevations cited throughout this work are representative of the general levels throughout the area.

The shoreline of the upper lake has undergone the greatest warping and rises from an elevation of approximately 905 ft. at the western boundary of the study area to slightly over 925 ft. in the northeast portion of the study area. This is a rise of about twenty feet in sixteen miles or approximately 1.25 ft. per mile. The younger, lower level shoreline is less strongly upwarped and rises from about 870 ft. at the western margin of the study area to around 880 ft. in the northeast, giving an approximate average rise of .75 ft. per mile. As a result of the difference in upwarping between the two shorelines, the water plains diverge increasingly to the northeast at an approximate rate of

0.625 ft. per mile. At the western boundary of Wentworth County the shorelines are approximately thirty-five feet apart. In the far northeast of the study area they are separated by an interval of approximately forty-five feet.

The fact that the highest shoreline has been the most severely upwarped strongly suggests that a period of extensive ice retreat between glacial substages probably occured during, and subsequent to, the recession of the upper lake, prior to the formation of the lower lake. During such a period of ice retreat upwarping of the highest shoreline would undoubtedly have occured. Although the extent of such upwarping cannot be determined, it would have been proportional to the amount of ice retreat and the length of time involved until the ice advance of the next glacial substage. Subsequent retreat of the ice sheets following the recession of the lower lake would again warp the upper beaches since they lie at the most northerly "end" area of the upper water plane, and also bring about the initial tilting of the lower beaches. Such a multiple warping of the upper shoreline seems likely to have been responsible for the present divergence of the water planes.

Lack of precise elevations and the relative shortness of the shoreline area under investigation in this thesis (slightly over sixteen miles), makes it virtually impossible to state which glacial lakes of the Erie basin formed the two raised shorelines in northern Wentworth County. Nevertheless in view of the vertical distance between the shorelines, their maximum elevations, and difference in upwarping of the two water planes, it is the author's arbitrary opinion that the

upper shoreline is probably related to one of the earlier glacial lakes in the Erie basin such as Wittlesey or Arkona. The lower shoreline on the otherhand is probably related to Lake Warren. An alternative interpretation would be that both shorelines represent the extreme northern divergence of the warped water planes of upper and lower Lake Warren. Such suppositions, however, are highly speculative and the answer to the question of which lakes occupied the area will have to await further investigation.

DELINEATION AND MAPPING OF THE SHORELINES

The shoreline features of both lakes have been determined primarily through field observations and the stereoscopic analysis of aerial photographs. In a few areas photo enlargements at 200 ft. to the inch were used. Morphology and distribution of materials were the major criteria for delineating the shorelines and their associated features.

The present raised beaches have been mapped on a scale of 1:50,000 using the National topographic series maps as a base. In a number of places it was found that the contours of the base map are in error. Due to the problems involved in changing the contours, however, this has only been done in a few cases. The beaches have been mapped as accurately as the scale would allow, and in cases where they seem to contradict the contours of the topographic map, it is the writer's opinion that the placement of the shoreline is the more accurate of the two. Despite the care taken to map the shorelines as accurately as possible the scale imposes some very severe limitations. In view of this it must be recognized that the shoreline symbols used are primarily

qualitative and are by no means an attempt at precise quantitative depiction. Although exaggeration has been necessary in order to depict certain features a conscious attempt has been made to keep this at a minimum.

In addition to mapping the present raised shore features, an attempt has been made to reconstruct cartographically the shorelines as they existed during the lifetime of the two lakes, showing depth contours, current, and wave movement, etc. Again it must be said that, due to the scale involved, the maps are essentially qualitative.

CHAPTER 4

THE UPPER LEVEL SHORELINE

PART A PRESENT SHORELINE FEATURES (SEE MAP NO. 4)

INTRODUCTION

The highest level lake was the first water body to cover the area during the last recession of the Ontario lobe. Shore features were left upon the Galt moraine and the high land to the northeast as well as on the drumlins of the Westover drumlin field. Shoreline elevations rise along a northeasterly axis from approximately 905 ft. at the west boundary of Wentworth County to just above 925 ft. in northeast East Flamboro. The shore features of this high level lake are almost entirely erosional forms. Analysis of these features will be on a regional basis.

REGIONAL ANALYSIS

Beaches on the Galt Moraine (Elevation 905 ft.-910 ft.)

Well defined shore bluffs have been cut in the till of the Galt moraine northwest of Sheffield. No gravel beaches were found along the moraine but a narrow sand beach of varying width seems to present at the foot of the bluffs in most places. These beach sands become more prevelant to the northeast towards highway No. 97. The Beach bluffs are most strongly developed at the most southerly point where the moraine leaves Wentworth County. Here the bluffs are about twenty-five feet high but exhibit moderate slope. Recent dissection has modified the bluffs somewhat. Elevation of the beach appears to be close to 905 ft. (see Fig. 9)

Fig. 9: Partially dissected upper lake beach bluff on the Galt moraine northwest of Sheffield. (Elevation approximately 905 ft.)

Fig. 10: Dotted line indicates where the upper lake strandline cuts across highway No. 52 north of highway 97. (View north along highway 52.)

Between Highways No. 8 and No. 97 the outline of the shore has been influenced by a number of small drumlins formed on the margin of the moraine. In most cases these drumlins have formed small points which projected out into the lake. The bluffs are best developed against these drumlins, and in a small sandy embayment immediately north of one of these drumlin points,at least three crescentic strand lines can be clearly seen on aerial photographs of the area. (lot 4 con. 8)

North of Highway 97 immediately west of Highway 52,the shoreline forms a fairly wide embayment which occupies most of the southern half of the concession block.* The northwesterly orientation of this bay has been determined by the presence of small drumlins on either side of the bay mouth. Here the shoreline has trended northwest parallel to the alignment of the drumlins. Bluffs are well developed on the north shore of this embayment indicating strong wave attack from the south. These bluffs are steeper than those to the south shown in figure 9. There is a distinct sandy beach at the base of these bluffs which tends to widen in the north central part of the bay. In contrast the west shore of this embayment is poorly developed indicating a protected lee environment from wave attack. Nevertheless a slight bluff development is distinctly visible and is characterized by a sandy soil at its base. As one moves up the bluff, there is a distinct change to till materials. Elevations appear to be close to 910 ft.

* (The southern portion of this bay is occupied by the western terminus of the Beverly swamp.)

where the beach crosses Highway 52 at the base of a small drumlin. (See Fig. 10)

Shoreline Features on the Drumlinized Till Plain North of Highway 97 (Elevations 910 ft. - 925 ft.)

East of Highway 52 the Galt moraine swings north into Puslinch Township. Between Highway 97 and the moraine lies a zone of drumlinized till interrupted by patches of limestone plain. A few drumlins have been formed directly on these limestone areas with little or no surrounding apron of till. Through this zone raised beaches extend in a discontinuous line to the east through concession 9 to the Beverly-Flamboro Townline. East of the Townline the beaches fade out except for a few disconnected bluffs in northern East Flamboro and West Flamboro Townships.

As on the Galt moraine, the main features are wave cut bluffs in the till deposits. In some cases the bluffs are extremely weak and difficult to trace. In addition to beach bluffs there are also areas where slopes have been over-steepened and slight terraces have developed. At least one drumlin shows distinct wave cut terraces, while others have been over-steepened on the lakeward side.

Examining this section in more detail, we find that immediately east of Highway 52 the shoreline trends northwest around another drumlin to form a similar embayment to that on the west side of the highway. The lakeward side of this drumlin has been slightly over-steepened by wave action. Bluffs have been formed along the north

shore of this embayment and a good deal of sandy material occurs at the base of the bluffs. At the present time this embayment is partially covered by a small section of swamp. Beyond the deeper sandy soils at the foot of the bluffs most of the embayment consists of poorly drained limestone plain. East of this embayment is a fairly large drumlin which has been over-steepened by wave action on its southwest side. East of this drumlin there is a gap of about three quarters of a mile until the next positive evidence of a shoreline is found. It is noteworthy, however, that throughout this gap the only overburden above the bedrock is almost pure sand except for a few poorly drained muck areas. The eastern end of this gap is bounded by a small narrow drumlin which cuts across Highway 97 one mile west of Valens. This drumlin shows distinct evidence of oversteeping on its southwest face and a slight terrace broadens out to form a wide wave cut bench around its northwest end. The strong erosional features on this drumlin have resulted from its exposed position to a long fetch from the southwest. Directly east of this drumlin is a small crescentic bluff which swings south along another, only slightly formed drumlin, from whence it trends northeast as a low sandy ridge just north of Valens. This ridge appears to have been a small sand spit built out across the mouth of a small embayment which, like the others to the west, extends in a northwesterly direction. (see fig. 11) This feature is one of the few constructional forms built by the high level lake in the study area. Immediately opposite this sand spit there is a ridge of till associated with

Fig. 11: The low sandy ridge of the Valens sand spit cuts diagonally across the ploughed field. Pines in the background occupy the western end of the spit.

Fig. 12: Very slightly terraced till directly north of Valens. This feature forms the north-east arm across the Valens embayment. Dotted line indicates the strand line. (Elv'n. approximately 915 ft.)

a large drumlin to the northeast. This ridge has been very slightly terraced and over-steepened by wave action. (See Fig. 12) The water level indicated by this strand line shows that the sand spit was probably just awash in the lake. The north face of the embayment is fairly well defined by a weak bluff. A drumlin within the embayment shows similar features. Bedrock outcrops in a small north-south escarpment ledge across the centre of the embayment. Only a little sand occurs throughout this bay.

East of Valens the shoreline is defined by narrow sand beaches at the foot of discontinuous beach bluffs cut in the till deposits. Immediately north of the Beverly Swamp beach bluffs are well defined and easily recognized. A distinct sandy beach is situated at the base of these bluffs and offshore sands extend right to the edge of the swamp in a few places.

In the concession block immediately west of the Beverly Townline the bluffs swing north around the swamp. An extremely steep bluff occurs on the west side of the swamp just south of the tenth concession. Stone free sand is again present at the base of the bluffs which, themselves, are composed of till. Northeast of the steep west bluff, the beach is recognizable almost to the Townline where it fades out amongst a jumbled mass of Kame deposits. A short bluff can be recognized in more even till moraine just west of No. 6 Highway.

East of number 6 Highway probable beach bluffs appear on the deeper till deposits. Relatively distinct strand lines also appear

in a chevron form on an outwash fan just west of Mountsberg. A probable shore cliff and terrace at 925 ft. seems to be located on the southern face of a drumlin directly north of Carlisle in the 10th concession of East Flamboro. East of this point the rugged thinly covered bedrock surface of northern East Flamboro Township has prevented any distinct beach development.

Raised Beaches in the Westover Drumlin Field (elevations 910 ft.-925 ft.)

The dominant beach features in the drumlin field are shorecliffs and wave cut terraces. Since most of the drumlins were steep sided islands in fairly deep water (25 ft.-50 ft.), almost no constructional work was accomplished during the relatively short existance of the high level lake.

Two or three facts stand out consistently in the drumlin field. First, almost without exception, the dominant shore features occur on the south face of the drumlins which were directly exposed to the strongest wave action. The protected north, or lee, side of the drumlins in contrast, shows little evidence of wave attack. Secondly, it has been typically at the weak "end areas" of the drumlins that the forces of wave attack have cut the largest terraces. Finally, it is clear that the most open and exposed drumlins east and west of the central group, plus the southernmost drumlins of the central group, have been subject to the brunt of wave attack throughout the area. The more enclosed northerly drumlins have been slightly protected, and thus do not show erosional shore features quite as strongly as the more exposed drumlins. This does not mean to say, however, that

wave erosion has not been severe in the more protected areas. It was evidently severe throughout the entire island system, but especially so in the most exposed southern areas.

Since all the shoreline features stand out clearly on the accompanying map, only a general discussion of the drumlin shorelines seems necessary.

Drumlins in the Sheffield area. The smaller drumlins of the Sheffield area were evidently entirely underwater during the existance of the upper lake. As a result they tend to be more rounded and subdued in form than the larger drumlins to the east. One or two of the higher drumlins in the area appear as though their crests may have been slightly bevelled and flattened by wave action. Lack of more positive evidence of wave action, and the small area involved in this probable bevelling have led to the omission of this feature from the map of shoreline features.

Drumlins east of Highway 52. Almost all of the raised beaches in the drumlin field occur east of Highway 52. Moving from west to east the first evidence of raised beaches occurs at Kirkwall. Here the southwest face of a small drumlin has been over-steepened to form a shorecliff which extends southeast right through the north margin of the road intersection in the hamlet. Just south of this shorecliff a similar oversteepened bluff occurs on the south side of a poorly formed small. Only a very slight sandy beach occurs at the base of these bluffs. Immediately east of Kirkwall there is a fairly large drumlinized ridge of till. Within this area one well formed drumlin lies in

Fig. 13: Horizontal bands of snow outline the narrow wave-cut terrace and shorecliff on the southwest face of the drumlin 1/2 mile due east of Kirkwall. Farm house is located at shoreline level on far side of the drumlin. (View of drumlin tail looking east.)

the northwest where it crosses the 8th concession road. On its southwest face a clear-cut narrow sandy terrace and shorecliff have been cut at approximately 910 ft. - 915 ft. (see fig. 13). South of the concession three or four poorly formed drumlins occupy the centre of the till ridge. The southern slopes of the larger drumlins in this group have been over-steepened to form distinct shorecliffs. No apparent wave cut terraces have been cut into the drumlins since the shorecliffs extend right to the basal till ridge. A very low drumlinoid ridge at the south edge of the till ridge has been reduced and modified by wave action to form a spit-like feature. The east end of this spit has been built out as a low sandy arm trending in a northerly direction to form a slight hook. The west end of the spit appears to have been almost joined to the shorecliffs of a drumlin just to the north by a strip of beach. At slightly lower elevations the entire till apron on which these drumlins have been formed appears to have been modified and bevelled by wave action. Most of the smaller drumlinoid swells on this apron of till have been bevelled by wave action with the result that the till ridge stands out above the surrounding rock plain as a flat sandy table in contrast to the bold relief of the large drumlins further east. Figure 14 shows the tabular form of this low, drumlinized till ridge. The rather exposed nature of this till ridge has apparently subjected it to more vigorous wave attack than the more protected drumlins to the east. About a mile and a half north of this till ridge there is a similarly planed off strand of moraine extending southwest of Valens which is outlined by the 900 ft. contour. The flattened crest of this

Fig. 14: Panoramic view of the wave-flattened till ridge east of Kirkwall looking south. Farmhouse on the left horizon is located on top of the till ridge above the limestone plain in the foreground. Slight drumlinoid swells appear at the right. (Contrast this subdued landscape with the well developed drumlins in figs. 18, 24 & 25.)

Fig. 15: Small morainic strand of till bevelled by wave action just southwest of Valens. The top of this feature is consistently flat throughout its length.

ridge appears to be about 910 ft. - 915 ft. elevation. (see fig. 15) The eastern portion of this morainic strand is higher since it merges with a poorly formed drumlin south of Valens. Here a distinct shore-cliff and probable wave-cut terrace have been cut into the south face of the drumlin. A narrow sand beach occurs at the base of the cliff. To the north, just southeast of Valens another high portion of the morainic strand stood out as a small island in the upper lake and is now outlined by a beach bluff and sandy materials.

South of the till ridge at Kirkwall a well formed drumlin in the northern part of the 6th concession block has been severely over-steepened along its south face and attests to the erosive strength of wave assault in this open area. The south face of this drumlin is undoubtedly the steepest shorecliff in the entire study area. Well developed wave cut terraces have been notched into the till as well as into the relatively weak Kame deposits at the ends of the drumlin. Little or no sand is present along the strandline and across the terraces of this drumlin.

To the south along the north margin of the 5th concession block, one mile east of Highway 52 is the southernmost drumlin of the Westover field. This drumlin, though probably small to begin with, has been further reduced in size by wave erosion along its south face. A distinct wave-cut terrace at least 200 ft. wide has been formed along the south face and extends slightly north around the ends of the drumlin. (see fig. 16)

Fig. 16: Wave-cut terrace and beach bluff on the south face of the southernmost drumlin in the Westover field. Terrace is about 200 ft. wide.

Fig. 17: Beach gravels found on the north (lee) side of the drumlin shown above. Elevation is approximately 910 ft.

Beach gravels occur on the northwest face of this drumlin where deposits three to four feet deep were built up along the relatively quiet lee shore. (see fig. 17) The elevation of these well bedded gravels is very close to 910 ft. or slightly above.

The Main Drumlin Field at Westover. Throughout the main body of the drumlin field all of the large drumlins have been definitely over-steepened on their southern slopes and most show evidence of strand-lines at the base of the shorecliffs by a more or less abrupt change in slope. This strandline zone is generally easily recognized in the field, and appears even more distinctly on aerial photographs. In only a few places is there evidence of strandline development on the northern, lee, sides of the drumlins.

Wave-cut terraces occur typically at the ends of the drumlins and especially across the steeper snout ends which face east. Along the southern line of outermost drumlins, narrow terraces occur along the south faces of the drumlins and also at both ends. Where they have been cut into both till and Kame deposits, these end terraces are generally covered by a thin layer of sand. In the Westover drum-lin for example, the end terraces have been cut into weak Kame fans splayed out around the ends of the drumlin (see fig. 18 cf. figs. 3 & 4).

Due east of Westover at the Beverly Townline is a small drumlin showing the most outstanding example of a wave terrace in the entire drumlin field. A large distinct terrace 150 ft. - 200 ft. wide has been cut across the east end of the drumlin and extends as a much narrower terrace along the south face (see fig. 19).

Fig. 18: Oblique view of the north side of the Westover drumlin showing the wave-cut terraces at either end. Both the barn on the left and the Westover Baptist Church on the far right have been built on the terraces. Gravel pit left of centre has exposed kame deposits on the flank of the drumlin. A similar pit occurs at the west end of the drumlin. (see figs. 3 & 4)

Fig. 19: The most prominent wave-cut terrace in the Westover drumlin field is seen at the right of this photograph. The oblique view does not convey a true impression of the size of this terrace. Buildings and farm lane are located on the extension of this terrace along the south face of the drumlin. Location, at the intersection of the Westover concession and the Beverly Townline. (Elv'n. approx. 920 ft.)

Just southwest of this drumlin is another small bevelled off drumlin formed on the same mass of till. It appears that these drumlins were never distinctly separate from each other as they merge with the till mass between them. Wave action, however, has reworked and modified this low col of till so that it now resembles a Tombolo linking the wave cut terrace of the northern drumlin with the flattened top of the southern unit. The reason for such a distinct and strongly developed terrace on the northern drumlin seems to be the combination of two factors. One is the exposed position of the drumlin at the southeast corner of the main group. The second factor has been the form of the drumlin. Rather than exhibiting the normal long, narrow, and relatively low form of most drumlins, this one is short, wide, and high, and as such it has been very susceptible to erosion by wave action. Immediately north of this well-terraced drumlin are two other drumlins showing terraces and shorecliffs on both ends, and on their southern flanks. Farther north the drumlins become larger and more protected with the result that distinct terraces have only been cut into the steep eastern ends. The southern exposures exhibit only a slight terrace development, (see fig. 20), though quite distinct shorecliffs are in evidence. In almost all cases throughout the main drumlin field relatively little sand occurs along the shoreline terraces and at the strandlines. Nevertheless, there seems to be a slight increase in sand deposits associated with the drumlin beaches in the more protected areas to the north. Recent excavations on the south face of the drumlin just east of Strabane have disclosed gravel beaches cutting across a heterogeneous till at about 920 ft. (see figs. 21 & 22) This is the

Fig. 20: Slight wave-cut terrace on a small drumlin in the north-central part of the Westover drumlin field. Dark horizontal band lies just below the terrace which appears as a grassy band just above.

Fig. 21: Horizontal beach gravels cutting across a heterogeneous till rubble at approximately 920 ft. on the south face of the Strabane drumlin.

Fig. 22: View showing wider extent of the beach gravels seen in Fig. 21.

only other gravel beach found beside that located on the drumlin southwest of Westover. (see fig. 17) It is interesting that despite the constructional gravel beaches, this drumlin also shows a steep shorecliff on the south side and a distinct wave cut terrace at its eastern end. The reason for this rather unexpected close proximity of erosional and constructional features appears to be that deposition of the gravels has taken place in a slightly protected recession along the south face of the drumlin.

South of the Strabane drumlin about one mile west of Harper Corners there is a small isolated drumlin which has been completely terraced on all sides by the highest level lake. This terrace is quite sandy and very distinct. (see figs. 23, 24 & 25) The unprotected position of the drumlin, plus its relative smallness compared to its height have combined to make it very susceptible to wave action resulting in a strong erosional shoreline. Beach elevation is approx. 920 ft. /

East of Harper Corners are two more drumlins in East Flamboro which have been terraced quite distinctly as a result of their exposed position. Significantly, the terraces once again occur on the southern exposures and around the ends of the drumlins with the southernmost drumlin exhibiting the strongest terracing and shorecliffs. Shoreline elevation is close to 925 ft./ The terraces are quite sandy, especially on the northern drumlin.

Raised Beaches on the Flamboro Moraine. (Elevation 925 ft.) For convenience the writer has arbitrarily assigned the name "Flamboro moraines" to the four moraines laid down by the last ice sheet parallel to the

Fig. 23: Panoramic view of the well marked upper terrace which encircles the small drumlin one mile west of Harper Corners in West Flamboro Township. View is to the north at right angles to the long axis of the drumlin. Beach elevation is approximately 920 ft.

Fig. 24: Looking west down the long axis of the completely terraced drumlin in West Flamboro. The clear-cut terrace clearly indicates how much of the drumlin was eroded away by wave action.

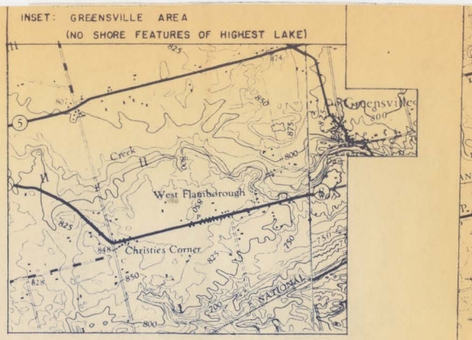
Fig. 25: Looking north down the short axis of the drumlin in figs. 23 & 24. Photo taken at right angles to fig. 24. Well developed terrace stands out as a horizontal line.

Niagara escarpment in the Flamboro Townships.

A beach was cut into the highest portion of the most westerly moraine near the Wentworth-Halton County line by the upper lake. This is one area where the contours of the topographic map seem to be in error. A well developed beach bluff about twenty feet high occurs near the county line with sandy stone free soil at the strandline and stoney till above the strandline on the bluff. (see fig. 26) From the contours it appears that the strandline couldn't possibly be higher than 910 ft. - 915 ft. This is inconsistent with all other evidence indicating a shoreline at least above 920 ft. in the area. Aerial photographs seem to indicate stereoscopically that the 900 ft. and 925 ft. contours are erroneous. The 925 ft. contour especially, seems impossible to reconcile with the relief seen in stereo photos. After a close study of both stereo photos and 200 ft. per inch enlargements, it is the writer's opinion that the base of the beach bluffs mapped is very close to the true position of the 925 ft. contour. Presuming this conclusion is valid, the location of the upper level bluffs on this moraine of necessity assigns the age of the highest lake to the recession of the last ice sheet which uncovered and formed the moraine since at any earlier period the moraine would not have existed. Lower level beaches on the moraine similarly assign the age of the lowest lake to the second ice sheet for the same reason. In addition,the presence of this relatively strong beach development on the most westerly Flamboro moraine indicates that during the lifetime of the highest level lake the ice front must have been standing "at least" as far east as the second most westerly moraine. The strength of beach development in this eastern zone, however, carries strong implications that the ice front must have been considerably farther

Fig. 26: Upper level beach bluff cut into the till of the Flamboro moraine.

back from the moraines during the existance of both lakes. This matter is more fully developed in the subsequent sections dealing with shoreline reconstructions.



SHORELINE FEATURES OF HIGHEST LEVEL LAKE

ELEVATION

SCALE 1:50,000

1 1/2 0 1 2

MILES

LEGEND

BEACH BLUFFS (CUT IN TILL)

WAVE CUT TERRACES

SHORECLIFFS

i) STRANDLINE EVIDENT

ii) OVERSTEEPENED DRUMLIN SLOPES (LITTLE OR NO STRANDLINE EVIDENCE)

SPITS & BARS (MODIFIED DRIFT FEATURES)

TOMBOLO

SAND BEACH

GRAVEL BEACH (KNOWN) GB

TOPOGRAPHIC CONTOURS 925

COUNTY BOUNDARY

TOWNSHIP BOUNDARY

N

SHORELINE DATA BY J. HORTON 1961

BASE MAP FROM NATIONAL TOPOGRAPHIC SERIES 1:50,000 . CONTOUR INTERVAL 25 FT.

(PART B) RECONSTRUCTION OF THE HIGHEST LEVEL LAKE IN WENTWORTH COUNTY

INTRODUCTION

In order to gain a clearer insight into the nature and origin of the present upper level raised beaches in Wentworth County, an attempt has been made to reconstruct cartographically the probable nature of the lake, its depths, water movement, and its entire shorelines in the county.

In this reconstruction the known beach features have been used as a guide for drawing the complete shoreline by interpolation across areas where little or no shoreline evidence exists today. Throughout interpolated areas due consideration has been given to the nature of the land on which the shoreline must have been imposed, the probable nature of the water movements and wave activity, and the probable elevation at which the shoreline would occur today. Aerial photographs were used extensively in reconstructing the ancient shoreline. Such factors as present day drainage, soils, relief, and vegetation, plus direct field investigation of many indistinct shoreline areas, have been weighed and used in combination with the other considerations listed, in an attempt to arrive at a reasonable copy of what probably existed some 10,000 or 12,000 years ago.

Since the map is essentially self-explanatory only a few comments seem pertinent.

In general the shoreline of the ancient high level lake was apparently very complex in its nature and outline. Similarly the movement of water throughout the area must have been equally complex since the nature of the bottom and the drumlin archipelago would have

complicated current movements and wave refraction considerably. Certain generalizations are apparent, however, and will be briefly mentioned.

LAKE CONDITIONS, WAVE ACTION, AND WATER MOVEMENT

Lake depths throughout the study area were complex as a result of the complex relief formed by the many drift features that were inundated by the lake. Bottom contours on the accompanying reconstruction map indicate the generalized depth pattern at twenty-five foot intervals. (see map No. 5) Along the central and eastern portions of the main shoreline there was a generally wide, shallow offshore zone. This zone was widest in the northeast and in the Valens-Kirkwall district where as far offshore as two miles, lake depths were less than twenty-five feet. In the west along the Galt moraine on the other hand, bottom depths increased to more than twenty-five feet relatively close to the shoreline. Most of the islands in the study area stood out in less than twenty-five feet of water except along the southermost margins of the archipelago where depths increased to fifty and seventy-five feet immediately offshore. It was throughout these deeper areas of minimal bottom friction that wave action was most erosive. In the extreme east, the valley of the Bronte Creek formed a deep trough which was at least seventy-five feet deep near Carlisle and 150 ft. deep at the eastern boundary of Wentworth County. The Flamboro moraines in the study area were, for the most part, under more than fifty feet of water.

The strong development of erosional shore features primarily on the south and southeast exposures of most of the islands, to the virtual exclusion of any shore features on the northern flanks, indicates the direction of the most consistent maximum fetch was apparently from the

south-southwest. This relationship is most strongly indicated by the shore features of most southerly islands of the archipelago. Here their exposed position has led to the development of wave-cut terraces predominantly along their south and south-eastern exposures. Terraces cut into the south-western end of some of these islands were generally fewer and less well developed than their south-eastern counterparts. Presuming the general outline of the lake was similar to that usually mapped for such lakes as glacial Lake Warren, where the shoreline follows the Galt and Paris moraines south to the Simcoe area and thence west along the southern margin of the "Ontario Island",[13] a maximum fetch into the study area from the south-southwest as indicated by the aforementioned shore features would be consistent with the overall spatial relationships of the lake. (see map No. 6)

In addition to the maximum fetch from the south-southwest, a secondary fetch of large magnitude from the east-southeast is indicated by the almost equally strong development of erosional features in the easternmost parts of the study area as in the western and central portions. The development of a terrace completely around the drumlin one mile west of Harper Corners, (see figs. 23, 24, 25) the erosion wave-cut terraces and shorecliffs on the two drumlins due east of Harper Corners, and the cutting of shore bluffs into the Flamboro moraine still farther east all seem to necessitate a strongly effective fetch from the east-southeast. A most important implication arises at this point. In order for a strong east-southeasterly fetch to have prevailed during the

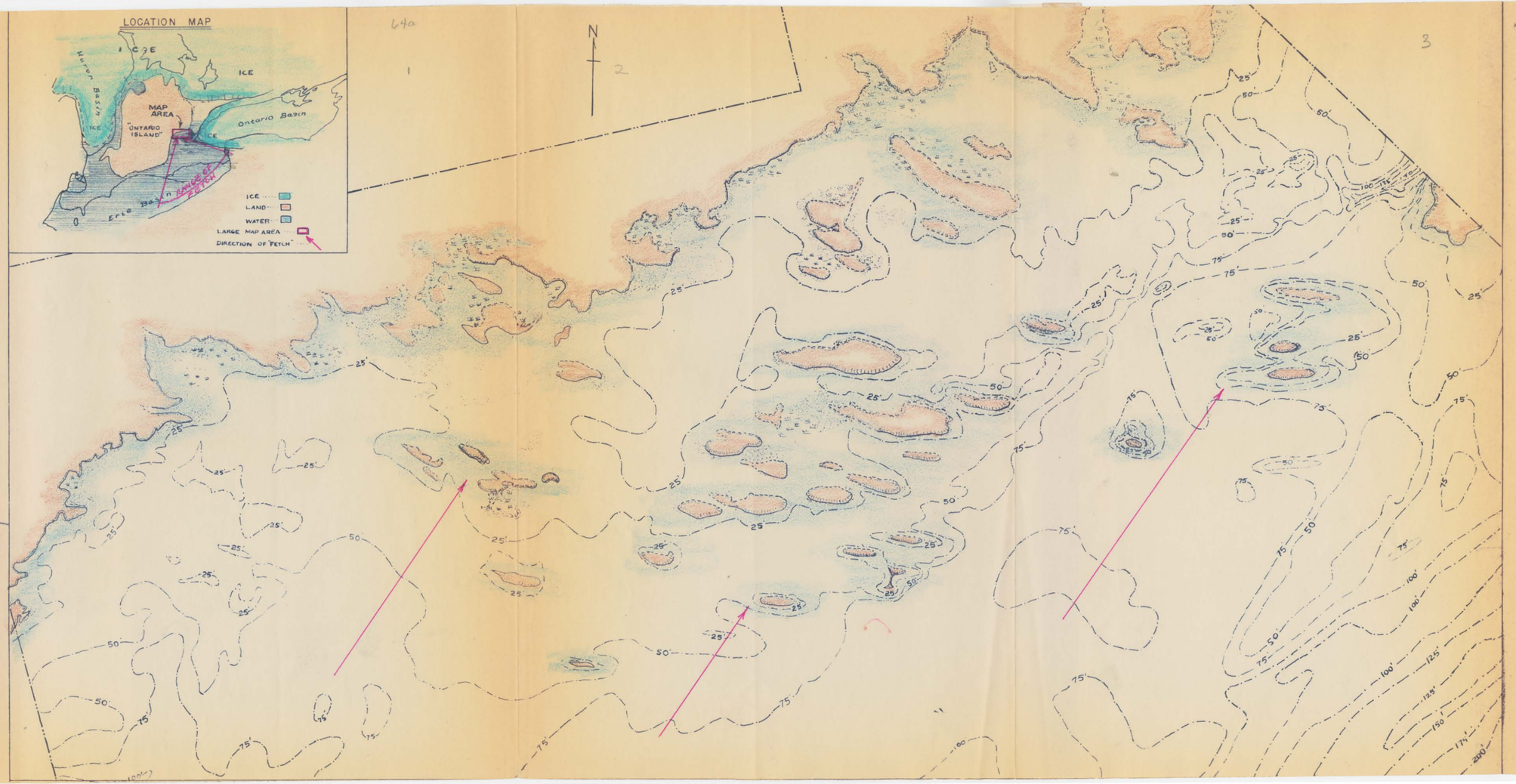
[13] Chapman, L.J., and Putnam, D.F. (ibid.) pg. 29, Fig. 21e.

existance of the high-level lake, the ice front of the Ontario lobe must have been in the Ontario basin below the Niagara escarpment at least as far east as 79° 45' longitude.[14] (see map No. 6) The ice front may have been even farther east than this, however, lack of further evidence forces this to remain supposition.

The range of fetch that was effective upon the shoreline in northern Wentworth County can best be described as a sector, bounded on the west by wind and wave action from the south-southwest, and on the east by the long fetch from the east-southeast. (see map No. 6) At any given time wave action would be generally from the south, but would shift throughout the sector in response to shifting wind conditions. As already mentioned, the most consistent fetch was from the south-southwest. Deriving from this most consistent fetch, dominant wave and current action in the study area was undoubtedly along a north-north easterly line. During storm periods the islands undoubtedly received the brunt of wave attack, while the main shoreline north of the islands was relatively protected, particularly in the far northeast. The main shoreline west of the islands would have received strong wave attacks mainly during times of storm. Complex wave refractions over most of the area must have occured due to the islands. Wave patterns were probably most consistent across the open area west of the archipelago.

[14] It is interesting to note that Fairchild indicated such an easterly position below the Niagara escarpment for the ice front, beginning with Lake Warren. Most writers subsequent to Fairchild have consistently mapped the ice front above the Niagara escarpment and indeed often so far west as to cover all of northern Wentworth County.

Fairchild, H.L.
1909: Glacial Waters in Central New York State: New York State Museum, Museum Bulletin 127, Plate 39.



Map no. 5

RECONSTRUCTED SHORELINE OF HIGHEST LEVEL LAKE

SCALE 1:50,000

1 1/2 0 1 2

MILES

LEGEND

- LAND AREAS
- WATER AREAS
- ICE FRONT
- SHORELINE DEFINITE
- SHORELINE INDEFINITE
- BEACH BLUFFS
- LITTLE OR NO BLUFF DEVELOPMENT
- SHORECLIFFS
- SPITS & BARS (MODIFIED DRIFT FEATURES)
- TOMBOLO
- SAND BEACHES
- GRAVEL BEACHES (KNOWN)
- MARSHY AREAS
- ISLANDS
- EMBAYMENTS
- DIRECTION OF GREATEST FETCH
- " " DOMINANT WAVE ACTION (EROSIVE)
- PROBABLE CURRENT & DRIFT PATTERN
- DEPTH CONTOURS (25 FT. INTERVAL.) (GENERALIZED)
- WENTWORTH COUNTY BOUNDARY

COMPILED & DRAWN BY J. HORTON, 1961.

Drainage along the ice front from the higher land to the northeast flowed into the extreme north-eastern arm of the lake probably beyond the study area.

THE MAIN SHORELINE

The main shoreline behind the drumlin archipelago was apparently quite indented with a series of embayments generally orientated in a northwest-southeast direction. Most of the embayments were very shallow and occured over areas of flat bedrock with little or no over-burden. As a result they were generally marshy. Along the main shoreline drainage into the lake was from the north and west off the back of the Galt moraine. Except in the extreme west where the shoreline is right against the moraine most of these streams flowing into the lake were probably extremely sluggish due to their origin among inter-drumlin swamps to the north of the shoreline. It seems almost certain from the nature of the land immediately north of the shore that many of the embayments were linked with extensive swamps and poorly drained areas back of the shoreline.

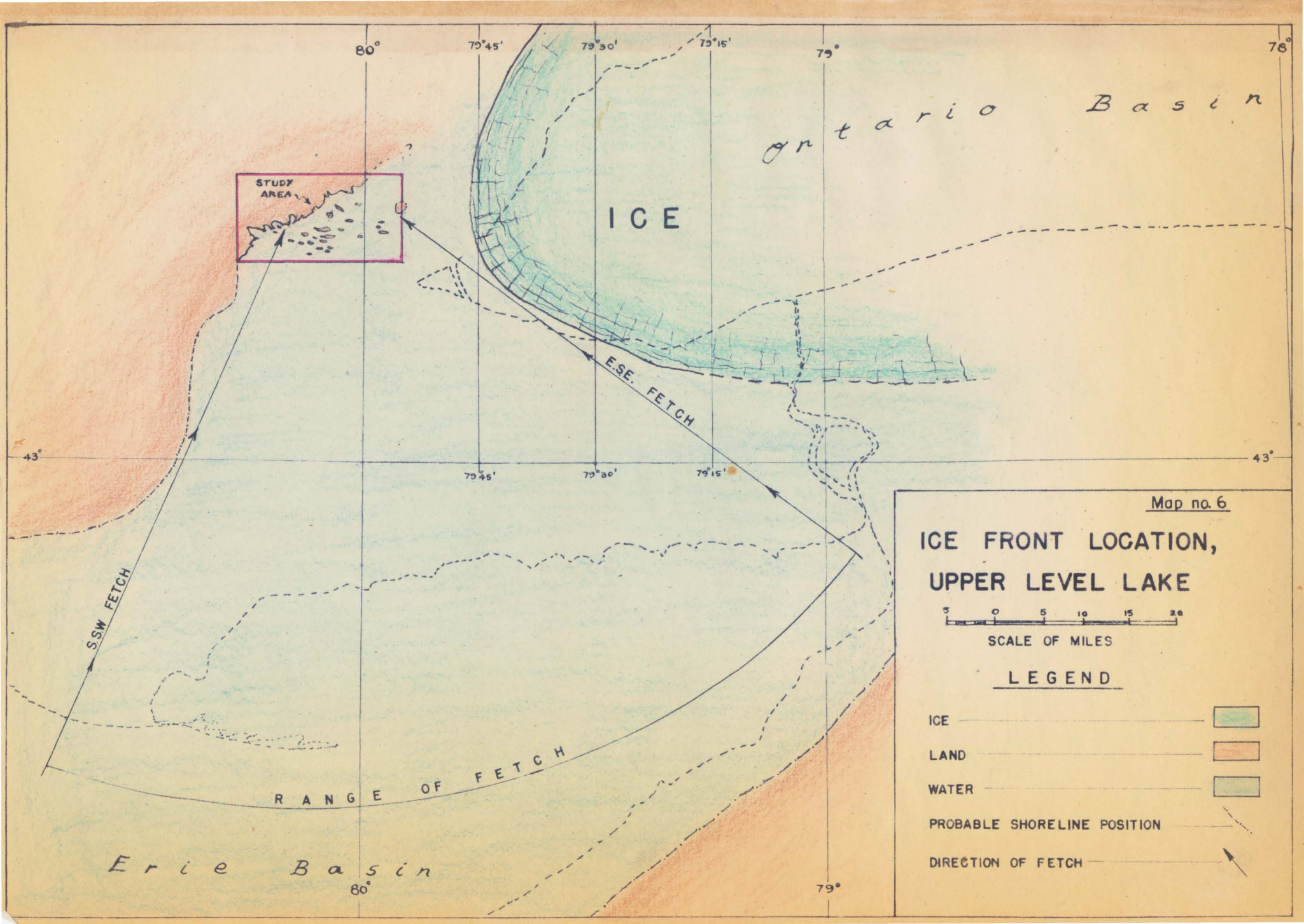
Beach bluffs were the most common shoreline feature where the shore abutted against the till deposits in the north. Beaches were sandy and narrow except in the most protected areas where they reached widths of 75 ft. to 100 ft. In the extreme northeast beaches were insignificant. Rather, there was a rocky bare shoreline since this is a zone of rough bedrock with little overburden.

THE DRUMLIN ARCHIPELAGO

Throughout the islands the bottom dropped off steeply from the

shoreline in most places except at the gently sloping tails of the drumlins. Shallow sandy terraces must have been just awash at the ends of many of the islands as well as along the south face of the most southern islands. Steep shore cliffs characterized the southern exposures of the islands while gentler slopes characterized the northern side of many of the islands. Gravel beaches were built up along selected areas of the quieter lee shores to the north. Sand was deposited in the quieter areas among the drumlins. It seems likely that a small marsh existed in a very shallow central area among the islands.

A number of areas were just awash such as around the islands of the Kirkwall district. It was in such areas of shallow water that the few constructional features were built.


80°
79°45'
79°30'
79°15'
79°
78°
Ontario Basin
STUDY AREA
ICE
E.S.E. FETCH
43°
79°45'
79°30'
79°15'
43°
S.S.W FETCH
RANGE OF FETCH
Erie Basin
80°
79°
Map no. 6
ICE FRONT LOCATION,
UPPER LEVEL LAKE
5 0 5 10 15 20
SCALE OF MILES
LEGEND
ICE
LAND
WATER
PROBABLE SHORELINE POSITION
DIRECTION OF FETCH

PART C EVENTS SUBSEQUENT TO THE LOWERING OF THE HIGH LEVEL LAKE

As the high level lake drained from the area a large marsh was left isolated in the lowest depression areas on the limestone plain between the central group of drumlins and the main shoreline. Drainage to the west was prevented by a low water parting just northeast of Kirkwall, formed by the pincer-like arrangement of the drumlinized till plain one half mile northeast of Kirkwall, and the southwest end of the morainic strand just to the north of this area. It seems probable that the material eroded out of the south face of the drumlin northeast of Kirkwall (see fig. 13) was deposited just to the north to help build this obstruction to the drainage of the area. West of this water parting the area was probably fairly well drained with only a small area of swamp being left in the extreme northern embayments. At the Beverly-West Flamboro Townline a slight north-south bedrock ridge in the 8th concession block prevented drainage of the marsh beyond this point to the east. The resultant area of impeded drainage corresponded to the central and northern area of the present Beverly Swamp.

An indeterminate period of time, perhaps a few hundred years elapsed until the water in the Erie basin once again rose high enough to enter northern Wentworth County and form the shorelines of the lower lake. In view of the stronger upwarping of the upper beaches it seems probable that there was an extensive eastward retreat of the ice sheet and some isostatic rebound of the earth's crust during this period. (see pg.31 of the work)

CHAPTER 5

THE LOWER LEVEL SHORELINE

PART A PRESENT SHORELINE FEATURES (SEE MAP NO. 7)

INTRODUCTION

During a later stage in the Erie basin a second lake was formed at an elevation high enough to enter northern Wentworth County and existed long enough to develop shoreline features throughout the area. This time the lake was some thirty-five to forty-five feet lower than the previous body of water, resulting in a southerly shoreline with only the very southern, and westernmost drumlins being isolated as off-shore islands. In general the shoreline extended along the line of contact between the areas of drumlinized till plain and the flat limestone plain. This location along a generally flat zone next to shorecliffs providing beach materials led to the development of more constructional features than were formed by the upper lake; however, like its predecessor erosional features were dominant. As in the case of the upper shore, the lower shoreline was also superimposed on the Galt moraine in the west as far north as the junction of highways 52 and 97. From this point the lower beaches swung south to form a large circular bay reaching as far west as Kirkwall. In the 6th concession block the shoreline once again swung northeast to the Strabane-Carlisle area. Due to post glacial crustal uplift the lower shoreline now rises to the northeast from an elevation of slightly below 875 ft. west of Sheffield to an elevation of 880-885 ft. near Carlisle.

REGIONAL ANALYSIS

The beach features will be briefly described on a regional basis.

Raised Beaches on the Galt Moraine (elv'n. 870-875 ft.)

As in the case of the upper beaches on the Galt moraine, the main features of the lower beach are beach bluffs. For the most part the lower shoreline exhibits a striking parallelism with the upper beaches since it trends around many of the same drumlins and promontories. (see fig. 27) Nevertheless the bluffs of the lower lake are somewhat more strongly developed than those of the upper lake in most places. The reason for this seems to lie partly in the fact that the lower shoreline is nearly at the base of the moraine where there is a natural break in slope between the moraine and limestone plain. Shorecliffs stand out clearly where the shore abutts against small drumlins at the edge of the moraine. Sand is found at the base of nearly all the wave-cut bluffs and shorecliffs of the lower lake, indicating a narrow beach. A very interesting constructional feature occurs just across the 8th concession road. Here, north of the concession, a small isolated drumlin which was probably once an island, has been attacked by wave action and modified by currents to form a sand spit southwest across the concession. Materials eroded from the drumlin have been transported southwest parallel to the shorecliff and deposited just south of the concession road to form multiple beach strands. These beach strands show up clearly on aerial photographs and display a curved or hook trend to the northeast. (Note accompanying map) The drumlin and the multiple spit are, in turn, linked to the main shore in the northwest forming a

Fig. 27: Close proximity of upper and lower level bluffs on the Galt moraine. Dotted lines indicate the base of the bluffs. Soils in foreground are extremely sandy, and are developed on the bottom deposits of a small bay just below the lower beach.

tombolo-like feature. Whether this is a true tombolo or not seems open to question since beach strands connecting it with the mainland are not clearly evident. Soils throughout this entire feature are, however, very sandy, especially to the west in the direction of transport. (see fig. 28) Just north of the sand spit the shoreline displays several curved strandlines in a same small embayment that contains similar features for the upper level beach. North-east of this embayment the shoreline continues in a saw-tooth series of points and embayments oriented almost due east reflecting the orientation of the drumlins. Near highway 97 the shoreline cuts around the same drumlins which formed the south arm of upper beach embayment just north of highway 97 and west of highway 52. A similar embayment existed on a smaller scale during the lifetime of the lower lake. A probable northern shoreline for this bay appears to be located slightly above the 875 foot contour in the form of a beach bluff cut into the base of the till deposits. A weak bluff seems to extend across highway 97 at the base of the drumlin till just east of highway 52. Beyond this point shoreline features cannot be traced on the shallow limestone plain across the Beverly swamp.

Raised Beaches on the Sheffield Drumlinized Till (elv'n. 870-875 ft.)

North of Sheffield, the highest areas of drumlinized till have been attacked by wave erosion of the lower lake. Shorecliffs appear at close to the 875 ft. contour where the southern exposures have been oversteepened. A very slight suggestion of terracing is found on the eastern ends of the largest drumlins. The most protected north sides

Fig. 28: Looking south over the limestone plain from the top of the small sand spit north of Sheffield built by the lower level lake. Note that the sandy soils of the spit are cultivated, whereas the shallow overburden of the limestone plain is largely in pasture.

of the drumlins shows little or no strandline evidence. Just northeast of Sheffield a very interesting beach feature is found straddling the southern end of the only curved road in the area. Here a poorly formed drumlin has been greatly modified by wave action and some material has been transported to the north to form a short double spit in an area where the presence of till just below the surface of the lake facilitated rapid sand spit development. The horseshoe-like feature thus formed, enclosed a small sandy bay which opened to the north. (see fig. 29) The frontal beach of this feature appears to be quite sandy below the wave-cut bluff on the south face.

In the far north in concession 8 two probable beaches occur on the southwest and southeast corners of a sub rectangular deposit of till.

Throughout the area north of Sheffield many small areas of shallow till deposits were evidently just awash in the low level lake. These areas which often fail to show up on the topographic map are typically sandy, subdued, and gently rounded with no sharp breaks in relief. (see fig. 30) Most of these areas are probably just below 875 ft. in elevation.

Shoreline Features Along Highway 52 (elv'n. 875 ft.)

Along the limestone plain north and south of Kirkwall only a few discontinuous beaches appear where deeper deposits of till occur. A probable sandy beach occurs just over one half mile north of Kirkwall along the south edge of the Beverly swamp just west of highway 52.

Southwest of Kirkwall a very slight beach bluff has been cut into the edge of the till surrounding a small drumlin. A shallow

Fig. 29: Looking north from the west arm of the "horseshoe" near Sheffield, across the small sandy bay enclosed by two spit-like arms of modified till and sand. East arm of the spit appears in background.

Fig. 30: Subdued till ridge modified by the waters of the lowest level lake appears as a gentle swell above the limestone plain in the foreground. Barn occupies the central portion of this drumlinoid ridge.

stone-free sandy beach occurs at the base of the bluff which is stony till. South of this beach there is no definite shoreline evidence for about one mile south across the flat limestone tableland. The sandy margins of a shallow till deposit on the table rock west of highway 52 in the southern part of concession 7 give only a suggestion of a former shoreline. East of highway 52 in the northern part of the 6th concession, however, a slight sandy beach curves southwest for nearly one half mile indicating a former strandline. South of this ridge there is a very, very slight sandy swell trending southwest of the highway in the form of a low sandy arm presumably built up by wave action. This feature which follows the 875 ft. contour, shows up distinctly on aerial photographs as a light better drained area above the surrounding poorly drained limestone plain.

Shoreline Features through the Westover Drumlin Field (elv'n. 875-880 ft.)

At the junction of highway 52 and the 6th concession road, the former shoreline swings east across the southern portion of the Westover drumlin field. The first shore features east of highway 52 occur on the lower southern slopes of two drumlins which run almost parallel to the concession road due east of the highway. On both drumlins there is an indistinct oversteepened basal portion forming a shorecliff. This is especially true of the more westerly of the two drumlins. At the base of these shorecliffs there are sandy deposits suggesting a beach very close to 875 ft. or just above. It is difficult to identify positive beaches in these areas; however, since they appear right at the normal break in slope between the drumlins and the surrounding limestone plain. The oversteepened south faces of the drumlins and the sandy soils are the best evidences of a strandline here.

In the central part of the 6th concession block a rather distinct bluff cuts east-west across the first road east of highway 52. This bluff represents the oversteepened south face of a small low drumlinoid swell. A narrow strip of sandy soil overlies the limestone plain at the base of this bluff.

One half mile to the northeast the shoreline again appears as a narrow sand beach at the base of a low bluff just south of a short, wide drumlin. From this point the shoreline extends in a more or less continuous line to the east across the relatively thin till deposits just north of the southern line of drumlins. Across this area most of the shoreline is marked by shallow discontinuous sand deposits at the base of a very slight break in slope.

Just west of the Westover road, the beach gives way to a rocky outcrop complex as a slight escarpment breaks through the shallow overburden. This area probably stood out as a rugged rocky shore in the low level lake although there are no traces of shore activity existing today. East of the Westover road the shoreline continues as a faint sandy terrace notched across the lower portion of the outwash fan north east of Westover. The fan lineations show a distinct truncation by the strandline when studied on aerial photographs. East of this fan the shoreline continues as a slight rise across low-lying areas, and as a faint bluff near the southern base of two large drumlins just west of the Beverly Townline. At the townline the shore comes up against the southeast end of a large drumlin and continues north-east around the drumlin as a sand beach at the base of a distinct shorecliff. From there it extends north east in a discontinuous sandy rise for about

one half mile. Paralleling this bluff is a large compound sand spit and bar which extends northeast toward Strabane. This feature is the largest constructional form found throughout the area. It has the appearance of a spit built mainly towards the northeast with a smaller extension built in the opposite direction to the southeast. Strand lines and lineations show up clearly on aerial photographs of the area. The spit is most strongly developed just south of Strabane and east of the Brock road. Throughout this section soils are extremely sandy with some areas being almost pure sand. The spit displays a "hooked" appearance at its northern end. This spit seems to have developed partly as a result of modification of a few small drumlin ridges in situ by waves, and the reworking of offshore sands from the former high level lake. The latter appears to have been the main source of beach materials for the area.

An exposure of the spit materials at the Brock road reveals cross bedded, medium to coarse, red buff sand. (see fig. 31) Farther northeast towards the end of the spit the sands become finer and are a mixture of reddish-buff and yellowish materials.

North of the Strabane spit the shoreline nearly encircles a fairly large drumlin as a sandy beach at the base of shorecliffs.

Very indistinct and discontinuous bluffs visible only on aerial photographs suggest there was an embayment northwest of the sand spit.

East of the Strabane drumlin the shoreline has been superimposed upon a large mass of till which has formed a promontory pointing southwest towards the Strabane drumlin. The beaches stand out clearly as very sandy flats at the base of well developed bluffs cut in this till mass. The shorecliffs are very steeply developed on the south side of

Fig. 31: Cross-bedded sand on the backside (north) of the Strabane Sand spit.

Fig. 32: Low subdued beach bluffs north of the northern arm of the Strabane embayment formed by relatively quiet water. Buildings occupy the top of the well drained bluff.

this feature and are close to 30-40 ft. high one half mile east of No. 6 highway. Strand lines and a slight discontinuous terrace occur at about 880-885 ft. at the base of the shorecliffs. The northern side of the arm shows a more subdued form and low beach bluffs are the distinctive shoreline feature. (see fig. 32)

Beyond the eastern end of the large till mass the shoreline fades out amongst the jumbled kame deposits around Carlisle due to the erratic topography and its protected position from strong wave attack.

South of Carlisle, well developed sandy wave-cut terraces and shorecliffs have been cut into the south faces of two large drumlins in East Flamboro. Here the shoreline seems to be close to 880 ft. A third drumlin just to the north was protected from wave attack by the other two and shows no signs of shoreline development. Probable beach bluffs do occur, however, on the more exposed east side of the till apron surrounding the drumlins.

To the west, the small drumlin near Harper Corners which is completely encircled by the upper level terrace also shows well developed sandy terraces cut by the lower level lake close to 875-880 ft. (see figs. 33 & 34) Two miles farther west terraces are also present on the southeast face of the two southernmost drumlins straddling the Beverly West-Flamboro Townline. Especially well developed, are the lower terraces on the southernmost drumlin. It is noteworthy that this is the same drumlin which shows such a well developed upper terrace. (see fig. 19) Beyond this drumlin to the west, the Westover drumlin appears to have been oversteepened near its base below the upper level strandline although the evidence is not especially clear-cut. Southwest of Westover a small,

Fig. 33: Lower beach strandline occurs as a horizontal terrace on the lower slopes of the drumlin one mile west of Harper Corners. (See also figs. 23, 24 & 25.)

Fig. 34: Oblique view of the drumlin shown in figs. 23, 24, 25 & fig. 33 above. Arrow indicates lower terrace at far right.

narrow drumlin shows very positive evidence of wave action and erosion close to 875 ft. where a slight terrace backed by shorecliffs has been formed on the south face.

All of these southernmost drumlins stood out as islands in the lower level lake but show no beach features on the northern sides, indicating only slight wave activity between the islands and the main shore.

Raised Beaches on the Flamboro Moraine

At the higher, eastern end of the most north-westerly Flamboro moraine laid down during the retreat of the last ice sheet, raised beaches occur slightly above the 875 ft. contour in a generally similar pattern to the upper beaches on the moraine. As in the case of the upper shoreline, the lower level features are shore bluffs cut into stony till and marked by very sandy deposits at their base. (see fig. 35) Most of the moraine below the bluffs of the lower level lake has been planed flat by wave action and stands out as a very distinct flat, sandy table. This bevelled moraine must have stood out as a huge shoal area just awash in the lower lake. (see figs. 39 & 40)

Raised Beaches on the Greensville Moraine (see map inset)

About five miles south of the study area proper, raised beaches also occur above the Dundas valley at the most southerly end of the second most north-westerly moraine. At this point the second moraine is actually farther west than the first strand which fades out south of Millgrove. Only on the highest areas of the moraine at Greensville are beaches developed. As in the case of beaches on the moraine to the

Fig. 35: Dissected beach bluffs of the lower level lake on the northwest face of the Flamboro moraine near the Wentworth-Halton County line. (Elv'n. approximately 880 ft.)

Fig. 36: Well developed beach bluff on the south face of the Flamboro moraine just west of Greensville.
(Note that in both figs. 35 & 36 the sandy beach soils are being used for cultivation while the steep bluffs remain as scrub and pasture.

Fig. 37: Flat water-bevelled sand table on the Flamboro moraine near Greensville appears as a flat-topped ridge in the central portion of the photo. Post-lake dissection has removed a good deal of sand in the foreground to form low swells and swales across the road.

Fig. 38: Dissected beach bluffs facing north just southwest of Christies Corners. Northern exposure has led to a gentler bluff development than the south-facing bluff in fig. 36.

north, the dominant features are wave-cut bluffs. It is significant that the most strongly developed bluffs face southward. Their southerly position far out into the lake was one of great exposure to the strongest forces of wave activity, hence the strong development of erosional features (see fig. 36). North of the large bluff at Greensville the moraine has been planed off at beach level to form a flat sandy tabular area, which was apparently just awash in the lake. (see fig. 37) Shoreline elevations in this area appear to be between 870 ft. and 875 ft.

Along the highest areas southwest of Christies Corners a few short areas of beach bluffs have been preserved primarily along the northern exposures since post-lake dissection into the nearby Dundas valley has destroyed most of the south facing bluffs in the area. The north facing bluffs have been relatively well developed by wave activity across the seven miles of open water between these outer islands and the main shore. This development contrasts sharply with the virtual absence of shore features along the north side of the islands in both lakes close to the main shore where the intervening water areas were narrow and relatively calm.

SHORELINE FEATURES OF LOWEST LEVEL LAKE

ELEVATION

SCALE 1:50,000

1 1/2 0 1 2

MILES

LEGEND

- BEACH BLUFFS (CUT IN TILL)
- WAVE CUT TERRACES
- SHORECLIFFS
  - i) STRAND LINE EVIDENT
  - ii) OVERSTEEPENED DRUMLIN SLOPES (LITTLE OR NO STRAND LINE EVIDENCE)
- SPITS & BARS (MODIFIED DRIFT FEATURES)
- SAND BEACHES
- TOPOGRAPHIC CONTOURS 875
- BEDROCK OUTCROP (AT BEACH LEVEL)
- COUNTY BOUNDARY
- TOWNSHIP "

N

SHORELINE DATA BY J. HORTON, 1960.

BASE MAP FROM NATIONAL TOPOGRAPHIC SERIES 1:50,000. CONTOUR INTERVAL 25 FT.

PART B RECONSTRUCTION OF THE LOWER LEVEL SHORELINE

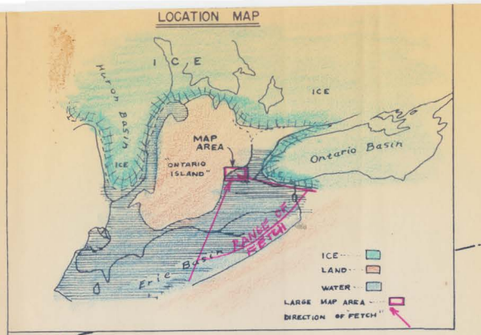
Employing the same methods used in reconstructing the upper level shoreline an attempt has been made to reconstruct the nature of the lower lake shoreline. In general the shoreline of the lower lake was slightly less complex, and not quite as well developed as the upper shoreline due to its more southerly position across broad uniform areas of limestone plain and shallow drift.

1. LAKE CONDITIONS, WAVE ACTION AND WATER MOVEMENT

Using the relative development and location of shore features as a guide, the direction of strongest wave action appears to have been similar to that in the upper lake. The location of wave-cut terraces principally on the south faces and east ends of the drumlins strongly suggests the line of greatest fetch was from the south or south-southwest. Such a conclusion is supported also by the orientation of constructional features to the northeast. In addition such a fetch would be consistent with the almost certain general spatial relationships of the lake. (see map No. 9) As in the case of the upper lake the presence of almost equally strong shoreline features in the east as in the west, necessitates a fetch of large magnitude from the east-southeast. The very strong wave-cut terraces on the drumlins just east and west of Harper Corners, plus the development of shore-bluffs and a flat water-planed surface on the first moraine east of Carlisle could only have been formed by a long fetch from the east-south east as well as from the south and southwest. Thus, as in the case of the upper lake, the range of maximum fetch can be mapped as a sector. In order for the east-southeast fetch to have existed the ice front must

Map no. 8

RECONSTRUCTED SHORELINE OF LOWEST LEVEL LAKE



SCALE 1:50,000

1 1/2 0 1 2

MILES

LEGEND

- LAND AREAS
- WATER AREAS
- ICE FRONT
- SHORELINE DEFINITE
- SHORELINE INDEFINITE
- BEACH BLUFFS
- LITTLE OR NO BLUFF DEVELOPMENT
- SHORECLIFFS
- SPITS & BARS (MODIFIED DRIFT FEATURES)
- BEDROCK OUTCROP AT BEACH LEVEL
- SAND BEACHES
- MARSHY AREAS
- ISLANDS
- EMBAYMENTS
- MORAINIC AREAS JUST AWASH
- DIRECTION OF GREATEST FETCH
- DIRECTION OF DOMINANT WAVE ACTION (EROSIVE)
- PROBABLE CURRENT & DRIFT PATTERN
- DEPTH CONTOURS (25 FT. INTERVAL) (GENERALIZED)
- WENTWORTH COUNTY BOUNDARY

COMPILED & DRAWN BY J. HORTON, 1961.

have been located well to the east, even farther to the east than its position during the existance of the first lake. (see map No. 9, cf. map No. 6) This conclusion is supported by a stronger development of eastern features along the lower shoreline than along the upper shoreline. (see map No. 10) Hence the sector of maximum fetch was probably somewhat larger in the lower lake than in the upper lake. (see map No.9 cf. map No. 6)

In most cases the north shores of the islands were protected from the direct assault of large storm waves since these could not develop in the narrow stretch of water separating them from the main shore of the lake. The islands also afforded some measure of protection for the main shore by absorbing the brunt of strong wave attack along their lakeward shores. Significantly the main shore beaches are weakest behind the islands and most strongly developed in those places where there were no offshore islands, such as along the Galt moraine and across the mouth of the Strabane embayment.

Overall, the net movement of materials along the shore was to the northeast in response to the prevailing winds and most consistant fetch from the south and south-southwest. Most of the beach deposits were derived from the offshore sands of the upper level lake and the wave-eroded glacial till and glaciofluvial materials. The most clear cut of the beaches thus formed is the large sand spit south of Strabane formed as a bay mouth bar across a broad shallow embayment.

In general the shore areas were quite shallow, being less than twenty-five feet deep for wide distances offshore from the main shoreline. In the central and western parts of the study area the twenty-five foot depth

contour lays from one and one half,to three miles offshore. From the Strabane sand spit eastward, however, the Bronte creek trough brought the twenty-five foot contour within one quarter to one half mile of the main shoreline. The very easternmost portion of the Bronte creek trough in Wentworth County attained a depth of just over 100 ft. to provide the deepest water in the study area. Most of the offshore islands stood out in less than twenty-five feet of water while the most northwesterly Flamboro moraine was just awash over most of its area. The other Flamboro moraines were under twenty-five to fifty feet of water.

As in the case of the upper lake, glacial meltwaters undoubtedly flowed along the ice front into the eastern end of the lake from the exposed highland areas northeast of Wentworth County.

2. THE MAIN SHORELINE

The main shore of the lower lake in Wentworth County was characterized by two distinct major sections, a relatively large complex embayment in the west, and a relatively straight shoreline throughout the central and eastern areas.

a. The Western Embayment

This embayment marked the most northerly extent of the lake along the Galt moraine which formed the west shore. The bay extended inland slightly over three miles and was some four and one half miles wide,east-west,across its mouth. A few small islands occured near the mouth of the embayment, while behind them there were a number of larger islands to the north. The entire bay was quite shallow, being less than twenty-five feet in

depth. Indeed, the extremely shallow northernmost section and the small bays of the west shore were so shallow and free from wave attack that they filled with marsh. It seems likely that the very marshy northern area of the embayment was connected to a large swampy zone to the east, left by the higher lake when it drained from the area since it would have been at about the same level. Along the west shore of the embayment promontories were eroded and shore bluffs cut into the till. The materials that were thus eroded from the shore contributed to the formation of a narrow sandy beach generally less than thirty to forty feet wide. One exception was a sandy compound spit at least 200 yards wide built southwest into a quiet bay which was protected from waves coming in from the south-southwest.

In contrast to the west shore, the east shore of the large embayment was almost without relief since the shoreline lay across the flat limestone plain. Offshore slopes were so gentle that waves lost most their energy to bottom friction before they reached the land. A few small beach bluffs were formed where the lake lapped against the deeper till deposits, but over much of the area no significant modification to the shoreline occured along the flat thinly covered bedrock. However, a shallow channel one quarter to one half mile wide between a small island of till and the main shore was covered by a thin deposit of sand.

The southernmost portion of the eastshore was formed by a broad but very low sandy point nearly a mile wide and three quarters of a mile long built up primarily from the offshore sands of the first lake. Much of this flat sandy shelf was probably just awash during periods of high water. Small marshy areas formed in depressions within, and on, the fringes of this

sandy point.

b. Central and Eastern Mainshore

In contrast to the indented western shore, the central and eastern part of the main shore in Wentworth County was relatively straight since it cut across the rather uniformly northeast-southwest southern margin of the drumlin field and the northern margin of the Bronte Creek trough.

The central section of the shore was particularly straight and was characterized by only a very slight change in slope at the strandline except for a few small areas of shorecliffs and one short section where the lake waters lapped against outcropping bedrock. Very little sand was present along this central shore.

East of the straight central shore a large sandspit extended northeast across the mouth of a sizeable marshy embayment west of the present hamlet of Strabane. As in the case of the western embayment it seems likely that this eastern bay merged with the large back swamp left by the upper level lake. A large, high arm of till extended southwest across the northern half of the bay mouth to almost merge with a large east-west drumlin which stood out as an island at the mouth of the bay. Only a narrow channel, about one quarter of a mile wide, separated the end of the sandspit to the south from the drumlin. The lakeward side of the northern arm across the bay was characterized by extremely steep shorecliffs at least thirty to forty feet high, footed by a narrow sand beach about seventy-five feet wide and a few small wave cut terraces. The very strong erosion along this part of the main shore resulted from the relatively deep water close to the shore which helped maintain most of the wave

energy for erosive work along the strandline, and a natural concentration of wave attack upon this portion of the shore. As the fetch shifted throughout the sector shown on map No. 9, wave attack would be focused along this area through either of the channels on either side of the small island one and one half miles directly offshore. (see map No. 8) In contrast to this, the bay side of the northern arm was protected from strong wave attack and was characterized by low beach bluffs and broad sandy beach deposits. (see fig. 31)

East of the high shorecliffs the main shoreline was more protected and was marked by only a very slight, discontinuous bluff cut into the Carlisle kame deposits and outwash gravels. The outwash gravels provided material for a very broad sandy beach. One mile west of the county line the shoreline probably swung north to form another fairly large embayment lying mostly outside of Wentworth County.

3. ISLANDS OF THE LOWER LAKE

In contrast to the situation in the upper lake, only the most southerly drumlins and areas of drumlinized till stood out as islands in the lower lake. They were fewer in number than the islands of the upper lake and they were distributed more evenly, in a single east-west line. The outermost islands of the western embayment were small drumlins in shallow water. Typically the south, or lakeward, side of these islands was oversteepened by wave action to form shorecliffs while the northern shore of the islands was relatively undisturbed by wave erosion. A small pseudo-sand spit was formed off the northeast end of one of these islands by wave modification of till deposits in situ. The northernmost islands

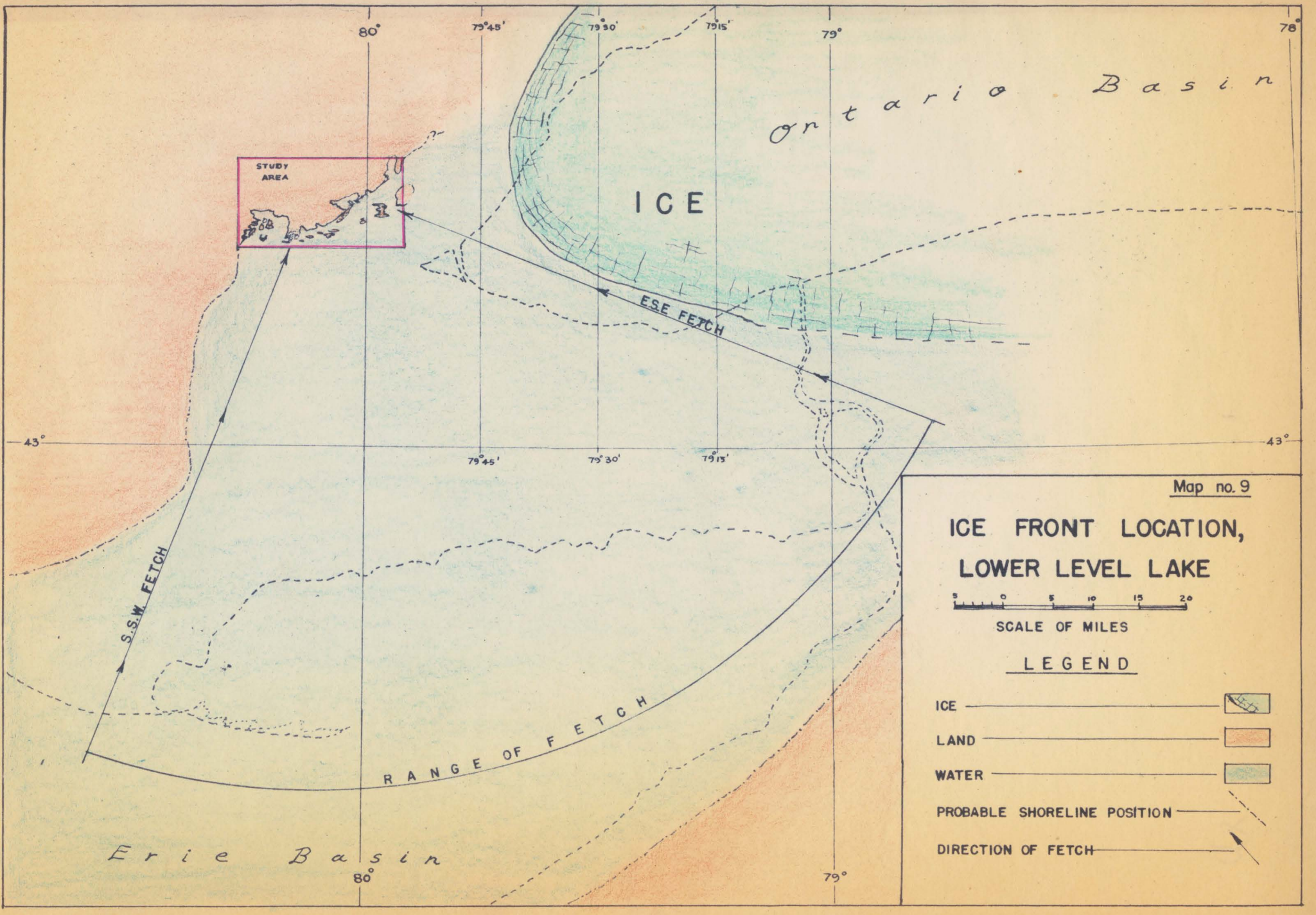
in the western embayment were typically wide low patches of poorly drumlinized till. Much of the area around and between these low flat islands was marshy and very shallow. Their protected position immediately behind the outermost islands of the bay allowed only a few distinct beaches to develop.

East of the large western embayment the most southerly drumlins of the Westover field formed a protective line one half mile to one mile out in the lake along the central section of the shoreline. The most easterly members of this group formed a distinct en echlon pattern paralleling the main shore to the northeast. Typically the southern and eastern exposures were oversteepened by wave assault to form shorecliffs while the lee shore on the north was undisturbed and often marshy. It is significant that the strongest wave erosion occured at the east end of this group where the water was deepest immediately offshore. East of the central group a three and one half mile gap, broken only by two small islands, occured offshore from the Strabane sand spit. Beyond the gap a large mass of drumlinized till stood out in the lake one and one half miles offshore. This island protected much of the main shore in the northeast from strong wave attack. However, on the island itself, shorecliffs and strong wave-cut terraces were formed, especially along the south shore. Very little sand was deposited off the shorecliffs, rather it was laid down in the more protected shallow lee areas which were probably partly covered by marsh.

4. LOWER LAKE SHORELINES ON THE FLAMBORO MORAINE

As in the case of the upper level lake beach bluffs were cut into the

till of the most north-westerly Flamboro moraine. Below the beach bluffs a large area of the moraine was planed flat by wave action and was just awash as a large shoal in the lower lake. Some seven miles offshore a few small islands were isolated out in the lake near the present site of Greensville where a high point of the second most westerly moraine stood above the lake level. Strong erosional features characterized the shoreline of these islands. In the same area a small portion of the moraine was just awash similar to the shoal area to the north.


80°
79°45'
79°30'
79°15'
79°
78°
Ontario Basin
STUDY AREA
ICE
ESE FETCH
43°
S.S.W. FETCH
RANGE OF FETCH
Erie Basin
Map no. 9
ICE FRONT LOCATION,
LOWER LEVEL LAKE
5 0 5 10 15 20
SCALE OF MILES
LEGEND
ICE
LAND
WATER
PROBABLE SHORELINE POSITION
DIRECTION OF FETCH

PART C EVENTS SUBSEQUENT TO THE RECESSION OF THE LOWER LAKE

1. AEOLIAN ACTIVITY

Immediately following the recession of the lower lake and before vegetation had established itself over the uncovered lake bottom, winds transported some of the finer lake sediments and deposited them as dunes in both offshore and onshore localities. At least two such wind blown deposits are known and the existance of others seems likely. One of the deposits found during the course of field work is a small dune on a former small island which was just offshore from the north arm of the Strabane embayment. The bright yellow loess of the dune stands out in sharp contrast to coarser red-buff beach sands nearby. The second area of known aeolian deposits occurs just south of the broad sandy point which formed the eastern arm of the large embayment of the lower lake in western Wentworth County. Here a wide crescentric depression at the foot of a small escarpment on the limestone plain has been infilled with very fine yellow loess similar to that found in the dune off the Strabane embayment.

2. ALLUVIAL ACTIVITY

As the lower lake drained from Wentworth County large areas of marsh in the Western and Strabane embayments were left isolated in depressional zones behind the former islands and baymouth arms. These poorly drained areas coalesced with the central swamp left by the recession of the upper lake to form a large east-west tract of impeded drainage. The present day Beverly swamp is the antecedant of this poorly drained zone and is

in effect a relic of the two glacial lakes which once covered the area.

As the lake continued to recede, regional drainage began to establish itself in its present form. The almost imperceptible water parting in the Beverly swamp north of Kirkwall divided drainage between the Erie and Ontario basins. At the present time the Fairchild creek and its tributaries drain the western area into the Erie basin via the Grand River. The eastern part of the swamp is drained by Spencer Creek and the Bronte Creek into the Ontario basin.

CHAPTER 6

RELATIONSHIP OF THE SHORELINES TO SOIL DEVELOPMENT, EROSION, DRAINAGE, AND VEGETATION

The raised shoreline features of both lakes have had important, if localized, direct effects upon soils, erosion, drainage, and vegetation, in northern Wentworth county. Since these effects have, in turn, influenced the land use and settlement pattern in the study area a brief consideration of their relationships to the shorelines will be considered.

SOIL DEVELOPMENT IN THE RAISED SHORELINE AREAS

One notable influence of the shorelines upon the soils is seen in the areas of sandy materials which have been laid down along the beaches. Here light textured sandy soils have developed. In some places along the Strabane sandspit, the sand content is so high, that soils are more accurately described as pure sand rather than sandy loams. Sandy loams are, however, found on most of the beaches and offshore sand deposits. These soils stand out in distinct contrast to the heavier soils developed on the till materials around them. The soils map of Wentworth County[15] indicates the presence of sandy loams on the largest areas of sandy shore deposits, but presumably for reasons of scale, the narrower sand

[15] Compiled by the Ontario Soils Survey, O.A.C., Guelph, who kindly allowed the author access to this most recent, and as yet, unpublished material.

deposits throughout most of the area have not been differentiated from the surrounding till loams.

Due to the difficulties in delineating and mapping beach sands as distinct from offshore, outwash, and deltaic sands, especially in East Flamboro Township, no attempt has been made in this thesis to map the soils developed from the sandy shoreline deposits. The distribution of these sandy soils follows very closely the distribution of sandy materials discussed earlier in the description of the upper and lower lake shorelines.

In addition to sandy soils the shorelines have had two other influences on the development of soils throughout northern Wentworth County. In a few places along the shorelines dark loamy soils rich in organic matter have developed over areas formerly covered by marshes of the two lakes. These areas are quantatively small, however, since many of the shoreline marshes were sandy. Of far greater importance has been the development of muck and organic soils rich in peat, over most of the areas still left in swamp by the recession of the two glacial lakes. The organic muck and peat of the Beverly swamp comprises the largest area of such soils formed under these conditions. The inclusion of these soils is justified by their close genetic and geographic relationship to the shorelines.

EROSION ALONG THE SHORELINES

The most apparent evidences of erosion are of course the shoreline features themselves. As has already been stated the dominant shore features are erosional forms such as wave-cut bluffs, steep

shorecliffs, and wave-cut terraces. Since they are the end products of wave erosion it is not unexpected that these features, themselves, have had an important effect on promoting continued sub-aerial erosion following the recession of the glacial lakes from the area. In view of the fact that a detailed quantitative study of post-glacial erosion along the shorelines is not within the scope of this thesis only qualitative generalizations can be made. Nevertheless such generalizations point up some very important relationships.

The most severe soil erosion in northern Wentworth County can be directly related to the areas of beach bluffs and the somewhat steeper shorecliffs. Along almost all the bluffs at least moderate to severe sheet erosion has occurred. On the steeper bluffs such as those cut into the Galt and Flamboro moraines, moderate to severe sheet erosion has occurred and, in some cases, severe gullying has developed resulting in a strong dissection of the bluffs. (see figs. 9 and 35)

More serious than erosion along the beach bluffs, however, has been the erosion of soil from many of the steeper shorecliffs throughout the drumlin field. As previously noted strong wave action from the south oversteepened the southern exposures of the drumlins which stood out as islands in the lakes with the result that many of the drumlins now exhibit a curious asymetrical cross-profile. To-day these south-facing shorecliffs are the steepest slopes in northern Wentworth County. As such, they have been very susceptible to continued soil erosion since the clearing of

their natural forest cover in the mid 19th century to provide land for the growing of wheat and other grain crops. As a result of these factors, sheetwash has been very severe on almost all the shorecliffs, especially among the southernmost drumlins. In the case of the Westover drumlin, which has a sharp knife-like crest due to the wearing back of the shorecliff, the steep south slope has been so severely eroded by sheetwash that little or no soil remains over most of the bare, extremely stoney till. Indeed, the erosion has been so strong that gullies are beginning to develop along most of the slope. In contrast, the north face of the drumlin has a longer, more gentle, slope which has suffered relatively little erosion compared to the south-facing shorecliff. (see fig. 18) This pattern of erosion is representative of nearly all the larger southern drumlins in the Westover field as well as those beyond the central group which were quite exposed to wave activity. In summary it can be said that the severity of soil erosion is generally proportionate to the wave-cut steepness of the shorecliffs and thus tends to decrease northward, among the more protected drumlins.

INFLUENCE OF THE SHORELINES UPON DRAINAGE

The most important effect the shore zones have had upon the regional drainage has been the creation of the Beverly swamp discussed earlier. The creation of this swamp as a relic of the former lakes has profoundly affected the regional drainage since it acts as a natural water storage area for the Fairchild, Spencer,

and Bronte creeks. At present the swamp plays an important equallizing role in retarding maximum stream flows and thus reducing the danger of downstream floods. In addition the swamp also contributes to continued stream flow throughout the watersheds in periods of drought. The present area of the swamp is approximately 1400 acres which is undoubtedly much smaller than the original zone of impeded drainage left by the glacial lakes. The shallow western fringes in particular appear to have been drained considerably since the land was first settled in the early 19th century. In most cases only shallow sandy soils have been uncovered by this drainage of these western fringes.

INFLUENCES UPON VEGETATION

The only outstanding influence of the shoreline areas upon vegetation has been the indirect creation of a dominantly hardwood swamp forest which has been maintained in the Beverly swamp. The major association is comprised of white elm as the dominant member, silver maple, aspin, and white cedar. No pure stands exist and in many places other species such as black ash, basswood and tamarach are present as secondary associations.

CHAPTER 7

PHYSICAL SUMMARY OF THE SHORELINES

PART A SIMILARITIES & DIFFERENCES BETWEEN THE UPPER & LOWER SHORELINES

Upon analyzing the nature of the two shorelines in Wentworth County a number of marked similarities and distinct differences have been apparent. These differences and similarities have been primarily a function of the various landforms on which the beaches have been superimposed, rather than the result of any dynamical differences between the lakes which formed the shorelines. A brief summary of the similarities and differences is given below.

SIMILARITIES BETWEEN THE UPPER & LOWER LEVEL SHORELINES

A. General Nature of the Shorelines

In both cases it may be said that the shorelines are very immature and complex as the result of two relatively short-lived innundations of a very complex glacial topography. The two glacial lakes existed long enough to leave distinct shoreline features throughout northern Wentworth County but not long enough to develop a mature shoreline by the wearing back of headlands etc., to give a relatively straight outline.

B. Elevation and Attitudes

Both the beaches have been upwarped to the northeast by isostatic rebound of the earth's crust.

C. Strength of the Shorelines across Wentworth County

Both the upper and lower shorelines show almost as strong a development in the eastern parts of Wentworth County as in the most western areas

of the county.

D. Location of the Shorelines

Both beaches follow an almost identical pattern along the Galt moraine in the western part of Wentworth County. Similarly, both beaches have been superimposed upon the first moraine east of Carlisle near the Wentworth-Halton County line. Both shorelines appear on drumlins of the Westover drumlin field and both seem to extend northeast into Halton County north of the Bronte Creek, although in both cases beach development is weak in the far northeast of the study area.

E. Shoreline Features

The dominant features of both shorelines are erosional forms which are best developed along southern and south-eastern exposures. Maximum development of erosional features for both shorelines is along lakeside of the southern islands. Along both shorelines relatively few constructional features were built. Those forms which do exist are largely the result of water modification of till and kame deposits. Both shorelines are characterized by beach bluffs, shore-cliffs, wave-cut terraces, sand beaches which are generally narrow, shoal areas which were just awash in the lakes, islands formed by the partial submergence of drumlins and other till deposits, tombolo-like features between islands, sand spits, marshy embayments along the main shores and around the islands, and indistinct beaches in the far northeast. The marshy embayments of both shorelines were connected to large areas of poorly drained backswamp behind the shorelines. In

general, on both shorelines the beach bluffs occur along the mainshore and on the moraines, while the steeper shorecliffs and wave-cut terraces are related principally to the drumlin islands.

F. Lake Conditions

In both lakes the maximum fetch and wave attack was distributed over a sector from the south-southwest and the east-southeast, with the most consistent wave activity coming from the south-southwest side of this sector. In both lakes the dominant wave action was strongly erosive along the south, and southeast exposures of the shorelines, especially where the lakes were deep immediately offshore. Longshore transport of materials resulting mainly from the dominant fetch and wave direction, was to the northeast, and built constructional forms in this direction in both lakes. In both lakes complex wave refractions occured among the islands. Drainage into both lakes was by small streams flowing south and southeast off the Galt moraine, and by a large channel of meltwater flowing into the lakes from the northeast parallel to the ice front.

G. Effects of the Shorelines

The shore features of both lakes have been instrumental in the development of sandy soils, dark organic-rich loamy soils in small localized patches, and large areas of organic peat and muck soils. The erosional features of both shorelines have been conducive to the development and maintenance of sub-aerial erosion on steep shorecliffs and beach bluffs. Both shoreline areas left large swampy areas on the landscape as the lakes drained and in so doing, indirectly led to the creation of the Beverly swamp and its present swamp vegetation.

DIFFERENCES BETWEEN THE UPPER AND LOWER SHORELINES

A. Elevation and Attitude

Although both shorelines are upwarped along a similar line to the northeast the high level water plane has been most strongly tilted and displays an average rise of approx. 1.25 ft./mile. The less strongly warped younger water plane in contrast has an average rise of approximately .75 ft./mile. In western Wentworth County the upper shoreline elevation is approx. 905 ft. while the lower shoreline is approx. 870 ft. In eastern Wentworth the upper shore is located near 925 ft./ while the lower shore is around 880 ft.

B. Location of the Shorelines

Although in certain sections the two shorelines have a similar location, the upper shore is generally much farther north than the lower shoreline. The main shore of the highest lake extends north beyond most of the Westover drumlin field, while the lower lake shoreline extends through the southern margin of the field. Correspondingly the upper lake had many drumlin islands offshore, while the lower lake had only a few islands offshore. In contrast to each other, the archipelago of the upper lake was located mostly in the central part of northern Wentworth County while the islands of the lower lake were more evenly distributed in an east-west direction parallel to the shore. Only in the lower lake where there islands far out in the lake in the Greensville area.

C. Relative Strength of Shoreline Development

Where they occur on the same landforms both shorelines are

equally well developed. In the general overall picture, however, the upper shoreline is by far the most strongly developed. The reason for this difference lies in the fact that the upper shoreline came into contact with more till deposits than the lower level shoreline which, along much of its length in Wentworth County, lay near the zone of contact between the till deposits and the limestone plain. Large areas of the lower shoreline were superimposed upon the thin overburden of the limestone plain and were unable to develop any prominent shore features as a result. In addition to this, the island shorelines of the upper lake were, in most cases, more strongly eroded because of the generally deep water immediately offshore as compared to the shallower offshore zone around most of the lower lake islands.

D. Features of the Upper & Lower Shorelines

Despite the fact that both shorelines display similar features, which are dominantly erosional forms, the relative number of such features varies considerably between the two beaches. The reasons for this variance are the different elevations and locations of the two shorelines, i.e. the patterns of superimposition.

As a result of the greater number of islands in the upper lake, the upper shoreline shows a correspondingly greater number of shore-cliffs and wave-cut terraces. In addition to this fact, gravel beaches, which were found only in two areas, both occur along the upper shoreline. In contrast, the lower shoreline is characterized by the development of larger and slightly more numerous constructional forms such as sand spits and bars. Another difference is in the relative extent of shoals

which occured in the two lakes throughout northern Wentworth County. In the upper lake only a few small areas in the west central section and the wave-cut terraces were just awash, while in the lower lake the large shoal of the Flamboro moraine occupied a considerably larger area. Another major difference occurs between the outline of the main shore of the two lakes. Due to the presence of numerous inter-drumlin hollows along its main shore, the upper lake was characterized by many small marshy embayments. On the other hand the shoreline of the lower lake formed fewer, but considerably larger and more complex, marshy embayments over broad areas of limestone plain and kame deposits.

E. Lake Conditions

The only major difference between the lake conditions under which the two shorelines were formed was the relatively deeper water immediately offshore from the many islands in the upper lake (50-75 ft. in most cases) compared to the much shallower offshore zone around the lower lake islands (generally less than 25 ft.). As already noted, this difference in depth affected the distribution of wave energy and was partially responsible for the stronger wave erosion of the upper level islands compared to that in the lower level group.

F. Effects of the Shorelines

The only apparent difference between the subsequent effects of the shorelines upon the physical geography of northern Wentworth County has been the relatively greater effect of the upper shore features in promoting sub-aerial erosion. The steep shorecliffs of the upper

beach have created far more serious erosional problems than have the features of the lower shoreline

PART B SHORELINE REGIONS & ASSOCIATED OFFSHORE ZONES

As a conclusion to the physical analysis of the raised shorelines in Wentworth County four shoreline regions and two associated offshore zones have been delineated. The basis of regionalization has been the homogeneity and similarity of physical characteristics of the shorelines in certain areas. The regions thus determined are not necessarily restricted to only one shoreline, but rather they include both shorelines in certain instances. Although the offshore zones are not technically part of the shoreline regions they have been included because of their intimate association with the ancient shorelines of northern Wentworth County. These regions and zones are as follows:

SHORELINE REGIONS

A. The Moraine & Till Plain Shore (Beach Bluff Regions)

This region is typically one of the narrow sand beaches and beach bluffs cut into fairly deep till deposits comprised chiefly of moraine and drumlinized till plain. Within the region,a few localized areas of wide sand beach occur. The type area for this region is to be seen along the east flank of the Galt moraine and includes both the upper and lower beaches. In addition,the region also includes the main shore of the upper lake north of highway 97 as far east as the Beverly-West Flamboro Townline, and the upper and lower level beaches on the Flamboro moraine in East Flamboro Township.

B. Central and Western weak Shore (On shallow Overburden)

This region includes the generally poorly developed lower shoreline on the limestone plain east of highway 52 and along the zone of contact between the till deposits and the limestone plain across the southern portion of the Westover drumlin field as far east as the Strabane embayment. In the east, only the southern sand spit of Strabane embayment is included in this region. Typically the beaches throughout this region are poorly developed sand ridges in the west and very slight wave-cut bluffs and ridges in the central area. The Strabane sand spit is the largest and most distinct constructional feature of the region.

C. The Island Shorelines

This grouping is the most distinct shoreline region in the study area. It includes all the island shorelines of both lakes and is typically characterized by a strong erosional shore on the southern exposures with wave-cut terraces and steep shorecliffs being the most prevalent features. The north arm of the Strabane embayment has been included in this region because of its similar character to the island shorelines. Throughout this region the northern shoreline of the islands is in most cases very indistinct. A few island areas, such as the northern group in the western embayment of the lower lake show few, or no, shore features at all.

D. The Northeast Shore

The unifying characteristic of this region is the insignificant beach development throughout the area. Beaches are typically poorly

developed and very discontinuous across the complex topography of kame deposits and the rugged thinly covered bedrock of the north-eastern portion of the study area. Included in this region is the main shore of the upper level lake east of the Beverly-West Flamboro Townline, the inner shore of the Strabane embayment and the main shore of the lower lake east of the north arm of the Strabane embayment.

ASSOCIATED OFFSHORE ZONES

A. The Zone of Shallow Water Embayments

This zone, which is closely associated with the main shoreline regions includes all the small embayments of the upper lake main shore, plus the two large major embayments of the lower shoreline and the few smaller embayments of the lower lake. Typically these embayments were marshy, and for this reason the few marshy areas associated with parts of the island shore region are included in this zone.

B. The Offshore Shoals

Because of their close association with beach development in both lakes, areas that were just awash have been grouped as offshore shoals. Included in this group are the small till plain and morainic shoals of the upper lake around Kirkwall, the Valens spit of the upper lake, and the large Flamboro moraine shoals of the lower lake.

RAISED BEACHES IN NORTHERN WENTWORTH COUNTY

(SHOWING ALL SHORELINE FEATURES FOUND)

SCALE 1:50,000

1/2 0 1 2
MILES

LEGEND

UPPER BEACH (HIGHEST LEVEL LAKE) ELV'N.

LOWER BEACH (LOWEST LEVEL LAKE) ELV'N.

BEACH BLUFFS (CUT IN TILL)

WAVE CUT TERRACES

SHORECLIFFS

i) STRANDLINE EVIDENT

(ii) OVERSTEEPED DRUMLIN SLOPES (LITTLE OR NO STRANDLINE EVIDENCE)

SPITS & BARS (MODIFIED DRIFT FEATURES)

TOMBOLO

SAND BEACHES

GRAVEL BEACHES (KNOWN) GB

ROCK OUTCROP (AT BEACH LEVEL)

TOPOGRAPHIC CONTOUR 900

COUNTY BOUNDARY

TOWNSHIP BOUNDARY

N

SHORELINE DATA BY J. HORTON 1961.
BASE MAP FROM NATIONAL TOPOGRAPHIC SERIES 1:50,000. CONTOUR INTERVAL 25 FT.

PART 2

CULTURAL GEOGRAPHY

CHAPTER 8

LAND USE IN NORTHERN WENTWORTH COUNTY

INTRODUCTION

Since it is essentially an expression of the interplay of forces including the physical on the one hand, and cultural, historic, and economic elements on the other hand, land use provides an excellent common denominator for a geographic analysis. It is, in effect, the meeting ground of physical and cultural geography. In any given area, any one of the multitude of contributing forces may be the dominant element in determining land use. Conversely no one element need be dominant above the rest. Virtually any combination of forces both in magnitude and number may be involved in determining land use. It is not within the scope of this thesis, however, to analyze in detail the total interplay of forces which has resulted in the present land use pattern throughout northern Wentworth County. Rather, it is the purpose of this thesis to investigate what effect, if any, the presence of the former shorelines has had upon land utilization throughout the study area. Since a complete isolation of this factor would be highly unrealistic, the overall land use pattern and its broad, physical, and cultural, controlling factors will be briefly considered first in order to provide a meaningful framework for the more specific question of shoreline effects.

GENERAL LAND USE PATTERN

Throughout the limestone plain most of the land is used for

pasture and the growing of hay and some grains. Large tracts of rough unimproved pasture occur over much of the land in the Sheffield area. Along the Galt moraine and throughout the drumlin field the land use is divided almost equally between pasture and the production of hay, and grain crops including corn. A few small, scattered parcels of land in these areas are used for the production of row crops such as turnips, beets and cabbage. Throughout most of northern East Flamboro and West Flamboro townships large areas of land are devoted to grain production and market gardening with the latter being especially prevelant on the Flamboro moraines. On the other hand in the extreme northern part of East Flamboro most of the land is devoted to hay and pasture. Much of the central part of the study area is covered by the Beverly swamp and other smaller swamp areas.

Physical Controls

The most important control of agricultural land use throughout the study area is the depth of drift. Cultivation is primarily on the calcareous soils developed on the deeper till deposits of the drumlins, the small patches of associated till plain, and the moraines and the deeper areas of outwash gravels and sands. In contrast with these better drained areas of relatively deep drift, the swamp and the limestone plains are not adaptable to cultivation and are generally left in woods or used for pasture and hay. The shallow soils of the limestone plain are often too wet in the spring

and dry out too rapidly in the summer to allow cultivation.

Except for a few minor instances where the road pattern has been either interrupted by swamp or where roads are forced to curve around a few topographic obstructions such as the tail of the Westover drumlin the physical landscape has had essentially no retarding effects upon the development of transportation or the location of villages and hamlets throughout the area.

Cultural and Economic Controls

The most important cultural-economic control of agricultural land use throughout the area is the proximity of large urban markets for agricultural products. Metropolitan Hamilton just ten miles south of the study area provides a market for high value market-garden crops which may be grown on the light sandy soils, and dairy products which are produced throughout most of the area. The urban centres of Galt, Oakville, and metropolitan Toronto also provide secondary markets for milk and other dairy products. The short haul market-garden crops are sold almost entirely in the Hamilton area.

RELATIONSHIP OF THE SHORELINES TO LAND USE

General Considerations

Although the former shorelines represent only one group of elements of the physical geography of Wentworth County, because they exert an influence on soils, erosion, drainage and vegetation, they have had a somewhat wider effect upon land use in certain areas

than would otherwise be expected. Nevertheless, despite the numerous shore features mapped (see map No.10) the general narrowness of the shoreline regions in the study area means that quantitatively the use of only a very small percentage of the total land in northern Wentworth County has been affected. Because the two offshore zones delineated in Chapter 7 are intimately associated with the shoreline area their effect upon land use will also be considered. A much larger area of land use is contained in these offshore zones than in the shoreline regions.

The most important effects of the shorelines have been upon agricultural land use; hence this topic will be the major consideration of this chapter. The accompanying map of agricultural land use was compiled from field observations and the study of aerial photographs taken in the late Spring of 1960. Despite the fact that the land use has been mapped on a field by field basis (with boundaries being eliminated between adjacent fields of similar land use) the narrowness of the shoreline regions makes it impossible to show detailed land use changes along these areas. These changes will, however, be discussed in the subsequent sections. In addition to agricultural land use a few other types of land use related to the shore features will also be considered.

Agricultural Land Use

Influence of the Shoreline on the Moraines and Till Plain. The most apparent influence of the shorelines upon land use in the morainic

and till plain areas has been the effects of the beach bluffs. Along the Galt moraine, the Flamboro moraine and the drumlinized till plain north of highway 97, the steeper bluffs are typically left in pasture, hay, or scrubland while the land immediately above or below the bluffs is often cultivated. (see figs. 35 and 36) The reason for this is twofold; first, the steepest bluffs are often too difficult to cultivate and secondly, they become susceptible to severe erosion when they are cultivated. Where bluffs, that have been left in scrub or hay, cut across an otherwise cultivated landscape they often form natural field boundaries separating areas of different crops. The strongest bluff development is generally on the most exposed south-facing slopes of the moraines and till plain and it is along these areas that the influence of the bluffs on land use has been greatest. In most cases the weaker bluffs developed in the more protected areas have not hindered cultivation except to require contour ploughing.

In addition to the influence of the bluffs, the beach materials of the moraimic shoreline region have also had a minor influence upon the character of land use throughout the area. In general the sand beaches of the Galt moraine and on the drumlinized till plain north of highway 97 are quite narrow; however, where they do widen out to cover an appreciable area such as around the lower level sand spit north of Sheffield and the upper level sand spit at Valens, the light sandy soils are used chiefly for row crops and market garden crops such as cabbages, turnips, field tomatoes, etc.

Almost all the small pockets of row and market garden crops north of highway 97 are associated with the beach sands. In contrast with these areas of row crops most of the till soils are used for the production of hay and grains or for pasture. On the Flamboro moraine on the other hand, the general sandy nature of soil has tended to obscure any effects of the beach sands along the immediate beach area below the bluffs.

Influence of the Central and Western Weak Shore. Throughout most of this region the shorelines have had almost no effects upon agriculture. The explanation of this lies in the fact that throughout most of this region the overburden is extremely shallow. As a result beach development has been generally weak and the overall influence of the limestone plain has been the dominant control of land use. The only appreciable effect the beaches of this region have had on land use has been in association with the Strabane sandspit. Along much of the sandspit the relatively deep, well drained, light sandy soils have provided an excellent base for the production of row crops and market garden crops such as potatoes, cabbages, turnips, and asparagus. These crops are almost entirely localized along the sandspit beyond which hay, pasture, scrubland and grain production form the dominant agricultural land use.

Influence of the Island Shorelines on Land Use. Of all the actual shoreline areas, the shorelines of the island regions have had the greatest effects upon agricultural land use. These effects have been

primarily of an indirect nature deriving from the strong wave erosion of the south faces of the islands. The most important effect has been along the zones of shorecliffs. Throughout these areas the erosion of soil from the oversteepened slopes has resulted in considerable deterioration of land along the south face of many of the drumlins. This deterioration was accelerated as the result of the indiscriminant clearing of the natural forest cover from these slopes in the mid 19th century and their subsequent use for cultivation in the early days of settlement. For example the severe erosion of soil from the south face of the Westover drumlin has rendered much of this slope agriculturally useless. Even as pasturage this land is of extremely poor quality, hence much of it has been left in idle scrub. In contrast, most of the gentler sloping north face which was unaffected by wave erosion provides fairly good pasturage (see fig. 18). A consistent pattern of different land use between the north and south slopes of the drumlins occurs throughout the Westover drumlin field wherever the south slopes have been oversteepened by wave action and subsequently eroded. Nearly all the steep southern shorecliffs are in hay, scrub, or very poor pasture (see fig. 16) whereas the less steep northern slopes are generally used for hay, some pasture, and grain production. Only a few exceptions occur where the shorecliff on some of the southern drumlins is relatively lower, and less steep, than most of those along the outer ring. The two best examples of this occur on the small drumlin just west of

Harper Corners (see figs. 23, 24 and 25) and the strongly terraced drumlin just north of the Westover road at the Beverly-West Flamboro Townline. (see fig. 19) On the other hand continued cultivation of the south slopes has been possible among the most northerly drumlins of the main Westover field where wave assault was relatively weak. (see figs. 13 and 20)

In general the extreme shallowness or complete absence of sand deposits over most of the wave-cut terraces has left these areas edaphically similar to the gentler slopes with the result that the agricultural land use is also similar. The danger of soil erosion over most of the broader terraces is much less than on any of the slope areas, however. One exception where agricultural land use on a terrace is distinctly different from that on the slope above once again occurs on the very exposed and completely terraced drumlin just west of Harper Corners. Here the terraces are wide enough to retain a covering of sand and provide excellent sites for the production of row crops such as turnips and cabbages, whereas the slopes above have been used for pasture, hay, and corn.

South of the main group of islands formed by the drumlins, the shorelines developed on the small islands at the south and of the Greensville moraine have also had an effect upon land use. Along the shoreline of the largest island the steep south facing beach bluff is suitable only as pasture and scrubland, whereas the sandy beach at the base of the bluff has been utilized for the cultivation of row crops and grains. (see fig. 36) The southern

beach bluffs of the island shorelines near Christies Corners have been dissected by recent drainage and are thus either left in scrubland or pasture, or used for small areas of silage corn. On the other hand most of the north-facing beach bluffs have been less steeply developed and are usable for cultivation of grains and corn along with the adjacent sand beach at their base. (see fig. 38) Since the land influenced by these outlying beaches is quantitatively very small no land use map has been drawn for the Greensville-Christies Corner area.

Influence of the Northeast Shore. Since the shoreline development in the far northeast of the study area has been relatively weak and insignificant the effect of the shore features of this area upon land use has been equally negligible.

Influence of the Offshore Shoals. Because of their quantitatively larger area the offshore shoals associated with the shorelines have had a more profound effect upon land use than have the shoreline region. These flat tabular shoal areas of light sandy soils have provided some of the best agricultural land in the study area. The most important area has been the most westerly Flamboro moraine which was flattened by waves and was just awash in the lower lake. The exceedingly flat nature of this land, plus its fine light sandy soils have provided an excellent physical base for market gardening. Throughout the entire shoal area this is the dominant land use with crops ranging from field tomatoes to potatoes, cabbages, turnips, asparagus, cucumbers, strawberries and raspberries. (see figs. 39 and

Fig. 39: Cabbages being grown on the light, sandy soils of the flat, water-planed Flamboro morainic shoal. The flatness of this former shoal in the lower lake has been an important asset to the market gardening activities of this area.

Fig. 40: Close-up of the long straight rows of cabbage seen in fig. 40. High-value row crops are grown over more than 80% of the former shoal.

40) In addition to the dominant market gardening some of this land is also used for hay, pasture, orchards and grains.

In contrast with the Flamboro shoal, the shoals of the higher lake around Kirkwall were under slightly deeper water and as a result they are neither as flat nor as sandy as the former. Despite this fact, the generally subdued topography of the area and its soils developed on sandy materials allows this land to be used primarily for grain and corn production, whereas the surrounding limestone plain is mainly in pasture. (see fig. 14) In addition a few fields of this shoal area are used occasionally for market-garden and row crops.

Influence of the Offshore Marsh Zone. The most important effects upon land use of the offshore marshes have been indirect. Since most of these areas occurred over limestone plain, even where they have been drained completely, the overburden is generally too shallow to permit cultivation. The drainage problems associated with the limestone plain overrides any favourable soil characteristics and thus relegates most of these areas to pasture land or hay production. In some places of deeper sands in the former marsh areas, grains are grown but in only a very few places are the soils used for row crops.

More important than the drained areas regarding land use are the zones which are still in swampland including the eastern, western and northern portions of the Beverly swamp. Although the central portion of the Beverly swamp was probably not a marsh in

the upper lake since it was under about twenty feet of water, its creation was genetically related to the incomplete drainage of the surrounding marshes with which it has merged to form the present day swamp. For this reason the influence of the Beverly swamp can be considered to be the indirect influence of the off-shore marshes and more especially, the drumlins, sand bars, etc. which prevented the complete drainage of these areas. Thus, as a result of these influences the present Beverly swamp prevents a large area of northern Wentworth County from being used for agriculture.[16] On the credit side, however, the swamp has acted as a natural water reservoir for the Spencer and Bronte creeks and has thus been indirectly beneficial to agricultural land use within these watersheds.

Location of Farmsteads, farmlanes and field boundaries

Throughout the Morainic and Island shoreline regions there is a distinct relationship between the location of certain shore features and the location of the farmsteads and other rural buildings. Along the shorelines on the moraines and till plain nearly all the farmsteads and other rural buildings are located on the flat well drained sites above either the upper or lower beach bluffs. (see figs. 27, 30 and 31) Even more striking has been the influence of the wave-cut terraces of the drumlins upon

[16]The total area of swampland in the study area is probably between 1500, and 1700 acres, of which 1400 acres is included in the Beverly swamp.

the location of farmsteads and other buildings. Throughout the drumlin field where the wave-cut terraces are well developed these flat benches have provided excellent well drained sites for the location of buildings. In most cases the only alternative sites have been the lower, interdrumlin flats, which have often been avoided because of their poorer drainage, or the comparatively less accessible drumlin summits. As a result, most of the rural buildings in the southern and central portion of the Westover drumlin field have been constructed on the widest wave-cut terraces, often at the ends of the drumlins. (see figs. 13, 18 and 19) The wave-cut terraces have also provided favourable level areas among the drumlin slopes for the location of farm lanes. Finally, both the base and summit of the beach bluffs, and the margins of the wave-cut terraces have provided natural field boundaries throughout much of the study area.

Reforestation

As a direct result of severe erosion along the shorecliffs, reforestation has been necessary in parts of the drumlin field. The Wentworth County forest on the east side of highway 52 in the 6th concession of Beverly Township covers one drumlin entirely and takes in much of the surrounding limestone plain. The drumlin that has been completely reforested in the tract had been severely oversteepened on its south face by wave assault in the upper level lake. Effective erosion control along this slope has only been realized since this reforestation. In addition to this drumlin a

few other smaller areas of shorecliff have been reforested. The severely gullied shorecliff and north slope of the drumlin in the concession 7, lot 29, of Beverly Township has been partially reforested with a rather open stand of scotch pine. One other very small area of reforestation occurs on the west end of the upper beach shorecliff on the strongly terraced drumlin just north of the Westover concession at the Beverly Townline. (see fig. 19) It is likely that the future will see more of these steep shorecliffs taken out of agricultural use and reforested if further erosion is not checked by careful land use practices. Indeed, it is the writer's opinion that all the steepest shorecliffs should eventually be reforested if effective soil conservation is to be realized throughout the area.

Recreational Land Use

The present Beverly swamp which has been formed by drainage obstructions to the former offshore marshes has, for a number of years, been important as a wildlife and outdoor recreation area. The swamp has favoured the abundant propogation of wildlife by preventing human occupance over a large area, yet at the same time it has also favoured hunting in the fall and winter since much of the land is relatively clear of water during these seasons. At present the major fauna of the swamp include some water fowl, grouse, partridge, rabbits, foxes, squirrels, muskrats, a few beaver, and an increasing number of deer. The fact that the last wolf was shot in the swamp less than ten years ago attests to its

protective nature. Indeed, despite the depletion and disappearance of some species in recent years, the Beverly swamp has still one of the greatest concentrations of wildlife to be found in Southern Ontario. The geographic location of the swamp close to the large urban populations of Hamilton, Brantford, Galt and Guelph makes it a readily accessible hunting area in the midst of an otherwise dominantly agricultural region.

Extraction of Resources

The shorelines throughout northern Wentworth County have been of little or no direct economic importance. The very limited quantities of beach gravels have not justified exploitation for commercial use or even for local farm use. Although many farm gravel pits occur consistently at, or near, beach elevations throughout the drumlin field, it is important that these areas should not be erroneously considered as evidence of the exploitation of beach materials. In almost every case where there are farm gravel pits they are located where kame and ice contact materials have been splayed out to the north around the ends of the drumlins. (see fig. 18) It has been these ice contact materials that have formed the basis for extraction and not beach gravels, despite the coincident elevations.

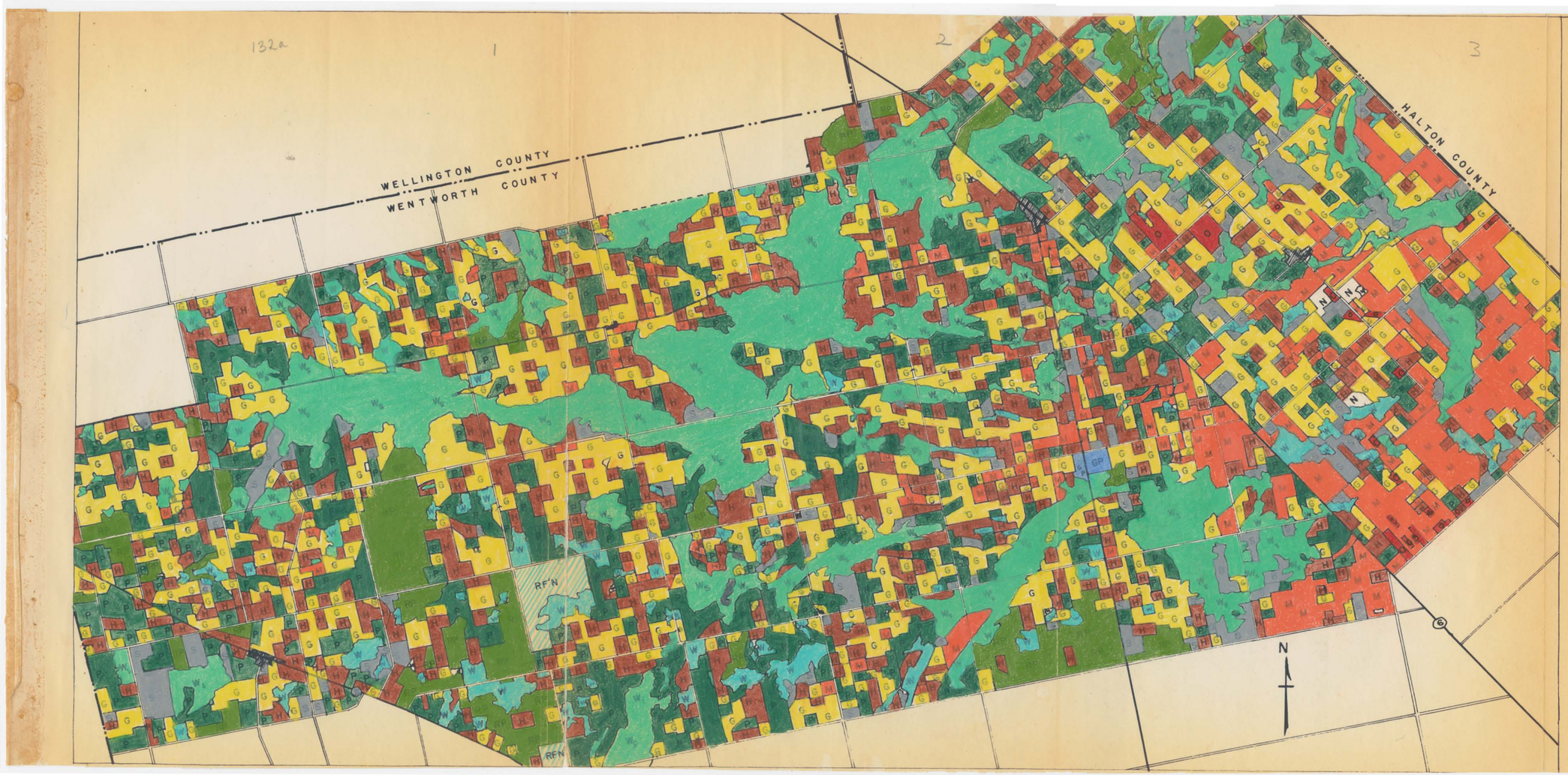
SUMMARY

The general land use pattern in northern Wentworth County reveals much of the limestone plain is devoted to pasture and the

growing of hay, whereas land use throughout the Galt moraine, the drumlin field and the drumlinized till plain, is divided almost equally between pasture, hay, and grain cultivation. In contrast, the Flamboro morainic land is largely devoted to market gardening and the production of row crops. The major regional controls of this land use pattern are the depth of drift and the proximity of nearby urban markets for agricultural products.

Although they represent only a small portion of the physical landscape in northern Wentworth County, the effect of the former shorelines upon land use has been extended through intermediate physical elements such as soils, drainage, erosion, etc. The bluffs of the morainic shoreline region have had to be left as pasture or scrubland in most cases. Sandy beach soils have given rise to a few small pockets of market gardening throughout this region. Except for the influence of the sand deposits of the Strabane sandspit in providing a good light soil for market gardening the beaches of this region have had a negligible effect upon land use. The steep shorecliffs and erosion of the island shore region on the other hand, have forced man to use these areas either as rough pasture, scrubland, or to reforest them. Cultivation is not possible due to the steepness of these slopes. Except in a few small areas of sandy soil the wave-cut terraces have not had any important influence on the type of crops grown. They have, however, provided areas of minimum erosion and relatively flexible land use. The sandy soils of the Greensville beaches

have favoured cultivation of row crops while the less steep bluffs of this area are used for cultivation of corn and grains. Beaches have had little or no effect upon land use in the far northeast of the study area due to their very poor development. The sandy offshore shoal of the Flamboro moraine has provided an important physical base for market gardening and has been used intensively for this purpose. The impeded drainage of the offshore marsh zone on the other hand has ultimately kept some 1400 acres of land out of agricultural use through the creation of the Beverly swamp. On the credit side, the Beverly swamp has acted as a natural water reservoir for the local watersheds. Outside of their influence upon crops, the beach bluffs and wave-cut terraces have provided important level, well drained building sites, as well as natural boundaries for fields. As a direct result of erosion along the steepest shorecliffs reforestation has been instituted in a few places but is needed in more areas. The Beverly swamp, as an indirect creation of the offshore zones in the lakes, provides an important wildlife and recreational area for the local urban populations. Beach gravels have not been of any importance as an economic resource, although many gravel pits occur in fluvioglacial deposits at beach elevations. In general, the former shorelines have had an appreciable effect upon land use in the study area despite their small aerial percentage of the landscape. Wherever these shorelines are well developed, their land use definitely differs from that above and below the shore zones.



4

AGRICULTURAL LAND USE

NORTHERN WENTWORTH COUNTY

SCALE 1:50000

1 1/2 0 1 2

MILES

LEGEND

- GRAINS (INCLUDING CORN) — G
- HAY & FALLOW — H
- MARKET GARDEN & ROW CROPS — M
- PASTURE — P
- ROUGH PASTURE (UNIMPROVED) — R
- SCRUBLAND — S
- NURSERY STOCK — N
- ORCHARDS — O
- WOODLAND (SWAMP ASSOCIATION) — Ws
- WOODLAND (WELL DRAINED) — W
- REFORESTATION — RFN
- COMMERCIAL GRAVEL PIT — GP
- VILLAGES
- HAMLETS
- MAJOR ROADS
- SECONDARY & TERTIARY ROADS
- COUNTY BOUNDARY
- RAILWAY LINE

CHAPTER 9

GENERAL SUMMARY

Northern Wentworth County is underlain by Paleozoic sedimentaries of Middle-Silurian age which dip gently to the southwest. During the Wisconsin glaciation in late Pleistocene times, continental ice sheets covered the area. In at least two or more advances, ice from the Lake Ontario basin moved in a westerly direction across the area and deposited medium to small scale drift features on the bedrock surface. The resultant physiography of northern Wentworth County is characterized by a small portion of the Galt moraine which cuts across the northwest corner of the County, a broad central section of limestone plain upon which the Westover drumlin field and the Beverly swamp have been superimposed, extensive outwash gravels and kame deposits, as well as a few small eskers in the northeast, and a low gently undulating morainic system on the dip slope of the Niagara escarpment in the Flamboro Townships.

At some time subsequent to the recession of the last ice sheet from the area, two glacial lakes formed in the Erie basin and extended eastward across northern Wentworth County leaving shoreline features at two different levels upon the landscape. It has been the main purpose of this thesis to investigate and analyze these features as elements of the physiography of Wentworth County and to illuminate their place in the geography of the area.

Previous works dealing with the glacial lakes of the Erie basin have largely ignored the existance of these shorelines so far to the northeast. Only a few of the earlier works in this century, such as Leverett and Taylor's classic monograph of 1915, suggest that some of

the lakes may have extended this far northeast. Even in these instances, however, no definite shorelines were ever mapped. Only Karrow's preliminary report on the Pleistocene geology of the Hamilton map area, published in 1959, definitely maps a very small portion of the shorelines.

Both water planes outlined by the raised shorelines in the study area have been upwarped to the northeast by isostatic rebound of the earth's crust following the removal of the ice sheets. The highest shoreline has an approximate elevation of 905 ft. at the western boundary of Wentworth County and rises at an approximate average rate of 1.5 ft./mile throughout sixteen miles to the northeast, where it reaches an elevation slightly in excess of 925 ft. near the eastern boundary of the County. The lower shoreline is less severely upwarped, and rises from around 870 ft. at the western edge of Wentworth County to about 880 ft. near the eastern boundary of the County. Although it was not within the scope of this thesis to measure and plot precise elevations for the shorelines, the stronger upwarping of the upper (oldest) shoreline is clear enough to suggest that a probable period of extensive eastward retreat of the ice front occured between the lowering of the upper lake and the subsequent formation of the lower lake. Isostatic rebound in such an intervening low level period would undoubtedly tilt the upper shoreline to some degree. When combined with recent post-Wisconsin crustal rise this initial tilt would account for the present differantial upwarp along the two shorelines. It is beyond the scope of this present work to identify the glacial

lakes which formed the shorelines across northern Wentworth County. Lakes Wittlesey and/or Warren are suggested, but further investigation is needed before a conclusive statement can be made.

Delineation and mapping of the present shore features was carried out only after extensive field work had been done. Direct field observations with particular attention to morphology and materials along the shorelines, supplemented by the stereoscopic study of aerial photographs, formed the major guide for delineating the shore features. To give a clearer insight into the nature of the former shorelines, cartographic reconstructions of the probable ancient conditions have been drawn. In order to arrive at these reconstructions, extensive use has been made of steroscopic aerial photographs, photo enlargements on a scale of 400 ft. to the inch, soil maps and data, and direct field investigations throughout many of the areas with indistinct shoreline features.

Shorelines of the upper level lake have been superimposed upon the Galt moraine in the west, the drumlinized till plain north of highway 97, throughout the Westover drumlin field, and on the Flamboro moraine near the Wentworth-Halton County line. With the exception of one small area the shore features of the upper lake are primarily erosional forms. Along the Galt moraine the dominant features are wave-cut bluffs fronted by a generally narrow sand beach along their base. Small drumlins along the margin of the moraine have formed a number of small east-west promontories separated by shallow embayments. North of highway 97 the shoreline outlines a number of larger embayments oriented northwest-southeast, parallel to the trend of the

drumlins in this area. Throughout the areas of deepest drift the prominent shore features are wave-cut bluffs and relatively narrow sand beaches. Shorecliffs occur on the south face of a few drumlins along the shore. Throughout most of the areas of thin drift and limestone plain, the shoreline is generally indistinct. This is especially true east of the Beverly-West Flamboro Townline where the shoreline becomes so indistinct and discontinuous that only a few small scattered areas of beach development on the deeper drift can be identified. On the Flamboro moraine, however, beach bluffs cut into the till distinctly record the former shoreline near the eastern boundary of the County. Throughout the Westover drumlin field the most characteristic shore features are shorecliffs along the south faces of the drumlins and wave-cut terraces along both the south faces and the ends of the drumlins. The steepest shorecliffs occur in the southernmost portion of the drumlin field. Wave-cut terraces or benches are best developed in the south and are generally absent in the more protected northern areas. A drumlinized till ridge near Kirkwall stood out as a small tabular shoal area in the lake. Throughout most of the drumlin field, sand beaches are generally very narrow and shallow. Only two small areas of gravel beach were found along the upper shoreline.

A reconstruction of the shoreline indicates that the coastal zone of the upper level lake was very complex and immature in northern Wentworth County. Most of the main shoreline was characterized by a number of small marshy embayments, while most of the drumlin field stood out as islands in the lake. The bottom contours of the lake

are essentially a reflection of the submerged glacial topography and indicate a generally shallow offshore zone except around the highest drumlins and along the deep trough of the Bronte Creek. The consistent orientation of strongest erosional features along the south and southeast exposures of the islands and the mainshore, indicates the most consistent maximum fetch was from the south-southwest. Strongly developed shore features in the eastern part of the County, however, indicates there was also an effective long fetch from the east-southeast. These two directions give rise to a sector through which the generally southerly fetch undoubtedly shifted in response to shifting wind conditions. In order for the east-south easterly fetch to have existed, however, the ice front of the Ontario lobe must have been located below the Niagara escarpment back in the Ontario basin at least as far east as 79° 15' longitude. (see map No. 6)

Subsequent to the recession of the upper level lake, the central and northern parts of the present Beverly swamp were formed by lake water being trapped on the limestone plain in depression areas behind the former drumlin islands. A probable low level period of an indeterminant number of years existed before the lower level lake was formed in the Erie basin.

With the rise of the Erie basin waters once again the lower level shoreline came into existance some thirty-five to forty-five feet below the now isolated raised shoreline of the upper level lake. As in the case of the higher shoreline, the shore features of the lower lake in Wentworth County are primarily erosional, although more constructional

forms were built than in the earlier lake. Along the Galt moraine in the west, the lower shoreline shows a striking parallelism to the upper shore both in form and outline. Beach bluffs and narrow sand beaches are the most characteristic features of the shoreline although one small sandspit does occur offshore where materials eroded out of a small drumlin have been transported southwest. East of the Galt moraine the shoreline cuts across the till deposit north of highway 97 parallel to the upper shore as far east as the west junction of highways 97 and 52. East of this point the shoreline becomes very weak and discontinuous across the limestone plain in a southerly line parallel to the east branch of highway 52. From highway 52 the shoreline cuts eastward in a relatively straight line across the deeper till of the main drumlin field as a low sandy ridge or slight break in slope. South of Strabane the shoreline forms a large sandy hooked spit which extends northeast across the 7th West Flamboro concession block, with a smaller minor spit extending in the opposite direction into the 6th concession. Beyond this spit, which is the largest constructional feature in the study area, the shoreline continues in a north easterly direction around a large drumlin and a large indistinct mass of till to form a south westerly extending promontory. Along this promontory there is a distinctly weaker shoreline development on the northwest side than on the lakeward side of the feature. Beyond this promontory one half mile east of No. 6 highway the shoreline fades out entirely among the jumbled kame deposits near Carlisle and the shallow overburden to the northeast.

On the Flamboro moraine, however, the shoreline exhibits a similar outline and form to that of the upper beach. Throughout the drumlin field south of the main shoreline most of the drumlins exhibit wave-cut terraces and shorecliffs along their southern and southeastern exposures. Lower lake beach bluffs have also been cut into the till of the highest southern area of the Flamboro morainic system in the Greensville - Christie's Corners district. Except for the Strabane spit, the Flamboro moraine, and the broad sandy ridge in the 6th concession block near highway 52 in Beverly Township, sand deposits along the shoreline are narrow and small, while beach gravels seem to be entirely absent.

A reconstruction of the lower shoreline reveals that, similar to upper lake, it was of a complex nature in Wentworth County, although relatively simpler. Most of the land between the Galt moraine and highway 52 was covered by a large marshy embayment with a number of broad, low islands in its central portion. This shallow embayment was probably connected in the east with the large central area of swamp left by the upper lake. The east shore of the embayment was characterized by a broad, low sandy rise which was probably just awash in times of storm. Beyond this point to the east, the main shoreline was marked by a very weak beach development. Offshore, a number of small islands were formed by the southernmost drumlins of the Westover field. In the Strabane area a large embayment was virtually cut off from the lake by the sandspit and northern promontory of till which formed two opposing arms across its mouth. As in the case of the western embayment, this area was shallow and marshy, and was probably

connected with the central swamp left by the upper lake. East of the Strabane embayment, beaches along the main shoreline were insignificant and poorly defined, partly as a result of their protected position and also due to the nature of the land in the northeast. The most northwesterly Flamboro moraine formed a flat sandy shoal which was just awash in the lake below the beach line. A few small islands with steep south facing bluffs and sandy beaches were isolated out in the lake some seven miles offshore near the present site of Greensville. A small shoal area existed just north of these islands. Due to its location over much of the limestone plain, the lower shoreline was characterized by a very shallow offshore zone. As in the case of the upper lake, the strongest erosional features developed on the south and southeastern shoreline exposures. This, plus the building out of constructional features to the northeast indicates the most consistant maximum fetch was from the south-southwest. Similarly, strong erosional features in the eastern part of the County indicate a secondary long fetch was effective from the east-southeast. As in the upper lake, in order for a fetch to have prevailed from the east-southeast, the ice front must have been below the Niagara escarpment east of 79° 25' longitude.

Subsequent to the lowering of the lower lake, large areas of the two major embayments in the east and west were isolated in depressional zones behind the former islands and spits of the lake. These poorly drained areas coalesced with the central swamp left by the upper lake to form a large ancient predecessor to the present Beverly swamp. In addition a few small sand dunes of yellow loess were formed by

aeolian activity, until vegetation became stabalized over the recently drained areas.

Both shorelines have affected local soils, erosion, drainage, and to a lesser extent, vegetation, throughout the study area. Former areas of beach sands and shoals have given rise to light sandy soils. Some of the former offshore marshes have left small areas of organic rich soils, while the legacy of the ancient swamp has resulted in over 1400 acres of poorly drained organic soils and peat throughout the present-day Beverly swamp. The slopes of the beach bluffs have given rise to moderate to severe sheet erosion. Along the steepest shorecliffs of the drumlin field, sheet erosion has been everywhere severe, and indeed has advanced to the point of severe gullying in some places. The creation of the Beverly swamp has formed a natural reservoir for the local watersheds, and has resulted in swamp vegetation over much of the study area.

As a summary to the physical analysis of the raised shorelines, a number of similarities and differences between the two shorelines have been listed. The most important similarities have been the general immaturity of both shorelines, the predominance of erosional features, the location of both shorelines on the Galt moraine, the drumlin field and the Flamboro moraine, the general similarity of lake conditions and water movement, and the effects of both shorelines upon soils, erosion, drainage, etc. The most significant differences exist in the elevation and attitude of the shorelines, the strength of shoreline development, the relative complexity of the shorelines, their locations in the central part of the study area, the greater number of constructional features along the lower shoreline, the relative size of shoal areas, the difference

in offshore depths, and the relative seriousness with which the shorelines have influenced soil erosion in the drumlin field.

On the basis of shoreline physiography four shoreline regions and two offshore zones have been delineated; the moraine and till plain shore, the central and western weak shore, the island shorelines, the northeast shore, the shallow water embayments, and the offshore shoals. Each of these regions and zones reflect more or less distinct conditions of formation and environment as well as physiography.

Because they have indirectly extended their effects through such media as soils, drainage, vegetation, and erosion, the former shorelines and the two associated offshore zones have had an appreciable effect upon land use in northern Wentworth County.

In general, the beach bluffs and shorecliffs have been left in pasture or scrubland because of their steepness and susceptibility to erosion. This is especially true throughout the Westover drumlin field where the land use pattern reflects a predominance of pasture, scrub, and hay along the south-facing shorecliffs, while the gentler north slopes are used for grain, hay, and relatively less pasture. In some areas the steepness of the shorecliffs has forced man to take these areas entirely out of agricultural production and reforest them. Outside the drumlin field the beach bluffs have acted as natural field boundaries, while the flat level land just above and below the bluffs has often provided excellent well drained sites for farmsteads and other buildings.

Throughout the drumlin field the wave-cut terraces have provided areas of minimal erosion and relatively flexible land use. Sand deposits on some of the wider terraces have given rise to light sandy soils which

in turn have been used for the production of row crops and market gardening. More important, however, is the fact that many of the terraces have provided very favourable flat, well drained sites for the location of farmsteads, other rural buildings, and farm lanes. In addition the margins of the terraces often act as natural field divisions.

Wherever they are wide enough to provide an appreciable development of sandy soils the beaches and sandspits have generally given rise to the production of market garden and row crops. Along most of both shorelines only a few pockets of such land use appear, however, the influence of the Strabane sand spit has been fairly extensive.

The sandy offshore shoals have been particularly important as an influence upon the land use pattern. Their flat level topography and light sandy soils have provided an excellent base for market gardening. This is especially true of the large Flamboro shoal which was just awash in the lower lake as well as the shoals around Greensville. Throughout both these areas the land use is almost exclusively market gardening.

Finally, the offshore marsh zones have favoured cultivation in a few areas where their drainage has uncovered a somewhat deeper sandy overburden on the limestone plain. In addition, the creation of the Beverly swamp by the incomplete drainage of these, and other areas, has prevented some 1400 acres of land from being used for agriculture. The regulating effect of the swamp upon the local watersheds, however, has been an indirect benefit to the regional agriculture. Today the most important land use of the swamp is as a recreational area for hunting.

Although many gravel pits occur in kame deposits at, or near, beach elevations, beach gravels have not been an economic resource in northern Wentworth County.

In general, wherever the shorelines are well developed, their land use differs from that above and below the shore zones.

C O N C L U S I O N S

During Wisconsin times, two of the glacial lakes in the Erie basin extended far enough to the northeast in Ontario, to leave distinct shoreline features upon the landscape of northern Wentworth County. Isostatic rebound of the earth's crust has raised, and tilted the shorelines so that in Wentworth County the highest beaches now occur at elevations ranging from approximately 905 ft. to just over 925 ft., while the lower shoreline now stands at elevations ranging from about 870 ft. to 880 ft. The majority of the shoreline features are erosive forms, although some constructional work was accomplished by both lakes. The strongest development of the shorelines occured along the southern exposures throughout the areas where glacial drift is deepest and lake depths were greatest immediately offshore. In general, throughout Wentworth County, the shorelines of both lakes were relatively complex and immature, indicating the lakes were short-lived. Shoreline features indicate that, in both lakes, the direction of fetch and wave action ranged throughout a sector bounded on the west by a relatively consistent maximum fetch from the south-southwest, and on the east by a long effective fetch from the east-southeast. The latter direction of strong fetch indicates that, in both lakes, the ice front was below the Niagara escarpment at some position east of 79° 25' longitude.

Differential tilting of the shorelines by isostatic uplift strongly suggests that, between the existance of the two lakes, there was a low-level interval marked by an extensive eastward retreat of the ice front.

To this day, both shorelines have had appreciable effects upon local soils, erosion, relief, drainage, and vegetation, and in these ways have influenced land utilization and settlement in northern Wentworth County. These influences are both beneficial and harmful. The most significant are the beneficial effects of the sandy soils as a basis for market gardening and the harmful effects of the steep shorecliffs in promoting serious soil erosion and restricting agriculture. The existance of the Beverly swamp as a relic of the former glacial lakes is of great significance to the regional drainage and land utilization. Considered on a regional basis the overall influence of the swamp is probably more beneficial than it is harmful.

In total, as part of the physical landscape, the raised shorelines are intimately, and significantly related to the cultural landscape. Indeed, when viewed from the perspective of geography, they represent a unique and meaningful fusion of the geologic past with the cultural present in northern Wentworth County.

B I B L I O G R A P H Y

Chapman, L.J., and Putnam, D.F.,
1951: The Physiography of Southern Ontario; Univ. of Toronto Press.

Fairchild, H.L.
1909: Glacial Waters in Central New York State: New York State Museum, Museum Bulletin 127, Plate 39.

Flint, R.F.
1947: Glacial geology and the Pleistocene epoch; John Wiley and Sons, Inc.

Hough, J.L.
1958: Geology of the Great Lakes; Univ. of Illinois Press.

Karrow, P.F.
1959: Pleistocene Geology of the Hamilton Map-Area; (Preliminary Report) Ont. Dept. Mines, Circular No. 8

Leverett, F., and Taylor, F.B.
1915: The Pleistocene of Indiana and Michigan and the history of the Great Lakes; U. S. Geol. Survey, Monog. 53.

McQueen, R.
1958: Beverly Township; Typed as manuscript, McMaster University.

Spencer Creek Conservation Report
1959: Ontario Dept. Planning & Development, Conservation Branch.

Summary Report No. 285
1913: Mines Branch, Dept. of Mines, Ottawa.

* * *