Sixteen Mile Creek

1958

conservation report

DEPARTMENT OF PLANNING AND DEVELOPMENT

DEPARTMENT OF PLANNING AND DEVELOPMENT

HON. W. M. NICKLE, Q.C.
Minister

T. A. C. TYRRELL
Deputy Minister

A. H. RICHARDSON
Chief Conservation Engineer

SIXTEEN MILE CREEK CONSERVATION REPORT 1958

ONTARIO

TORONTO
1958

One hundred and eighty copies of
this report have been prepared of
which this is

Number 157

Honourable W. M. Nickle, Q.C., Minister,

Department of Planning and Development,

Parliament Buildings,

Toronto, Ontatio.

Honourable Sir:

I take pleasure in transmitting herewith the complete Conservation Report for the Sixteen-Mile Creek Conservation Authority.

The report covers Land, Forestry, Water, Recreation and Wildlife.

Yours very truly,

A. H. Richardson,
Chief Conservation Engineer.

November 25, 1959.

CONSERVATION BRANCH

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Grateful acknowledgement is made of the assistance rendered by; Mr. E. J. Costigan, Town Clerk of Milton; Mr. B. McKerr, Milton Works Superintendent; Dr. G. W. Peck of Oakville; Mr. Hubert Moore of Long Branch; Mrs. Hazel Matthews and the members of the staffs of the:-

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Department of Lands and Forests - Hespeler Office
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INTRODUCTION

Conservation has long been a subject of concern to the people of Ontario. This concern had to do originally with the protection of forests because of their importance as a source of revenue to the Province; but allied with this was the problem of wildlife management and the protection of source areas of rivers and streams. In Southern Ontario interest in conservation was indicated first by reforestation and woodlot management, but more recently this has broadened out to include flood and pollution control, improved land use and provision for recreation facilities.

While the progress in these activities has been steady up to the present, most of the programs heretofore were initiated by government departments. Recently, however, there has been a growing conception of personal obligation, especially where land use problems, farm ponds and small reforestation projects are concerned. On the other hand, control of flooding, summer flow and pollution; large reforestation projects; and recreation areas have come to be considered the responsibility of the community - the community in this case being the river valley.

With the advent of this new concept of personal and community responsibility in conservation, the Authorities movement was born, and the willingness of our people to undertake conservation in this way is indicated by the fact that in the last thirteen years 28 Authorities have been established, with a total membership of 403 municipalities and an area of 17,363 square miles.

The first step in establishing a Conservation Authority is undertaken by all the municipalities wholly or partly within a watershed. Two such municipalities must first by resolution petition the Government to call a meeting for the purpose of ascertaining whether or not an Authority should be established. Two-thirds of the number of representatives which the municipalities are entitled to appoint (on a population basis) must be present to make the meeting legal. If two-thirds of those present vote in favour of establishing an Authority a resolution is forwarded to the Government. The Authority is then established by Order-in-Council and under the Act becomes a body corporate, including representatives from all the municipalities in the watershed.

While some Authorities were brought into being because of flooding within their areas, all were aware of the necessity of carrying out such supplementary measures as improved methods of land use, reforestation, proper woodlot management, prevention of pollution, investigation of underground water supplies, wildlife studies and recreation. But the Authorities were not equipped to carry out the extensive investigations that would indicate where such work should be done. Consequently the Conservation Branch of the Department of Planning and Development undertook to carry out the preliminary investigations as a service to the Authorities, to appraise, by means of surveys and reports, the conservation needs of each watershed, and to submit to the Authority a detailed report outlining the conservation measures that should be implemented.

The survey work is grouped under five general headings, namely, Land Use, Forestry, Water, Wildlife and Recreation. The scope of the studies made in each of these subjects varies with the condition and needs of the area under investigation. In addition to the five topics indicated above, a study of the history of the area is made. This serves as a backdrop to all the conservation problems of the watershed and compels the reader to understand the abuses of the past and the need for a diversified program in the future.

The starting point for all surveys is aerial photography. Before the survey is commenced in the field all such contributing data as maps, old records, photographs, unpublished reports and other useful information are thoroughly explored and recorded. While the survey is in progress similar data are gathered locally, and agricultural representatives, zone foresters, municipal clerks and other officials and private citizens are interviewed for additional material.

The results of these conservation surveys, together with the recommendations based upon them, are set down in the reports presented to the Authorities and intended to serve them as a blueprint. The carrying out of any scheme is not the work of the Conservation Branch of the Department of Planning and Development, because it is not an operating department. Its active participation for the most part ceases when the planning is complete and the report is submitted, although it stands by to interpret the report and give advice and assistance in carrying out the plans recommended in the report. The Authority must assume responsibility for initiating the schemes which it considers most urgent; it must also make approaches to the government departments or other bodies from which it hopes to get assistance.

If, for example, an Authority undertakes a scheme having to do with land use, it must seek assistance from the Department of Agriculture; if it involves a forestry or wildlife problem, then the Department of Lands and Forests is approached. In the case of flood control, however, as there is no department of the Government doing hydraulic surveys except the Conservation Branch, whose staff is not large enough to carry through the engineering works of several Authorities, the Authority must engage a consulting engineer to do the final engineering and designing and to carry the work through the construction stage. Similarly, where an Authority undertakes a scheme which has to do with recreation, it may have to employ men specially trained in this work.

As the work being done by Authorities is a new approach to the conservation problem, in that the responsibility of carrying it out is left entirely in the hands of the Authority concerned, much directing and assistance have been necessary from the Conservation Branch and, in the case of 20 Authorities including the Sixteen-Mile Creek, a member of the staff of the Department of Planning and Development has been assigned to work in the watershed.

The Sixteen-Mile Creek Conservation Authority was established by Order-in-Council on December 20, 1956, following an organization meeting which was held at Trafalgar Township Hall on December 12, 1956, when six representatives out of a total of six attended the meeting and five voted in favour of establishing the Authority.

As mentioned above, the Department of Planning and Development, as a service to an Authority, undertakes to carry out a conservation survey of the valley for the guidance of the Authority, but the commencement of conservation work in the valley does not necessarily have to wait until such a survey has been made and the report presented. This has been the case with the Sixteen-Mile Creek Conservation Authority, where two Conservation Areas have been established and considerable development work carried out.

The Sixteen-Mile Creek Conservation Report has been prepared in sections, namely Land, Forests, Water, Wildlife and Recreation. The Land and Forest Reports were presented to the Authority on February 5, 1959, and the Water and Wildlife Reports were presented and discussed by members of the technical staff of the Conservation Branch on March 18, 1959. The Recreation Report is included in this volume which contains the five technical reports.

- A. H. RICHARDSON

RECOMMENDATIONS

RECOMMENDATIONS

STATED OR IMPLIED IN THIS REPORT

LAND

1. That further enquiry into the water resources of the sub-surface sands and gravels in the area north of Milton and Hornby be made. p. 5

2. That the Authority investigate the question of exercising some control over the manner in which quarries, gravel and sand pits, are exploited and left after such exploitation. p. 27

3. That the Authority lend support to municipal development plans. p. 29

4. That the Authority use its good offices to urge retention of the best land for agricultural use. p. 41

5. That the Authority urge review of drainage works prior to installation. p. 41

6. That the Authority consider assisting in the control and renovation of existing gullies and of grassed waterways. p. 42

7. That the Authority support the County farm pond program. p. 43

8. That the Authority publicize the services and advice available to farmers from the various agencies. p. 49

FOREST

9. That a Sixteen-Mile Creek Authority Forest be established and that it be expanded through a definite program of annual additions and planting until the total recommended area of 7,208 acres is acquired and reforested. p. 23

10. That the Authority encourage private reforestation by providing a planting service at nominal cost and by offering a planting subsidy for trees privately planted. p. 25

11. That the Authority establish woodlot improvement projects on its own properties or on private woodlots under agreements with co-operators in order to demonstrate the advantages of better forestry practice. p. 26

12. That the Authority, by purchase of equipment, organization of cutting crews, or direct subsidy, encourage private owners in thinnings and improvement cuttings in their woodlots. p. 29

13(a) That the Authority publish a simple, attractive bulletin on the disadvantages of woodlot grazing. p. 34

(b) That the Authority co-operate with the County of Halton to devise ways to make the County woodlot fencing by-law more effective in eliminating woodlot grazing. p. 19

14. That the Authority co-operate with schools, government departments, and all other groups and agencies possible to publicize the need and methods of reforestation and woodlot management; and in particular that the Authority sponsor tours, practical demonstrations and field days for this purpose. pp. 20 and 27

15. That the Authority encourage and co-operate in research to find improved methods of managing plantations and natural woodlands and publicize results which would help private woodlot owners. p. 27

16. That the Authority encourage landowners to convert to productive forest such parts of the 2,172 acres of scrubland as cannot economically be restored to agricultural use. p. 16

17. That the Authority act as co-sponsor for:

    (a) The Tree Farm movement p. 21
    (b) 4-H Forestry Clubs p. 21

18. That the Authority investigate, publicize and urge the implementation of the best methods for protecting natural woodland and plantations from:-

    (a) fire p. 36
    (b) insects and diseases pp. 38 and 39

19. That the Authority encourage the establishment of windbreaks, shelterbelts and snow fences. p. 42

WATER

20. That the Authority set up an Advisory Committee on pollution control. p. 42

21. That the Authority purchase the necessary lands for the proposed channel improvement immediately. p. 50

22. That the channel improvement work be carried out in stages over the next ten years or as funds become available. p. 50

23. That observation test wells be established to record fluctuations of the water table. p. 53

24. That further studies be undertaken to determine the potential subterranean storage and the possibility of recharging the aquifers. p. 54

25. That lands for the possible reservoir sites be purchased now should reservoirs be required later for flood control or water storage. p. 57

26. That a number of sites be acquired throughout the watershed and community ponds be constructed as funds become available. p. 58

WILDLIFE

27. That the Conservation Authority consider the stocking of Hungarian Partridges experimentally in the northern part of the watershed. p. 12

28. That the stocking of fish in the watershed be restricted to those streams which have been shown on the map accompanying this report to be both suitable for the species concerned and are also able to support the numbers of fish stocked. p. 23

29. That the Authority make agreements with the Provincial Department of Highways concerning the sections of trout streams along the new Highway 401. p. 28

30. That the Authority consider purchasing a section of the upper West Branch of Sixteen-Mile Creek for a demonstration of stream improvement and for public fishing. p. 28

RECREATION

31 That the Authority consider the acquisition of any or all of the following areas for conservation and recreation:

(1)	Halton View	p. 13
(2)	Scotch Block	p. 14
(3)	Escarpment	p. 15
(4)	Twin Waters	p. 16
(5)	Oakville	p. 17

SIXTEEN MILE CREEK CONSERVATION REPORT

LAND

ONTARIO DEPARTMENT OF PLANNING AND DEVELOPMENT

CONSERVATION BRANCH

CHAPTER 1

SOME GEOGRAPHIC ASPECTS OF THE WATERSHED

1. Introduction

The land of the Sixteen-Mile Creek Conservation Authority is contained entirely within the county of Halton and its streams drain portions of the three townships of Nassagaweya, Esquesing and Trafalgar. These townships, plus the towns of Milton (4,497) and Oakville (10,147) constitute the member munipalities of the Authority*. There are, in addition, a number of hamlets including Palermo, Trafalgar and Campbellville.

The drainage area of the Authority extends north-west from Lake Ontario a distance of approximately 22 miles and contains some 159.4 square miles (102,000 acres) of land. In addition to Sixteen-Mile Creek (Oakville Creek) which drains the bulk of the land, there are several smaller streams which empty into the lake to either side of the main outlet at Oakville.

Topographically the area ranges from level to moderately rolling with the roughest land in the headwaters to the north-west. The elevation increases from about 246feet above sea level at Lake Ontario to 1,300 feet a.s.l. north-west of Speyside. A good proportion of this increase is provided by three bluffs - those of the present lake, of glacial Lake Iroquois to the north of the Queen Elizabeth High-way, and of the Niagara escarpment to the west of Milton. The last rises up to 300 feet above the plain below and in many places the face is perpendicular.

2. The Bedrocks

In the lower reaches of the watershed, and in the headwaters, the bedrocks are at or near the surface and this

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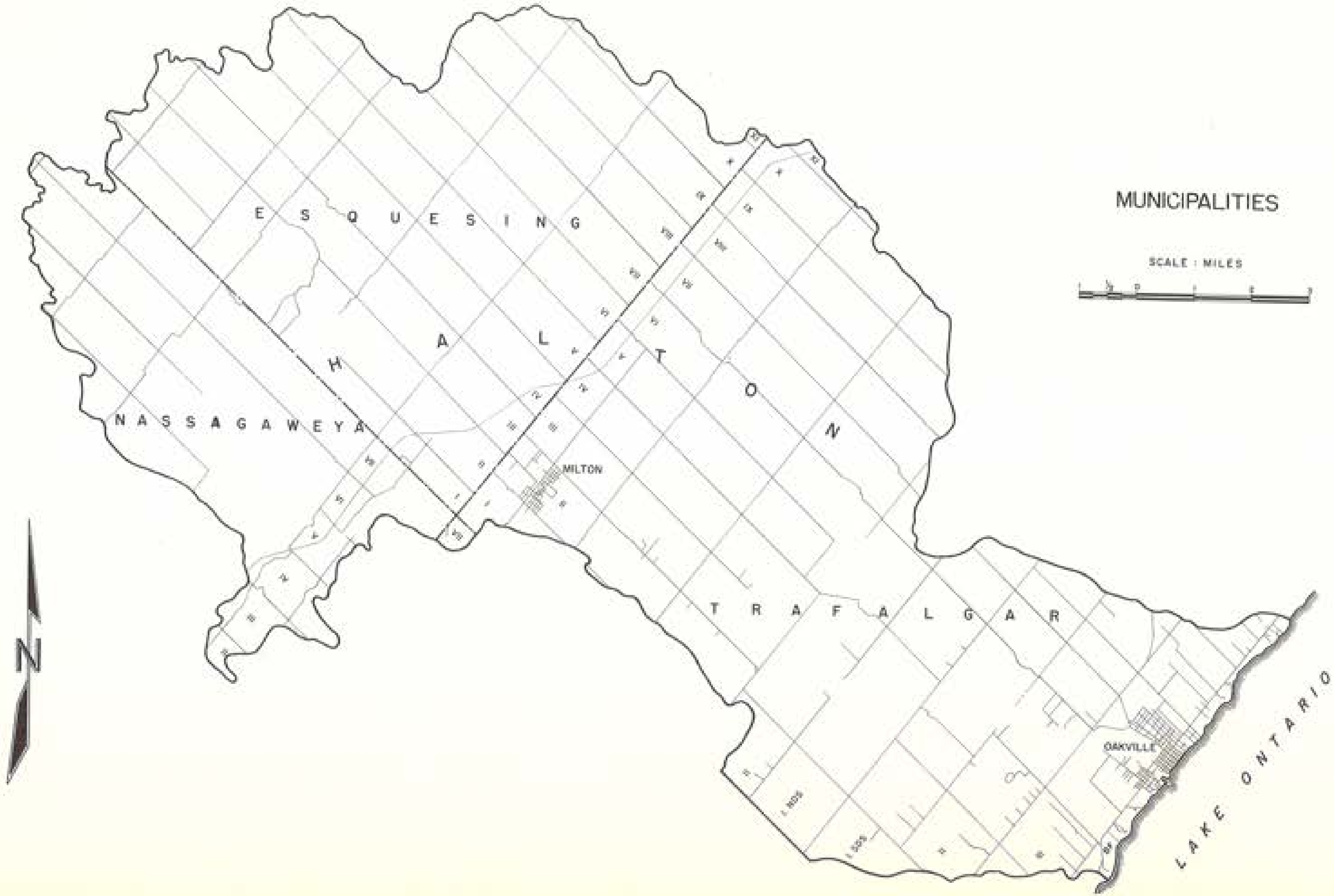
* Population figures taken from 1958 Municipal Directory, Department of Municipal Affairs.

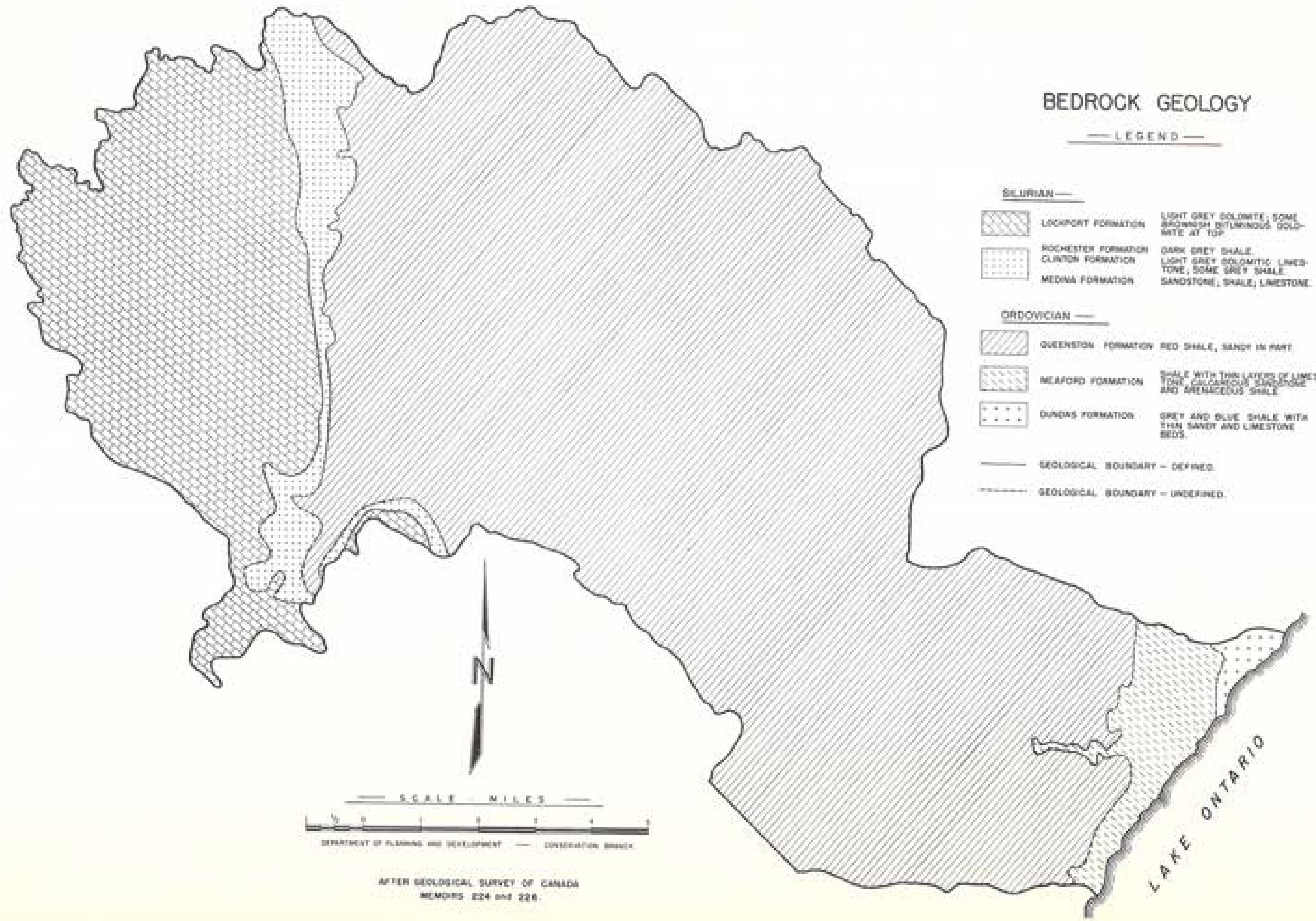

MUNICIPALITIES
SCALE : MILES
ESQUESING
HALTON
NASSAGAWEYA
TRAFALGAR
MILTON
OAKVILLE
LAKE ONTARIO
N

fact has some influence on land use in these areas. The rocks are undisturbed and slope very gently to the south-west. They are derived from sedimentary deposits laid down in Ordovician and Silurian epicontinental seas. The two groups are set off one from the other by the prominent Niagara escarpment which crosses the watershed to the west of Milton.

The Dundas, Meaford and Queenston formations comprise the Ordovician rocks in the watershed. Only a small area of the Dundas formation is found in the watershed. It is located in the south-east and is dominantly gray and blue shale with thin sandy and limestone beds. Outcrops may be found along the lakeshore. The shales are of considerable economic importance and are widely used in the manufacture of brick and tile.

The Meaford rocks occupy a narrow band further west between the Dundas and Queenston formations. The sediments are primarily gray, bluish and brownish shale but include thin layers of limestone, calcareous sandstone and sandy shale. The formation underlies most of Oakville and is found in outcrops along the lake and in some of the stream valleys.

The dark red shales of the Queenston formation underlie a large area of the watershed and outcrop in many places, particularly along the stream valleys and at the base of the escarpment. Below No. 5 Highway these rocks are very near the surface and they form the basis of the heavy red soils of this area. Except in this area, and along the foot of the escarpment, the bedrock is fairly thickly covered by glacial and fluvial deposits. The prominent greenish-coloured bands in this shale are found along fissures and joint planes and are probably due to bleaching by percolating waters charged with organic acids in solution. Many of the qualities desired for brick and tile making are found in this shale and the rocks have been quarried extensively for these purposes. Large brick-yards are found to the west of Milton.


BEDROCK GEOLOGY
— LEGEND —
SILURIAN —
LOCKPORT FORMATION
LIGHT GREY DOLOMITE; SOME BROWNISH BITUMINOUS DOLOMITE AT TOP
ROCHESTER FORMATION
DARK GREY SHALE.
CLINTON FORMATION
LIGHT GREY DOLOMITIC LIMESTONE; SOME GREY SHALE.
MEDINA FORMATION
SANDSTONE; SHALE; LIMESTONE.
ORDOVICIAN —
QUEENSTON FORMATION
RED SHALE, SANDY IN PART.
MEAFORD FORMATION
SHALE WITH THIN LAYERS OF LIMESTONE, CALCAREOUS SANDSTONE AND ARENACEOUS SHALE.
DUNDAS FORMATION
GREY AND BLUE SHALE WITH THIN SANDY AND LIMESTONE BEDS.
GEOLOGICAL BOUNDARY – DEFINED.
GEOLOGICAL BOUNDARY – UNDEFINED.
N
LAKE ONTARIO
— SCALE · MILES —
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AFTER GEOLOGICAL SURVEY OF CANADA
MEMOIRS 224 and 226.

The Silurian rocks include the Medina, Clinton, Rochester and Lockport formations. The first three occupy a very narrow band of country along the face of the escarpment and are of little importance in the valley. They comprise shales, limestones and sandstones.

The Lockport dolomite underlies the whole north-west portion of the watershed and has a pronounced influence on land use in this area. Much of the soil cover is thin or non-existent and the rock surface is often rough. The dolomite is quite hard and resistant to erosion and is one of the chief reasons for the continued existence of the escarpment as a major landform. The rock has been quarried extensively for the manufacture of lime, for building purposes and, after crushing, for road metal.

In the past several years deep drilling (for Ontario) has brought in a number of natural gas wells in the area north of Milton. These wells recover modest amounts of gas from the Gull River Section of the Black River (Ordovician) sedimentary rocks. These wells take gas from about 1,800-1,900 feet below the surface. At this level the gas formation is only 100 to 150 feet above the basement Precambrian rocks.

. Water

The main branch of the Sixteen-Mile Creek has its headwaters in the springs and swamps of the Galt moraine and the limestone plain above the Niagara escarpment. From this area it flows in picturesque falls and rapids over the escarpment and then in an ever deepening channel across the Peel plain to join, west of Glenorchy, with the combined flow of the Middle and East Branches. The Middle Branch, like its parent, starts in the lands above the escarpment and continues as a permanent stream to join the East Branch at Drumquin. This last rises in the drumlinized till plain in the north-east quarter of the watershed.

West of Milton the dark red (green banded) shales of the Queenston formation are used in the manufacture of brick.

Hard Limestone caps the softer underlying shales to form the Niagara escarpment.

In the limestone country of the north-west, stream dissection has been slight but the same is not true where the soil materials and bedrocks are less resistant to erosion. Many of the small valleys upstream are fairly broad and relatively shallow but downstream the creeks have cut through the surface deposits and bedrocks to a depth of 125 feet or more. Downstream from Drumquin and Boyne the valley becomes gorge-like and the valley slopes are precipitous.

In his paper of 1940 Coventry showed that by far the greater mileage of stream courses in the valley had only intermittent flow*. Most of the streams exhibiting temporary flow characteristics had their origins and courses through the till and clay plains below the escarpment. There is no evidence to indicate that conditions are any different today. The heavy soil materials which form the surface of so much of the watershed are relatively impermeable and a considerable portion of the snow-melt and precipitation of spring goes downstream in a short time. In areas like that above the escarpment where the soils and bedrock are more open and more extensive swamps prevail the insoak is greater. There is, consequently, a more gradual release of water from the ground into the streams. The much more extensive bush cover in this area is also important in protecting the snow from melting too rapidly in spring.

With the great spread of urban amenities and urban opulation in the watershed in recent years there has been a ubstantial increase in the number of deep wells drilled to tap nderground water supplies. Some of these are "flowing" wells nd the waters they deliver help, in a small way, to maintain ome streams during the summer season. A similar effect comes bout from an overall increase in water consumption due to eater domestic and other uses of water.

The town of Oakville obtains its water supply from

Coventry, A.F. Dessication in Southern Ontario, Trans. Roy. Soc. Can. 34, Dec. 5, 1940.

Lake Ontario while Milton gets its water from deep wells to the west of the town. Over the rest of the watershed, domestic, industrial and commercial needs are supplied by shallow and deep wells. On many farms supplementary supplies for stock watering, irrigation and other needs are obtained from dug-out, run-off and permanent stream ponds.

Generally speaking the subsurface water supplies in the watershed are only fair in quality and quantity when the source rocks are the shales of the Ordovician formations. The supplies obtained from the Queenston formation are usually small and salty water is often encountered. The supplies from the lower Silurian rocks are also modest and frequently mineralized. The zone of contact between the fairly porous Lockport dolomites and the underlying, impermeable Rochester shales is often marked along the escarpment by springs. Water obtained from the dolomite is usually fairly good though frequently hard.

Deep-well logs for the area in the watershed between Highway No. 5 and the escarpment show that in many wells sand and gravel layers are found at depths of 15 feet or over. These deposits come much nearer the surface and in some places are quite extensive, particularly to the north of Agerton and Milton. They are probably fluvial deposits relating to one of the later interglacial stages. The overlying material is till.

There seems to be no large intake area for the water entering these sands but the disposition of the beds between the shale bedrock and till below and the heavy till above is sufficient to provide artesian flow in wells penetrating to them. The flows from the aquifer(s) do not appear to be large but it seems reasonable to believe that the aquifer(s) will become more important as urbanization increases. Further enquiry into the nature and extent of the aquifer(s) should probably be made before long, as well as ascertaining the feasibility of recharging it from surface flows.

The spillway along the face of the escarpment from north of Speyside toward Campbellville has been little used as a source of water up to the present, perhaps because these lands are well watered by springs and creeks. It may be, however, that Milton can in future obtain substantial supplies from this source. Examination of the problem is required.

4. Climate

The Sixteen-Mile Creek Watershed lies within two of the climatic regions defined by Putnam and Chapman as the "South Slopes" and the "Lake Erie Counties" regions*. The latter region is delimited on the north by the 45°F. average annual isotherm. This boundary would appear to be somewhere between the Iroquois bluff and the Trafalgar moraine. The South Slopes region covers the balance of the watershed.

Climatically the Lake Erie Counties region is one of the more favoured in the province from the agricultural point of view and, as a consequence, a wide variety of crops may be grown. The length of the growing season averages a little more than 200 days, while the frost free season ranges from about 150 to 155 days. Both of these factors are of considerable importance in the production of fruit and truck crops produced in this part of the watershed. The average annual temperature is about 46°F. with the temperature of the winter months averaging 23°F. and that of the summer months 67°F. On the average the total precipitation amounts to a little less than 32", of which about 6" comes in the form of snow (as water equivalent). In the foreseeable future most of this area in the watershed will be removed from agricultural use by reason of urban and industrial expansion.

The South Slopes region is climatically less rugged than areas further north but at the same time is not so well favoured as the Lake Erie Counties region because of greater distance from the lake and its modifying influence. The mean annual temperature ranges from 43°- 45°F. while the precipitation averages 31" of which 6-7" comes as snow (60-70" of snow). The

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Putnam, D.F. and Chapman, L.J., The Climate of Southern Ontario, Sci. Agric., 18:8, April, 1938.

frost free season is about 147 days in length and the growing season (average temperatures above 42°F.) averages a little more than 196 days. The average temperatures of the summer and winter periods are slightly less than in the littoral area.

The average annual daily maximum temperatures (53°F.) is about the same in both regions in the watershed but the South Slopes region is decidedly cooler when reference is made to the mean minimum temperatures (34° compared to 37°). The watershed averages between 100 and 125 rainy days per year where the precipitation averages .01 inch or more.

Although Southern Ontario is generally considered to have a humid climate the probability of recurring periods of drought must not be excluded. According to Sanderson the average annual water deficiency in the watershed runs between 2 and 3+ inches (i.e., when the potential evapotranspiration exceeds the supply of moisture in the soil)*. It is likely that this deficiency means less on the heavy, more moisture-retentive soils of the watershed than it does on the lighter soils and on the limestone plain. Such a deficiency would appear to be of modest importance when related to general farm crops, but would be of more significance in the production of high value specialized crops. In such cases irrigation would offset the effect of drought. Some truck and orchard crops are being irrigated at the present time.

5. Physiography

In common with a large portion of the North merican continent the Sixteen-Mile Creek Valley has undergone series of continental glaciations during the last million years. ccording to available evidence there seem to have been at least hree glaciations, although in any specific place there may be vidence of only one or two. Each ice sheet was marked by adances and recessions which varied in magnitude in different

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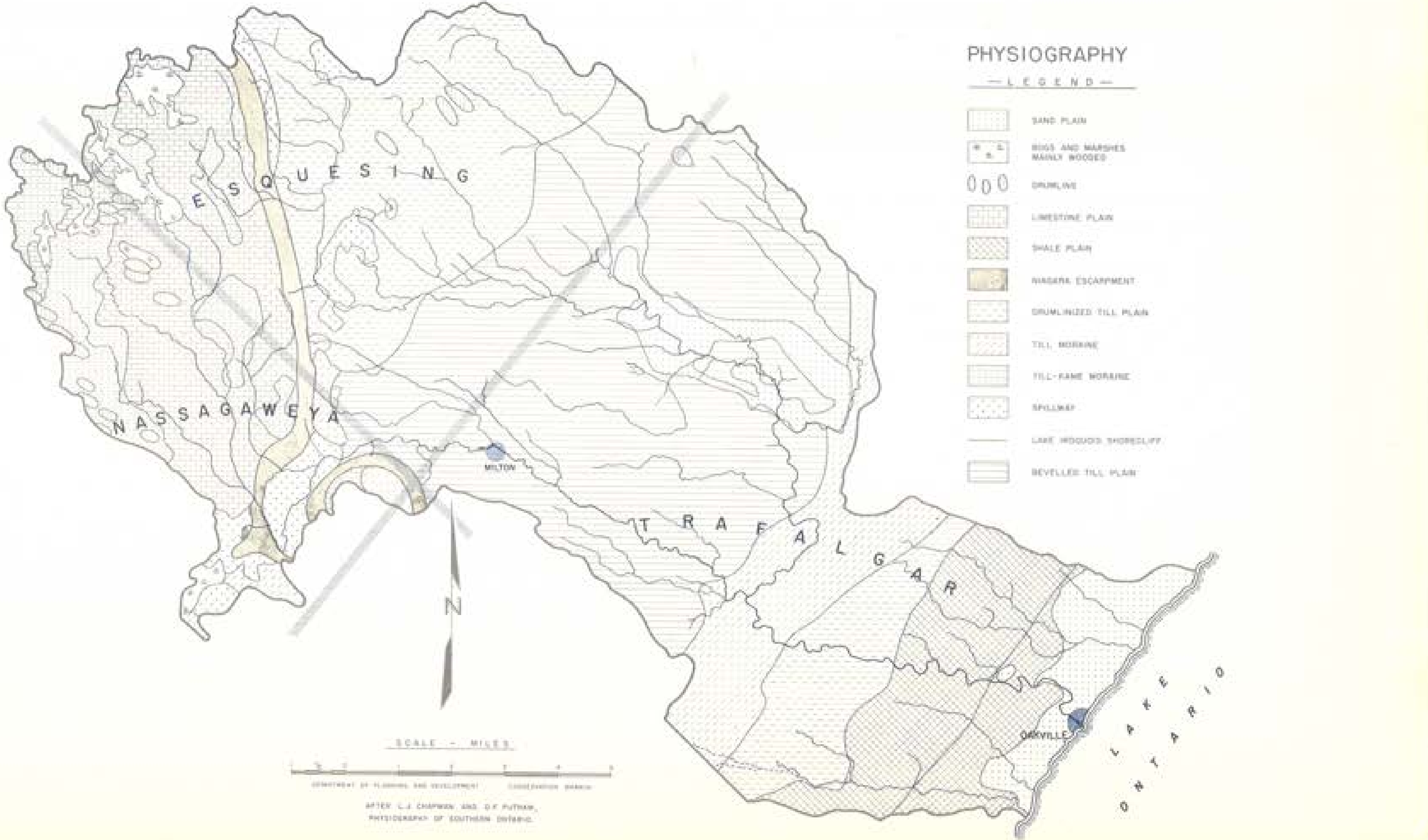
Sanderson, Marie. Moisture Relationships in Southern Ontario. Sci. Agric., 30:6, June 1950.


PHYSIOGRAPHY
— LEGEND —
SAND PLAIN
BOGS AND MARSHES MAINLY WOODED
DRUMLINS
LIMESTONE PLAIN
SHALE PLAIN
NIAGARA ESCARPMENT
DRUMLINIZED TILL PLAIN
TILL MORAINE
TILL-KAME MORAINE
SPILLWAY
LAKE IROQUOIS SHORECLIFF
BEVELLED TILL PLAIN
ESQUESING
NASSAGAWEYA
TRAFALGAR
MILTON
OAKVILLE
LAKE ONTARIO
N
SCALE - MILES
1 ½ 0 1 2 3 4 5
DEPARTMENT OF PLANNING AND DEVELOPMENT
CONSERVATION BRANCH
AFTER L.J. CHAPMAN AND D.F. PUTNAM,
PHYSIOGRAPHY OF SOUTHERN ONTARIO.

regions. The ice of the last glaciation, the so-called Wisconsin, left the Sixteen-Mile Creek Valley under the impress of a warming climate probably 10-15,000 years ago. Between each of the ice ages there were long periods during which the climate was warmer, at times warmer than now, and the land was ice free.

During their passage these ice sheets acted as eroding agents, plucking, quarrying and grinding the bedrock and surface deposits and mounding and spreading the pulverized material. This unstratified, stony material is known as till and the rock materials composing it were often carried considerable distances from their point of origin. Succeeding ice sheets, and often fluctuations of the same ice sheet, largely destroyed the work of the one before so that the local topography seen in Southern Ontario today is chiefly the work of the Wisconsin ice and of post glacial drainage. The landforms resulting from the ice action were of several kinds and some of these may be found in the Sixteen-Mile Creek Valley.

Sometimes the till was moulded under the ice into the form of oval hills known as drumlins. Locally these are often called "whaleback" hills. Over Ontario the dimensions of these hills may vary but they are often up to 75 feet in height, a quarter mile in width, and half a mile or more in length. Usually the drumlins are clustered in large groups to form the pleasing and so-called "basket-of-eggs" topography.

Drumlin soils are usually loamy, fairly fertile and well-drained but steep slopes, the stony nature of the soils and the poorly drained inter-drumlin areas often provide difficulties to cultivation. Good management is necessary to prevent severe sheet-erosion of the smooth slopes. A number of specimens may be found in the watershed, chiefly in the north-west quarter. These drumlins are part of the extensive Guelph drumlin field.

In its movement the ice often spread the till beneath it to form an undulating plain of low relief. Such a landform is known as a till plain and it is often drumlinized. The topography is mild but restricted soil drainage is often a problem. Several areas of till plain, or modified till plain, may be found in the watershed. The most southerly occupies a belt of country centered along No. 5 Highway. A second area lies north of the 5-6 sideroad of Esquesing Township. Both of these regions are drumlinized and contain specimen drumlins or exhibit glacial drumlinoid grooving. The soils of both areas are loamy, though stiff because of the high content of local shale, and are fairly productive for agriculture. Restricted soil drainage is a problem in patches and over wider areas.

Between the Base Line Road of Trafalgar and the 5-6 sideroad of Esquesing Township there is a broad band of country known as the Peel Plain. This plain extends from west of Highway No. 25 east into Scarborough. It is a till plain modified, or "bevelled", by the waters of the Peel Ponding, a shallow, short-lived glacial lake dammed between the ice of the Ontario lobe on the south and the higher land on the north. Because of the action of the water the plain is smoother than most till plains, the soils are somewhat heavier and restricted drainage is a more acute problem. While the lake was in existence the ice melt-waters deposited fine material in it to produce varved (stratified) clays which are heavier in texture and more alkaline than the tills.

During its movement the ice often piled up large ridges of till along its border to form what are known as till moraines. Often these moraines are rough and bouldery and it s difficult to achieve a prosperous agriculture on them. On ome, however, the topography is not so rough and the soils are uch less bouldery. A case in point is the Trafalgar moraine, he east-west trending ridge of higher land north of Highway o. 5. This moraine was apparently laid down under water and ubjected to a smoothing action by the water.
t least two other moraines are represented in the watershed, he so-called Vinemount and Galt moraines. Both of these

The Niagara escarpment is the most striking physiographic feature in the watershed.

Gentle slopes, restricted drainage and heavy soils are typical of much of the agricultural land in the watershed.

moraines are found above the escarpment and the latter covers the greater area. Both are rougher and stonier than the Trafalgar moraine. Frequently the ice melt-waters dropped sands and gravels at the ice edge in hummocky moraine called kame moraine. Some moraines are largely till, some largely kame, and some a mixture of both.

As the Wisconsin ice age advanced the climate warmed and the ice retreated, pouring off vast quantities of melt-waters. These waters were important in the creation of land forms of significance.

A major effect in this region was the creation of the short-lived Peel Ponding. Not all of the sediments laid down in this lake were clays and silts; the streams entering the lake carried sands which were laid down as deltas. The shallow sand in the vicinity of Drumquin and Agerton is deltaic. It is an important though minor producer of vegetables.

The voluminous melt-waters from the Orangeville-Caledon area seem to have found their way southward along the foot of the escarpment through Scotch Block, Kelso and Campbellville. These waters varied greatly in speed and quantity and the materials they laid down along their spillway range from coarse gravels to moderately fine sands. The area between Kelso and Campbellville is quite gravelly and much stone has been removed from the fields. Sand is more prominent farther north and around Scotch Block, south of Speyside, is used in the production of truck and orchard crops.

As the ice retreated from Ontario a succession of great glacial lakes were formed. One of these, Lake Iroquois, occupied the Lake Ontario basin but its waters were much deeper and extended farther inland than do those of the present lake. In the Sixteen-Mile Creek Watershed the lake extended to the north of where the Queen Elizabeth Highway is located and there constructed a pronounced shorecliff. The forerunners of the present stream drainage brought large amounts of coarse sediments into the lake to form deltas which are now exposed as sand plains. The sand plain at Oakville originated in this fashion.

In two areas in the watershed the ice left the bedrock clean or but lightly covered with till. The shale plain south of Highway No.5 has only a scanty cover of heavy till. Probably most of the cover over the bedrock is residual due to fairly rapid breakdown of the shale. The soil resulting is somewhat acid, heavy, and difficult to work.

Above the Niagara escarpment one finds the limestone plain. This rock, much more resistant to weathering than the shale is totally lacking in soil cover in many places. The surface of the limestone in this area is quite rough due to the plucking and quarrying of the ice and the region is poorly equipped for agricultural use.

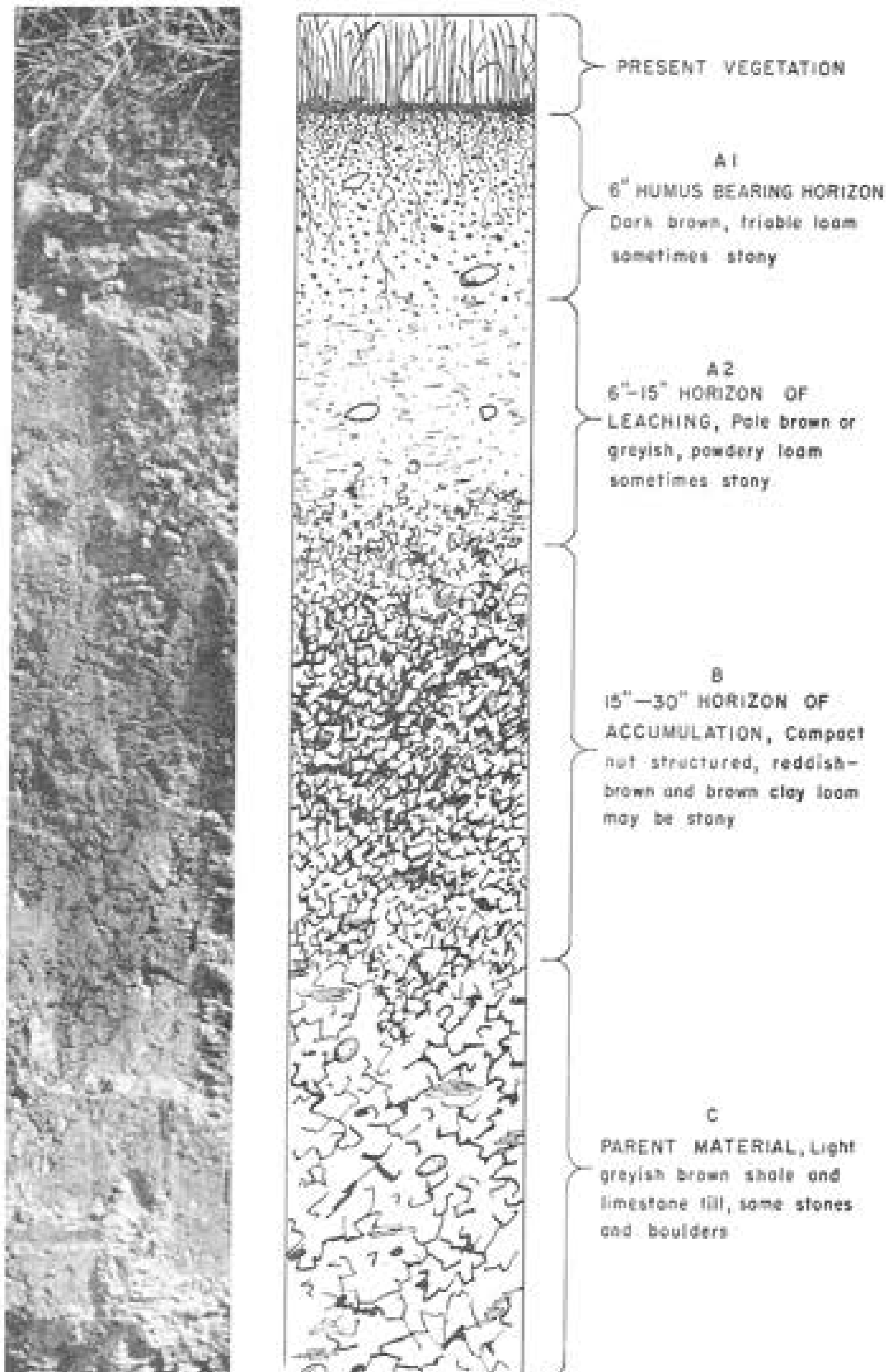
The Niagara escarpment is a landform spectacular, interesting and important. From the point of view of recreation the Authority will undoubtedly be paying it considerable attention. The escarpment is a general hindrance to transportation and to agriculture although its face is used for orchard crops where not too steep and covered thickly enough with soil.

While the broad pattern of the watershed was formed in glacial and pre-glacial time some developments have taken place since the last ice retreated. These developments include the formation of the present Lake Ontario shorecliff, the deepening of the river valleys, the creation of muck and peat bogs and the development of soil from the parent materials laid down before and during the ice ages.

6. Soil

(a) The Soil Profile

Although soil may be described loosely as being the medium in which plants grow, even general observation reveals the fact that there is considerable variation in the



Profile of a representative gray-brown podzolic soil.

soil and in its ability to support crops. Not only is there variety in the materials making up the soil but different soils of different capability may develop on much the same type of material.

As described here the soil is a reflection of the environment in which it developed. As a result, the development of any particular soil is a matter which involves a number of factors, some one or group of which may be of more importance than the others. Type and composition of the parent material, surface slope, soil drainage, climate and vegetation are some of these factors. In any single instance they operate together in such a way that, given time, they produce a soil possessing certain recognizable characteristics. The soil will not change materially so long as the environment under which it was produced remains stable.

If a vertical cut is made to a depth of three or four feet through the soil it will be seen that the cross-section is marked by a layering, each layer, or HORIZON, possessing certain characteristics of colour, texture, structure, organic content, acid reaction and so on. Together these horizons make up the soil PROFILE. The depth of the profile is variable, in some soils a foot or less and in others several or many feet. Most of the well-drained soils of the watershed have fairly well developed profiles but we have seen that in some cases, particularly on the limestone plain, there may be little or no soil cover let alone profile development. Profile development is also weak or non-existent on the flood plains of the streams because of periodic inundation.

Throughout Ontario several distinct kinds of profile may be found and each is representative of a great soil roup. The well-drained Gray Brown Podzolic soil, of which a eneralized profile description follows, is common in Southern ntario and is represented on the watershed.

HORIZON

A_0 - Partially decomposed litter from deciduous trees

A_1 - Dark grayish-brown to very dark brown mineralized humus layer - loose and friable and slightly acid in reaction.

A_2 - The leached horizon, yellowish to yellowish-brown to gray in colour. The iron, lime, organic matter and clay have been washed out and the reaction is acid.

B - The horizon of accumulation, containing a high proportion of clay and sesqui-oxides. Usually the colour is dark or reddish-brown while the structure is blocky or nutlike. In reaction it is usually neutral to slightly acid but the lower portion of the horizon may contain some free carbonates.

C - The unweathered, calcareous parent material, usually gray or brownish-gray in colour.

In no case are the horizons separated one from the other by a sharp break; there is always a transition, in some cases greater than in others.

Profile complexity also varies. In some soils not all horizons are represented, or they may be poorly developed. Also, the horizons may vary considerably from soil to soil in thickness; some have a thin A_2, some have a thick A_2, and so on.

When speaking of the soil horizons the A is considered to be the topsoil, the B the subsoil and the C the parent material. In a poorly drained soil the A_2 and B horizons may be missing and a G (glei) horizon exhibited, hence the name Dark Gray Gleizolic applied to soils of this kind. The inferior soil drainage is reflected in the dark colour of the soil and the blue or bluey-gray colour and rusty mottling of the glei horizon.

As plant material decays it is gradually incorporated into the A horizon as humus by the action of earthworms, micro-organisms and so on. During this process certain acids are formed and these are washed downwards by the rain. Partly as a result of this acidic solution, lime, iron, clay colloids, and organic matter are leached out and carried downward to be redeposited, in part, in the B horizon. The B horizon thus has a rather high clay content and is dark-brown to reddish-brown in colour. Depending on their thickness several horizons may be mixed together when cultivated to form an A_c (cultivated) horizon.

Under conditions of a fluctuating water-table near the surface a soil may be considered to be imperfectly drained. Such a soil may possess a thicker A_1 horizon and at the same time the A_2 or leached horizon may be less well developed. Field identification is guided by mottling (rusty streaks and patches) appearing in the lower part of the A_2,and in the B horizons

In addition, there are on the watershed several other kinds of soil which reflect local environmental conditions. In the case of organic soils (muck and peat) the drainage has been so poor for so long that normal profile development has been unable to take place. The poor drainage conditions have prevented the complete decomposition of the plant residues with the result that they have accumulated over the years. The persistence of water inhibits the activity of aerobic bacteria, earthworms and fungi.

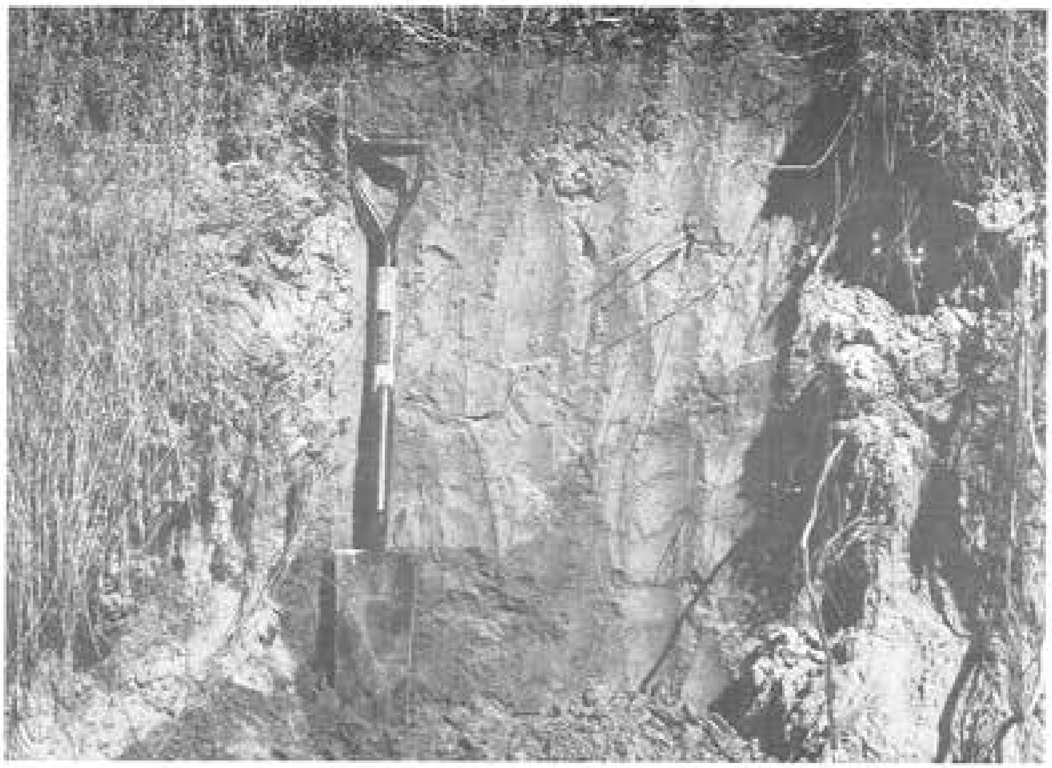
Most of the organic soil deposits are found above the Niagara escarpment and there seems little doubt that they help to sustain the flow of the streams rising in this region. The deposits are not extensive and the materials are rather shallow. Most of the peats are derived from a forest cover and are consequently woody. Sometimes, however, carex, cattail and marshgrass remains can be found. Except for small areas in existing fields the organic soils of the watershed have remained unused for agricultural purposes. There is little need to clear them for agriculture and it would be highly desirable to keep these areas in forest.

Bottomland, a land type consisting of soils made up of alluvium, is found along the stream courses where periodic inundation takes place. This flooding leads to the deposition of various mixtures of sand, silt, clay and gravel. Soil drainage is usually imperfect to poor and soil profile development is most often non-existent. For the most part these lands are so limited in extent or are so awkwardly situated that it is not normally feasible to use them for crop production and they are either left in forest or have been cleared and used for rough pasture. Soil fertility is variable but is usually fairly good.

(b) Soil Erosion

Many people are possessed of the misconception that erosion of the land, that is, the translocation of soil materials from place to place by the natural forms of wind or water, can be stopped completely. This is impossible except, perhaps, over small areas, for relatively short periods of time, and under certain conditions. Through the ages erosion of the land has taken place, moulding it into the scenery we see today. Under natural conditions this erosion is a very slow process and long years are required to alter the landscape appreciably. We call this form of erosion "geologic" erosion.

Under natural conditions the face of the earth is masked by a cover of vegetation and it is this cover which is chiefly instrumental in retarding run-off and slowing down erosion by wind and water. Because of the slow rate of erosion the soil, as seen in the profile, is not greatly affected by it and the process of soil building is easily able to keep pace with it. While conditions remain more or less the same the loss of a fragment of surface soil is offset by an increment from below as the parent material weathers and is incorporated into the soil. Under conditions such as this



Fox sandy loam. Note the well defined A and A2 horizons. Because of a moist subsoil the narrow B horizon is a little indistinct.

The stiff clays of the Lockport series erode easily unless well managed.

Gully erosion is serious in many places and can often be prevented through the use of grassed waterways.

nature is, by and large, in balance.

When the land is cleared for cultivation or used for grazing, however, this may be greatly changed: the protecting cover of vegetation is removed or reduced; cultivation may be carried on up and down the slope and surface water enabled to flow over the land more easily; the structure of the soil changed for the worse and organic content lessened with the result that the soil's moisture absorptive capacity is impaired. All of these changes can easily produce, in a rather short time, a less productive or even a ruined soil.

Such erosion is called induced or "accelerated" erosion. It is this erosion that the conservationist is concerned about and which every farmer should be aware of.

Some soils erode more readily than others and the same soils under different forms of land use may show vastly different amounts of erosion. There are also other factors which affect the rate of erosion: surface slope, topography, intensity of land use, rate of rainfall and the physical condition of the soil. For these and other reasons a farm plan based on conditions peculiar to the individual farm is desirable to control erosion.

In Ontario the removal of soil by erosion is accomplished by wind and water; the former is of importance in only a few areas, chiefly those of light soils. Erosion by water is much more widespread, although, as intimated, it is more damaging on some soils than on others.

When the surface run-off is concentrated into channels which are unprotected, or inadequately protected, gullies may develop. This is the most spectacular form of erosion in Ontario and a gully can grow quickly to the detriment of the land and the farmer. Fortunately, this form of erosion is not common on the present watershed but some gullies are found cutting back through streambanks. Run-off channelled in an unprotected field, unprotected tile drain outlets, and channels formed through cattle always using the same path are among the contributing factors leading to gully erosion.

At the start a gully may be insignificant but it can become large very rapidly. Small rills which are found on the slope of a cultivated field after a heavy rain and which can be covered over at the first cultivation are danger signals every farmer should heed.

Sheet erosion is much less spectacular but is dangerous because it is so widespread and most often goes unnoticed. This form of erosion usually takes place relatively slowly, but a whole field may be affected, with the result that the humus-rich portion of the soil, together with its store of available nutrients, is removed. Much of this erosion takes place during summer storms, just at a time when crops need the moisture which is flowing over the surface of the land into the streams. A reduction in the run-off would thus prove directly useful in at least two ways: reduced erosion and increased moisture supply for crops.

Many measures may be adopted to control run-off and reduce erosion. Land kept under a permanent cover of grass or trees and properly managed may erode very little. The same may be true on level lands regardless of the form of use, although, of course, the land may become less productive unless soil management practices are adequate. Soil-building rotations, the use of cover crops and fertilizers, contour tillage and grassed waterways are among the measures that may be used.

(c) The Estimation of Erosion

There are a number of ways of determining whether erosion has taken place and the amount. The effect of erosion may often be easily seen in poor crop response due to drought. On slopes or knolls where the A and/or B horizons have been removed, the soil is less able to absorb moisture, and the crop may be thin and weak. Where erosion has been severe, the grayish parent material may be seen at the surface.

A patch with an excessively stony surface may also be a sign of severe erosion and reflect the removal of the finer soil constituents. Erosion of this severity is relatively rare on the watershed.

Where observations such as this may be made, other evidence is also usually available: sediment may be seen to have accumulated at the bottom of a slope; soil may accumulate on the uphill side of a fencerow, while the downhill side is cut away.

To get a more certain determination of the degree of erosion the soil profile must be examined. It is usually possible to find a good profile of a virgin or nearly undisturbed soil in woodlots and along old fencerows. Such a profile may, for instance, exhibit one foot of topsoil (A_1 and A_2) and two feet of subsoil (B). On an adjacent cultivated slope of the same soil type and on which erosion is suspected, there may be only 6 inches of topsoil over the subsoil. In such a case it would be fair to assume that something like 6 inches of topsoil had been eroded away. In another case one might find the subsoil exposed at the surface and the parent material at a depth of only 12 inches. All of the topsoil and one half of the subsoil, something like 2 feet of material, would thus have been removed.

If the recognition of horizons by colour or texture is difficult, a simple chemical test can be used to aid in erosion estimation. A dilute solution of hydrochloric acid produces an effervescense when applied to soil containing free carbonates. In the imaginary virgin profile mentioned above, a fizz would be obtained at 3 feet at the start of the lime-rich parent material. On the severely eroded site the same result would be obtained at 1 foot. If the surface soil effervesced it would indicate that all of the topsoil and subsoil had been removed. A note of caution should be made, however, in that some soils may be found where other horizons naturally possess sufficient free carbonates to produce a reaction.

(d) Watershed Soils

The soil materials of the watershed might be divided into two broad groups on the basis of texture. In the one group the clay fraction is rather high and from them have developed the clay and clay loam soils which may be found in the shale plains, till plains, and till moraines.

In the other group the soil materials are generally coarser, they are easier to work (where stoniness is not a problem), and they are more permeable. These soil materials include the alluvial sands at Oakville and Drumquin, the fluvial sands and gravels of the spillway, and the kame and till deposits found above the escarpment. The drift deposits of the last area include both medium and coarse-textured tills and the stony content is often considerable. There are also the bottomlands, the swamplands and the rough rocky lands of the limestone plain.

On these varied materials different soil types have developed and associated with each are certain problems of use. In some cases these problems of use are so similar that for practical purposes several soil types may be considered as one. They have been so considered in determining land capability. A brief description of one or two of these soils follows. For fuller treatment reference may be made to the Soil Report of Peel County.*

Among the best soils in the watershed are those of the Oneida catena. The well drained series of this group include the Oneida clay loams and silt loams, while the imperfectly and poorly drained series include the Chinguacousy and Jeddo soils. These soils are found on the unmodified till plains, and, at times, on the bevelled till plains. The following is a profile description of the Oneida clay loam, a representative of the Gray-Brown Podzolic Great Soil Group, found under woodlot conditions.

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* Soil Survey of Peel County. Report 18, Ontario Soil Survey, Ontario Dept. Agric. 1953.

A_0 - Thin layer of partially decomposed leaves, twigs, etc.

A_1 - 0-5 inches clay loam; very dark grayish-brown; fine granular structure; friable consistency; few stones; pH - 5.6.

A_{21} - 5-12 inches clay loam; yellowish-brown; weak platy structure; friable consistency; stonefree; pH - 5.4.

A_{22} - 12-15 inches clay loam; brownish-yellow; weak platy structure; friable consistency; stonefree; pH - 5.5.

B_2 - 15-29 inches clay; dark brown; coarse blocky structure; hard consistency; few stones; pH - 6.4.

C - Clay till; pale brown; prismatic structure; hard consistency; calcareous; stony; pH - 7.4.

This soil is moderately fertile and is adaptable to a fairly wide variety of crops. Its chief drawbacks are susceptibility to erosion, mainly because of the prevailing slopes, and a modest organic content which can be rectified only by careful farm practice. General fertility levels may be maintained and improved by the application of mineral fertilizers. At the present time the soil is used almost exclusively for grass and grain crops, but some hoe crops are also grown and some of the land is still in woodlot.

The imperfectly drained Chinguacousy soil is very similar to the Oneida although the profile is a little shallower and the A_1 horizon is a little thicker. Erosion is generally slight on this soil but restricted soil drainage is a restricting factor of consequence. The somewhat acid soil, as with the Oneida, may require the addition of lime before some crops can be grown successfully.

The third member of the catena, the Jeddo clay loam is of scattered distribution and small extent. Poor natural drainage is the chief restricting factor to use on this soil and most of it is in woods or pasture. With satisfactory drainage its capability is improved considerably. The organic content of this soil is usually fairly high and the pH is satisfactory for most farm crops. The following is a description of the Jeddo clay loam, one of the soils in Dark Gray Gleizolic Great Soil Group, found under forest conditions.

A_0 - Thin layer of partially decomposed leaves, twigs, etc.

A_1 - 0-8 inches clay loam; very dark brown; medium granular structure; friable consistency; stone-free; pH - 6.5.

G_1 - 8-16 inches clay; dark grayish-brown; mottled; medium nuciform structure; plastic consistency; stonefree; pH - 6.8.

G_2 - 16-37 inches clay; yellowish-brown; mottled; coarse blocky structure; plastic consistency; stonefree; pH - 7.0.

C - Clay till; pale brown; prismatic structure; plastic consistency; calcareous; few stones and grit; pH - 7.4.

The soils of the Cashel catena are found on the level lands of the bevelled till plain. They are largely stonefree and possess a higher pH (more free calcium) and somewhat shallower profile than the Oneida soils. If anything these soils are more productive than the Oneida and they are well adapted to dairy production but drainage imperfections are more widespread and the proportion of well drained soil is much less. Contrariwise, surface water supplies are a more acute problem due to high run-off and inferior storage areas and consequently the largest number of farm ponds in the watershed have been constructed on these soils. Soil wash is not generally a great problem although gully erosion can become serious.

The final group of "heavy" soils in the watershed are those of the Lockport catena. These shallow soils have developed over red shale and include the poorly drained Lockport clay and the imperfectly drained Trafalgar clay. They are stiff to work, are somewhat acid and run-off is usually rapid. A fairly extensive acreage of the type is found south of Highway No.5, but samples are also found north of Hornby and Milton. By any standards these are inferior soils for most agricultural pursuits because of susceptibility to erosion, slow drainage, difficulty of working, shallowness to bedrock, summer drought and so on. Because of shallower slopes and a lower erosion factor the Trafalgar clay is a generally more useful soil for agriculture. Grass is the most successful farm crop although feed grains may do fairly well.

The sandy soils are for the most part shallow and although suffering drainage restrictions because of shallowness over clay have been, locally, the premier horticultural soils. Lakeshore climatic conditions have been partly responsible for this but ease of working is also a factor. The chief soil concerned, the Berrien Sandy Loam, is not generally recognized as a first-class soil for agricultural use. Restricted drainage and modest inherent fertility are the chief problems, but wind drift could be serious under some conditions. Most of this land has been taken for urban use but a portion still remains at Drumquin and is extensively used for vegetable production.

Sandy soils are also found south of Speyside and above the escarpment in Nassagaweya Township. Those south of Speyside are well drained and used for vegetable, small fruit and orchard production. The extent of these lands is quite limited and they will never be of great importance in the economy of the watershed. The gravelly spillway soils west of Milton Heights occupy a greater area and have not been adapted to any special use. These gravels may prove useful in the construction of the portion of Highway 401 which is to cross this area and if so the Authority should have some say in the condition in which the pits are left. Perhaps the Authority could take over such areas when gravel has been removed.

The Agriculturally productive soils above the escarpment are formed mainly in medium-textured tills. These soils are moderately fertile but the topography is broken and the slopes are often fairly steep. These factors, combined with thin soil over bedrock in many places, often make agriculture here less rewarding than it might otherwise be. Much of the land, often wet, is best suited to tree growth and for maximum return over the long term the farm woodlots should be managed and cattle excluded.

The following tables summarize the erosion and drainage and slope conditions of the watershed.

TABLE 1

SHEET EROSION

Deg. of Erosion	0	1	2	3	4	Total
Acres	19,954	66,870	10,242	190	134	97,390*

0 No apparent erosion
1 Less than 1/3 topsoil removed
2 1/3-2/3 topsoil removed
3 2/3 + topsoil and less 1/3 subsoil
4 All topsoil and 1/3-2/3 subsoil
* Does not include urban land. Much of erosion class 0 is made up of bottomland, marsh and rocky land.

TABLE 2

SOIL DRAINAGE

Drainage	2	4	6	Total
Acres	47,250	30,596	2,367	80,213*

2 Well drained
4 Imperfectly drained
6 Poorly drained
* Does not include urban land, bottomland, marsh, or rocky land (much of which is poorly drained) above the escarpment.

TABLE 3

SLOPE CONDITIONS

Slope Group	Acres
A	35,381
B	5,002
C	1,967
D	526
M	33,195
N	3,822
P	172
R	170
Total	80,235*

SMOOTH SLOPES

A	0 - 2 %
B	2 - 6 %
C	6 - 10%
D	10 - 15%

HUMMOCKY SLOPES

M	0 - 7 %
N	7 - 15%
P	15 - 25%
R	25 + %

* Does not include urban land, bottomland, marsh and some of the rocky limestone plain which was not classified.

CHAPTER 2

LAND USE

1. Some Historical Developments:

Settlement in the old survey of Trafalgar Township was underway by 1810 and by the end of the second decade the balance of the township and Nassagaweya and Esquesing Townships were being opened up. In all three townships settlement proceeded rapidly and by 1846 W.H.Smith was able to report substantial progress in his Canadian Gazetteer. He also passed comment on each of the townships in turn:

> "Trafalgar is a well settled township, containing numerous well cleared and cultivated farms, most of which have good orchards. The land in general, with the exception of that bordering on the lake, which is light and sandy, is of excellent quality. 70,115 acres are taken up, 28,180 acres of which are cultivated."

> Esquesing ".... is a fine township, containing excellent land, and many good farms, which are generally well cultivated. Wheat of superior quality is grown in this and adjoining townships. 57,347 acres are taken up, 19,622 acres of which are under cultivation."

> Nassagaweya ".... township is well watered .... and contains some excellent land. 25,121 acres are taken up, 7,314 acres of which are under cultivation."

Between 1851 and 1891 the census recorded a persistent increase in the acreage of land under cultivation. Cultivated land in Trafalgar Township, for instance, rose from 39,800 acres (a substantial increase over Smith's report) to 56,800 acres, while the increase in Esquesing Township went from 28,000 acres to 53,200 acres.

In the years prior to 1880 wheat was a substantially important crop and occupied from 1/4 to 1/3 of the cultivated land. Until the 1860's fall wheat was emphasized but smut and declining yields saw it lose favour as a major crop. Spring wheat became relatively more important but its production was troubled by the wheat midge and the opening of the West. Western hard wheat became the world standard for quality and the Ontario farmer was forced to use his generally

Truck cropping is a small but highly important part of watershed agriculture.

Cutting asparagus for the Campbell Soup Company at New Toronto.

Vegetable production requires considerable labour and intensive practices.

more valuable land for higher cost crops and animal husbandry. In Halton County, as in some other parts of the province, barley increased in acreage somewhat at the expense of wheat. Winter wheat is still important in the county but only a minute acreage of spring wheat is grown. Barley is also of minor importance.

In keeping with the pioneer tradition peas, potatoes and turnips were once important but specialization and supermarkets have rendered subsistence on these unnecessary. The importance of peas is shown by the figures for 1861, there being 3308 acres in Trafalgar Township and 2017 acres in Esquesing. The potato and turnip acreages were similarly important though smaller.

Market gardening, still engaged in locally and likely to grow in importance as time goes on, had its beginnings in the fifties as a result of steady urban growth. Jones mentions one market gardener in the county who had sales of produce amounting to $1,200 in 1859, an amount somewhat below that obtained in previous years. * He also notes that the sand plain of the Oakville area became the chief strawberry region of the province and by 1880 was shipping 126,000 quart baskets annually. This area has, of course, declined in importance in fruit and truck crop growing because of urban growth. Within the forseeable future it will have produced its last commercial crops.

2. Present Land Use

Apart from vegetable and fruit growing the agriculture of the watershed depends almost completely on the

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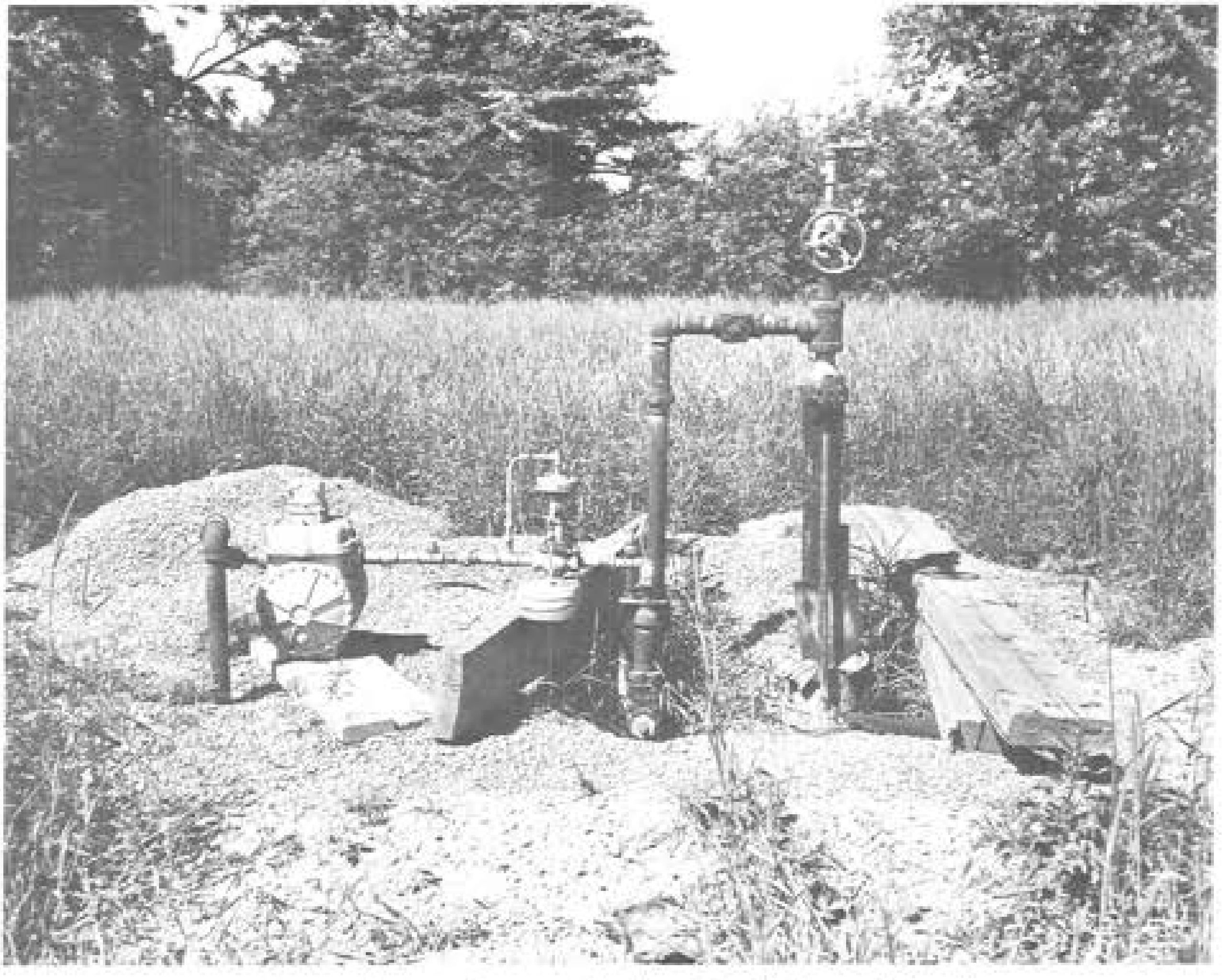
* Jones, R.L. History of Agriculture in Ontario 1613-1880 University of Toronto Press, 1946

production of animal products. This interest is reflected in the attention paid to feed grains and forage crops. Primarily the area is a milk producer for the Toronto market, but also for local consumers and those in Hamilton. Beef cattle, while definitely in the minority, are also important. Some are kept for show and breeding purposes. A herd of Highland cattle, an uncommon breed in this country, may be seen north of Oakville. While not of general importance a few flocks of sheep may be found. Swine are commonly kept and are important in rounding out farm income. Poultry are of modest importance on many farms and the main line of business on some. Toronto and its contiguous urban belt is the chief market for all livestock products.

Some other forms of land use, more industrial than agricultural, may be found. These include mushroom growing, chinchilla breeding, nursery production for landscaping purposes, and sod growing and sod production for the same purpose. The sod growing, an interesting operation, has been carried on near Drumquin by the Ruthven Company. The "farm" is one of several owned by Mr.Ruthven and is devoted chiefly to the production of high quality merion blue grass sod grown from seed. The operation involves seeding, fertilizing, clipping and weed spraying before the crop is removed. This is done only after a period of two or three years during which time the sod develops a matted root system. The cut is selective to ensure uniform high quality. According to recent information it appears that this enterprise may be closed down and the land used for a golf course. Sod is also taken from old pastures by others engaged in the landscaping business.

The exploitation of sand and gravel deposits is as yet a very small business in the watershed but it could become of considerable importance very quickly. From the little information available it would appear that there are substantial amounts of sand and gravel in the spillway from

The sands and gravels underlying the till north of Milton and Hornby apparently carry at least modest supplies of potable water.



Natural gas is taken in modest quantities from the bedrocks east of Speyside.

Scotch Block to Campbellville. A considerable volume of sand also underlies the north-east section of the watershed in Esquesing Township. A small pit has been opened in these deposits between Hornby and Ashgrove.

The shale and limestone resources of the escarpment have been exploited for many years in the manufacture of tile, brick and lime products and several of the quarries are extensive.

All of these materials occupy places of importance in the economy of the province and substantial sources close to urban developments have considerable value. In the public interest however, these deposits should be exploited in such a way that the extractive operations do not pollute and impede streams. Where possible, too, the pits should be returned to a usable condition for other purposes after the resource has been exhausted. This applies particularly to sand and gravel pits.

It is recommended that the Authority, together with the townships, establish a procedure to be followed in the development of pits and quarries. There is some urgency in this matter in view of the fact that Highway 401 is being built through the area where these deposits are apparently plentiful, and also in view of the fact that urban development of the whole region to the south is proceeding rapidly.

Although occupying a minor acreage special crop production is quite important and bids fair to become more important as time goes on. These special crops include tree fruits (apples,, pears and cherries), small fruits (raspberries and strawberries) and truck crops. The last include beans, cabbage, lettuce, potatoes and asparagus. The asparagus is concentrated in a large acreage (125 acres) west of Agerton and is produced by the Campbell Soup Company of New Toronto . The soil on which this crop is grown is Berrien sandy loam and the bulk of the crop area is artificially drained.

Most of the truck crops are produced on the sand plain around Drumquin and to a lesser extent on the small sandy area at Scotch Block. A little vegetable growing is also

Subdivisions have their own special demands on the land.

Increasing urbanization leads to agricultural specialization, a developing trademark of Sixteen-Mile Creek agriculture.

Grass is by far the most extensive user of land in the watershed. The lack of legumes is often a reflection of soil acidity.

taking place on the heavier tills. This land may be expected to become more important for some truck crops as time goes on. Truck crops are still being produced in the Oakville area but the amount is limited and production can be expected to cease as residential and industrial building expands.

Orchard production is of minor importance and is restricted to two areas in the watershed. Several commercial orchards are found south of No.5 Highway but most certainly these will disappear with urban growth. Most of the balance of the tree fruits is grown on the escarpment slope at Scotch Block. It would seem that tree fruit production is capable of expansion in this area. A small expansion of tree fruit growing is also taking place on the northern till plain.

The following table (No.4) indicates the land uses in the watershed, and the acreage involved in each.

3. Population Growth

One of the most interesting features of this part of Ontario is its recent urban growth. With the rapid growth of Ontario, particularly the Oshawa - Niagara Lakeshore industrial belt, it could not fail to do so. This lakeshore region has become the industrial heart of Canada. The lands of the Sixteen-Mile Creek are destined to continue sharing in this growth and now is the time to make sure, as far as is possible, that this increase comes to the advantage of all.

In the present watershed most of the urban and industrial growth has taken place south of No.5 highway but expansion at Milton also has been substantial. This expansion has led to a demand for better services of all kinds and is bringing with it problems which the Conservation Authority can help to solve.

In addition to its own industrial development the area is situated advantageously between the industrial complexes of Toronto and Hamilton and serves to some extent as a dormitory for these centres. The area is well served also in respect to major highways (Nos.2, 5, 25 and Queen Elizabeth)

TABLE 4

PRESENT LAND USE

USE	ACRES		PER CENT	
Oats	4,357		4.28	
Mixed Grain	7,406		7.28	
Fall Wheat	4,267		4.18	
Rye	31		.03	
Barley	37	16,098	.03	15.80
Corn	1,480	1,480	1.30	1.30
Hay	27,042		26.55	
Pasture	22,132	49,174	21.65	48.20
Nursery and Truck Crops	829		.80	
Tree Fruits	892		.87	
Sod	138	1,859	.13	1.80
Idle	3,476		3.40	
Fallow	1,282	4,758	1.30	4.70
Forest - not Pastured	11,582		11.40	
Forest - Pastured	7,984		7.90	
Plantation	336		.37	
Swamp	37	19,939	.03	19.70
Farmsteads	1,340		1.30	
Urban	7,352	8,692	7.20	8.50
TOTAL		102,000		100.00

If present rates of population increase are maintained much of the southern portion of the watershed will soon be urban. Speculation and subdivision holds much land idle.

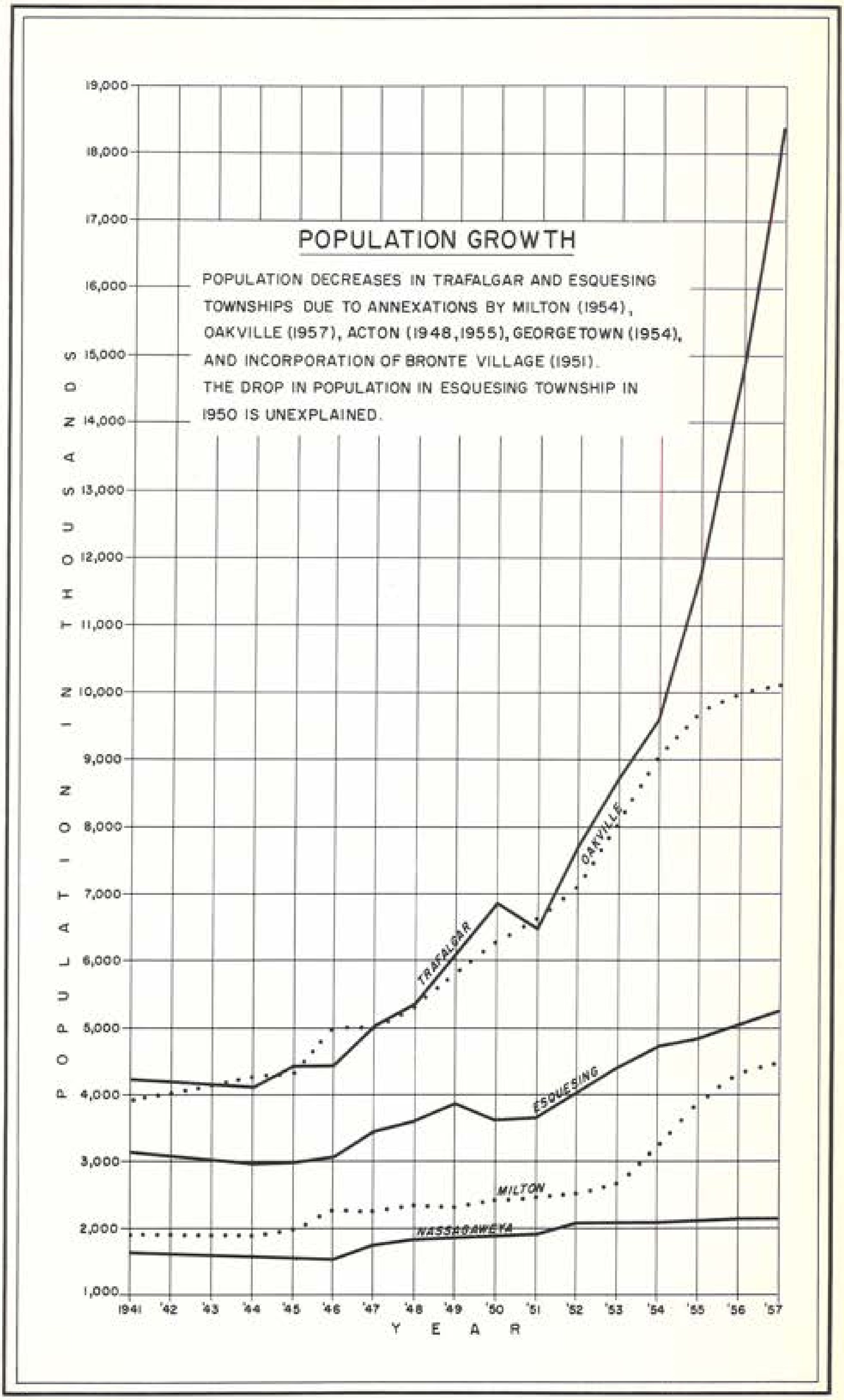
Cheap land and low taxes are bringing many people to live in Nassagaweya and other townships. The construction of Highway 401 will accentuate this trend which may, unless guided, bring conservation problems with it.

Well drained woodlots on accessible roads became choice building sites for urban workers. The Authority should work to acquire those desirable for conservation use.

and railways. Highway 401 is being extended across the watershed just to the north of Milton and this can be expected to contribute further to the growth of the town. Access to Toronto from Milton via this highway will be extremely good. It seems very likely that Campbellville must also face a period of expansion as a result. Unless obstructed, Milton will undergo substantial growth to the north. There is every likelihood that within a few years another multi-lane express highway will be constructed across the watershed in the vicinity of Highway No.5. This highway will not only help to satisfy existing demands but will itself be a factor in leading to further population growth. There is no doubt at all that in the next few years the entire lakefront belt between Toronto and Hamilton will become an urban agglomeration.

The orderly regulation of this growth is primarily the job of urban planners and municipal councils. The responsibility for deciding, through zoning, to what uses various tracts of land will be put also has been, primarily, the job of local authorities. The Conservation Authorities have in no way entered this field of responsibility except indirectly through the purchase of land for flood control, reforestation, Conservation Areas and other purposes. The beneficial effect of this form of public control of land will become even more apparent as time goes on.

The urban development of Sixteen-Mile Creek Watershed south of the Trafalgar moraine would seem to be of small importance from an agricultural point of view. Compared with most areas in the watershed the urbanization of this one would interfere least with agriculture. The soils of this section are much less valuable than those of the Peel Plain or the northern till plain. Also, the region is reasonably close to the lake for water supplies and is likely to suffer in only a minor way from flooding provided reasonable precautions are taken. The Trafalgar Township zoning by-law map indicates that most of the Peel Plain in the township is zoned for agriculture. It is suggested that the Conservation Authority


POPULATION GROWTH
POPULATION DECREASES IN TRAFALGAR AND ESQUESING TOWNSHIPS DUE TO ANNEXATIONS BY MILTON (1954), OAKVILLE (1957), ACTON (1948, 1955), GEORGETOWN (1954), AND INCORPORATION OF BRONTE VILLAGE (1951).
THE DROP IN POPULATION IN ESQUESING TOWNSHIP IN 1950 IS UNEXPLAINED.
POPULATION IN THOUSANDS
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
TRAFALGAR
OAKVILLE
ESQUESING
MILTON
NASSAGAWEYA
1941
'42
'43
'44
'45
'46
'47
'48
'49
'50
'51
'52
'53
'54
'55
'56
'57
YEAR

lend support to this proposal. The covering of prime agricultural land with bricks, mortar and tarmac is not necessarily the best use of our resources, especially when land of lower capability is available in the same region for this purpose.

The graph of population growth indicates even more clearly than figures the nature of the problem and should suggest to the Authority the desirability of an active forward-looking programme in the several fields of conservation work. If the trend of the past several years is maintained Trafalgar Township alone may be expected to at least double its population in the next four years.

CHAPTER 3

LAND USE CAPABILITY

1. Introduction

The use capability of land depends largely on the climate and on the inherent characteristics of the soil. Within limits which are not necessarily rigid man may modify some of these factors by draining, irrigating, fertilizing, land levelling and using better crop varieties. In general, however, the nature of the land determines the general use to be made of it and suggests the kind of use which should be made of it. The farmer should always try to fit his husbandry to the land, not vice-versa.

One of the most important aims of conservation is the adjustment of use and the management of land according to its capabilities. In this way the greatest long-run economic return will be obtained and the continued productivity of the soil maintained.

On many of the fields on most of the farms of Ontario the land is variable in quality because of changes in the soil itself, in slope, and in drainage. Most farmers know and appreciate the fact of these differences and many, by themselves or with technical aid, adjust use to capability. To bring about efficient use of land each farmer needs to make an inventory of his land and its capability. Considerable individual assistance in this matter may be obtained through the farm planning facilities of the Soil Advisory Service of the Ontario Agricultural College.

Any long range programme of conservation work eventually (often quite soon in some forms) runs into the question of land capability, for many of our land problems stem from a lack of, or a poorly balanced adjustment between use and capability. Each piece of land an Authority acquires for reforestation, for example, is a concrete example of an attempt by the Authority to match long term public good to land capability. By and large such land is deficient in one or

Well drained productive land such as this may often be cultivated on the contour to reduce erosion and run-off.

There is little Class IV land on the watershed. It should be kept in grass most of the time.

On the limestone plain the soils are often thin and bouldery. They are best suited to the production of trees.

more respects for profitable agricultural use and would normally be defined as Class V land, or worse, in the classification outlined below. Except with good reason no Authority would take over better land for any use but agriculture. Even agricultural land may be graded into various categories according to its capability and suitability for use.

In order to assist the Authority in its present and future work the capability of the land throughout the watershed was judged and a map prepared delineating the various classes of land. A copy of the map accompanies this report.

The land of the watershed may be divided into four broad classes on the basis of its suitability or unsuitability for agriculture. In assessing the suitability of a piece of land for agricultural use, the piece of land in question is rated according to one of the following categories, the rating depending on a number of things including soil, slope, erosion, erosibility, drainage, and inherent fertility.

A - Suitable for cultivation

B - Suitable only for occasional cultivation

C - Suitable only for permanent vegetation and unsuitable for general cultivation.

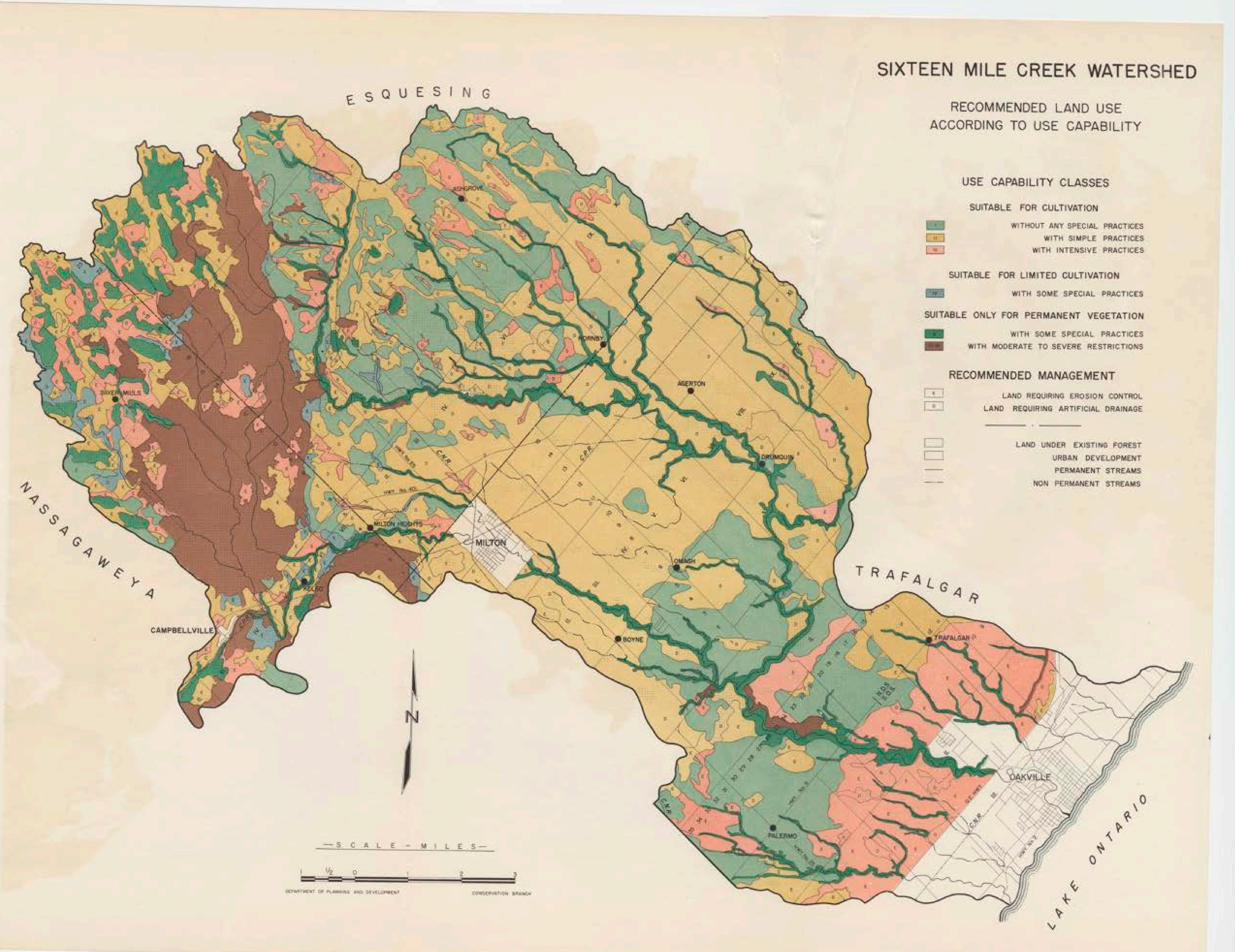
D - Not suitable for cultivation or for commercial grazing or forestry.

Within these broad categories various classes of land are recognized.

A - Suitable for Cultivation

Class 1 - Without any special practices over and above what is considered to be good farming for the area. This land may be continually cultivated with safety and will produce good crops for an indefinite period.

Class 11 - Requires moderate restrictions in use and more specialized conservation practices to produce good yields with minimum risk to the land.


SIXTEEN MILE CREEK WATERSHED
RECOMMENDED LAND USE
ACCORDING TO USE CAPABILITY
USE CAPABILITY CLASSES
SUITABLE FOR CULTIVATION
WITHOUT ANY SPECIAL PRACTICES
WITH SIMPLE PRACTICES
WITH INTENSIVE PRACTICES
SUITABLE FOR LIMITED CULTIVATION
WITH SOME SPECIAL PRACTICES
SUITABLE ONLY FOR PERMANENT VEGETATION
WITH SOME SPECIAL PRACTICES
WITH MODERATE TO SEVERE RESTRICTIONS
RECOMMENDED MANAGEMENT
LAND REQUIRING EROSION CONTROL
LAND REQUIRING ARTIFICIAL DRAINAGE
LAND UNDER EXISTING FOREST
URBAN DEVELOPMENT
PERMANENT STREAMS
NON PERMANENT STREAMS
ESQUESING
NASSAGAWEYA
TRAFALGAR
LAKE ONTARIO
ASHGROVE
HORNBY
AGERTON
DRUMQUIN
SAYERS MILLS
MILTON HEIGHTS
MILTON
OMAGH
KELSO
CAMPBELLVILLE
BOYNE
TRAFALGAR
OAKVILLE
PALERMO
C.N.R.
C.P.R.
N
SCALE — MILES
DEPARTMENT OF PLANNING AND DEVELOPMENT
CONSERVATION BRANCH

Class 111 - Needs intensive restrictions in use to provide good crops on a sustained production basis with minimum risk to the land.

B - Suitable only for Occasional Cultivation

Class IV - Best used for permanent vegetation but may be safely cultivated occasionally to certain crops.

C - Suitable only for Permanent Vegetation

Class V - Normally uncultivable because of restricted drainage, periodic flooding or topographic difficulties. No special practices or restrictions are required.

Class VI - Requires moderate restrictions in use.

Class VII - Needs severe restrictions in use.

D - Not Suited to Cultivation or Commercial Grazing or Forestry

Class VIII - Includes areas of rock outcrop or marsh which do not lend themselves to cultivation or commercial grazing or forestry.

2. Recommended Land Use according to Use Capability

These land use capability classes may be converted into classes of recommended use by indicating generally what special practices and restrictions are required for each type. In this report this has been done by adding the letters D. and E. to those areas designated as classes II, III and IV. On classes V and VI, recommendations are given as needed. No special practices are required on class I land and normally no restrictions are placed on use.

The symbol D is applied to those land classes where restricted drainage is the main use problem and where, in most cases, artificial drainage would correct the problem. Practically all of this land is level to very gentle sloping and erosion is not usually a difficulty. Where it is the drainage should be accompanied by sterner erosion control measures than would normally be the case. Particular attention should be paid to providing adequate outlets for tile drains so that the possibility of gullies developing from this source is eliminated.

The symbol E is applied to those land classes where erosion or susceptibility to erosion is the chief hazard. It includes land capable of being cultivated on the contour and land where the topography is too broken to be dealt with in this fashion.

Land Class I

Although the land of the Sixteen-Mile Creek Watershed suffers from a variety of ills which impede cultivation and reduce yields, the watershed still possesses a favourable supply of good agricultural land of which a higher than average percentage may be considered class I. Altogether about one-fifth of the land, some 20,000 acres, may be placed in this class. Such land is quite level or gently sloping, well drained, free from erosion and stoniness and reasonably fertile. With reasonable care it will remain productive for a long time to come. No extraordinary practices are required to keep it productive but it should be cultivated, fertilized and managed to the best advantage. A considerable proportion of this land should be quite suitable for orchard and truck crop production.

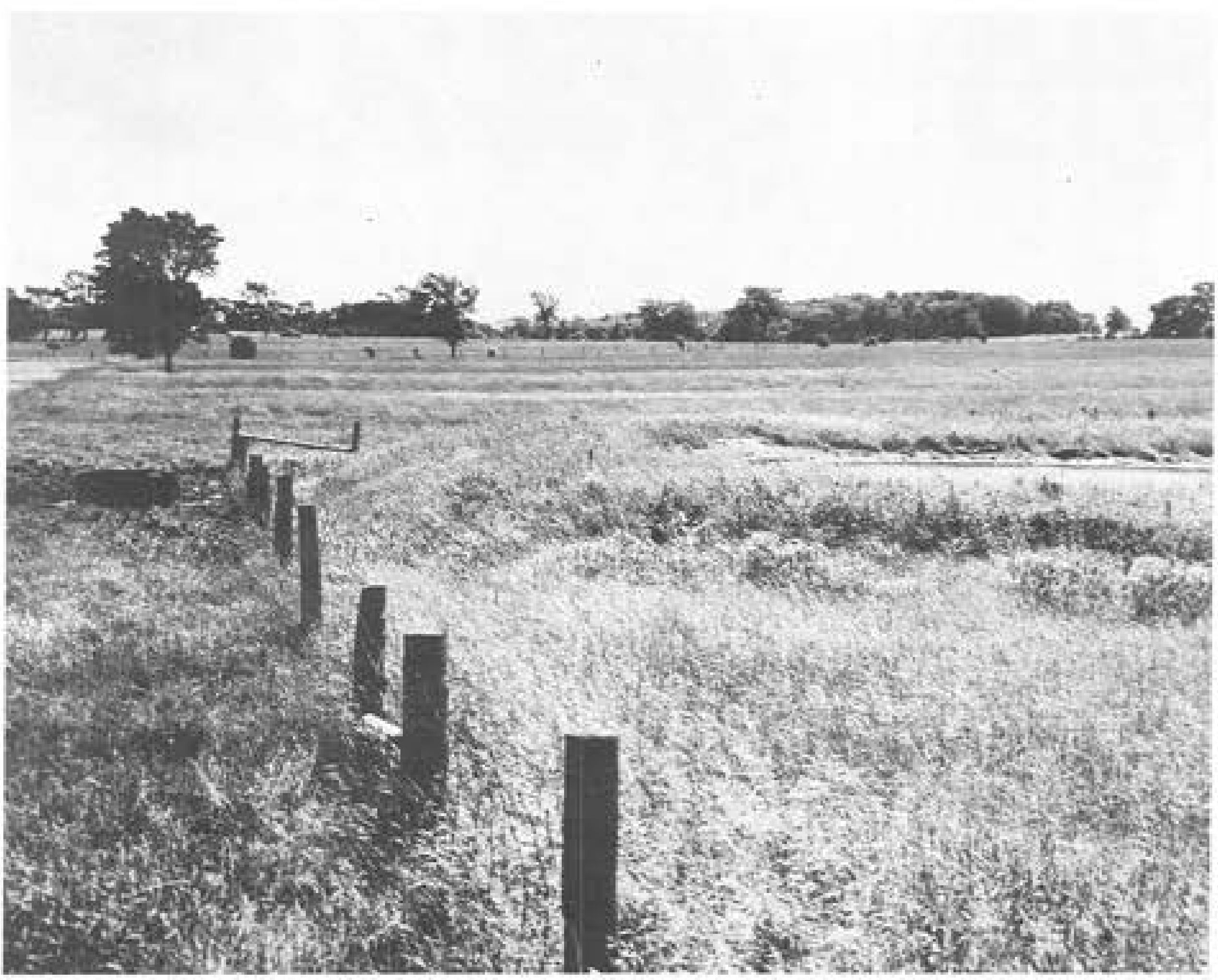
Land Class IIE

Like the class I land this type is generally well drained, stonefree and reasonably fertile. Because of steeper slopes, and sometimes of more hummocky terrain, erosion is a more serious problem. Erosion may be prevented and controlled by the use of satisfactory rotations, winter cover crops, maintenance of the soil organic content and restriction of intertilled crops, particularly on the more steeply sloping land. Most of this land, some 10,500 acres, is used for general farm crops. Some is still being used for woodland but the acreage involved is small. Part of this land might be cultivated on the contour but broken slopes on the balance would make it difficult.

Land Class IID

This class is by far the most extensive of those found and comprises about 30,000 acres. The land is level to

The extensive use of grass in the watershed aids in no small way in controlling erosion.



Farm ponds help to overcome acute surface water deficiencies. Note the fenced pond area and external drinking trough.

gently sloping and imperfect soil drainage is the main restriction to cultivation and favourable yield. The soils are mostly heavy tills and water-worked tills in which a low pH is sometimes a problem. The use of agricultural grade ground limestone in adequate amounts should prove a beneficial corrective measure in reducing soil acidity and allowing legume production.

The production of forage crops is a main endeavour on these soils but the imperfectly drained sandy soils of the Berrien series found around Drumquin are used a great deal in the production of market garden crops.

Land Class IIIE

The land in this class is similar to that in class II but conditions are generally more severe - the slopes are steeper, erosion is greater, or the erosibility factor is higher. Approximately 11,000 acres of land lie in this class.

Some of this land is suitable for contour cultivation methods but on a large acreage the slopes are broken to the extent that this type of cultivation would be difficult or impractical. Cultivation and remedial measures required to correct or prevent erosion include rotations, cover crops, grassed waterways and elimination as far as possible of cultivated crops. Fertility improvement and the maintenance of a high soil organic content are both necessary for maximum yields.

Land Class IIID

Approximately 2,300 acres of this land are found in the watershed and a large proportion of it is located in the southern section. In addition to providing a drainage problem the Trafalgar clays are stiff and difficult to work. Soil acidity and modest fertility help to lower the rating for this land. Because the land is level to gently sloping,erosion is a minor problem. Improvement of soil drainage to a satisfactory level is a fairly difficult problem due to the heaviness of the soil.

Land Class IVE

This class is rather limited in the watershed, there being only a little over one per cent of it. Soil fertility may be reasonably good but the capability is lowered by steep slopes, more erosion, and a higher susceptibility to erosion. In some cases the class includes, because of an erosion problem, land which would otherwise be considered as class III.

Land of this class should be restricted from regular cultivation because of rough topography and susceptibility of the soil to erosion. It is best placed under a permanent grass cover with controlled grazing. Occasional cultivation to provide new pasture may be carried on with reasonable safety. The occasional grain crop may also be grown.

Land Class IVD

Considerably less than one per cent of the watershed acreage falls in this class. These areas are wet and cannot be drained economically or easily. Erosion is negligible and in a dry year, with a lower water table, a crop may be taken off. Generally, however, the land is devoted to pasture or woodlot.

Land Class V

This type includes those areas subject to periodic flooding, chiefly the flatlands adjacent to the streams but also including swamp and muck areas. For mapping reasons much of the steeper sloping land of the valley slopes is included. This land would normally be rated as Class VI; VII or VIII. It is almost completely forest land but may, along with the bottomland, have considerable recreational value. The bottomland itself is variable as to soils and drainage, and is useful mainly for pasture and forest. Where the area is extensive enough it may make good cropland. Bottomland pasture generally requires a minimum of care but an attempt should be made to minimize overgrazing and damage to stream banks. Surprisingly enough the class takes in over 8,500 acres of the watershed. There would seem to be good opportunity for the Authority to set aside substantial acreages of this for recreational use.

Land Class VI

This type, occupying some 10 per cent of the watershed, is rather variable and embraces, in addition to the land which would normally be considered class VI, areas of class VII and class VIII land. The difficulty of mapping these three classes separately in the time available made it necessary to lump them together into one class. Much of this land is thinly covered with soil, is steep, or is bare rock. Most of it is covered with various grades of forest.

By and large this land is useful chiefly for forest production,wildlife and recreation. In some instances the topography and soil will permit grazing but where this use is carried on care should be taken to see that overgrazing is not practised.

TABLE 5

RECOMMENDED LAND USE

Land Class	Acres	Per Cent of Watershed
I	19,846	19.5
IIE	10,526	10.5
IIR	30,058	29.5
IIIE	11,047	10.9
IIIR	2,276	2.2
IVE	1,369	1.3
IVR	314	.3
V	8,689	8.5
VI	10,828	10.4
Urban (not classified)	7,027	6.9
Total	102,000	100.00

CHAPTER 4

CONSERVATION MEASURES

One of the chief aims of conservation is that land shall be used and managed according to its natural capabilities. One usually has the choice of using a piece of land in several different ways. Some of these uses may fit the capability of the land very well and others may not. For instance, we may be able to use a piece of hummocky land for the production of grass and occasional grain and actually improve the fertility and tilth of the soil. Under persistent production of corn or potatoes the same soil might become badly eroded and suffer severe loss of fertility. The capability map described in Chapter 3 attempts to overcome this problem by indicating those lands which are suitable for different broad forms of use.

In this chapter brief attention will be paid to those measures which seem to have some importance in the watershed in maintaining and increasing the tilth and productivity of the land. Most of these measures, and others, are being used in the watershed to some extent but many farmers are paying them only scant attention, or none at all. The agricultural lands of the Sixteen-Mile Creek Watershed are too valuable to be allowed, other things being equal, to produce less than their capability. Too, the natural capability of the land may be increased measurably, often through simple practices.

The principal agricultural lands of the watershed now and in the future, embrace the heavy soils of the Peel Plain and the loamy, better drained soils of the till plain in Esquesing Township. As the urban development in southern Trafalgar, and indeed between Toronto and Hamilton, increases, it becomes more and more urgent that these premium crop lands be preserved and improved. As the regional population increases, the demands on the productivity of those lands will also increase.

Because of these demands some of this land will be devoted to the production of special crops - vegetables, fruits and nursery stock for landscaping. These uses demand special and intensive measures so that the productivity and health of the land will be maintained. On the greater balance of the agricultural acreage the emphasis will be on dairy production as a major use of land. Swine and fowl will remain at least as important as now and are likely to become more important.

1. Drainage

Among the more important measures which may be undertaken by farmers of the watershed is that of land drainage. A large part of the Peel Plain is imperfectly to poorly drained and crops tend to suffer as a consequence. In the spring the land may be too wet to work and seeding impossible to accomplish with the result that the farm enterprise suffers. On the other hand, and this is not an infrequent occurrence on heavy soils like these, summer drought may lower the water table faster than the shallow rooted (due to a high water table) plants can extend their root systems. The net result is poor crop response and loss of income.

By having a planned and effective drainage system the farmer is not only able to enter on his land earlier but the seeds germinate faster, the plants send down deep root systems early and more readily withstand summer drought. It is a fact that farm underdrainage will often pay for itself within two or three years after installation through reducing operating costs, reducing seed loss through faulty germination, and through higher yields.

As individuals and as groups, farmers can obtain a good deal of assistance under the several provincial drainage acts. In addition, a farmer may call on the agricultural engineers of the Ontario Agricultural College to provide a drainage plan of his farm for a very modest fee.

In addition to general farm underdrainage it is often expedient to install a line of tile down the course of a grassed waterway. By so doing the waterway is rendered more usable and more effective.

Drainage by open ditches is generally less suitable on a farm than tiling for several reasons - they harbour weeds, and they soon become overgrown; they fill with silt; they may be a hazard to, and by trampled by, livestock; they require periodic cleaning for effective life. Drains of this type have the advantage of lower initial cost. Most important, perhaps, they are suitable for draining a depression but not suitable for general soil drainage because of a limited active zone to either side of the ditch. In heavy land even tile drains must be located close together to be effective.

Beyond dispute, there are many areas in Ontario which should never have been drained and in which the drainage works have failed to function effectively. Likewise, there are many areas in the present watershed which should not be drained. The cost of doing so would in many cases be uneconomic in relation to benefit and the work might also adversely affect wildlife and water resources of the watershed. All of those areas rated Class IVD and Class V on the land capability map should be left undrained. It is possible also that a few of those areas classed as IIID would be better left undrained. Where the land has not already been so treated it is suggested that planned tile and ditch drains would be beneficial. Control of water is one of the important aspects of conservation.

Imperfectly manufactured tile and ditch drains have in the past developed into serious problems. All tile drains should have outlets which are protected by splash aprons, headwalls and gates so that the possibility of gully erosion is reduced to a minimum. The tile should also discharge into "safe" areas where water flow will not result in a greatly increased erosion hazard. Ditch drains should be built so that the side slopes are shallow enough to prevent slumping and facilitate weed cutting.

Many serious gullies have developed in Ontario through inadequately protected tile outlets. In the Sixteen-Mile Creek Watershed this is not a serious situation but land drainage may become more important as pressure on the land increases. With this intensification of use may come greater erosion problems. It is therefore suggested that the Authority carefully consider adopting a policy of assistance for farmers in the establishment of satisfactory tile drain outlets. Such outlets would not only assist in gully erosion prevention but would help to reduce stream pollution and sedimentation.

It is possible that some farmers in the two above-mentioned areas of the watershed will be ill-disposed to putting in soil drainage works because of the growth of the urban community. An earlier suggestion in this report that the Authority use its good offices to urge retention of these lands for agriculture is therefore reiterated. It is also suggested that the Authority urge that any proposed drainage works (particularly those at a municipal level) be reviewed from the point of view of whether the soil needs draining or whether they are required for the cropping schemes on the land.

2. Grassed Waterways and Gully Control

Existing gullies are common enough on the watershed to warrant some short discussion as to their origin and control.

The majority of the gullies were observed along the stream banks where slopes were steep or changes in gradient abrupt. In most instances these gullies had developed in existing drainage channels which, under natural conditions, were able to discharge surface water flow safely. With clearing and cultivation the capacity of these channels was overloaded and the silt-laden waters were able to erode them.

In a number of cases the repair of these gullies will have to be undertaken on an individual basis. The repair of others and the prevention of future ones may be effected through the construction and maintenance of grassed waterways. If properly built these waterways will deliver the water safely and at the same time provide substantial amounts of hay of high quality. The grass sown should be of such types as to safely withstand the effect of running water. The bunch grasses such as timothy and tap-rooted legumes like alfalfa should be avoided.

When building waterways or turning gullies into waterways the watercourses should be broadened and flattened to carry a maximum flow. The hay should be cut several times in a season and fertilized for maximum healthy growth. The waterways should remain undisturbed by livestock and implements.

The Authority might, on a demonstration basis at least, and perhaps as general policy, assist in the control and renovation of existing gullies. In many cases the work and expenditure required to rehabilitate these gullies would no doubt be beyond the resources and capabilities of the landowner. Such work would, however, be in the interests of the community at large.

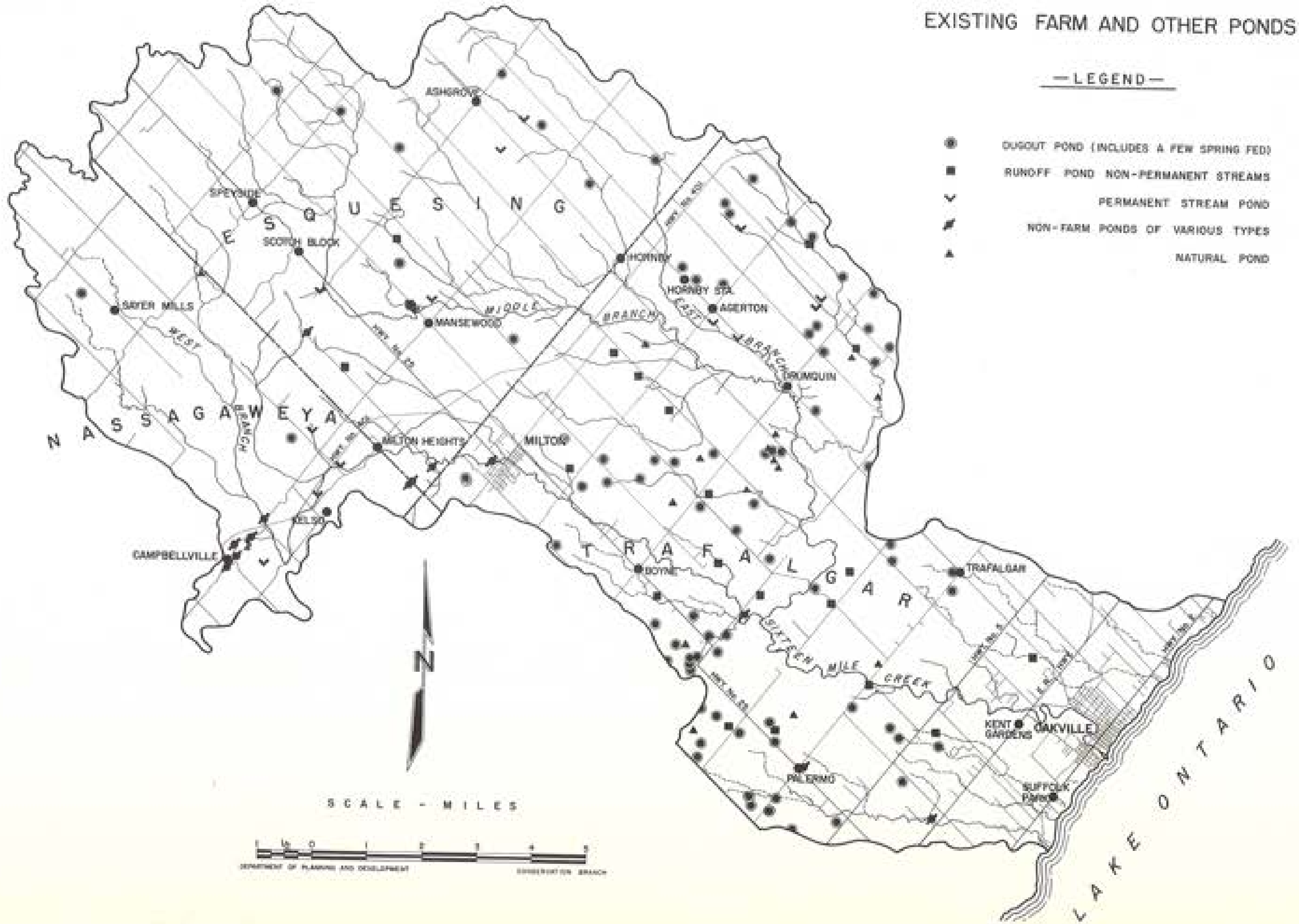
Grassed waterway construction should, generally, be within the resources and capabilities of the individual, although technical advice on such construction may often be needed. The Authority might consider providing or arranging for such advice in those instances where it is needed and aid more directly in one or more waterways for demonstration purposes.

3. Farm Ponds

An examination of the map showing the distribution of farm ponds reveals that these water bodies are concentrated on the Peel Plain, an area where imprefections in soil drainage are widespread. This fact may seem anomalous but there are, in fact, very good reasons for this apparent peculiarity. The area is primarily one producing beef and dairy products and demands for stockwater are fairly heavy. The vegetable growers also require water in good supply for irrigation purposes. The

Tree fruit and small fruit growing is expanding into the till plain of southern Esquesing townships.

The successful production of high value fruit and vegetable crops frequently demands supplementary irrigation and often puts a strain on surface water supplies. Farm ponds may often meet these demands.


EXISTING FARM AND OTHER PONDS
— LEGEND —
DUGOUT POND (INCLUDES A FEW SPRING FED)
RUNOFF POND NON-PERMANENT STREAMS
PERMANENT STREAM POND
NON-FARM PONDS OF VARIOUS TYPES
NATURAL POND
ESQUESING
NASSAGAWEYA
TRAFALGAR
LAKE ONTARIO
ASHGROVE
SPEYSIDE
SCOTCH BLOCK
SAYER MILLS
HORNBY
HORNBY STA.
AGERTON
DRUMQUIN
MANSEWOOD
MIDDLE BRANCH
EAST BRANCH
WEST BRANCH
MILTON HEIGHTS
MILTON
KELSO
CAMPBELLVILLE
BOYNE
TRAFALGAR
SIXTEEN MILE CREEK
PALERMO
KENT GARDENS
OAKVILLE
SUFFOLK PARK
HWY. No. 25
N
SCALE - MILES
0 1 2 3 4 5
DEPARTMENT OF PLANNING AND DEVELOPMENT
CONSERVATION BRANCH

nature of the land is such that streams originating in the region are dry during the summer season. This lack of surface water has forced farmers to construct farm ponds to overcome this deficiency.

Surface water above the escarpment is rather plentiful and farm ponds are few in number. On the till plain north of Milton surface water supplies are moderately good and the demand for farm ponds is limited as a consequence. On many farms, however, ponds can augment the water supply to advantage. More intensive forms of agriculture will undoubtedly create demands for water which may be met by ponds.

The realization that farm ponds are an excellent low cost method of augmenting farm water supplies has resulted in the building of some thousands of ponds in the province in the last 10 years. The heaviest concentrations of these are in those areas where Conservation Authorities are active. In Halton County pond construction has been facilitated by co-operation of the County, and the Authority is urged to back, even supplement, the program if this proves necessary or desirable.

The Authority is also urged to publicize the desirability of adequate construction amd maintenance standards in farm ponds. Particular care should be taken in building the dams and spillway channels of run-off and permanent stream ponds. A large number of dams in the province have failed because this has not been done. Some of these may be found in the Sixteen-Mile Creek Watershed. It should also be pointed out that permission is required from the Surveyor-General for Ontario before any structure can be placed across any permanent stream.

The dug-out pond is popular, useful, low in cost and easy to construct. It should, however, be adequately built and maintained. For best results and long life it should be fenced and an outside watering trough constructed for stock watering.

The recent publication of the Ontario Department of Agriculture dealing with farm pond construction and management is very useful and informative and is recommended to all those contemplating building a farm pond.

4. Contour Cultivation and Strip-Cropping

Contour tillage means the cultivation of land along the contour and at right angles to the slope. Easily contoured slopes are broad and smooth and possess a minimum of slope change or of surface drainage channels. The best installation of such measures may require the removal and/or relocation of one or more fencerows. When the land is tilled "on the level" each furrow or drill-row acts as a small dam to retain the run-off water, which is better able to be absorbed by the soil. It may not be possible to follow the contour exactly, but this should be done as nearly as possible. If the furrows or drill-rows are not on the line of contour, there is the danger of water accumulating in depressions behind the implement-formed ridge and breaking across it to cause rill or gully erosion. This may be overcome by careful tillage and by providing grassed waterways in normal drainage channels.

Strip-cropping is often carried on in conjunction with contour tillage. This involves the establishment of alternating crop strips across the slope. Some strips would be devoted to grain or intertilled crops, and the strips between would be in hay or pasture. By the use of such a practice any water which escaped from the cultivated strip and which carried soil with it would be checked by the grass strip, with the result that the soil load would be dropped.

Contour tillage not only helps to save the soil but saves money and time. Experiments in the United States have shown time savings of 10-15 per cent and fuel savings of the same magnitude simply by working at right angles to the slope instead of up and down it. Experience in Ontario has been similar.

The amount of land suited to contour cultivation in the watershed is relatively small but there are many areas where its use would be beneficial.

5. Farm Planning

To most farmers the idea of planning is not something new; in some measure or other they plan the use and management of their land so that they know a year or so in advance what cultivation sequence they are going to follow. They plan for repairs to buildings, equipment, fences and so on. They plan so far as they can the day to day and month to month work they are going to do, and much of it becomes routine. Planning, in short, is an essential feature in the life of the farmer as it is with anyone concerned about his future.

Although many farmers have a plan regarding the use to which they put certain or all of their fields, relatively few have had their farms planned so that the maximum use, consistent with the best use, is made of each piece of land. The object of a plan of this sort is to enable the farmer to get the most out of his land and at the same time to do it in such a manner that no damage to the land occurs. When a farm is planned each piece of land is judged according to its capability to produce, and various use recommendations are made. These may include pasture management, crop rotations to follow, woodlot management and reforestation, farm drainage, fenceline removal or relocation, or any other works and practices which would benefit the farmer and his land.

Planning does NOT need to be so rigid that there is only ONE recommended use or management for a piece of land of one class. Alternative recommendations may be made for a piece of land in a certain class. The first rule is to apply the easiest and cheapest remedy. The next thing that determines the choice of use is the relation of the field to the rest of the farm. Other factors apply, such as suitability for using powered mechanized equipment, or the distance from the barn and ease of access. The final determination depends on the crops and animals the farmer chooses to carry. The final plan, therefore, is the end result of a good many compromises and at each stage of preparing the plan certain choices have to be made.

In developing the plan a farm planner goes over the farm field by field and maps the soils as he finds them. He uses an aerial photograph as a base map. The soil series and types are identified and an estimate of the degree of erosion is made by examining vertical sections of the soil. The slope of the land is measured, using a hand level which gives slope as a percentage. A rise of four feet in a run of one hundred feet, for example, is a 4 per cent slope.

The occurrence of watercourses, either permanent or intermittent, with or without a definite channel, is noted, as are fencelines, stonepiles, springs, seepage areas, gullies or any other items of importance.

All of the information gathered is marked on the map, using symbols, and each piece of land of the same type with respect to soil, slope and erosion is delimited by a boundary line.

From the map of soil type and conditions a map of use capability is prepared. Each piece of land is assigned to one of eight capability classes. These classes are the same as those used for the watershed and are included here as part of the plan. On any one farm not all classes will necessarily be found.

The plan of the farm is then worked out with the farmer so that each field, or each piece of land, is put as nearly as is practicable to the use which fits the capability. Any systems of tillage or cropping or special practices to control erosion and water loss are applied where necessary. The fields and rotations are worked out so that there is the correct balance of pasture, fodder and grain to meet the requirements of the herd which the land can carry.

Before the planned rotations are put into effect it may be necessary to arrange a transition period in which the change-over from present cropping to the planned rotation is made without losing a year of cropping. Also, it may take a year or two to get special devices like grassed waterways and terraces in working shape. A time of transition such as this may also prove useful in providing a period during which any desired changes in the plan may be implemented.

In adjusting use to capability it may not be possible to outline fields exactly according to natural soil conditions. The inclusion of a small area of, for example, Class II land in a field which is predominantly Class I land may mean that this small area of land of lower capability will be worked as intensively as the Class I land. This is not strictly following the principle of "using each acre according to its ability", but is a compromise weighed against the possible cost of fence removal, difficulties of tillage and so on. In a plan, therefore, there may be found one or more small areas of one land class within a larger area of another land class.

Even though possessing high merit from the point of view of work simplification, land improvement and increased income, it is unlikely that any farmers in the watershed will feel inclined to engage in land use planning of this order unless they are given reasonable guarantees that their land will remain agricultural and be taxed accordingly. The rate of farm turnover makes the problem difficult enough but compounding it with urbanization makes it impossible. The Authority is therefore urged to press for stabilization of land use in co-operation with the municipalities so that a healthy and rewarding agriculture may be continued and so that farm planning may take its rightful place in the development of the watershed.

6. Grassland

There are many good pastures in the Sixteen-Mile Creek Watershed but there are also many which can be developed to greater productivity. Improved soil drainage and a raised pH (lowered soil acidity) through the use of lime can do much to raise productivity where the use of these measures is indicated. Lack of legume growth is often due to one or both of these factors.

The production and management of first-class improved pasture is no simple job for it is both art and science and requires substantial knowledge on the part of the farmer. Perhaps first and foremost is the fact that pasture is a composite of grasses and legumes, each with its own peculiarities and demands. The selection used must fit,as nearly as possible, the peculiar soil characteristics of the field and must also stand up to maximum browsing by livestock as well as climatic variations.

In an area such as the present watershed where livestock products are so important and hay and pasture cover nearly half of the total acreage it behooves the farmer to make the most of his grassland. It should never be considered a lesser use of land but one which will pay dividends for adequate care. Successful pasture depends on many things including the quality of the seed, the seed mixture, the physical and chemical condition of the soil and the treatment of the pasture once it is in production. Soil tests and the application of fertilizer are just as important in the production of top-quality pasture as in the production of other crops.

It should also be pointed out that grassland has high importance in controlling erosion and improving soil moisture relations. Grasses and legumes provide organic material for the soil and protect it almost completely against erosion. By improving the soil structure and providing a continuous cover the impact of the rain is dispersed and the water is more readily able to enter the ground to the benefit of the crop and of the ground water supplies.

In any matters concerning pasture production the farmer should consult his local Agricultural Representative who can, if necessary, obtain further expert opinion in the solution of a problem. He may also consult many bulletins on the subject and a few of these are listed below.*

Farmers are often unaware of the many services and professional advice available to them through their Agricultural Representative, Zone Forester and Conservation Authority Field Officer, and it is recommended that the Authority publicize this matter as fully as possible.

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* Useful bulletins include:

(a) Guide to Crop Production in Ontario. Ontario Department of Agriculture, Extension Bul. No.68.
(b) Soil Management and Fertilizer Use. Ontario Department of Agriculture, Bul. No.497.
(c) Better Ontario Pastures. Ontario Department of Agriculture, Bul. No. 469.
(d) Fertilizers for Cereal, Hay and Pasture Crops. Ontario Department of Agriculture. Circular 144 (Rev. May 1955).
(e) Better Pastures in Eastern Canada, Department of Agric. Ottawa, Pub. 809. Farmers Bul. 150, Oct. 1948.

SIXTEEN MILE CREEK CONSERVATION REPORT

FOREST

ONTARIO DEPARTMENT OF PLANNING AND DEVELOPMENT

CONSERVATION BRANCH

CHAPTER 1

THE FOREST IN THE PAST

1. At the Time of Settlement

Good early descriptions of the forests of Southern Ontario are rare, for the early settler regarded the forest more as an obstacle to cultivation than as a positive asset worthy of recording. However, a fairly good picture may be obtained by piecing together the scattered information which does exist. Such early concern as there was with timber resources centred around pine and oak for the British navy and the easily cut softwoods for building purposes. Fuelwood was important, but was everywhere abundant and not worthy of special note. In addition the type of timber was of indirect interest as an indication of the quality of the land; pine - oak forests indicating light, easily worked soil, and maple - beech stands suggesting richer but heavier soils.

In order to record this information prior to settlement, the early surveyors were instructed as follows;

> "Your field book is to be kept in the accompanying form, comprising the kind and quality of the soil and timber, entering each kind of timber in the order of its relative abundance."

In accordance with these instructions, the surveyors' notebooks included a running account of the compositon of the forest cover along every line they ran, and thus they provide a reasonably accurate picture of the original bush in each township surveyed.

The townships comprising the Sixteen-Mile Creek Watershed were surveyed between 1806 and 1819. From the surveyors' field notes it is clear that they worked through a primeval forest almost unbroken except for an occasional "beaver meadow", a few Indian corn fields in the lower valley flats or a patch of windfall. The path of one violent storm was apparent from a strip of small timber which was noted on many survey lines and which impressed the early settlers as noted by Mr. J. Norrish, writing some time later (in 1889) on

"The Early History of Nasagiweya".

> "This township was visited at one time by a heavy cyclone, but at what date is not known as there is no record of it that I have ever heard of, but it must have been from one hundred to one hundred and fifty years ago. It crosses the township diagonally from west to east, taking a strip about a mile wide, the middle of the strip is about Lot 23, in the 1st Concession, and crossing the line into Esquesing about Lot 8. It is said to have extended from lake to lake and took down everything in its course except an odd pine stubb."

The path of devastation extended on east through Trafalgar Township, past Drumquin and then on beyond the limits of the watershed.

The narrow sand plain between the lake shore and the present Queen Elizabeth Way supported a forest usually associated with more southern regions and the surveyor Samuel Wilmot records:

> "Oa(k) Pine & chesnutt Light Sandy Soil"

These were among the few species of value at the time of settlement, and formed the basis for an early development of industry. Pine and oak extended northward through the watershed and memory of many fine specimens has caused later reports to exaggerate their abundance. The surveyors' notes show that the upland forests were mainly hard maple, beech and basswood, with the pine and oak intermixed in smaller numbers. The Canadian Gazetteer of 1846 records for Nassagaweya, "Timber principally hardwood", and for Trafalgar, "Timber principally hardwood, with a little pine intermixed." There were, nevertheless, limited areas where the pine did predominate. Such was the area just west of Milton Heights, where Reuben Sherwood in 1819 recorded the timber as "principally tall heavy pine." With some slight allowance for the haze of time we may appreciate Mr. Norrish's description of "Nasagiweya":

> "The mountain crossing it at the south-east end causes the land to be very uneven and very stony, some places solid rock and high precipices, but even this territory is getting to be valuable now. The timber in this part of the township was mostly pine up to the middle of the township and in some parts a little above that. In some places there was a

scattering of hardwood among the pine and some very good red and white oak. In these places the pine grew very large, I knew of one tree that grew on Lot 20, in the 1st Concession, that measured two feet in diameter, ninety-five feet from the ground. This part of the township was very hard to clear up, as after they had got the timber off the pine stumps were a great obstruction, and the timber itself of very little value in the early days of settlement. But the stump and stone machines have worked wonders here, but a stranger visiting here could form but a very faint idea of the labour and expense of constructing those stump and stone fences. The hardwood consists of maple, beech, and some elm and basswood, there was also some hemlock in places, but a great part of it was destroyed before it became of any value; we had some white and black ash and a large amount of cedar swamp. In the upper end of the township there was some good rock elm, but the best of it was cut and shipped to Britain several years ago."

2. Clearing the Land

The attitude of the early settler to the forest was completely hostile. Although the forest supplied his meagre needs for construction material and fuel, this was but a drop in a seemingly limitless sea of supply. Transportation was poor, and markets for his woodland produce extremely limited. For agriculture to develop the forest must go, and much of it was simply piled and burned. Settlement duties required a certain amount of land to be cleared before a patent could be obtained. After January, 1820, this obligation included the cutting of all trees on a strip 165 feet deep across the entire front of each lot.

When a new area was opened for settlement the best land was naturally taken first and the rough and swampy areas were avoided. Land was cleared first along the fronts of the farms and the woodland cut farther and farther back toward the end of the farm which lay farthest from the road. This was done, in many cases, without reference to the quality of the soil except where it was swampy.

The accompanying table gives an estimate of the remaining woodland at various dates in the townships making up the Sixteen-Mile Creek Watershed. Although slight irregularities appear in the table, due to incomplete information,

REMAINING WOODLAND IN PER CENT
ESTIMATED FROM CENSUS OF CANADA FIGURES

Township	1851	1861	1891	1911	1921	1931	1941	1951	1957 Survey *
Esquesing	56.8	48.4	19.7	13.4	13.3	13.5	12.0	11.5	19.4
Nassagaweya	62.0	53.5	27.3	18.9	20.9	23.0	19.0	22.5	42.0
Trafalgar	41.6	30.7	16.8	5.0	6.8	8.4	5.2	5.6	8.1
Total	52.5	42.8	20.4	11.6	12.7	13.8	11.4	12.1	17.0

* Survey figures refer only to that part of each township within the Sixteen-Mile Creek Watershed.

the general trend of events is obvious. Until about 1910, the decrease in woodland was rapid. After that the small remaining area of woodland was at least tolerated, and in some cases has probably shown a slight increase. There is not as yet any evidence of a sharp increase in woodland cover such as might be brought about by a real enthusiasm for reforestation of submarginal lands.

The figures from actual measurements made in the 1957 survey, given in the last column for comparison, refer only to that part of the township within the watershed. Due to varying topography this part may be more heavily or less heavily wooded than the township as a whole. In part, however, these differences may simply reflect different opinions as to what should be classified as woodland. The condition of the remaining woodland is described in the following chapter.

3. Forest Products

The earliest interest in timber in Ontario was the reservation of pine and oak either by specified areas or by individual marked trees for the use of the British navy. This system was already weakening when settlement on Sixteen-Mile Creek began. We find a few lots marked as suitable for "Masting" in the original survey of Trafalgar Township, but these were never officially reserved and were soon released for settlement. South of Dundas Street six lots were listed as containing "a great many" oaks 6 to 8 feet in circumference and 30 to 40 feet high and three lots with many pines 6 to 9 feet in circumference and 60 to 70 feet high. Much that we would consider fine timber today was below the high standards set for the Royal Navy.

The square timber trade commenced, no doubt, somewhat later than the mast trade and was carried on simultaneously with it from the thirties.

Square timber was obtained by selecting large trees, mostly white pine, and squaring the best part into one long stick. In the earliest days of the industry the timbers were squared on all four sides to a fine "proud edge", but later, when the best timber had been cut, they were squared with a rounded shoulder or "wane", and were known as "waney timber". Such methods, of course, were wasteful since the finest grained wood was sacrificed in the operation, but this was the type of material called for by the British market.

> "Often only one tree in a thousand would yield a finished 'stick' (so was the heavy square timber nonchalantly called in the trade) fit for export. A good stand might yield thirty or forty trees an acre for over the whole area allowance had to be made for 'wants' - the non-bearing patches of swamp, burn, etc. Today a whole township or limit (in Northern Ontario) may not have one good square stick of the quality of the square timber of another day."*

Until 1890 the Census of Canada lists all pine and oak not sawn into lumber as "square timber", and even as late as 1910 most species are listed as "square, waney or flattened".

As settlement and trade grew, sawmilling became important. It is uncertain when the peak was reached in this industry. Actually it would not be the same in all parts of the watershed. In Trafalgar Township there were four sawmills as early as 1817. By 1846 the number of mills in the township had increased to 23, but by 1850 only 19 sawmills were recorded. The record for Esquesing Township shows 11 sawmills for 1846 and the same number in 1850, but Nassagaweya, being more recently settled, shows an increase in this period from three to seven sawmills.

Oakville was the great shipping port for most of this lumber, as it was for other products. W. H. Smith reports the following exports:

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* A Hundred Years A-Fellin', written for Gillies Bros. Ltd., by Miss Charlotte Whitton.

Year	Pine Boards	Staves	Oak and Pine Timber	Ashes
1840	555,501 feet*	48,354	31,550 feet*	58 bbls.
1841	495,571 "	13,563	27,415 "	17 "
1842	602,533 "	7,070	3,000 "	-
1843	883,500 "	-	20,000 "	15 "
1844	1,073,000 "	-	52,000 "	33 "
1845	1,145,311 "	7,780	70,750 "	79 "
1846	963,500 "	-	3,600 "	- "
1847	1,922,137 "	1,300	-	3 "
1848	398,504 "	-	-	-
1849	2,049,703 "	-	-	-
1850	4,518,500 "	6,000	-	44 "

Some blanks, due probably to faulty records, obscure the picture a little, but we get an impression of a thriving industry, very selective in the material it would use.

The "ashes" in this list refer to potash, shipped to Britain for use in soap making and the dyeing industry. It was extracted from the ashes of hardwood trees, 60 large maple trees producing one barrel of 650 pounds. In the early stages of land clearing this was a source of some revenue, and without roads and factories there was no other market for these trees. However, from the 1840's on increasing amounts of lumber were needed for local building and carriage manufacture, and the potash trade was on the way out.

For later periods the Census of Canada figures help us trace the changes in forest production and products. While the varying basis used for census returns at different periods makes exact comparison difficult, some general trends are clear from the accompanying table. The peak production

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* Presumably the lumber is recorded in board feet and the (square) timber in cubic feet

FOREST PRODUCTS
ESTIMATED FROM CENSUS OF CANADA FIGURES
COUNTY OF HALTON

Products	Species	Unit	1870	1880	1890	1900	1910	1920	1930	1940	1950
Pulpwood		Cords			2,512	113			31	8	
Tanbark		"	520	321	125	104	2				
Lathwood		"	21		50						
Masts & Spars		Number			8	4					
Staves		M	939	1,166	121	$213	$200				
Fence Rails		Number						4,075	2,950		
Fence Posts		"			32,572	22,895	4,795	6,231	13,660		3,169
Poles		"			225		500	8	162		118
Railway Ties		"			800	400					
Piling		"				2					
Shingles		"			6,656M						
Fuel Wood		Cords	62,946	61,780	59,018	35,956	29,005	21,786	17,371	14,121	4,275
Square Timber & Logs	Ash	Cu.Ft.				100	130				
	Birch & Maple	"	215		1,200		1,000				
	Black Walnut	"			100						
	Elm	"	3,801	1,219	10,525	2,380	1,100				
	Hickory	"		237	6,040						
	Oak	"	5,870	28,855	1,986	2,378	2,300				
	Pine	"	5,023	274,088	12,532	2,157	5,810				
	Tamarack	"	9,033	4,417	1,000						
	Others	"	37,299	31,893	8,022	1,500	14,300				
Lumber	Pine	M.bd.ft.	13,585	12,175	6,496	496	276)	673	785		542
	Others	M.bd.ft.	1,436	1,870	2,360	3,042	1,418)				
Other Products		$							629	4,571*	1,790

* Includes lumber, posts and poles

M = Thousand (1,000)

shown for many products is in 1870 or 1880. Soon after 1900 such products as tanbark, lathwood, masts, staves, shingles and piling drop from the list, and production of other products shows a sharp decline. The one product which has persisted throughout the record is fuelwood, which has dropped from a peak of 62,946 cords in 1870 to a low of 4,275 cords in 1950. This decline reflects both the decrease in available supply and the increasing competition of other fuels.

The addition in 1890 of fence posts, poles and railway ties reflects the development of the area. The introduction of wire fencing, the development of the telephone and the expansion of telegraph service all stimulated forest production at this period. The subsequent sharp decline in these products shows the rapid depletion of supplies.

Tamarack was an important timber until 1890 when the species was almost wiped out by the depredations of the larch saw-fly. The amount of walnut, butternut and hickory cut was never large, and after 1890 these species disappear from the record.

In 1920 no square timber is shown, and from this time on lumber production is small and is no longer separated by species.

The native chestnut does not appear in these records, although its presence was noted in the original survey of Trafalgar Township. In the early years of the present century a disease, the chestnut blight, practically wiped out the species, but for years a few sprouts and the durable dead stubs of trees persisted. As late as 1936 one woodlot owner near Oakville was still taking out dead chestnut for sale as saw logs.

Maple sugar was almost the only sugar available to the pioneers. In 1910 census records begin to list maple syrup as well, indicating the change from a pioneer necessity to a modern luxury. For the sake of comparison the table

PER CENT WOODLAND

FUELWOOD PRODUCTION

MAPLE PRODUCTS

below shows these products expressed as an equivalent amount of syrup. Production in 1951 was less than eight per cent of that for the peak year of 1861.

MAPLE PRODUCTS OF HALTON COUNTY
CALCULATED AS SYRUP
FROM CENSUS OF CANADA FIGURES

Year	Gallons
1851	4,856
1861	5,472
1871	710
1881	105
1891	1,171
1901	1,252
1911	1,791
1921	1,165
1931	1,932
1941	830
1951	423

CHAPTER 2

SURVEY OF PRESENT WOODLAND

An accurate inventory of the existing woodland in the watershed and an estimate of its present condition is a basic necessity in establishing a woodland conservation program. A detailed study was consequently made of all woodlands, scrubland, plantations and land which is suitable for reforestation.

Most of the Sixteen-Mile Creek Watershed lies within the Huron-Ontario Section of the Great Lakes-St.Lawrence Forest Region.* In this forest section, as a whole, the prevailing association of forest trees is dominated by sugar maple and beech and this association is described as the climax type† for the area. Occurring in this climax type are other associated species such as basswood, white elm, yellow birch, white ash, hemlock and white pine. After disturbances such as cutting or fire this climax type may be replaced for a time by poplar and white birch. On local or specialized sites such as river bottoms and swamps there occur other aggregations of trees which may bear no relation to the typical or climax forest of the area; for example, an association where white cedar is the dominant species. These distinctive local combinations of tree species are in response to very local climatic, soil, topographic and drainage features.

The Deciduous Forest Region* which occupies much of the eastern half of the United States, includes only a small part of Southern Ontario. In the Sixteen-Mile Creek Watershed it extends only a few miles from the river mouth. Here the modifying influence of Lake Ontario makes possible a characteristic association containing black and white oaks, sassafras and shagbark hickory.

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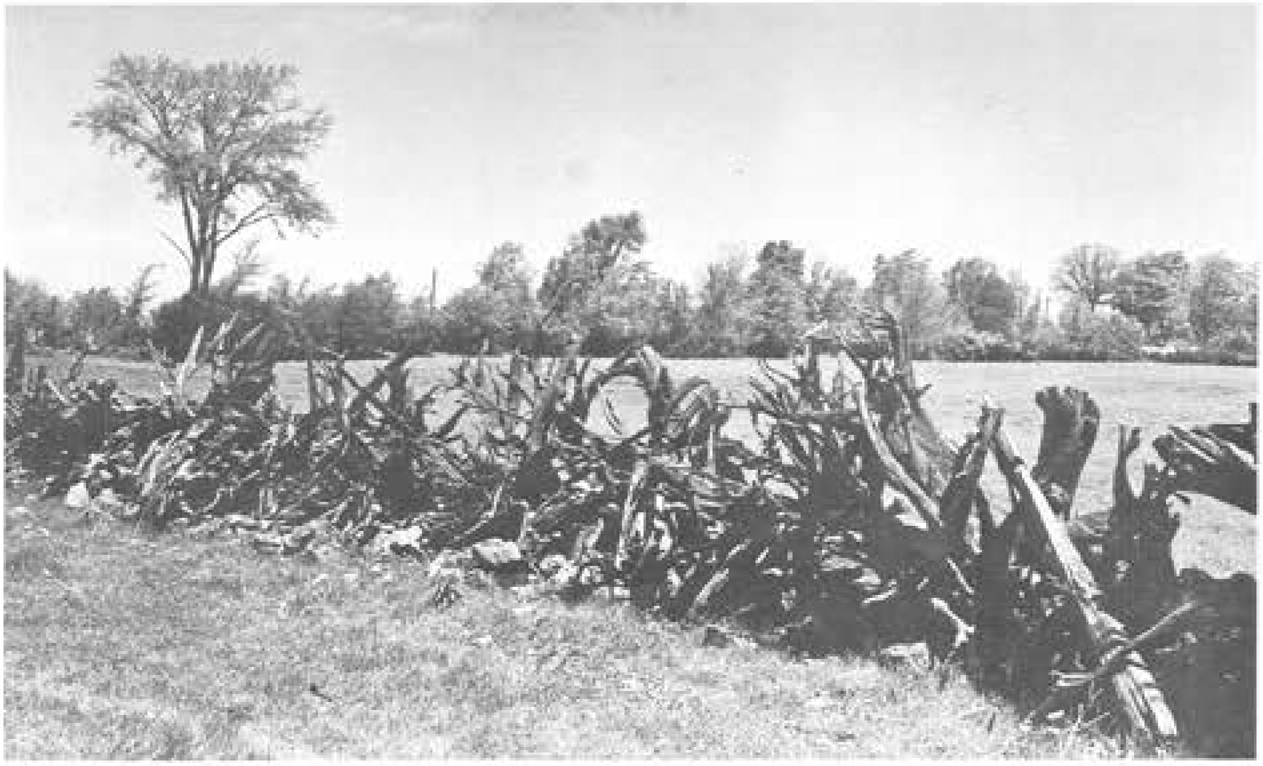
* W.E.D. Halliday. A Forest Classification for Canada, 1937.

† The climax type is the one best suited to maintain itself permanently under the climatic conditions of a given area. Unless disturbed by fire, axe, or other agents it will eventually take possession and hold most of the area against the competition of other trees.



Pine stump fences remind one of the fine timber which once covered the Sixteen-Mile Creek Watershed.

Beech-hard maple stands covered the better soils but are now much reduced by clearing.

The soft maple-elm type keeps wet land productive and protects the head-waters of streams.

Although pure pine stands are not common, a scattering of white pine through the woodlots in both these forest regions is a noteworthy characteristic of the watershed.

1. Survey Methods

Aerial photographs, each covering about 1,000 acres, were provided to the forestry party, and mapping in the field was done directly on the photographs. Each area of woodland, scrubland, swamp and rough land was visited and described as to acreage, cover type, presence of grazing, reproduction, and average diameter at breast height.

Each woodlot was classified as hardwood, coniferous or mixed. The term "hardwood" is used to denote all broad-leaved trees regardless of their physical hardness. A woodlot in which 80 per cent or more of the trees are hardwoods is called a hardwood stand: one in which 80 per cent or more of the trees are conifers is called a coniferous stand; and all other stands are classed as mixedwood.

Plantations were likewise examined and records made of method of planting, approximate age, care, damage and survival.

Land suitable for reforestation was mapped, and descriptions prepared in some detail for the larger areas.

2. Forest Cover Types

The term "forest cover type" refers to those combinations of tree species now occupying the ground, with no implication as to whether these types are temporary or permanent. A slightly modified form of the system drawn up by the Society of American Foresters has been used on this survey so that the system will adequately describe the cover types common to the watershed. The gaps in the numerical system are due to certain cover types found in the eastern United States which do not enter Canada.

The following cover types were encountered on the Sixteen-Mile Creek Watershed:

Type Number	Name
4	Aspen
6	Paper birch
8	White pine - red oak - white ash
9	White pine
10	White pine - hemlock
11	Hemlock
12	Sugar maple - beech - yellow birch
13	Sugar maple - basswood
14	Sugar maple
14a	Black cherry
24	White cedar
26	Black ash - white elm - red maple
45	Bur oak
50	White oak
51	Red oak - basswood - white ash
52	Red oak
57	Beech - sugar maple
58	Beech
59	Ash - hickory
60	Silver maple - white elm
60a	White elm

Although twenty-one cover types were identified in the watershed over 85 per cent of the woodland area is contained within six cover types. In order of the area which they occupy these types are as follows:

Type 14 - Sugar maple, which occupies 40.8 per cent of the woodland acreage. This type and the closely related Type 57 (beech - sugar maple) originally covered most of the upland or better drained areas of the watershed, but since it occupied land which was considered fertile and with good moisture conditions much of it was cleared to make way for agriculture.

Calcareous soils are considered desirable for the vigorous growth of high-quality hard maple timber, and the upland soils of the area seem to satisfy this requirement well. Common associates of the type are white elm, white ash, basswood, black cherry and hemlock, with butternut and yellow birch typically occurring in the lowland locations of this type.

FOREST COVER TYPES

Township	Acres	4	6	8	9	10	11	12	13	14	14a	24	26	45	50	51	52	57	58	59	60	60a
Nassagaweya	6,667	426	432		47		27		77	3,049	22	868	104			8		351	12	4	589	651
Esquesing	6,577	616	46	130	74	64	140	84	10	2,681		471						667	63	28	543	951
Trafalgar	4,125	71	44	180	44		139		159	1,374		4		113	87	105	46	475	100	114	58	1,012
Nelson	26																	21				5
Total	17,395	1,113	522	310	165	64	306	84	246	7,104	22	1,343	104	113	87	113	46	1,523	175	146	1,190	2,619
Per Cent	100	6.4	3.0	1.8	0.9	0.4	1.8	0.5	1.4	40.8	0.1	7.7	0.6	0.7	0.5	0.7	0.3	8.8	1.0	0.8	6.8	15.0

Type 60a - White elm, occupies 15.0 per cent of the woodland acreage. Type 60a is very similar to the silver maple - white elm swamp type described below, but often occurs on somewhat drier sites.

Type 57 - Beech - sugar maple, occupies 8.8 per cent of the woodland acreage. This is regarded as the typical association forming the climax type for the uplands of the region. Its associates are hemlock, white elm, basswood, white ash and black cherry, with hornbeam an important subordinate. The type,like Type 14 (sugar maple) was formerly very extensive in the area but, because it occupied the best land, its area has been tremendously depleted.

Type 24 - White Cedar, occupies 7.7 per cent of the woodland acreage. This type occurs most commonly on the muck soils of the swamps where it has such associates as black ash, white elm, tamarack, red maple, yellow birch, hemlock, white pine and white birch. Where lime is plentiful white cedar may extend even to the droughty upland slopes where it tends to form pure stands.

Type 60 - White elm - silver maple, occupies 6.8 per cent of the woodland area. This type occurs in river bottoms and on swampy depressions where the land is too wet for agricultural purposes unless completely underdrained. Species sometimes associated with it are red maple, cottonwood, white, black and green ash and bitternut hickory.

Type 4 - Aspen, occupies 6.4 per cent of the woodland area. Aspen is a pioneer type coming in after clear-cut operations, overgrazing or fire. It quite frequently is the invasion species on abandoned fields and pastures. Though it avoids the wettest swamps it does grow on soils that are wet throughout a good part of the year, and occurs as well on the droughty soils. Its associates may be large-toothed aspen, balsam poplar, red cherry, white elm and paper birch. An understory of dogwood or of spruce and balsam fir on the wet sites, or of tolerant hardwoods on the drier sites, is frequently present.

The remaining fifteen types are present in amounts which vary from three per cent of the woodland within the watershed to trace amounts of a few acres. Briefly these cover types may be described as follows:

Type 6 - Paper birch, like aspen is a pioneer type following cutting or fire.

Type 8 - White pine - red oak - white ash occurs on moist but well-drained soils, mostly along valley slopes.

Type 9 - White pine, most common on light sandy soils.

Type 10 - White pine - hemlock, favours moister, cooler sites, ravines and north slopes.

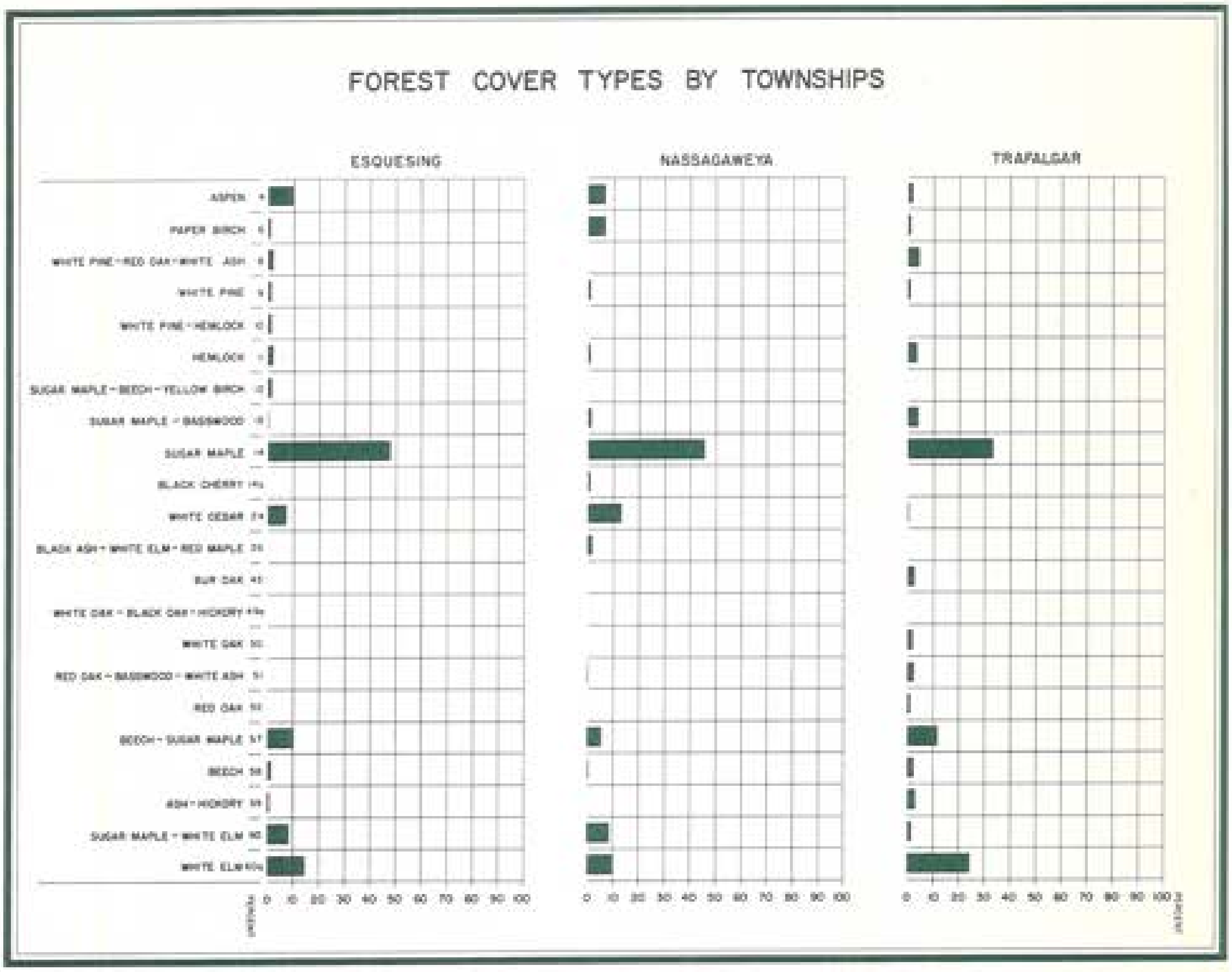
Type 11 - Hemlock, similar to above type, but with hemlock predominant over any single associate.

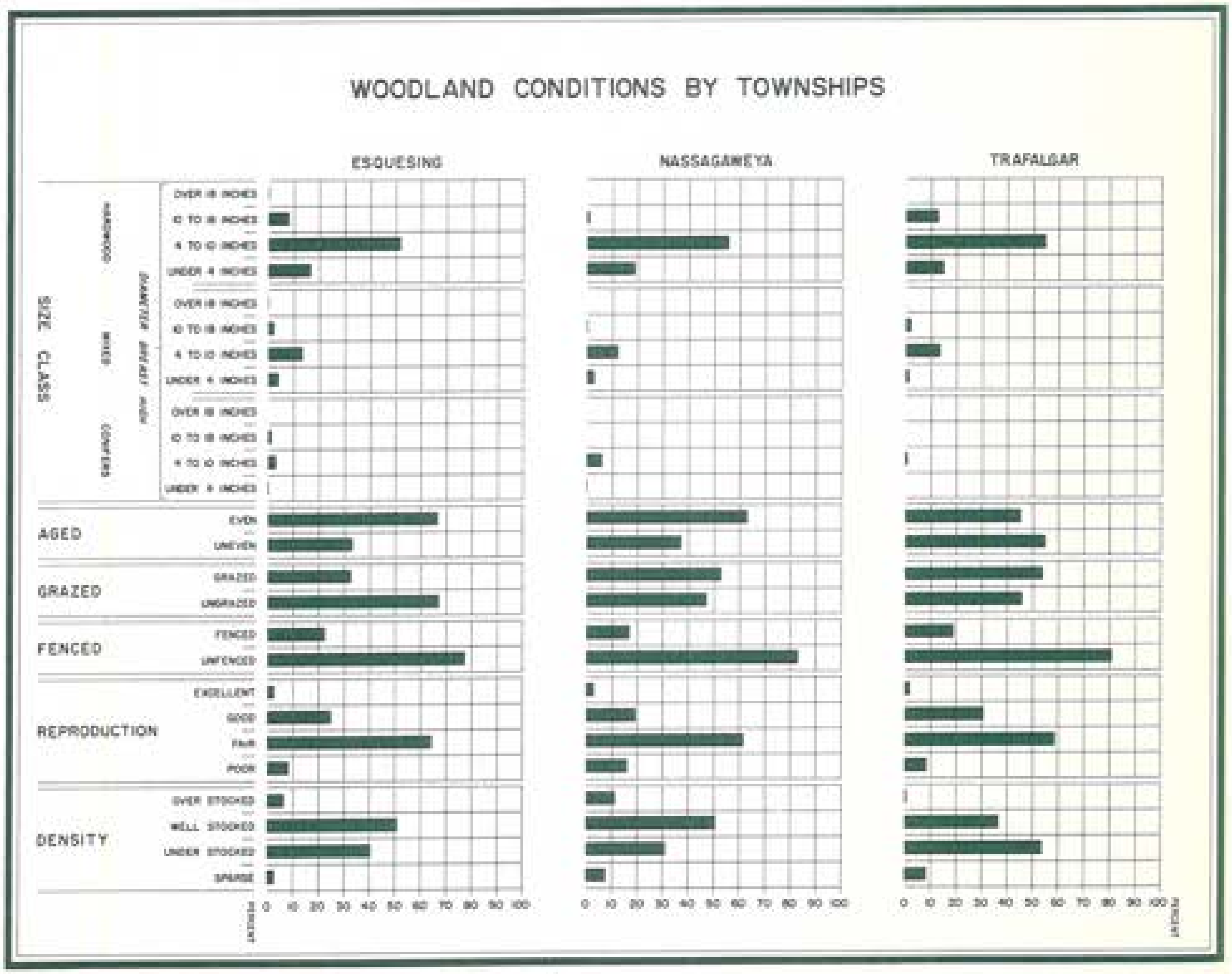
Type 12 - Sugar maple - beech - yellow birch is a cover type which is close to its southern range (latitude and altitude) within this watershed, consequently it has a limited distribution.

Type 13 - Sugar maple - basswood is another cover type in which hard maple is an important component of the stand. This type is important due to the demand for basswood logs.

Type 14a - Black cherry,occurs in small patches on fertile well-drained soils; a temporary type following clear-cutting.

Type 26 - Black ash - white elm - red maple, occupies wet muck soils in areas of slow drainage.


FOREST COVER TYPES BY TOWNSHIPS
ESQUESING
NASSAGAWEYA
TRAFALGAR
ASPEN
PAPER BIRCH
WHITE PINE - RED OAK - WHITE ASH
WHITE PINE
WHITE PINE - HEMLOCK
HEMLOCK
SUGAR MAPLE - BEECH - YELLOW BIRCH
SUGAR MAPLE - BASSWOOD
SUGAR MAPLE
BLACK CHERRY
WHITE CEDAR
BLACK ASH - WHITE ELM - RED MAPLE
BUR OAK
WHITE OAK - BLACK OAK - HICKORY
WHITE OAK
RED OAK - BASSWOOD - WHITE ASH
RED OAK
BEECH - SUGAR MAPLE
BEECH
ASH - HICKORY
SUGAR MAPLE - WHITE ELM
WHITE ELM
PERCENT
0 10 20 30 40 50 60 70 80 90 100


WOODLAND CONDITIONS BY TOWNSHIPS
ESQUESING
NASSAGAWEYA
TRAFALGAR
SIZE CLASS
HARDWOOD
MIXED
CONIFERS
DIAMETER BREAST HIGH
OVER 18 INCHES
10 TO 18 INCHES
4 TO 10 INCHES
UNDER 4 INCHES
AGED
EVEN
UNEVEN
GRAZED
GRAZED
UNGRAZED
FENCED
FENCED
UNFENCED
REPRODUCTION
EXCELLENT
GOOD
FAIR
POOR
DENSITY
OVER STOCKED
WELL STOCKED
UNDER STOCKED
SPARSE
PERCENT
0 10 20 30 40 50 60 70 80 90 100

Type 45 - Bur oak is found in scattered patches through Trafalgar Township.

Type 50 - White oak, occurs on well-drained soils in the south end of the watershed.

Type 51 - Red oak - basswood - white ash, contains a greater variety of species and extends a little farther north than the above type.

Type 52 - Red oak occurs as small patches among the southern oak types.

Type 58 - Beech, as a pure type is scattered in small areas through the watershed.

Type 59 - Ash - hickory is a residual type which often occurs after logging and grazing of Type 60 stands.

SUMMARY OF COVER TYPES

(a) The upland areas of most of the Sixteen-Mile Creek Watershed are characterized by sugar maple and beech - sugar maple stands which are the common climax type for the Great Lakes - St. Lawrence Forest Region. These types make up 49.5 per cent of the total woodland of the watershed. These cover types once extended over most of the upland areas. As they occupied the most desirable agricultural land, a large proportion of these stands was cleared.

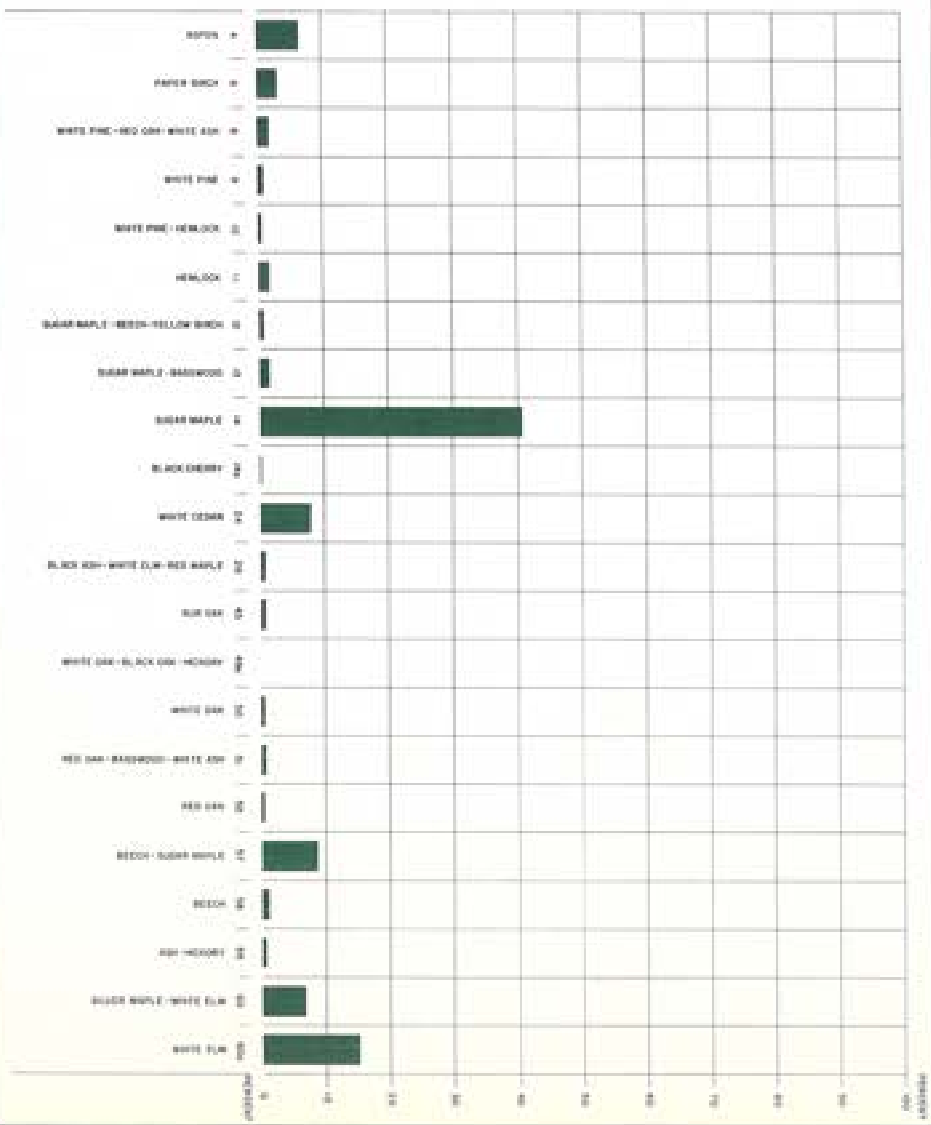
(b) The presence of oak types and the abundance of hickory in the lower parts of the watershed indicate that a small area along Lake Ontario may be included in the more southern Deciduous Forest Region.

(c) Types characteristic of swamp areas comprise 29.5 per cent of the woodland. Elm, soft maple and cedar swamps produce a forest crop on lands not suited for other use, and at the same time form valuable water storage areas.

(d) Aspen and white birch, which are temporary types of low commercial value, now occupy 9.4 per cent of the

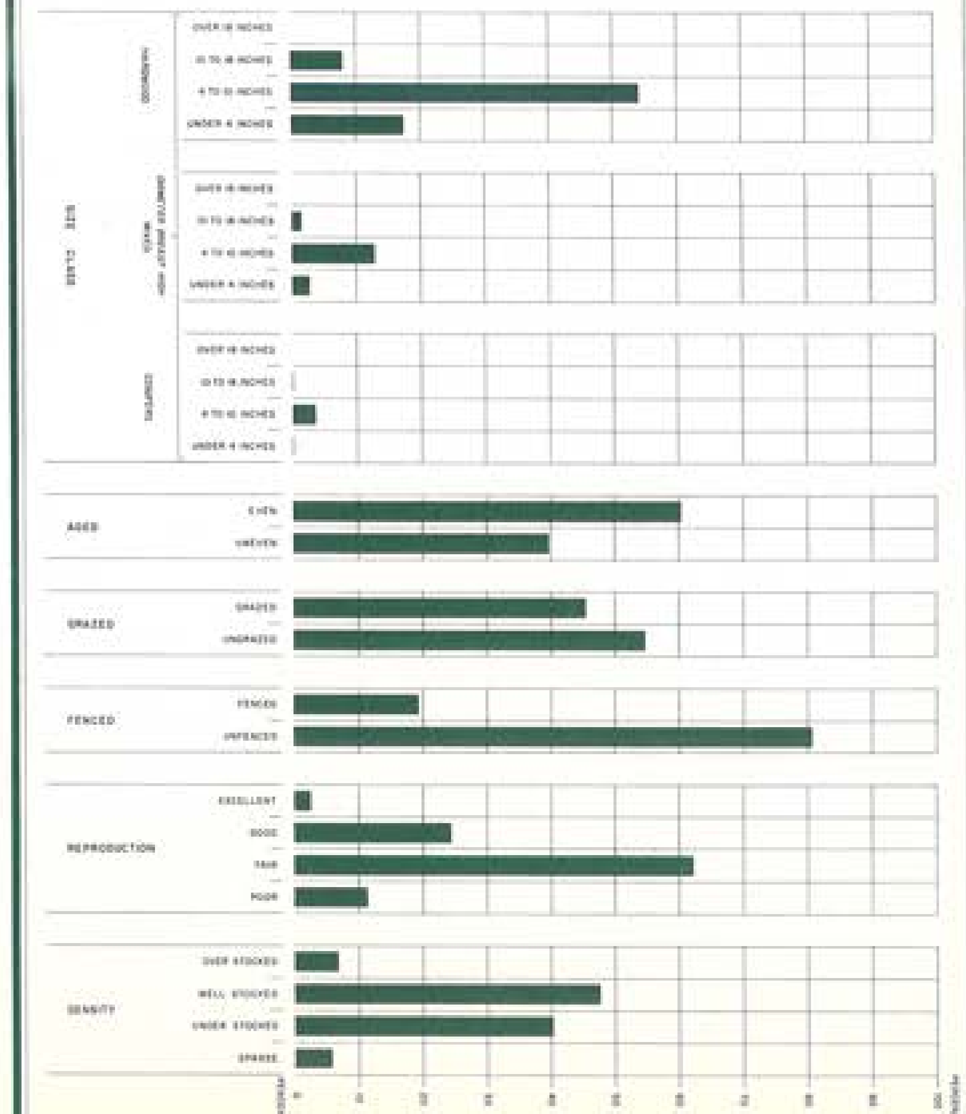
FOREST COVER TYPES

PERCENTAGE OF TOTAL WOODLAND
1957



WOODLAND CONDITIONS

PERCENTAGE OF TOTAL WOODLAND
1957



woodland due to clear-cutting or other opening up of the forest. Much of this area could be occupied by more valuable forest species.

(e) White pine, although not abundant, is scattered widely through the woodland and could be a valuable constituent of the woodlots of the watershed.

3. Condition of Woodlands

Conditions revealed by the survey are shown in some detail in the accompanying tables and graphs.

Woodland within the watershed comprises 17,395 acres, which is 17.0 per cent of the total area of 102,000 acres. Of this woodland, 79.2 per cent is classed as hardwood stands, 17.1 per cent as mixedwood, and only 3.7 per cent as coniferous. This indicates that even the cedar type has a considerable admixture of swamp hardwoods. As upland conifers and mixedwood types are relatively limited, the supply of softwood sawlogs from the area is very small.

Practically none of the present woodland is mature and merchantable. Only 13 acres is classed as over 18 inches diameter breast height. Coniferous stands between 10 and 18 inches, the size desired for posts and poles, make up only 0.2 per cent. The 20.0 per cent of young stands, under four inches diameter breast height, and the 54.1 per cent of hardwoods between four and 10 inches will require some time to grow to merchantable size. Where the stands are overstocked, this time may be shortened by thinning; but nearly half of the woodland is already slightly to severely understocked. The remaining hardwoods between 10 and 18 inches diameter (8.0 per cent), mixedwood from four to 18 inches (14.3 per cent) and conifers four to 10 inches (3.4 per cent) will soon reach maturity and should pay for proper management in a relatively short time.

The survey indicates that 39.9 per cent of the woodland is uneven-aged, and therefore might readily become

This bouldery soil discouraged the attempt at clearing. The Authority should reforest land of this type.

Hawthorn comes in on neglected hillside pasture. Where it cannot be controlled, reforestation will be more profitable.

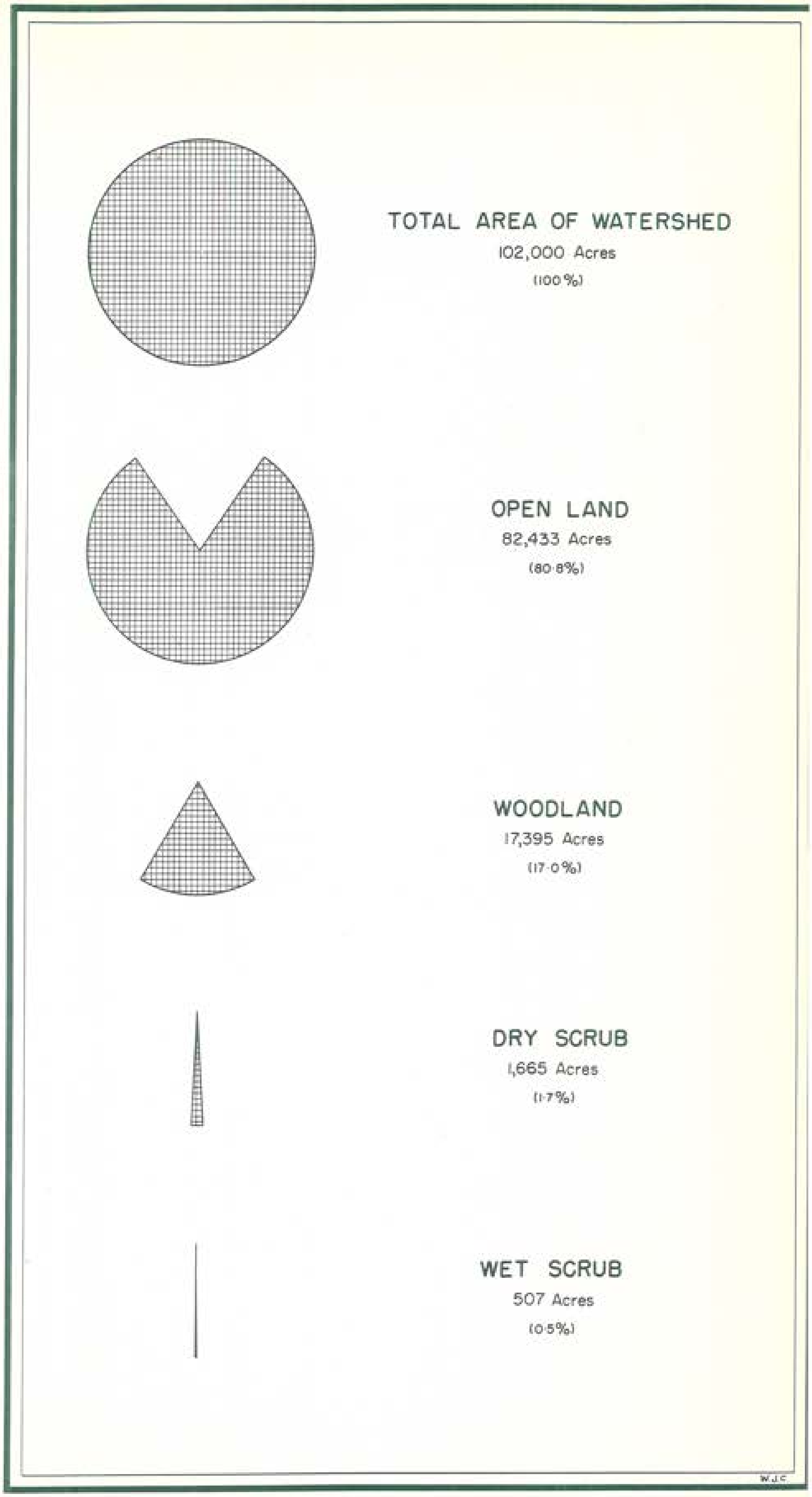
Wet pasture is soon invaded by willow scrub. This land should either be improved for agriculture or returned to forest.

a source of continuous revenue to the owner. However, this continuous production will not last for long unless there is an improvement in natural regeneration in the woodlots. Over 73 per cent of the woodland area shows regeneration only fair to poor. One obvious reason for this condition is the fact that nearly half the woodlots are grazed.

4. Scrublands

In all 2,172 acres in the watershed are covered with tree species which never attain commercial size. The most common species are scrub willow and dogwood on poorly drained sites and hawthorn and sumach on dry sites. Much of this area is located on abandoned farmland or neglected pasture.

In some cases this land can be restored to agricultural use through drainage or through eradication of dry scrub. However, where such restoration does not seem economically feasible, the area should be returned to tree cover through systematic replacement of the scrub species with more valuable species.



LAND CLASSIFICATION – TOTAL WATERSHED

CHAPTER 3

FOREST CONSERVATION MEASURES IN PROGRESS

Active forest conservation measures in the Sixteen-Mile Creek Watershed are almost entirely confined to the northern part of the area, in Nassagaweya and Esquesing Townships. Here the steep slopes of the escarpment, the shallow soils on its crest, and areas of stony soils or poor drainage provide sites more suitable for trees than for agricultural use.

Nearer the lake increasing urbanization, and the mild topography suitable for intensive agriculture, prevent any extensive areas remaining in forest.

1. County Forests

The first county forest in Ontario was established in 1922. The agreements which are in force at the present time run for a period of 30 years, during which time the Ontario Government agrees to establish the forest and pay the cost of such items as fencing, buildings, equipment, labour, maintenance, trees, etc. - in short, everything connected with the management of the forest.

At the end of the 30-year period the county has the privilege of exercising one of three options: First, to take the forest over from the Government and pay back the cost of establishment and maintenance without interest; second, to relinquish all claim to the forest, whereupon the Government will pay to the county the cost of the land without interest; third, the forest may be carried on as a joint undertaking by the Province and the county, each sharing half of the cost and half of the profits.

The Halton County Forest was started with the purchase of the Cox Tract in 1939, and now comprises 1,545 acres. Eleven properties, totalling 1,019 acres, are wholly or partly within the watershed. In this section 193 acres

Eighteen year old larch in the Cox Tract of the Halton County Forest. The first public forest in the Sixteen-Mile Creek Watershed.

Windbreaks protect both fields and buildings and enhance the beauty of the farm.

A well placed snow fence piles the snow where it will do no harm and leaves the road surface clear.

of open land have been planted. Most of the rest is young natural woodland in need of management.

2. Private Planting

Private planting in the Sixteen-Mile Creek Watershed started nearly forty years ago but, due to the absence of large, easily planted sandy areas, progress has been slow. At present there are 146 acres of private plantation in the area.

Individuals and municipalities may obtain advice and assistance in reforestation and woodlot management through the Department of Lands and Forests' Zone Forester at Hespeler. The Zone Forester assists also in the establishment of Authority forests, County forests, demonstration and school plots.

The forest tree nurseries at St.Williams and Midhurst are the chief sources of planting stock for this area.

3. Demonstration Woodlots

One of the most important measures which can be taken for forest conservation in any area is the improved management of present woodlots. An early effort in this direction was the establishment by the Department of Lands and Forests of demonstration woodlots. These are areas of private woodland on which the owners have agreed to follow prescribed methods of woodlot management and to permit access to the area by interested persons.

Twelve demonstration woodlots were established in the Sixteen-Mile Creek Watershed and undoubtedly helped to call attention to the superiority of well-managed woodlands.

Unfortunately, some of these demonstration woodlots have been cut over when the property changed hands, and others have been neglected so that they no longer serve their original purpose.

4. Tree-Cutting By-Laws

Under The Trees Conservation Act of 1946 and its successor The Trees Act (R.S.O. 1950, c. 399) twenty-three counties have passed by-laws to restrict and regulate the cutting of trees. These by-laws do not interfere with the right of the owner to cut material for his own domestic use, but specify certain diameters below which trees may not be cut for sale. The Halton County by-law forbids the cutting for sale of cedars under seven inches stump diameter and other species under fourteen inches.

Such diameter limits are only an elementary step to prevent indiscriminate slashing of woodlands. Where these by-laws have been enforced rigidly they have proved of considerable benefit. There will, however, usually be fast-growing trees above the diameter limit which are increasing rapidly in value, and should be left for future cutting. There will also be poorly formed or diseased trees below the diameter limit which should be removed.

Better than a rigid diameter limit is the marking of trees for cutting according to their condition. Professional advice on such marking is available through the Zone Forester. Many tree cutting by-laws, including that of Halton County, provide for the necessary variations from a strict diameter limit where the cutting is done under such supervision and in accordance with good forestry practice.

5. Woodlot Fencing

Since 1948 the County of Halton has had a program of assistance for the fencing of woodlots against grazing. To date this program has had only a very limited success, partly because of administrative difficulty but more particularly due to indifference on the part of woodlot owners. Such a program may be useful as a supplement to public education but not as a substitute for it. It is recommended that the Authority should co-operate with the County of Halton to make this program more effective.

6. Woodlot Meetings

For several years the Department of Lands and Forests held a series of woodlot meetings to discuss better woodlot management with interested residents. The Sixteen-Mile Creek Conservation Authority should offer its co-operation in organizing such meetings and promoting the maximum attendance at them.

7. Forest Conservation Measures in Other Areas

(a) Authority Forests

The agreements for establishment and management of Authority forests, which have been drawn up between ten Conservation Authorities and the Ontario Government, are substantially the same as those made with the counties, except that the Government will provide half the land cost as an interest-free loan during the period of management. Authority lands are subject to municipal taxes. Under these agreements 35,275 acres had been acquired for reforestation and management up to December 7, 1957.

(b) Municipal Forests

Several municipalities other than counties have established forests, which are eligible for assistance from the Department of Lands and Forests. Some of these forests protect town water supplies, and all will eventually add to municipal revenues.

(c) Tree Farms

In the past few years a movement has been under way to recognize well-managed forest properties as Certified Tree Farms. With the sponsorship of several organizations interested in better forestry, the Canadian Forestry Association in 1953 formed a National Tree Farm Committee to recognize with a suitable sign and certificate those owners who agree to maintain their land for growing forest crops, protect the land adequately, employ cutting practices satisfactory to ensure future forest crops, and permit inspection by Committee foresters. To date two Tree Farms have been certified in Halton County but none within the watershed.

Several Conservation Authorities have become co-sponsors of the Tree Farm movement in their areas, and it is recommended that the Sixteen-Mile Creek Conservation Authority give its support to this movement.

(d) 4-H Clubs

These clubs are organized by the Ontario Department of Agriculture assisted by the Department of Lands and Forests and must be sponsored by an organization interested in the improvement of woodland and reforestation.

Members must be between 12 and 21 years of age and each member undertakes a project such as marking a half-acre plot of woodland for thinning or reforesting a quarter-acre of land. Projects are judged annually on Achievement Day and prizes awarded; for this purpose the Department of Agriculture furnishes $3.00 per member and the sponsoring organization $1.50. Winners may enter the Provincial Inter-Forestry Club Competition.

Sponsorship of these clubs in the schools of the Sixteen-Mile Creek Watershed would be a worthwhile project for the Authority.

CHAPTER 4

FOREST CONSERVATION MEASURES REQUIRED

The future of forestry will vary greatly in different parts of the watershed. In the immediate vicinity of Oakville and Milton woodlots will disappear before advancing subdivisions. In these sections it is only along the valleys that any substantial area of woodland will remain and, since its main importance will be recreational, the preservation of this type of forest will be left to other sections of the report.

On the escarpment there are still sections where the nature of the land and its location make the retention of forest cover on large tracts quite practical both for wood production and for the protection of the headwaters of the river.

The lowland farming areas farther east present a different problem. Here we must consider the higher agricultural potential of the land, the pressure of urban workers seeking country home sites, and the conversion of many farms into country estates where farming is continued but is no longer the primary source of income. Large forests cannot be expected, but woodlots on the poorer parts of farms will be retained for their aesthetic value if not primarily for timber production. Whatever the owner's point of view, it is better to retain a good woodlot than a poor one.

The activities through which the Authority may further forest conservation fall into three broad categories. In larger areas needing reforestation or management the Authority may acquire land and manage it directly. In private planting and woodlot improvement demonstrations the Authority may co-operate with private landowners. Through public meetings, field days and publications the Authority may educate and encourage residents of the Sixteen-Mile Creek Watershed to practise conservation on their own lands.

Areas recommended in this chapter as suitable for private reforestation or public forest conservation measures are shown on the folded map in the back of the report.

1. <u>Sixteen-Mile Creek Authority Forest</u> (see map following p.23)

When large areas (100 acres or more) require reforestation or woodland management, the task is frequently too great for private initiative. In such cases acquisition by the Authority is recommended. This is particularly desirable where these forests form natural water-storage areas which decrease the severity of floods and maintain the summer flow of streams. Other tracts which at present lie idle or produce only sparse, droughty pasture can again be made to add to the economy of the area through reforestation.

In all 7,208 acres are recommended for acquisition by the Sixteen-Mile Creek Conservation Authority. Of this total, 1,185 acres are open lands, 5,618 acres have some form of tree cover, and 405 acres are scrubland. A minimum of land in better land classes has been recommended for reforestation. However, it was impossible to omit such land entirely when it formed a small part of a lot which was composed mainly of a poorer type of soil.

Because of the rougher topography in the northern part of the watershed, the recommended areas are concentrated in parts of Esquesing and Nassagaweya Townships. As most of the streams in the watershed rise in these townships, this is also the area in which reforestation will have most effect on stream flow. The areas recommended are listed on the following page.

The problem of land acquisition should be approached carefully. In most cases purchase will be arranged by direct negotiation. The Authority should also be alert to acquire tax-delinquent lands. The Authority has the power to expropriate land and is justified in doing so when an unreasonable attitude on the part of the owner stands in the way


RECOMMENDED
AUTHORITY FOREST
AND
WOODLOT IMPROVEMENT
PROJECT
LEGEND
RECOMMENDED AUTHORITY FOREST
WOODLOT IMPROVEMENT PROJECTS
SCALE - MILES
NASSAGAWEYA
ESQUESING
TRAFALGAR
MILTON
OAKVILLE
LAKE ONTARIO

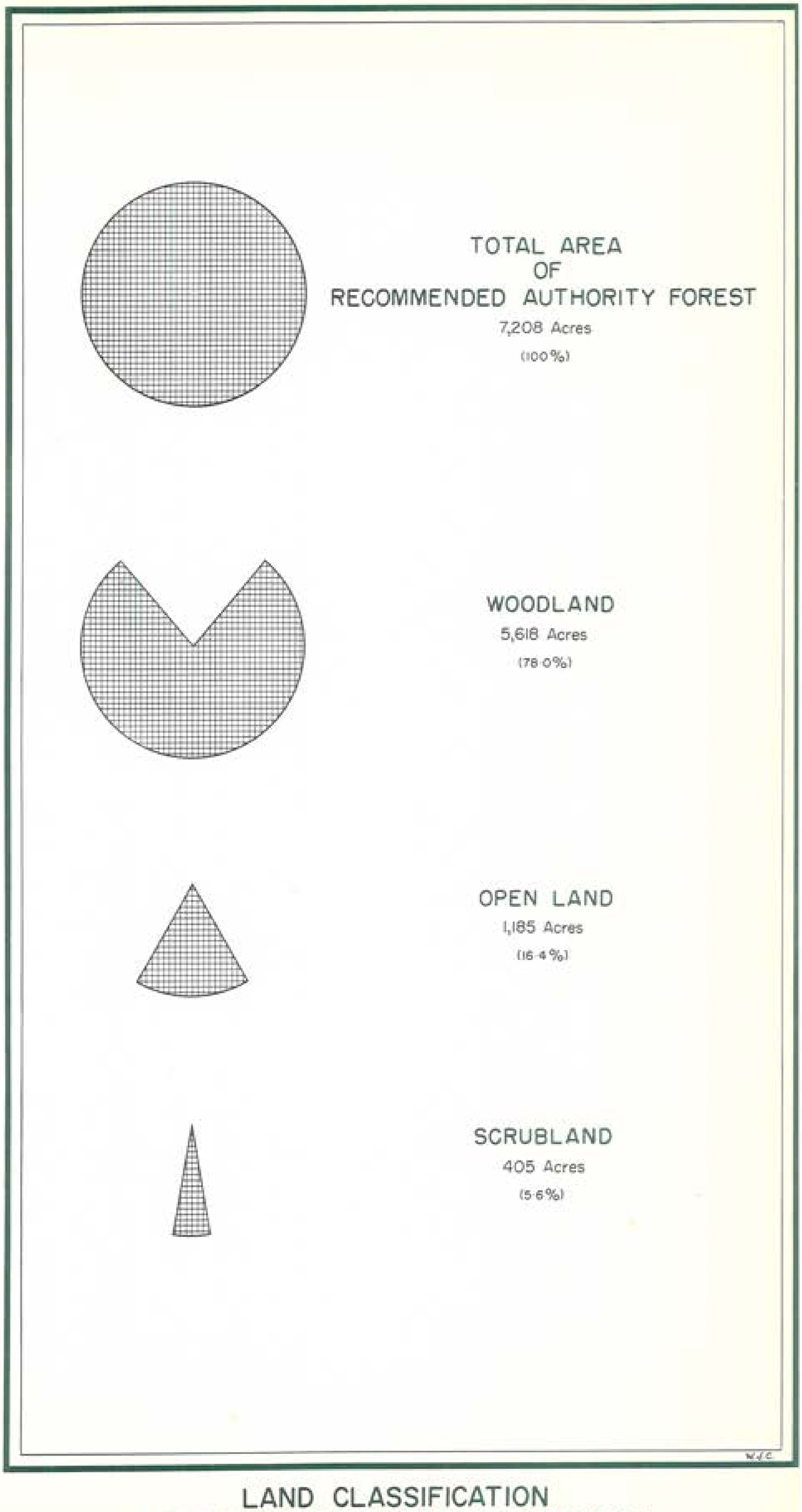
RECOMMENDED AUTHORITY FOREST

NASSAGAWEYA TOWNSHIP

CONCESSION							
IV		V		VI		VII	
Lot	Area Acres	Lot	Area Acres	Lot	Area Acres	Lot	Area Acres
3 pt.E½	75						
				6	100		
7 E½	100	7	200	7	100		
8 E½	100	8	200	8	100		
9 N.pt.	38	9	200	9	200		
E½		10E½	100	10	200	10	200
		11	200			11W½	100
		12	200			12NW¼	50
		13	200	13	200	13W½	100
		14W½	100	14	200	14NE¼	50
				15	196	15E½	100
						16	200
						17 pt.	100
						18W½	100
		19W½	100				
		21W½	100				
	313		1,600		1,296		1,000
Township Total							4,209 ac

ESQUESING TOWNSHIP

CONCESSION							
I		II		III		IV	
Lot	Area Acres	Lot	Area Acres	Lot	Area Acres	Lot	Area Acres
8 pt.	50						
9	140						
10	140						
11	132						
		13	200				
14	134	14	200				
15	138	15	189				
16	142	16W½	100	16W½	100		
17	145	17W½	100			17	200
18E½	100			18E½	100	18W½	100
						19W½	100
		20E½	99			20E½	100
						21E½	95
				22E½	100		
		23W½	95				
	1,121		983		300		595
Township Total							2,999 ac.



LAND CLASSIFICATION
RECOMMENDED AUTHORITY FOREST

of works urgently required for the general good. However, a favourable public attitude is essential to the furtherance of conservation and such powers must be used with discretion. Very few of the recommended properties are occupied. In an exceptional case, if a hardship would be entailed by asking an old resident to move, some special provision such as a life tenancy of the house might be arranged.

Land prices paid by different Conservation Authorities and even within the individual Authority have varied greatly. The Grand Valley Conservation Authority, on purchases of 2,879 acres, has paid an average of slightly less than $18 per acre. In the Humber Valley, nearer the Toronto metropolitan area and more influenced by suburban prices, the price paid for the 1,017 acres of Authority Forest purchased to date has been nearly $38 per acre.

2. Private Reforestation

On many farms, even in the better farming areas, there are small tracts which, because of steep slopes, stoniness or poor drainage, would be better in tree cover. A total of 288 acres of such land requiring private reforestation were mapped in the recent survey. These tracts are not suitable for public acquisition and management, but the effect of reforestation on control of run-off, improved summer stream flow and stabilization of wood-using industry justifies public assistance in such work. These areas have not been privately reforested heretofore because the owner has some other minor use for the area, because he is discouraged by the long period between planting and harvest of a forest crop or more commonly simply because of inertia on his part.

The interest of private owners in reforestation may be fostered in several ways. Public education, such as that now carried out by the Zone Forester in the district, can be furthered by the Authority. In addition, direct assistance to private planting can be given.

Several other Conservation Authorities have purchased tree-planters which supply a planting service to private owners at a nominal cost. Where rough ground makes hand planting necessary, some Authorities refund $10 per acre if inspection shows that planting has been done carefully and the plantation is adequately protected from livestock. When labour conditions permit the Authority might itself organize crews for hand planting on these sites.

It is the policy of the Department of Lands and Forests to charge $14 per thousand for Scotch pine and $10 per thousand for other planting stock. For some years trees were distributed free. Following the end of the war in 1945, the nurseries were unable to meet the greatly increased demand, and it was felt that a charge for trees would ensure more care in ordering the required amount and in planting the trees received.

The assistance schemes carried out by other Authorities have stimulated interest in private reforestation while still ensuring the good use of the planting stock. It is recommended that the Sixteen-Mile Creek Conservation Authority adopt some similar policy of assistance to private reforestation.

3. Woodlot Improvement Projects

For most persons the best lesson in conservation is field observation of specific examples of the present abuses and efforts to remedy them. Woodlots chosen as illustrations must be near good roads and should be marked with large signs giving considerable detail of conditions and improvement measures in progress. Roadside or other parking facilities would have to be provided so that visitors could take the full time necessary for inspection without interfering with other traffic.

In addition to any inconvenience the owner may suffer from visitors, it is possible that he may consider the whole program as experimental in nature and unproven in value.

On these sample areas the Conservation Authority is therefore fully justified in assuming part of the actual woodlot improvement cost as well as the cost of signs and parking facilities.

To use a private woodlot in this way for educational purposes would require a definite agreement with the owner to ensure that the proposed improvements were carried out, and that the benefits of this work would not be lost by a change of ownership or of attitude on the owner's part. In addition a detailed record of costs and returns would be necessary to show other owners that it would pay for them to adopt similar practices in their own woodlots.

Some owners may be willing to see their woodlots used for such demonstrations, but wish to be relieved of any personal participation in the project. In such cases the Authority might lease the woodlot or purchase it outright.

One example of a woodlot suited for such a demonstration is located about three miles east of Highway No. 25 on a good road two miles north of Milton (Lot 6, Con.VI, Esquesing Township). The woodlot is mainly young hard maple with a few white pine and larger maple and beech. The main needs are the prevention of grazing and the removal of ironwood, beech and the poorer quality maples to favour the better maple and the white pine.

Above the escarpment there are many areas proposed for public acquisition or at present in public ownership which might be used for similar demonstrations.

4. Forest Research

Detailed scientific research is the task of universities or government departments with greater research facilities than are available to a Conservation Authority. Large-scale application of proven methods is the task of private owners or of the Department of Lands and Forests in managing Authority Forests. Between these two extremes, however, there are many possibilities for small-scale investigations which are urgently needed and which the Authority might encourage on its own land or on private land under agreement. Determination of the best planting methods on difficult sites such as valley slopes, comparison of growth in different plantation mixtures, investigation of the value and cost of cultivation in plantations and the actual improvement in woodlots following thinnings or other treatment are all projects which would guide the people of the watershed in managing their own plantations and woodlots. The Authority should encourage such investigations and co-operate with the Department of Lands and Forests in carrying them out.

5. The Authority and Conservation Education

Many agencies at present do, or can, engage in conservation education. The Authority can supply opportunities and materials to encourage and enlarge these activities. Wall maps, literature, conservation pictures and conservation lectures supplied to the schools will help to give geography, history and conservation practices a local significance. Building up a library of slides on local conservation problems and accomplishments would be of great assistance to speakers. Organization of public meetings and contact with individuals and groups such as farm forums will gain support for both private and public conservation efforts. Landowners should be encouraged to make greater use of the services available from the Conservation Authority and from officers of the Department of Lands and Forests and the Department of Agriculture.

The most effective educational activity is actual participation in or field observation of conservation activities. Tree planting days, group visits to woodlot improvement projects and conducted tours over a well-organized conservation trail could all be sponsored by the Conservation Authority. These activities would all stimulate individual action on forest conservation measures, such as those described in the following chapter, which cannot be carried out directly by the Authority.

CHAPTER 5

FURTHER FOREST CONSERVATION MEASURES REQUIRED

1. Woodland Management

The woodlot inventory shows that there are 17,395 acres of woodland on the Sixteen-Mile Creek Watershed. While experimentation is desirable to determine the best method of handling certain problems, the general principles of woodlot management have been known for years but have not been applied. A free advisory service is available from the Zone Foresters, but is not sufficiently used, and a readily understood pamphlet on "The Farm Woodlot" can be obtained from the Department of Lands and Forests.

One of the most difficult problems confronting the private owner in the management of his woodland is the utilization of the small woodland products which can be readily made and handled by the owner. These products such as fuel-wood, pulpwood, bolts, posts and poles, if properly harvested, increase the productivity of the woodlot and the gross returns per acre. The county diameter limit regulations have wisely prevented whole woodlots from going into these low grade products through wholesale commercial slashing. Nevertheless, much material of this type could still be produced from thinnings and improvement cuttings and from limbs and tops of trees. The difficulty of marketing such low-grade material has seriously hampered owners in carrying out the needed improvement work in their woodlots. Any means which can be discovered for using small and poor-grade wood should be developed to the fullest extent. At the present time interest is increasing in the possibility of manufacturing wood chips in the woodlot by means of a portable chipper. Such chips can be used for the manufacture of pulp for paper, and as cattle bedding and chicken litter which can subsequently be spread on fields to increase the humus content of the soil. They can be made from any species of wood, and tops and branches can be utilized.

A fuelwood market and other uses for low grade material are needed to encourage woodlot improvement.

A heavily pastured woodlot contains no regeneration. It is neither good woodland nor good pasture.

Masses of slash interfere with young trees and increase the danger of fire. Slash disposal by a wood chipper or other means will remove this nuisance.

The number of pulp companies which can use hardwoods is limited at the present time and only those making kraft paper can use chips containing bark, but the demand for hardwood chips will increase and portable barkers are being developed. Every woodlot owner should consider the possibility of improving the quality of his woodlot by utilizing the low-grade material as chips or otherwise.

Owners of large woodlots might be encouraged to undertake thinnings and improvement cutting if equipment or trained crews were available at reasonable cost. The Authority should consider offering such a service. As an alternative, the Authority might offer a subsidy for each acre improved to its specifications and found satisfactory on inspection by the Authority's officers.

2. Elimination of Woodland Grazing

The Report of the Ontario Royal Commission on Forestry, 1947, contains the following statement:

> "The most widespread abuse of forests is that of utilizing them as pasturage for animals. If this practice alone could be eliminated more than half the battle to save Ontario woodlots would be won. Forestry and pasturage cannot succeed on the same piece of ground, as diametrically opposite conditions are necessary for each.
>
> "It is foolish to consider replanting millions of acres to forests unless the owners of millions of acres already under forest are convinced of the necessity and economy of caring for them in such a manner that they will be perpetuated and improved."

This is not a new theme. As early as 1908 the Ontario Legislature, in providing an exemption of one acre in ten used for forestry purposes, included a "no grazing" clause. There are a number of reasons for the widespread practice of allowing woodland grazing. The woodlot has always been considered a pasture field even though the value of woodland pasture is low compared to cleared land. The reason for its low carrying capacity is partly because grass grown in the shade is not nearly as high in food value as that grown in full sunlight. The following statement in respect to woodland pasture has been made by leaders in agriculture: "On the whole, the opinion of the Agronomists is that, on the average, woodland pasture will produce about one-sixth the quantity of pasturage, and the quality will be about one-half as good as that of the improved pasture". Weeds are usually prolific in wooded pastures, often smothering most of the grass.

If shade is required for stock, it may be desirable to leave a portion of the woodlot in the pasture when fencing the woodlot. Another solution is to establish small groves of fast-growing hardwoods which can be fenced temporarily until the trees are sufficiently tall that browsing will not damage crown growth. Where springs or streams that supply water for the stock are situated in the woodlot access may be made to a trough near the spring and the area should be fenced to prevent trampling.

The economic fallacy of grazing woodlands is illustrated by the following examples:

(a) *The Wisconsin Agriculture Experiment Station measured the total yield per acre of dry matter from three types of pasture over a five-year period in Richland County:

Improved pasture (grass and legume)	3,210 lbs.
Unimproved open pasture	1,453 lbs.
Woodland pasture	276 lbs.

Here the improvement of one acre of open pasture provided a gain of 1,757 pounds of feed, which is equivalent to the forage from 6.4 acres of woodland producing at the rate of 276 pounds per acre. In this case the improvement of about 6½ acres of existing open pasture would provide all the additional roughage that could be obtained from 40 acres of woodland.

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* The Case Against Cows. Wisconsin Conservation Bulletin, December 1951.

(b) *The U.S. Soil Conservation Service co-operating with the Wisconsin Agriculture Experiment Station conducted studies which showed that the daily pasture cost per cow was greater in woodland pastures. Taxes and other charges against the land, fencing, costs of establishment and acres required per cow were all considered. The study showed the relative daily pasture costs per cow on different classes of pasture to be approximately as follows.

Rotation pasture	5¢
Open permanent pasture	6¢
Improved pasture	5¢
Wooded pasture	17¢

At this rate, for a 180-day grazing season, woodland pasture cost $30.60 per cow, whereas on improved pasture the cost was $9.00. In other words, wooded pasture cost over three times as much as improved pasture.

(c) A fully timbered average maple stand, 60 years old, may yield about 4,000 board feet of saw timber per acre, net scale. Such a woodlot is virtually ruined by 20 years of heavy grazing, whereas 20 years of protection and no logging may increase the net volume to approximately 8,500 board feet per acre. The gain of 4,500 board feet is equivalent to an annual increase of 225 board feet per acre. At $28 per thousand on the stump this amounts to a mean annual gross income of $6.30 per acre over the period of utilizing only the increase in volume.

Basically the problem in grazing, as in all woodlot forestry, is the fact that a tree takes not one or two seasons but often more than the lifespan of a man before it is ready for harvest. This makes it difficult for many owners to understand the advantages of proper care for their woodlots or submarginal land. Examples such as those given show that good

* Soil Conservation Service, U.S. Department of Agriculture. Forestry Handbook (Fourth Edition), 1948. Upper Mississippi Region. Compiled and Edited by S.S. Locke, Chief, Regional Forestry Division.

forestry practice in the woodlot will return more dollars than the scant forage value which it may produce for livestock. The Authority will find very little local or regional data on woodlands to prove these arguments on economic return, and should recommend that the appropriate agencies extend their studies in this field.

The number of cattle permitted to graze and the size of the woodlot have a direct relationship to the damage which is done. A large woodlot, of course, is not as seriously damaged by a few head of cattle as a small one. However, in most cases where grazing is permitted over a number of seasons the damage is serious.

Livestock admitted to woodland browse on the leaves and shoots of small trees and ride them down, and by scuffing the surface roots of larger trees injure them and permit entry of fungus diseases.

Field observations indicate that cattle have preference habits in grazing woodlands. Unfortunately this preference is for the more economically desirable species such as maple, basswood, elm and beech, whereas undesirable species such as hornbeam, blue beech, dogwood and hawthorn are grazed only when cattle are seriously underfed. This combination of factors, under continued grazing, changes not only the quantity but the quality of the reproduction and so the succeeding stand. The poorer hardwood species, and conifers where these occur, are favoured. The invasion of pastures by cedar and hawthorn is an illustration of this grazing preference.

Continued overgrazing affects natural reproduction both directly and indirectly; directly in so far as it affects the reproduction itself and indirectly through its effect on the soil. Livestock trampling compacts the soil, breaks up the protective layer of litter, exposing the mineral soil to drying, and the cattle, by consuming the vegetation within reach, reduce the volume of litter naturally returned to the soil. It is this litter which keeps the soil open or porous and in a highly absorptive state. Thus water relations are changed, which adversely affects the rate of tree growth and may early eliminate seedlings which manage to make a start in the compacted soil.

A woodland is doomed where conditions persist which will not permit natural regeneration. After a time with no new growth to replace larger trees which die of natural causes, the canopy begins to open up, and sunlight let in further dries out the soil. Weeds and later grasses which require plenty of light gain a foothold and a sod begins to form. In general, tree seeds which germinate cannot compete with an established grass cover. As these effects of grazing progress the stand becomes open or park-like and eventually all the trees disappear.

Livestock grazing affects more than the growth of trees on the owner's land. Soil erosion in the woodland increases as the absorptive capacity and mechanical protection afforded the soil by the litter is reduced. The open canopy exposes the soil to the erosive force of rain impact and a compacted soil forces overland movement of water. Livestock tend to follow trails in the woodland and these often become centres of serious erosion. Thus continued grazing increases surface run-off and soil erosion.

Soil losses and the amount of water which ran off the land were measured at the Soil Conservation Experiment Station, La Crosse, Wisconsin. The following table* shows the results of measurements of four heavy rains recorded during the 1935 growing season on three separate watersheds having the same soil type.

* Technical Bulletin No. 973. U.S. Department of Agriculture, Soil Conservation Service. 1949.

	Run-Off		Soil Loss
	Inches	% of Total Precipitation	(Lbs. per Acre)
Watershed A (Grazed Woods)	1.01	12.61	1,560
Watershed B (Protected Woods)	.02	.25	20
Watershed C (Open Pasture)	.34	4.24	560

Watershed A: 2.67 acres of second growth hardwoods.
Slope 15 - 18 per cent.
Grazed to optimum carrying capacity.

Watershed B: 11.5 acres of second growth hardwoods.
Slope 25 - 50 per cent.
Neither grazed nor burned.

Watershed C: 5.85 acres cleared of second growth timber in 1932.
Slope 25 - 35 per cent.
Grazed to optimum carrying capacity.

Obviously continued woodland grazing is more than the private affair of the property owner. Anything which contributes to soil loss and to increased surface run-off lowers the yield capacity of the land on the one hand and adds to the flood hazard on the other. The lessened value of wood products reaching the market and the increased cost per cow on poor pasture are economic losses to the community as well as to the individual.

In spite of the studies and publicity to-date, the seriousness of the grazing problem has not yet been brought home to the person most concerned, the farm woodlot owner. It is recommended as a step in this direction that the Authority publish a simple, attractive bulletin on woodlot grazing.

3. Forest Fire Protection

The average person does not realize the seriousness of damage caused by fire in the woodlot. Though he may know that young growth and small trees are burned by surface fires he does not realize the extent of the less obvious damage such as the destruction of humus which itself preserves the condition and water-retaining capacity of the soil. When the humus and ground cover are destroyed the sun and dry winds remove the moisture required for tree growth and plant nutrients are destroyed. The heat of the fire also injures the growing tissue inside the bark of older trees which are not actually burned, exposing the wood to attack by insects and fungi. Even though through time the wounds may be completely healed, the damage shows up as defects when the tree is cut for lumber.

The first step in fire control is fire prevention, and the best assurance of prevention is an enlightened public opinion which will make every member of the rural community conscious of the seriousness of the fire damage and of his duty as a citizen to do all he can to prevent it. The farmer can prevent most fires in farm woodlots if he exercises the same care that he does around his home and buildings. It is particularly necessary to exercise such care in areas which have been cut recently, since the accumulation of slash creates a serious fire hazard. Close utilization of tops and the scattering of slash so that it lies close to the moist ground and rots faster will help to reduce this danger.

From the evidence collected in the northern states of the United States, where conditions most nearly approximate those of rural Southern Ontario, it is apparent that the most effective fire protective systems are those set up under the following conditions:

(a) Where the system is organized under the direction and control of the state forester and the wardens in each township are appointed by him on the recommendation of the local council.

(b) Where wardens paid an annual retainer are actual residents in the locality. Usually they are farmers who have had practical instruction in fighting fire. They have the power to call out other local residents to help in fire-fighting and maintain a store of fire-fighting tools on their premises.

(c) Where the warden is assisted in his work by all members of the community. That is, his address and telephone number are known to everyone and fires are reported to him immediately.

(d) Where designated members of the community know that they are likely to be called on to fight fire and are paid so much per hour for the time they are so employed.

(e) Where every resident is thoroughly fire-conscious and realizes that loss of timber by fire is a loss to the whole community, and considers it his duty to prevent, report and fight fire.

(f) Where fires for burning brush and rubbish may be set only after a permit has been obtained from the local firewarden.

Such a system might be adapted to the more heavily wooded areas of Nassagaweya and Esquesing Townships. It is therefore recommended that the Authority set up a committee to determine the best method of providing fire protection for public and private lands, through the co-operation of the Department of Lands and Forests, for the protection of woodlands in that section of the Sixteen-Mile Creek Watershed.

4. <u>Protection from Insects and Diseases</u>

In projects such as the public and private reforestation recommended for the Sixteen-Mile Creek Watershed, careful consideration should be given to the prevention of outbreaks of insects or tree diseases and adequate arrangements made for the immediate application of control measures when these become necessary. While it is not possible to predict accurately the course insects or disease may take under the ever-changing conditions of a newly forested area, there are a number of fundamental principles which, if applied, will greatly lessen their destructiveness.

Large areas of one kind of tree present ideal conditions for an outbreak of insects or fungus disease. Mixing species in the plantation or separating the species in small blocks tends to slow the spread of outbreaks until natural agencies bring them under control or direct control measures can be applied.

It is important to plant only the species of trees suitable to the site and existing growing conditions. Healthy, vigorous trees are certainly more resistant to attack than weak, struggling ones.

Over-mature and dead trees should be removed from the existing stands as these harbour bark-beetles and wood-boring insects which may become excessively abundant and attack healthy adjacent trees. Fungus infections may likewise spread from such sources.

Care should be exercised to prevent ground fires. Even light ground fires are frequently followed by severe outbreaks of bark-beetles and wood-boring insects and fungus infection at the base of the trees.

It is essential that an inspection be made each year so that any abnormal increase in insects or disease may be noted and control measures initiated before the outbreak becomes serious. Prompt action may reduce control measures to a comparatively easy task and confine damage to a small area.

(a) Some Important Insect Pests

The White Pine Weevil has caused serious damage to plantations by attacking the leading shoots of young white pine. As this insect prefers to work in full sunshine, white pine should be grown in mixture with some other species which will shade the pine in its early years.

In recent years the European Pine Shoot Moth has increased to epidemic proportions in red and Scotch pines. Investigations are under way but no simple and effective control measures have yet been discovered. Another enemy of these species, the Root-collar Weevil, has recently been reported near Angus in Simcoe County. This insect kills young trees by girdling them below the ground. In the U.S.A., where this insect is better known, certain emulsions applied around the base of infested trees are said to give good control.

Leaf-feeding insects may kill conifers by one complete defoliation and hardwoods by defoliation for three years in succession. However, even partial defoliation may so weaken trees that they will be attacked by other enemies. Protection from leaf-feeding insects is therefore desirable. This is the kind of attack against which spraying is most successful.

Since investigations of forest insects are constantly under way, the owner considering insect control should always check with the Zone Forester to find the most effective methods now in use.

(b) <u>Tree Diseases</u>

The chief diseases of the hardwoods are the various trunk, butt and root rots, and chronic stem cankers, which are all endemic and may cause serious damage under aggravating conditions. Woodlots on the Sixteen-Mile Creek Watershed present very diverse conditions with respect to the incidence of these diseases, a circumstance which is usually related to their past history. Thus many containing old timber are in need of heavy preliminary salvage and sanitation cuttings as a result of mismanagement or neglect. Such cuttings should precede or be combined with cleanings and improvement cuttings, designed to improve the composition and structure of the stands. Having established a sanitary condition, normal care should maintain it and obviate loss on account of decay.

The wood rots are commonly thought of as diseases of mature and over-mature timber, but experience has shown that infection may occur at a very early age. In hardwood sprouts the stem may be infected from the parent stump. In older trees infection is chiefly through wounds, either of the root or trunk, which may be caused by fire, trampling by animals, insects, meteorological agencies, or by carelessness or accident in felling and other woods operations.

For many reasons "cleanings"in the reproduction are desirable, especially where the woods have been heavily cut. Besides favouring the valuable species, those stems which are of seedling origin should be favoured over stump sprouts which are more liable to decay.

In harvest cuttings, which should recur at frequent intervals, the permissible volume allotted should include trees in which incipient decay is discovered and so far as possible those which have become a poor risk through injury or other circumstances.

The white pine blister rust is a serious enemy of that important species. It can be controlled by elimination of the currant and gooseberry bushes which spread the disease. This is economically feasible where white pine is growing on good sites, and where a considerable concentration of white pine on a small area reduces the labour involved.

The Dutch elm disease, which causes rapid wilting and death to all native elm trees and most introduced species, has caused great concern ever since the first discovery in Canada in 1944. The five cases definitely identified in the Oakville area in 1957 show that the disease is now well established in the Sixteen-Mile Creek Watershed. Control is achieved by elimination of diseased trees and by spraying healthy trees to prevent attack by the elm bark beetles which carry the disease. For valuable trees in parks, along streets or around houses the cost of control is well within reason. The Authority should alert its member municipalities to the danger and co-operate with them in making plans to control this disease.

5. <u>Windbreaks and Shelterbelts</u>

In the process of clearing land for agriculture, woodlots and belts of trees along fence lines have been removed which had served as natural shelterbelts. The restoration of these in the form of windbreaks is essential to a complete conservation program in many parts of Southern Ontario.

When proper species are used and windbreaks are correctly placed the effects are almost entirely beneficial. The effects may be direct or indirect, but in either case are the result of reduction in wind velocity. The effects of windbreaks on crops and cultivated fields may be listed as follows:

(a) Direct Effects

(1) Wind damage and lodging in small grains and corn is reduced or eliminated.

(2) Snow and the resultant moisture are more evenly distributed over fields, particularly on the higher spots where they are required most.

(3) Wind erosion of the soil is minimized.

(b) Indirect Effects

(1) Moisture loss by evaporation is reduced.

(2) Temperatures in the fields are raised, which may prevent frost damage, accelerate growth and even lengthen the growing season slightly.

(3) Erosion of the soil by water may be reduced by its more even distribution when released from snow.

The benefits of windbreaks to buildings in reducing heat loss in winter have been shown to be considerable. Experiments conducted in the United States proved that more than twice as much heat is lost from a house, per day or per hour, with a wind of 20 m.p.h. as with one of 5 m.p.h., and a windbreak can easily reduce wind velocities in this proportion. Used in this way they can often be made to form an effective background for the house and a protection for farm buildings. Another advantage of windbreaks is that they provide shelter and runways for insectivorous birds and small animals.

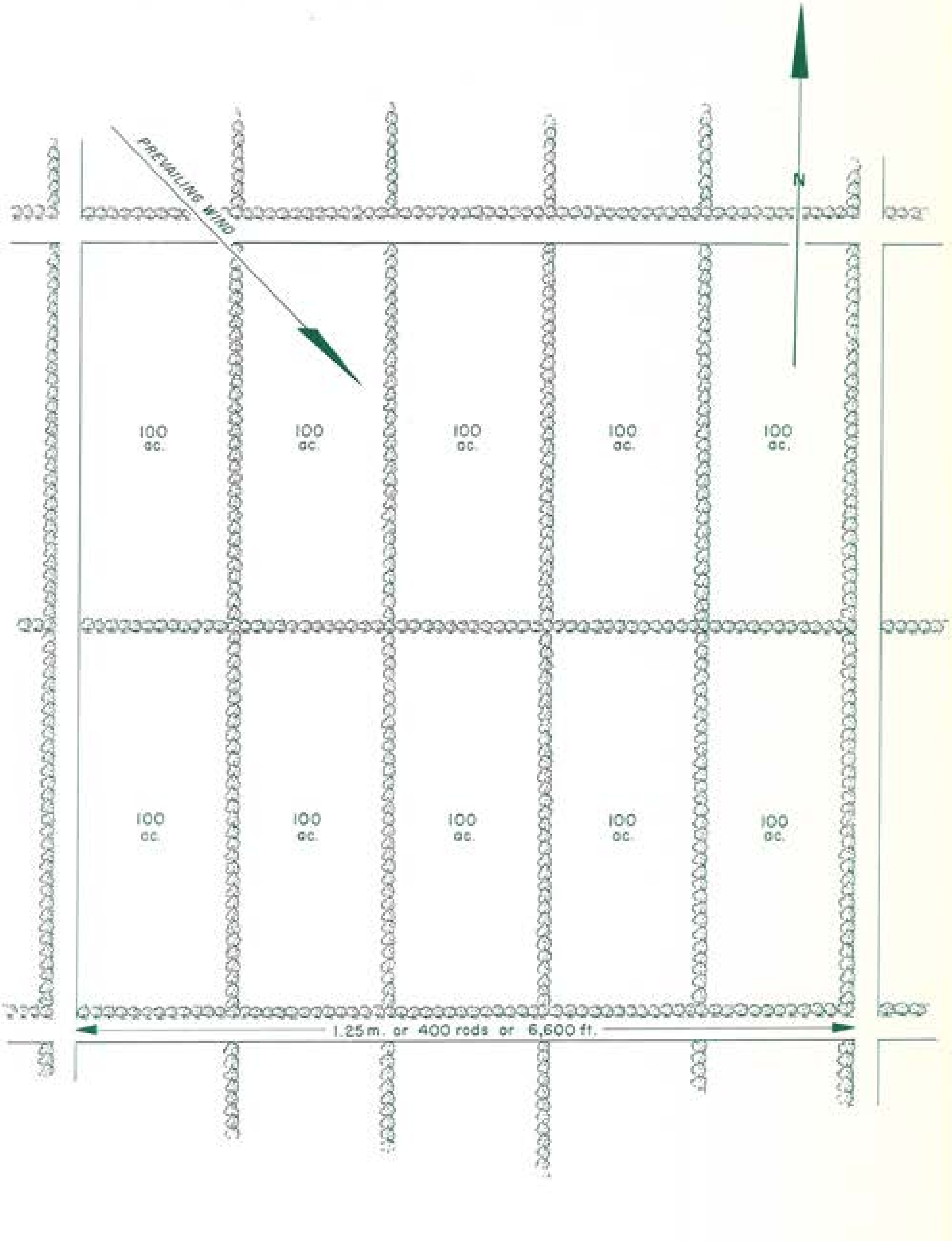
Belts of trees comprising one or two rows are usually called windbreaks, and with more than two rows, shelter-belts. In Southern Ontario windbreaks as a rule give sufficient protection except where wind erosion of soil on rolling land is severe, when shelterbelts may be required. On level land windbreaks may nearly always be established along existing fence lines, but on rolling land consideration should be given to the contour of the land. The prevailing winds in Southern Ontario are generally from the west, so that the greatest protection will be derived from windbreaks on the west side, but the placement of windbreaks on the other three sides as well should be considered.

Both the height of the trees and the wind velocity influence the effective range of a windbreak. An average windbreak will reduce the ground velocity of a 20-mile wind 10 per cent or more for a distance of about 30 times the height of the trees. About one-fourth of this effect will be felt on the windward side of the windbreak and three-fourths on the leeward side. For example, if the trees are 40 feet high the total effective range with a 20-mile wind will be 30 x 40 or 1,200 feet, 300 feet of which will be on the windward side and 900 feet on the leeward side. Generally speaking, the reduction in velocity is greatest close to the windbreak and tapers out to zero farther away. With higher wind velocities and/or higher trees the proportionate reduction and the effective range will be greater.

A few years ago European alder gained considerable popularity as a windbreak tree because it is a nitrogen-fixer like the legumes and does not rob the soil to the same extent as non-nitrogen-fixing species. At the present time stock is hard to obtain.

One consideration that should be kept in mind is that under certain circumstances windbreaks may cause air stagnation, which may increase temperature and moisture conditions to a dangerous degree in summer or increase frost damage in spring and fall on small areas, particularly in hollows. Where this is likely to occur, windbreaks should be planted so as to guide the flow of air past such spots. Where these conditions develop after the windbreaks are established they may be relieved by judicious opening up of the windbreaks.

WINDBREAK PLAN
for
1,000 ACRE BLOCK



This plan shows the minimum windbreak requirements for a 1,000 acre block on level land. Woodlots and plantations will replace some of this and placement will have to be adjusted according to topography and soil on rolling land.

Experience has shown that windbreaks are an asset to any farm, that their adverse effects, if any, are local and easily remedied, and that in many areas they are essential to the control of soil erosion by wind. It is therefore recommended that the Authority encourage the establishment of windbreaks by private owners in every way.

6. Snow Fences

In the climate of Southern Ontario snow drifting may cause much inconvenience and sometimes hardship. Control can be readily effected by means of windbreaks and is dependent on proper placing with reference to lanes of travel and topographic features.

Where space is limited or land valuable lath or board fences are frequently used, but the cost of erection, removal or maintenance of these can be materially reduced by using trees as permanent windbreaks or shelterbelts.

The object of a snow fence is to mechanically reduce wind velocity near the ground in such a manner as to cause a drift to form where it will be least harmful. The reduction in velocity creates two pools of relatively calm air, a small one on the windward side and a much larger one on the leeward side, and it is here that drifts form, leaving the area farther to the leeward free of drifts and comparatively free of snow. As winds become stronger the wind reduction and the width of the calm pool on the leeward side will increase and the centre will tend to move farther away from the windbreak.

A wide belt of trees which will accumulate a large drift of snow on its windward side may be planted right to the edge of the road, the windward edge extending back a distance equal to three or four times the height of the trees and generally at least 100 feet.

In some places the snow trap type of windbreak is effectively used. It is composed of one or more rows of trees close to the road with a wide opening to windward and then a single row of trees. The single row arrests the first force of the wind and the snow is deposited in the opening. This has the advantage of requiring fewer trees than the shelterbelt and leaving the ground between open for cultivation in the summer.

Poor placement of windbreaks may accentuate drifting conditions. A single row of trees, unless it is a dense coniferous type, is seldom dense enough to completely stop winter wind, and may likewise create drifts.

Any prejudice which may exist against windbreaks for protection against drifting snow on roads arises from such poor or poorly placed windbreaks. If a windbreak has openings in it or if it ends abruptly streamer drifts will form. Windbreaks should be kept dense and tapered down at the ends by using progressively smaller species of trees and shrubs to prevent the formation of streamer drifts.

Trees are being used successfully as snow fences in Ontario by the Department of Highways, by railways and by a number of counties. Every encouragement should be given to the establishment of such snow fences in place of the removable type of lath fence now in use.

SIXTEEN MILE CREEK CONSERVATION REPORT

WATER

ONTARIO DEPARTMENT OF PLANNING AND DEVELOPMENT

CONSERVATION BRANCH

CHAPTER 1

GENERAL DESCRIPTION OF THE WATERSHED

1. Boundaries and Dimensions

The Sixteen-Mile Creek Conservation Authority covers an irregular-shaped area of 159.0 square miles. The watershed extends inland from the north shore of Lake Ontario for a distance of 21.6 miles and has an average width of about nine miles. The rivers in the Authority drain into Lake Ontario along a shoreline of five to six miles.

Three other watersheds bind the Authority, viz., the Bronte Creek and the Eramosa and the Credit Rivers. The former lies to the south-west and covers the area from Lake Ontario to the hamlets of Campbellville and Moffat. The Eramosa, a tributary of the Grand River, rises just west and north of the Sixteen-Mile Creek Watershed, in the vicinity of the town of Acton. This watershed forms the north-western boundary. Finally, the entire northern and north eastern area is bounded by the Credit River Watershed. Lake Ontario lies to the south-east.

A map of the watershed appears in Figure 1.

2. Municipalities

The entire Authority lies in Halton County and takes in 77.36 per cent of Trafalgar Township, 35.38 per cent of Nassagaweya Township and 52.99 per cent of Esquesing Township. There are about 29,967 people living in the watershed with the majority living in the town of Oakville (10,147*) and Milton (4,497*). Both of these towns lie in Trafalgar Township.

The following table shows the areas and percentages of the total areas of the townships within the watershed as well as the distribution of population.

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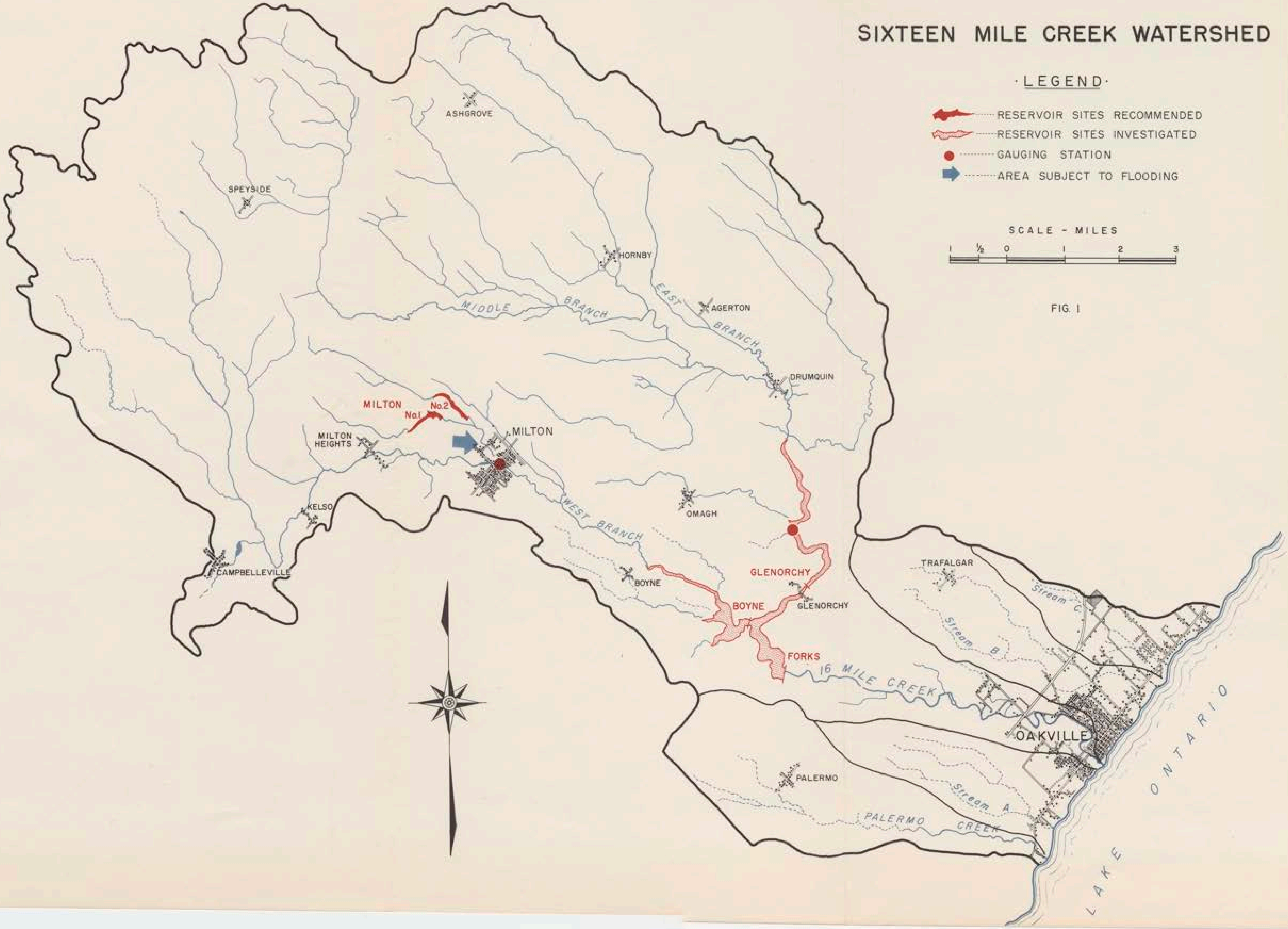
* Population figures taken from the 1958 Municipal Directory, Department of Municipal Affairs



SIXTEEN MILE CREEK WATERSHED
LEGEND
RESERVOIR SITES RECOMMENDED
RESERVOIR SITES INVESTIGATED
GAUGING STATION
AREA SUBJECT TO FLOODING
SCALE - MILES
1 ½ 0 1 2 3
ASHGROVE
SPEYSIDE
HORNBY
MIDDLE BRANCH
EAST BRANCH
AGERTON
DRUMQUIN
MILTON
No.2
No.1
MILTON
MILTON HEIGHTS
KELSO
CAMPBELLEVILLE
WEST BRANCH
OMAGH
BOYNE
GLENORCHY
BOYNE
GLENORCHY
FORKS
16 MILE CREEK
TRAFALGAR
Stream C
Stream B
OAKVILLE
PALERMO
Stream A
PALERMO CREEK
LAKE ONTARIO

FIG. 1

POPULATION AND AREAS OF TOWNSHIPS WITHIN THE AUTHORITY

Township or Town		Area Within Authority		Population in Authority
		Per Cent	Square Miles	
ESQUESING	Rural	52.99	52.90	2,800
NASSAGAWEYA	Rural	35.38	24.74	770
TRAFALGAR	Rural	77.36	78.67	11,753
MILTON	Urban	100.00	1.32	4,497
OAKVILLE	Urban	100.00	1.15	10,147
TOTAL			159.00	29,967

3. Terrain

The Sixteen-Mile Creek watershed can be considered as being a small one, covering an area of only 159.0 square miles and having a maximum length of 21.6 miles. Yet the elevation varies from 246 feet above sea level (G.S.C.)* at Lake Ontario to almost 1,300 feet elevation on the Niagara escarpment in the north-west corner of the watershed. This gives a difference in elevation of almost 1,054 feet and an average gradient of about 49 feet per mile.

This variation in elevation is due to three series of bluffs. The first series is located at the present lake shore. The second series lies north of the Queen Elizabeth Highway, and were formed by the glacial Lake Iroquois. Finally, the Niagara escarpment, which lies to the west of Milton, rises almost 300 feet above the plain below, with the cliffs being almost perpendicular in places.

This general picture has an important effect on the hydraulics of the drainage area. First of all, the main watercourse, viz., the Sixteen-Mile Creek, has numerous small tributaries, especially in the upper reaches of the watershed. Due to the slope of the area, the stream bed gradients average anywhere from 10 to 97 feet to the mile. In fact, one of the

* G.S.C. = Geodetic Survey of Canada.

tributaries of the Middle Branch has an average gradient of almost 190 feet per mile for a distance of about 1.5 miles where the stream drops over the escarpment near Speyside. The combination of numerous short tributaries and steep gradients result in a very fast run-off and short flood concentration times. For example, the drainage area above Milton has a flood concentration time at the town of between two to seven hours. These facts are important when consideration is being given to the control or routing of floods through the watershed.

Secondly, this general topographic picture also has an effect on the available water storage within the watershed. For low-cost storage, a broad, flat, flood plain with suitable restriction for a short low dam is necessary. Unfortunately, such sites are not common in the watershed. In the area above Milton and Drumquin, (excluding the escarpment cliffs) the land is generally too flat and the stream gradients too high for suitable low-cost sites. Farther downstream, the valleys become deeper and wider, which make them more suitable for large dams. Unfortunately, the gradients are still in the 20 to 35 feet per mile range thus preventing large reservoir capacities. The available water storage potential will be discussed further in a later chapter.

Only 17.0 per cent of the total area of the Authority is at present covered by woodlots. By townships; Esquesing has 19.4 per cent; Nassagaweya has 42.0 per cent and Trafalgar has 8.1 per cent of their land area in woodland.

The soil materials in the area are predominantly clay till with smaller areas of sand, gravel, weathered shale and lighter-textured till. Table 1 shows the permeability of the various soil materials in the watershed.

4. The Watercourses

The Sixteen-Mile Creek Conservation Authority is drained by five watercourses. The largest of these, the Oakville Creek, (known locally as the Sixteen-Mile Creek and

TABLE 1

PERMEABILITY OF SOILS IN SIXTEEN-MILE CREEK AUTHORITY
SHOWN IN PER CENT OF WATERSHEDS

WATERSHED (as shown in Fig. 1)	PERVIOUS	SEMI-PERVIOUS	ALMOST IMPERVIOUS
	Sand Plain Drumlins Till Kame Moraine Limestone Plain Spillways	Lake Iroquois Shorecliffs Niagara Escarpment Till Moraine Bevelled Till Plain Drumlinized Till Plain	Shale Plain Muck *
SIXTEEN-MILE CREEK	27.7	67.7	4.6
PALERMO CREEK AND STREAM A	14.1	40.9	45.0
STREAMS B AND C	32.1	31.3	36.6

* Dependent on Antecedent Moisture Conditions.

referred hereafter as such) is the most important since it drains almost 84 per cent of the entire watershed. It empties into Lake Ontario at the town of Oakville which is located midway along the Authority's lakeshore boundary. The four other streams are much smaller in comparison and officially they have no names. Two lie to the north and two lie to the south of the Sixteen-Mile Creek. For the purpose of this report, the southernmost stream will be called the Palermo Creek due to the proximity of its headwaters to the hamlet of Palermo. The stream draining the area lying between the Palermo and the Sixteen-Mile Creek Watersheds, (Area A) will be referred to as Stream A; while the first stream north of Oakville will be called Stream B, (draining Area B); and the northernmost stream will be called Stream C, (draining Area C).

Table 2 shows the drainage areas of the various watercourses in the watershed.

(a) The Sixteen-Mile Creek

The Sixteen-Mile Creek drains 84 per cent of the entire watershed by means of its extensive system of tributaries. The main branch extends from Oakville to the "Forks" just south-west of the hamlet of Glenorchy. Here the river splits into the West and East Branches. About 9 miles farther up the East Branch is the confluence with the Middle Branch. Each of these branches has its own system of minor tributaries.

The water level profiles and the gradient tables for the five streams in the Authority are shown in Figures 2 & 3. Only the important tributaries of the Sixteen-Mile Creek have been shown so as to avoid confusion. The Creek has a maximum single stream length of just over 32 miles, this being from the lake to the headwaters of the Middle Branch.

The West Branch rises on the escarpment at altitudes close to 1,300 feet G.S.C. The stream flows southwards to a point between Campbellville and Kelso where it turns

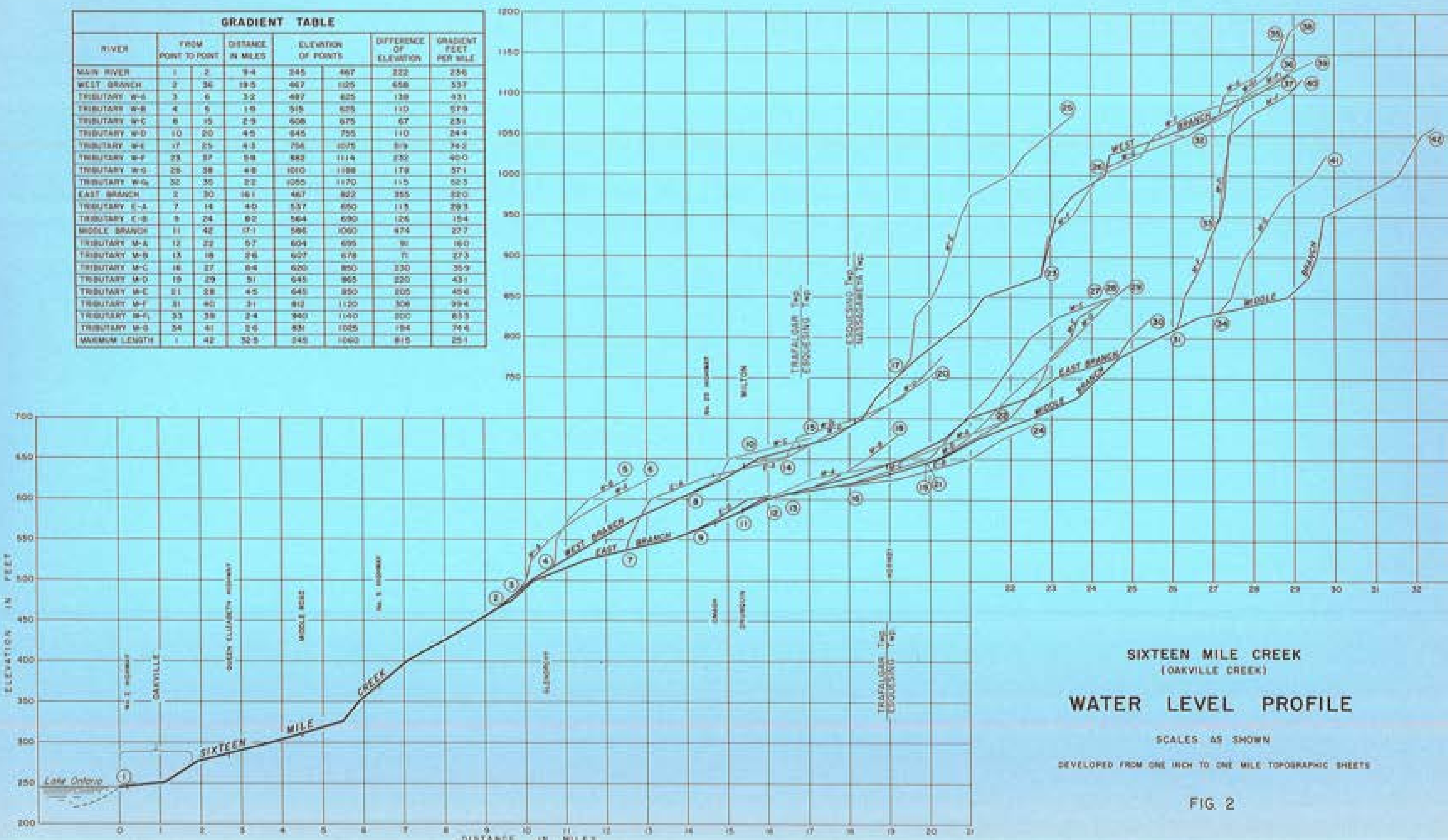
TABLE 2

DRAINAGE AREAS

Area	Square Miles
SIXTEEN-MILE CREEK WATERSHED	133.6
PALERMO CREEK WATERSHED	9.4
AREA "A"	5.0
AREA "B"	7.9
AREA "C"	3.1
SIXTEEN-MILE CREEK AUTHORITY	159.0
AREA ABOVE C.P.R. TRACKS ON TRIBUTARY W-D	5.5
GAUGE AT MILTON	36.2
GAUGE AT OMAGH	75.6

GRADIENT TABLE

RIVER	FROM POINT TO POINT		DISTANCE IN MILES	ELEVATION OF POINTS		DIFFERENCE OF ELEVATION	GRADIENT FEET PER MILE
MAIN RIVER	1	2	9.4	245	467	222	23.6
WEST BRANCH	2	36	19.5	467	1125	658	33.7
TRIBUTARY W-A	3	6	3.2	487	625	138	43.1
TRIBUTARY W-B	4	5	1.9	515	625	110	57.9
TRIBUTARY W-C	8	15	2.9	608	675	67	23.1
TRIBUTARY W-D	10	20	4.5	645	755	110	24.4
TRIBUTARY W-E	17	25	4.3	756	1075	319	74.2
TRIBUTARY W-F	23	37	5.8	882	1114	232	40.0
TRIBUTARY W-G	26	38	4.8	1010	1188	178	37.1
TRIBUTARY W-G1	32	35	2.2	1055	1170	115	52.3
EAST BRANCH	2	30	16.1	467	822	355	22.0
TRIBUTARY E-A	7	14	4.0	537	650	113	28.3
TRIBUTARY E-B	9	24	8.2	564	690	126	15.4
MIDDLE BRANCH	11	42	17.1	586	1060	474	27.7
TRIBUTARY M-A	12	22	5.7	604	695	91	16.0
TRIBUTARY M-B	13	18	2.6	607	678	71	27.3
TRIBUTARY M-C	16	27	6.4	620	850	230	35.9
TRIBUTARY M-D	19	29	5.1	645	865	220	43.1
TRIBUTARY M-E	21	28	4.5	645	850	205	45.6
TRIBUTARY M-F	31	40	3.1	812	1120	308	99.4
TRIBUTARY M-F1	33	39	2.4	940	1140	200	83.3
TRIBUTARY M-G	34	41	2.6	831	1025	194	74.6
MAXIMUM LENGTH	1	42	32.5	245	1060	815	25.1



SIXTEEN MILE CREEK
(OAKVILLE CREEK)

WATER LEVEL PROFILE

SCALES AS SHOWN

DEVELOPED FROM ONE INCH TO ONE MILE TOPOGRAPHIC SHEETS

FIG. 2

eastwards and plunges over the escarpment to an elevation of 700' G.S.C., which results in gradients of between 90 and 100 feet per mile at some points. It continues flowing eastwards, just north of the C.P.R. tracks, until it reaches the western limits of the town of Milton where it passes beneath both the C.P.R. and C.N.R. tracks. In the centre of Milton it is joined by a tributary coming from the north and thence flows south-easterly; passes under Highway 25, and then continues at gradients of about 30 feet per mile until its confluence with the East Branch at the "Forks".

The Middle Branch has its headwaters in the northernmost corner of the watershed near the village of Limehouse. One tributary rises on the escarpment near Speyside at an altitude of nearly 1,150 feet G.S.C. The main stream flows southward at the base of the escarpment, and is fed by tributaries rising in the escarpment. At a point about 2 miles north of Milton Heights, the stream course changes to an easterly direction which it maintains until its confluence with the East Branch just south of Hornby. The gradients vary anywhere from 10 to over 99 feet per mile.

The East Branch rises at a point just east of Stewartown and flows south-eastwards for about 4 miles; thence turns southwards for 2½ miles and then reverts to its south-easterly direction until its confluence with the Middle Branch at Drumquin. It then follows a very winding, southerly course in a deepening valley until its confluence with the West Branch at the "Forks". The gradient averages about 22 feet per mile for most of the stream's length.

The Main Sixteen-Mile Creek is 9.4 miles in length and has an average gradient of 23 feet per mile. It flows in a fairly deep valley from the "Forks" to its mouth at Oakville on Lake Ontario. The overall gradient of the entire creek is about 32 feet per mile.

Headwaters of the West Branch three miles South of Speyside.

The Main Branch as it meanders through the wide valley south of No. 5 Highway.

The mouth of Sixteen-Mile Creek at Oakville.

(b) Palermo Creek

The Palermo Creek drains an area of about 9 square miles in the southern extremity of the Authority. The stream rises just west of the hamlet of Palermo and flows eastwards for 7.0 miles to its mouth on Lake Ontario. It has an average gradient of about 40 feet per mile and has three minor tributaries from 1.1 to 2.7 miles in length. Many stretches of the river bed are dry during the summer months.

(c) Stream A

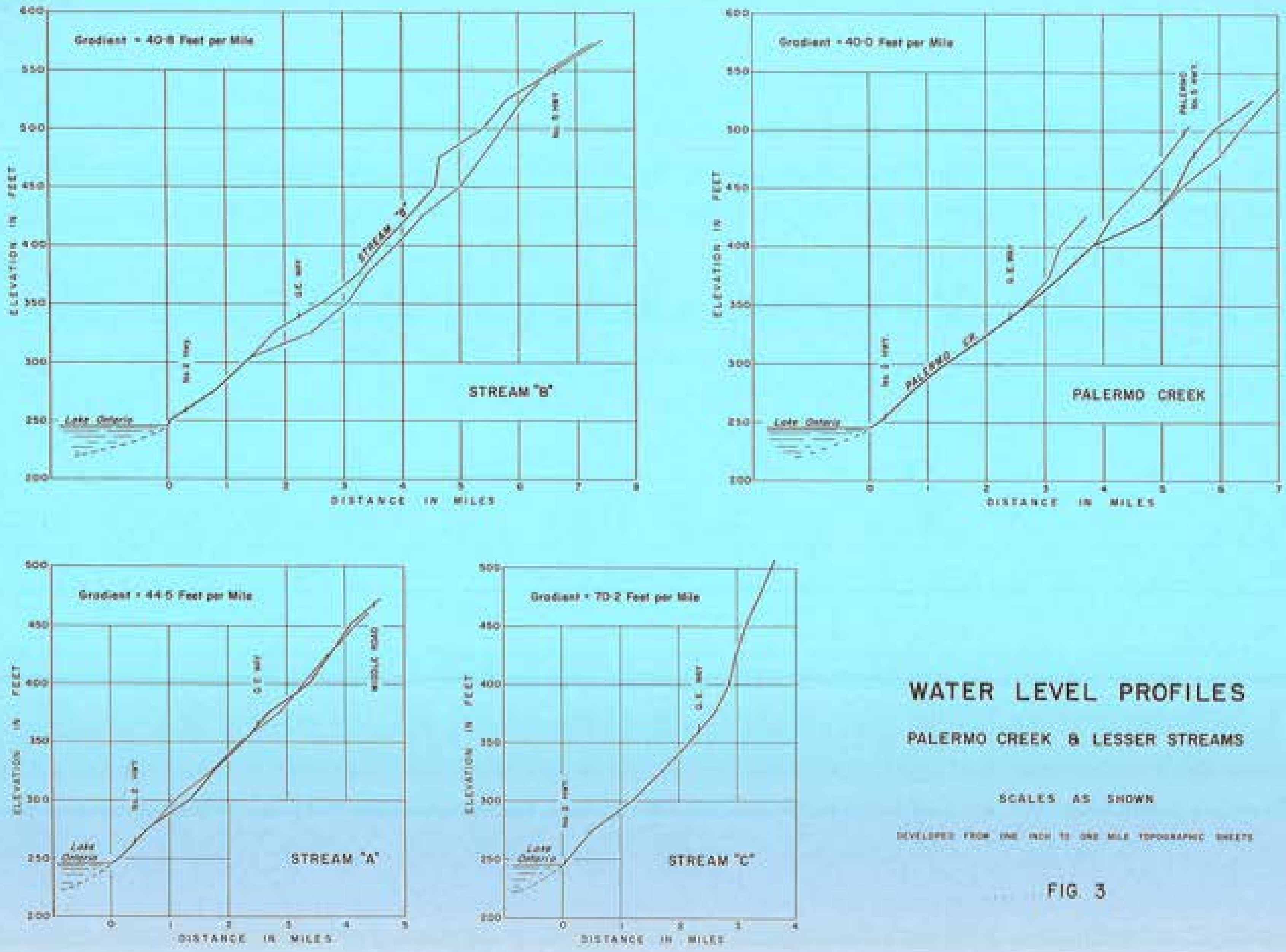
This Creek is only 4.6 miles in length and has an average gradient of about 45 feet per mile. It drains just over 5.0 square miles between the Sixteen-Mile Creek and Palermo Creek watersheds. There is one major tributary of 4.4 miles in length and the entire watercourse is dry during the summer months.

(d) Stream B

Stream B has a watershed of about 7.0 square miles, which lies just north of the Sixteen-Mile Creek. The main stream has a length of 7.47 miles and the major tributary is about 6 miles in length. The average gradients are 41 and 43 feet respectively. This stream, like both stream A and stream C, runs dry during the dry summer months.

(e) Stream C

This should rather be called a drainage ditch. It is only 3.63 miles in length and has a drainage area of about 4 square miles in the most eastern corner of the watershed. The gradient is about 70 feet per mile.



WATER LEVEL PROFILES

PALERMO CREEK & LESSER STREAMS

SCALES AS SHOWN

DEVELOPED FROM ONE INCH TO ONE MILE TOPOGRAPHIC SHEETS

FIG. 3

CHAPTER 2

FORMER FLOODS

An examination of the record of the known floods that have occurred in that part of Canada which today is called Ontario readily leads the investigator to certain conclusions, some tentative, others fully confirmed, which may be stated as follows:

(1) The record is incomplete, even within what we regard as "historic times"; that is to say, floods occurred of which no record has been found.

(2) Floods occurred on the rivers of Ontario before the coming of the white man.

(3) The process of clearing and settling the land has tended to increase the frequency and severity of floods.

(4) The increase in recent years of the recorded floods is largely the result of improved methods used in reporting them (newspapers, stream gauges, and the observations of trained investigators), rather than an increase in the actual number of floods.

(5) There is a tendency to measure the severity of floods by the amount of damage done to property, rather than by the volume of flow.

Present-day knowledge of the frequency and severity of former floods depends upon two things; the care with which such floods were originally recorded, and the preservation of the records for present-day study and examination. In the early days of the settlement of this Province, only the occasional diarist or letter-writer took any pains to set down in writing the record of his observations; and, as a rule, such a writer saw only what took place in his own immediate vicinity, and wrote within a few days of the event he recorded. In some parts of the Province, careful and consistent records were thus made of the "annual rising of the waters", in the years before 1800; in the neighbourhood of the Sixteen-Mile Creek, only one such reference is known.

About the middle of December, in the year 1797, Captain Joseph Brant set out from his home at the Mohawk Village, on the Grand River (near the present city of Brantford) to travel on business to York (Toronto); on December 15th, having arrived at Burlington Beach, he found himself prevented from proceeding to York by "the rise of the waters" in the streams he would have to cross. On the assumption that this December freshet would have equally affected all the streams between the Head of the Lake and the town of York, this mention is regarded as the earliest reference, so far as is known, to a flood on the Sixteen-Mile Creek. The fact that it is little more than a passing mention suggests that the occurrence caused no particular surprise, and was not the first time that such a flood had taken place. Even the circumstance that it took place in mid-December calls for no special comment. The writer is concerned only with the fact that "the rise of the waters renders it unsafe for me to proceed".

Early in 1796, Lieutenant-Governor Simcoe had instructed Augustus Jones, Deputy-Surveyor,"to open a road and to bridge the Creeks between the River Humber and the Out-let of Burlington Bay"; and on May 26th of the same year, Jones reported "the Bridges Compleat over the two large Creeks, the 12" [now the Bronte Creek] "and 16 miles". It should be noted that Captain Brant, in his mention of "the rise of the waters" in December, 1797, makes no reference to the fate of the bridges. It is perhaps not unreasonable to infer that Jones' bridges had been destroyed by floods in the <u>spring</u> of 1797, leaving the traveller, as in the unrecorded pre-historic times, to guide himself by the weather and the freshets, the foot-paths and the accustomed fords.

After 1797, an interval of forty years was to pass without any mention of floods on the Sixteen-Mile Creek. During this long period, it is likely that the creek, like the other streams of Upper Canada, was subject to freshets of annual or almost annual frequency; if so, the records are lacking, and speculation remains unsupported by any reference to the probable facts.

The next reference to a flood on the Sixteen-Mile Creek comes from the pen of William Lyon Mackenzie, who, writing many years after the event, has left a narrative of his escape from Upper Canada in the days following the defeat he and his followers suffered on December 7, 1837, at Montgomery's Tavern. The narrative is incorporated into a book entitled "The Life and Times of William Lyon Mackenzie", by Mackenzie's son-in-law, Charles Lindsey, published in 1862, a year after Mackenzie's death. Describing the events of December 8, 1837, the narrative refers to the Sixteen-Mile Creek:

> "..... Our pursuers, nevertheless, gained on us, and when near the Sixteen-Mile Creek we ascertained that my countryman, Col. Chalmers, had a party guarding the bridge. The creek swells up at times into a rapid river; it was now swollen by the November rains."

Mackenzie's narrative does not appear to indicate a severe flood; to continue to be "swollen by the November rains" on December 8th, suggests a protracted period of high water, but not one of extreme severity. And the narrative goes on to relate that Mackenzie and one companion, in spite of high water and floating ice, succeeded in wading across the creek; this would hardly have been possible in the face of a violent freshet.

It will be noticed that both the first and the second flood thus recorded on the Sixteen-Mile Creek occurred in the month of December; and that, in each case, the flood is mentioned only because it occasioned a hindrance to travel. Thus far, no mention has been found of a spring freshet on this creek; and no reference is found to any such freshet for another twelve years.

A Toronto weekly newspaper, the Christian Guardian, on April 10, 1850, quoted from the Hamilton Gazette an account of rain and flood in the vicinity of the latter city.

> "On Wednesday last" /April 3_7 "it commenced raining, and continued, with slight interchanges of snow, until Friday afternoon ..... A vast amount of damage has been sustained by the sudden and almost unparalelled rise of water in Rivers and Creeks ..... A correspondent writing from Oakville says that they have had the heaviest freshet ever known in that quarter. The bridges at Bronte and Oakville have both been carried away, and all travel on the Lake Shore Road temporarily suspended in consequence. It is also added that several other bridges in that section have been swept from their foundation."

The floods of this date were severe and widespread through a great part of Western Ontario, and resulted in enormous damage on the Thames, the Grand, the Humber, and the Don. It is, accordingly, not surprising that a freshet of the same date occasioned considerable damage on the Sixteen-Mile Creek; it is, perhaps, more to be wondered at that the account that was published in the Hamilton Gazette, and copied by the Christian Guardian, is the only report of that freshet on the Sixteen that has been found.

The next flood of any note that took place on the Sixteen-Mile Creek occurred on February 16, 1857. The report published by the Toronto Globe, on February 21, was copied from the Oakville Sentinel:

> "On Monday morning last" /February 16_7 "the creek running through this town, rose to a great height, flooding the shipyards and carrying away a large quantity of timber. Fears at one time were entertained for the safety of the craft moored in the harbor; fortunately, the ice held and the danger passed. An old scow moored on the northern side of the bridge broke away, and floated down, but being stopped by posts embedded in the bottom of the creek, the ice piled upon and around her, thus creating a dam close to the bridge. A number of spectators were posted at different points viewing the rushing water and watching the bridge, which they expected would give way."

Like the floods of 1850, those of February, 1857, were widespread throughout the Province, from Chatham to Port Hope. The Toronto Globe referred to the "Fearful Flood on the Grand River"; while the Toronto Leader reported the carrying away of "the bridges over several of the small streams ... between Collingwood and Owen Sound." Apart from the damage sustained by the shipyards, the vicinity of Oakville appears to have suffered only minor injury, and to have been threatened with the loss of the bridge over the Sixteen - a threat which did not materialize.

After the floods of 1857, an interval of fourteen years elapsed before there was any further mention of floods on the Sixteen-Mile Creek. The Toronto Globe, of March 11, 1871, reports that "a few days ago", Mr. Benjamin Johnston, a farmer of Trafalgar Township, returning home from Toronto by way of Dundas Street, at night, had a narrow escape from drowning as he attempted to cross the Sixteen-Mile Creek.

> "The water in the creek, now raised to a flood, had cut a channel through the roadway constructed across the flats. The water here was about three feet deep, but Mr. Johnston thought he would be able to get across. He entered the stream, when the waggon wheels on the upper side loosened some ice that had dammed the water back, and at once a flood rushed down upon the horses and waggon, sweeping them into the deep water below."

Mr. Johnston and one of his horses were saved by the neighbours; the other horse was drowned.

No account of the occurrence of this flood on any other part of the creek has been found.

The "great flood" of September 13, 1878, was, on many Ontario streams, the greatest that had ever been known, and for many years remained without anything to equal it. The report from Oakville, published in almost identical words in the Toronto Globe and the Toronto Mail, indicates that much damage was done on the Sixteen-Mile Creek, but does not give many particulars of the damage done.

> "Owing to the heavy rains of the last three days considerable damage has been done in this vicinity. The flood is larger than was ever known before. Several small boats and open yachts have been carried away, also a steam yacht, belonging to Mr. H. Haines. J. Warcup & Co. have sustained damage to the amount of several thousand dollars. Bridges and roads are washed away in all parts. The great Western Railway track is washed out in several places. No trains have passed here" /Oakville/ "today."

No report of this great flood has been found from any other point on the creek, though its effects must have been felt at Milton, at the crossing of Dundas Street, and elsewhere. The bridges and roads "washed away in all parts" remain unidentified.

The fifth of June, 1890, was marked by a series of intense thunderstorms and heavy downpours across the greater part of Southern Ontario. The Oakville Star, in its issue of June 12th, tells of extensive damage done at such widely separated points as Port Hope, Whitby, Barrie, Schomberg, and Simcoe. The date is included in this chapter because, according to the Star's account, there was a washout on the Grand Trunk Railway line "about a mile north of the station here"; the waters that caused the washout are not identified, but there can be little doubt that the effects of the storms of that day were felt on the Sixteen-Mile Creek.

During the ensuing twenty-five years there is no known report of a flood on the Sixteen. Then came the spring and summer of 1915, with "more rain at Oakville than ever we can remember". On August 4, 1915, the Toronto Globe stated: "Oakville reports the water in Sixteen-Mile Creek higher than it was in the spring". The Oakville Record and the Milton Champion, both published on Thursday, August 5th, report a severe storm and heavy rains on Tuesday, the 3rd; they make much more of the storm and wind damage than they do of the state of the creek. Thus, the Record: "Such a storm as that which we had here on Tuesday has not been seen for many long years. The rain came down in torrents, and was accompanied by a high wind...... The rain fall was over four inches, the heaviest known in this part in many years." To this the Champion adds:

> "Yesterday" [August 4th], "on account of the heavy rains, there was a freshet in the creek and its branches, which were bank full ..... The rain ..... was the heaviest for many years

> "in this part of the country and, with the wind which accompanied it, did a tremendous amount of damage ..... There was a wash-out on Tuesday night on the C.P.R. near the works of the Milton Pressed Brick Co., a freight train was partly derailed ..... "

These reports indicate that the heavy rainfall of August 3rd caused the creeks to run "bank full", but that the damage done was the result of the wind and the rain, rather than the result of the floods.

The spring break-up in 1922 was attended by ice jams on some of the streams in the vicinity of Toronto, but not by any serious floods. Among these streams, on March 8, 1922, the Sixteen-Mile Creek is mentioned as having "cleared of ice yesterday afternoon" /March 7th/ "without any damage resulting".

A flood in the spring of 1925 caused some damage at Oakville, which, because of the special circumstances, happened not to be serious. A new bridge over the Sixteen-Mile Creek had been built to carry Colborne Street and the lakeshore traffic over that stream; and a disused temporary detour bridge "built two years ago, at a cost of some hundreds of dollars", still stood beside the new structure. When, on the morning of the 19th of March, 1925, the creek "rose several feet", the detour bridge was carried out into the lake; the new bridge was left unharmed. Both the Toronto Globe and the Mail and Empire, on March 20th, carried reports of the occurrence; neither of them reports any other damage on the Sixteen-Mile Creek.

In 1926, there was considerable flooding in the town of Milton, which was reported in the Toronto Mail and Empire on March 24th:

> "Milton, Ont., Mar. 23. - As a result of the heavy downpour of rain last night and today, the creek running through the South ward overflowed its banks and caused a big flood. A large portion of this section of the town is inundated and many cellars are flooded, furnaces put out, and other damage done."

A flood that took place in Milton on March 13, 1928, was described as "one of the worst floods in the history of Milton". According to the Toronto Globe:

> "..... the stone arch bridge on Martin Street, through which the Sixteen-Mile Creek flows, became blocked with ice, causing the water to back up.
>
> "Factories, foundries, the Milton curling rink, and many houses on Mill and Martin Streets were flooded, with water rising to a depth of six feet ..... and the water is" [March 13th] "still rising ..... The damage will amount to thousands of dollars."

The Mail and Empire, on March 14th, carried a much briefer dispatch, but, on the 15th, added:

> "Milton yesterday was clearing up following the inundation which caused damage to residences and business buildings, running into thousands of dollars. The flood is described as the worst in 60 years."

This flood was described in greater detail in the Milton Champion, on March 15, 1928:

> "About nine o'clock Tuesday night" [March 13], "following an afternoon's heavy down-pour of rain, which swelled the Sixteen-Mile Creek to enormous proportions, great ice cakes jammed against the stone arch bridge on Martin Street causing the water to back up and flow over the adjoining low land. The water rose to a dangerous depth, and by ten o'clock ground floors in the path of the flood became inundated and every cellar on the east side of Mill Street, from T. A. Hutchinson's law office to Clements & Co's hardware store, were filled with several feet of water, causing considerable damage. Clements & Co. estimate their loss at about $1,000. Clifford Hill, clerk, fell in the inundated cellar while trying to salvage hardware articles, but is none the worse for his experience. One family only, that of Mr. and Mrs. Wm. McMullen, with their five-months-old baby, Kenneth, who had recently recovered from an attack of diphtheria, were forced to vacate, after moving their furniture upstairs. The Baylis, Roffey, Norris and Bardoe families remained steadfastly in their homes, staying upstairs until the flood subsided. Horses in the barn at Art Merkley's planing mill were flank-deep in water when led to safety by John A. Allen, an employee. Had a providential cold snap not stopped the heavy rain, the water would have risen to a much higher level. When the water between Mill and Main Streets disappeared late last night [14th], "the flood passed into history."

The Toronto Globe, of January 19, 1929, reported floods on a number of streams in the vicinity of Toronto on the previous day, and includes among them "the Sixteen-Mile Creek, at Oakville". It had been found necessary, in 1928, to make alterations in the Colborne Street bridge, at Oakville, over the Sixteen, and a detour bridge was in use to accommodate the lakeshore traffic. On the 21st, the Globe reported that the detour bridge had been damaged, and that traffic had to be re-routed by the next bridge north of the town. The Mail and Empire, January 21st, adds a few details:

> "The most serious effect of the flood ..... was the weakening of the detour bridge at Oakville by the flood waters and jammed, broken-up ice, to such an extent that it will not be opened to the traffic until Thursday" [January 24], "when repairs will be completed."

Floods on March 14, 1929, were general throughout Western Ontario, being especially severe on the Grand River. There was probably a considerable freshet on the Sixteen-Mile Creek, that did not amount to a flood. The Toronto Globe, on March 15th, states that the Sixteen-Mile Creek furnished no news of flood conditions: "Officials ..... offered 'nothing to report'".

On the 5th of April, 1929, according to the Milton Champion:

> "Milton and district was visited by the worst electric storm of the year. Rain poured down in torrents for a considerable length of time, and the Sixteen-Mile Creek overflowed its banks ..... Streets in low-lying sections in the south ward were completely covered by water as a result of the deluge."

This storm also occasioned considerable disruption of railway services by washouts at many points between Hamilton and Barrie. Washouts between Milton and Georgetown interrupted the service on the Canadian National Railway line for several days.

The next known flood on the Sixteen-Mile Creek occurred on the 24th of March, 1939. The Toronto Globe and Mail of the 25th carried the following dispatch:

> "Milton, March 24. - Sixteen Mile Creek, fed by melting snows, rampaged today and covered Highway 25 on the outskirts of Milton to a depth of three feet. The flooded area is about 150 yards long.
>
> "Workmen, roped together, attempted to break the ice jam at the Woodward Avenue bridge over the creek to relieve pressure on the structure. It is believed danger to the bridge has been temporarily averted.
>
> "Officials said this was the first time in twenty years that ice has imperilled the bridge."

About a month later, on April 18, 1939, there was a second freshet on the same creek. According to the Globe and Mail, "rains swelled the Sixteen Mile Creek at Milton to a new high"; the dispatch refers to the damage done in terms that suggest that the "new high" was an exaggeration, for the damage was said to consist of "loss of valuable top soil" and a further delay in seeding operations. Perhaps the "new high" had reference only to a comparison between the second flood of the year and the first of the same year, the second being the higher; even this seems doubtful.

The Milton Champion, of March 26, 1942, stated that "the Drumquin branch of the Sixteen Mile Creek has been very high this Spring owing to heavy rains". The date of the high water was not given, and no further particulars were supplied.

A flood occurring on March 16, 1948, according to the Toronto Telegram, occasioned "the worst damage in years" at Oakville, where

> "heavy chunks of ice destroyed boathouses which had resisted spring floods for 35 years. The creek, usually 40 feet across, swelled to 500 feet on the flats. The creek appears to be gouging out a new channel for itself."

At Milton, the damage was light; the Champion of the 18th gave an encouraging account of the situation there.

> "It was pleasing to note that in the sudden rise of spring water on Tuesday" /March 16/ "that the new culverts and drains on No. 25 Highway were ample to handle the quick rising spring floods. Many roads were under water Monday afternoon" /15th/, "including a section of the Base Line north of Milton ..... Flood

> "conditions were general on Tuesday both in and out of town. The heavy rain of Monday brought water from every hillside to the valleys, but this section was not seriously damaged by any flood waters."

The spring break-up in 1950 was not reported to have done a great deal of material damage on the streams east and west of Toronto, but was the cause of a number of drowning accidents, and narrow escapes from drowning. The Globe and Mail reported that two Toronto youths had found themselves trapped on a small island in the Sixteen-Mile Creek five miles north of Oakville, in the course of the afternoon of March 25, 1950; it was past 2 o'clock in the morning, March 26th, before they were rescued.

Ten days later, on April 5th, Milton experienced a flood of considerable severity. The following account is taken from the Champion, of April 6, 1950.

> "Most families on lower Mill St. were isolated by flood waters of the Sixteen Mile Creek for a first time since 1926, early Wednesday morning" [April 5th]. "Mr. H. Fay, Bell Telephone operator, and Constable Sam Hall warned merchants along the Main Street of the rapidly rising water.
>
> "First noticed by Constable Hall about 2 a.m., he said the water in the creek was rising very rapidly. He did not become alarmed until an hour later when the muddy water rose a foot. By 4 a.m. it became worse as merchants hastily moved stored merchandise in their store basements to the first floor. ..... Close watch was kept on the mill dam and mill pond retaining wall. All during the night the water level was precariously near the top of the earthen bank, which was thought at one time might break through .....
>
> "By six o'clock yesterday morning" [5th] "all danger had passed when water receded a foot.
>
> "Milton Hardware, Milton Lumber Co., Thos. Dear & Son, and Metcalfe's Garage were flooded. Unestimated damage was caused at those places.
>
> "Older residents recalled the flood of 1926 as more severe than the one today. They said the water rose three feet higher then. All blamed the heavy week-end rains coupled with melting snow as the cause for the sudden gush of water."

An examination of the accounts of the floods at Milton, of March 23, 1926, and March 13, 1928, appears to indicate that the latter was the more severe. Thus it seems likely that, in the recollections of the "older residents", these two floods had become confused; and that the one they recalled was that of

1928, which the Toronto Globe had called, "one of the worst floods in the history of Milton". Accurate measurements of water levels are not available for any of these flood periods; in their absence, it is hardly possible to establish the correctness or incorrectness of such recollections.

On February 15, 1954, the Sixteen-Mile Creek at Milton again overflowed its banks. The Champion, in a caption subjoined to a staff photo, notes that

> "Highway 25 at the southern entrance to the town was covered with water, as was Bronte St. and Ontario St. north of the tracks. Flooded cellars and disrupted sewers kept town workmen busy all day relieving plugged storm sewers."

There can be little doubt that the floods which accompanied Hurricane Hazel, October 15-16, 1954, caused damage far in excess of that caused by any other known flood on the Sixteen-Mile Creek. The Toronto newspapers gave scant attention and small space to reports from the Sixteen, probably because of the focussing of public interest on the spectacular damage and loss of life occasioned by the floods on the Humber and the Don. The following excerpts are all that have been found in Toronto papers of October 16th, 1954, in reference to the Sixteen.

> TELEGRAM: "In Oakville, heavy flooding forced scores of residents to flee their homes."
>
> "Trafalgar Township, 3rd, 7th, and 8th lines, under water in places, but passable."
>
> STAR: "Sixteen Mile Creek ..... overflowed."
>
> "At Oakville, where Sixteen Mile Creek went on the rampage, two large power cruisers and more than 20 outboard boats were swept out to sea and wrecked. Their total value was estimated at $60,000."
>
> "In the Oakville area, only one bridge, a small culvert bridge on the Upper Middle road, was washed out."

A dispatch dated at Oakville, Oct. 17th, published in the Globe and Mail of the 18th, gave the estimated storm damage at Oakville "at close to $500,000". A considerable proportion of this damage was the result of the winds and the waves on Lake Ontario; it is impossible to distinguish what part of it resulted from the flooded condition of the creek, though it is almost certain that the swollen creek played a considerable part in driving valuable boats and other property from the harbour out into the lake where they were lost.

> "At least 26 craft were either sunk or damaged. Owners watched helplessly while lashing waves ripped boats from their moorings, pounded them against dock installations, and sucked them out to sea .....
>
> "The $35,000 luxury cruiser, Jomar, snapped its moorings and was found washed up on the beach six miles from its berth. The Harbor Master, a 60-foot construction tug, was last seen being swept out to sea with its lights blazing."

Two weekly newspapers, the Oakville-Trafalgar Journal and the Oakville Record-Star, are both published on Thursdays; accordingly, in the issue next following the hurricane, that of October 21, 1954, both these papers were able to look back on the disaster after an interval of nearly a week, and to provide their readers with a review of the whole experience. From their accounts the following summary has been compiled.

At the height of the storm, the rainfall amounted to seven inches in a 24-hour period, an unprecedented downpour. The Sixteen-Mile Creek quickly became a raging torrent; the Record-Star states that the water level rose eight feet in as many minutes. Surface water flooded hundreds of cellars and basements; one estimate mentioned 800 to 1,000 homes flooded "in the district", but this number probably included many that were outside the Sixteen-Mile Watershed. It was not possible to form an estimate of the damage done by such flooding; one business enterprise suffered a loss of $20,000, another $5,000. At an early stage of the storm, five motor cars became stalled in the Dundas Street subway; later these were submerged under 18 feet of water. All roads between Oakville and the Queen Elizabeth Way were washed out or were otherwise impassable.

In Trafalgar Township, north of the Queen Elizabeth Way, there were numerous washouts on roads and railways.

The Record-Star stated that four bridges in Trafalgar Township had been destroyed or damaged, that would cost $30,000 to replace. According to the Journal, the state of the bridges was as follows:

> "Bridges out of commission are the following: Second Line bridge completely washed out in the storm; a smaller one also on the Second Line was knocked out of commission; the approaches to the bridges on the Ninth Line and the Upper Middle Road are gone, the bridges unusable.
>
> "The Base Line bridge between the Sixth and Seventh Line was washed out by flooding, rampaging water. Finally the Sixth Line bridge above the Base Line was destroyed."

In Oakville, and throughout the greater part of Trafalgar Township, there was, from Friday evening until Saturday morning, an almost complete failure of electric power and of telephone services. The police services were able to maintain communication by means of two-way radio.

Damage to boats in the harbour at Oakville was not listed as a separate item: "The hurricane destroyed or swept out into the lake some fifty boats in Oakville and Bronte harbours." "Ships lost in both Oakville and Bronte was (sic) valued at more than $125,000."

This vast and widespread destruction was conservatively estimated at a total in excess of $500,000 in Oakville and Trafalgar Township. There was no loss of life. "Despite all the havoc ..... Oakville got off lightly compared to other communities."

The damage sustained at Milton was largely the result of the flooding of the low-lying central part of the town, which included several important business enterprises. According to the Champion, of October 21, 1954:

> "Flooding on Ontario Street was unbelievable unless witnessed. From the vantage point of the railway crossing at midnight" [October 15th] "the eye could see little but acres under water.

"Reaching over to the Model Knitting Mills on the west, the water filled the eastern field through which the muddy creek raced to the full railway culvert normally eight to ten feet above the level of the quiet creek .....

"Cellars in residences all over town were flooded ..... The sewerage system was completely flooded.

"The block bounded by Commercial, Foster, Mary and Charles Streets was still under water Saturday morning .....

"In all about seven inches of rain drenched the area in the 24 hour torrential downpour that swelled creeks and swamps to the highest level ever recorded in modern times."

"Torrential rain", on March 6, 1956, combined with melting snows at the headwaters of local streams to send flood waters through the town of Milton. Between 5:30 p.m. and midnight, on that date, the creek rose five feet. Bronte Street and Ontario Street were under water. At Woodward Avenue, the water rose to within six inches of the top of the culvert.

The Champion, March 8, 1956, stated:

"At the Robert Street pumping station, an auxiliary pump kept that unit from becoming flooded, while the Fulton Street station was flooded as the creek rose and covered a man-hole that bubbled over with storm filled water on the creek bank ..... The water dropped suddenly between midnight and 1 a.m., presumably when the ice gave way south of the disposal plant .....

"Operations were back to normal and all roads cleared by morning, since rain had slowed up to a drizzle and the weather turned colder."

On February 25, 1957, the Sixteen-Mile Creek at Milton was once again "the swollen waters", filled with "fences and fallen trees, ice floes and heavy currents". No property damage was reported, apart from the broken fences; but a seven-year-old boy was drowned in the muddy waters of the creek. "At six o'clock next morning" [February 26th], "the creek was still filled with floating chunks of ice."

This chapter has discussed the occurrence of twenty-six periods of high water on the Sixteen-Mile Creek, recorded between 1797 and 1957, a spread of 160 years. Only seven of these recorded floods took place before 1900; nearly three times as many have been recorded in the ensuing 57 years. In the 36 years, 1922 to 1957 (inclusive), the number of floods is eighteen, an average of one every second year. If these figures represented the actual rate of incidence of floods through the periods concerned, they would indicate that the recent rate is more than seven times the rate in the first century under discussion. But the early reports of floods are almost always limited to observations made on only a part of the watershed; and they hint strongly of the possibility of still further omissions, when, through long periods of years, no floods at all are mentioned.

A similar observation has to be made respecting the reporting of estimates of flood damage. Except in the case of Hurricane Hazel, there is almost never an attempt to assess all the damage done; and yet, in many cases, the reports indicate that costly damage was sustained. Seldom is there any reference to the intangible but very real losses occasioned by disruption of business, personal distress, anxiety, and exposure, impairment of health, and loss of life, losses on which no money value can be set. There can be little doubt that some share of these intangible losses must be charged to the floods that, during the first century of the reckoning, were not even recorded. To present a succinct and tabulated account of flood losses caused on the Sixteen-Mile Creek over a period of 160 years is impossible. This, however, is not a reason for supposing that they did not occur, or that they were not a considerable burden to the dwellers on the banks of the creek. Nor is it a reason for neglecting to use every means that can be devised to control the waters of the creek and to prevent its recurrent flooding.

N.B. Courtesy Milton Champion (all three photos)

View looking south-east from corner of Charles and Pine Streets showing flooding caused by backwater from sewers.

West Branch at Oak Street in Milton. This picture and the one above were taken the day after Hurricane Hazel.

High Flow in ditch on east side of Highway No. 25 at entrance of Halton County Centennial [illegible]

CHECK LIST OF KNOWN FLOODS

1797 - December 14. Letter, Joseph Brant to D. W. Smith, Dec. 15, 1797, written from Burlington Bay: refers to "the rise of the waters" in the streams between Burlington Bay and York (Toronto), a hindrance to travel.

1837 - December 8. C. Lindsey, "Life and Times of Wm. Lyon Mackenzie", 1863, Vol. II: page 106, quoting Mackenzie: "the Sixteen-Mile Creek ..... swells up at times into a rapid river; it was now swollen by the November rains."

1850 - April 4-5, Christian Guardian, April 10, 1850, quoting the Hamilton Gazette: "heaviest freshet ever known in that quarter"; Lake Shore Road at Oakville, and "several other bridges" carried away.

1857 - February 16. Toronto Globe, Feb. 21, 1857. At Oakville: shipyards flooded, bridge threatened.

1871 - March 8. Toronto Globe, Mar. 11, 1871. At Dundas Street: water three feet over the roadway and across the flats.

1878 - September 13. Toronto Globe, Sept. 14, 1878; Toronto Mail, same date: damage at Oakville to bridges, roads, and boats.

1890 - June 5. Oakville Star, June 8, 1890. Washout near Oakville.

1915 - August 3. Toronto Globe, August 4, 1915. At Oakville: the water in the Sixteen "higher than it was in the spring".

1922 - March 7. Toronto Globe, Mar. 8, 1922. At Oakville: the creek cleared of ice; no damage.

1925 - March 19. Toronto Globe, Mar. 20, 1925; Toronto Mail & Empire, same date: at Oakville, a temporary detour bridge carried away.

1926 - March 23. Toronto Mail & Empire, March 24, 1926. At Milton: "a big flood", part of the town inundated, many cellars flooded.

1928 - March 13. Toronto Globe, March 14, 1928; Toronto Mail & Empire, March 14 and 15, 1928. At Milton: the stone arch bridge blocked with ice: "worst flood in 60 years".

1929 - January 18. Toronto Globe, Jan. 19 and 21, 1929; Toronto Mail & Empire, Jan. 21, 1929. At Oakville, temporary highway bridge damaged.

1929 - March 14. Toronto Globe, Mar. 15, 1929. High water, but no flood.

1929 - April 6 & 7. Toronto Mail & Empire, April 6 and 8, 1929. At Milton, C.N.R. tracks under water.

Check List of Known Floods

1934 - March 3, Toronto Globe, Mar. 5, 1934. Break-up reported, but no indication of actual flooding.

1939 - March 24. Toronto Globe, Mar. 25, 1939. At Milton: water over the roads; a bridge threatened.

1939 - April 18. Toronto Globe, April 19, 1939. Creek swelled "to a new high" at Milton, but no damage reported.

1942 - March 17. Canadian National Railways report, 1950. A small washout, one mile north of Milton. At about the same time, high water reported on the Drumquin branch of the Sixteen. (Milton Champion, Mar. 26, 1942).

1948 - March 16. Toronto Telegram, Mar. 17, 1948; Milton Champion, Mar. 18, 1948. At Oakville, much damage to boathouses; the creek overflowed the flats. At Milton, "flood conditions were general on Tuesday (16th) both in and out of town".

1950 - March 25. Toronto Globe, Mar. 27, 1950. Two boys trapped on an island five miles north of Oakville.

1950 - April 5. Milton Champion, Apr. 6, 1950. At Milton, a sudden flood, streets flooded, homes isolated, between 2 a.m. and 6 a.m., Wednesday, April 5th. Considerable damage to commercial properties.

1954 - February 15. Milton Champion, Feb. 18, 1954. At Milton, streets and cellars flooded, sewers plugged; water over Highway 25.

1954 - October 15. (Hurricane Hazel) Toronto Telegram, Oct. 16, 1954; Toronto Star, Oct. 16, 1954; Toronto Globe and Mail, Oct. 18, 1954; Acton Free Press, Oct. 21, 1954; Milton Champion, Oct. 21, 1954. Several bridges destroyed or damaged; washouts on roads and railways; stores flooded; extensive property damage.

1956 - March 6. Acton Free Press, Mar. 8, 1956; Milton Champion, Mar. 8, 1956. At Milton, the creek rose about 5 feet.

1957 - February 26. Toronto Globe and Mail, Feb. 27, 1957; Milton Champion, Feb. 28, 1957. At Milton, a boy drowned in the swollen Sixteen-Mile Creek.

CHAPTER 3

HYDROLOGY

Hydrology encompasses the behaviour of water as it occurs in the atmosphere, on the surface of the ground, and underground. The movement of water from the atmosphere, to the earth's surface, and back again is known as the "Hydrologic Cycle". There are many factors which influence this movement, and particularly that portion between the incidence of precipitation over the land and the subsequent discharge through stream channels or the direct return to the atmosphere by evaporation and transpiration.

The drainage area of the Sixteen-Mile Creek is subject to the constant phases of this hydrologic cycle, and not unlike other areas, problems exist which are peculiar to the prevailing climate and physical characteristics of the area.

1. Precipitation and Streamflow

(a) Precipitation as used in meteorology includes all the moisture that reaches the earth's surface, whether in the form of rain, snow, sleet or hail. The most significant of these are rain and snow.

The Sixteen-Mile Creek area drains into Lake Ontario about midway between Toronto and Hamilton. There is one meteorological station within the watershed at Hornby and others at Guelph, Morriston and Clarkson around the perimeter of the watershed, with continuous periods of records varying up to 115 years. From these stations it has been determined that the average annual total precipitation over the watershed area is approximately 31.0 inches, of which 5.8 inches* are snow, and the annual mean temperature of the area is approximately 45 degrees.

In some areas sufficient reliable data are available for generalized estimates of the precipitation

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* This is the approximate water equivalent of 58 inches of snow.

factor, but on the whole, additional self-recording precipitation gauges are required for a more accurate evaluation of the precipitation-run-off relationship.

On this watershed there are no self-recording instruments.

(b) Streamflow, or run-off consists of surface flow and ground water which is constantly entering the river channel along its course, and is broadly the excess of precipitation over evapo-transpiration and deep seepage. Surface flow is that portion of rainfall, melted snow and ice, or both, which reaches the stream channels directly by flowing over the ground surface.

Ground water flow is going on continuously and is responsible for maintaining the flow in streams during periods of drought. This is usually referred to as base flow.

The factors affecting run-off are numerous and varied, and appear in so many combinations, that it is difficult to classify them in any order relative to their direct effect on run-off. Where quantitative results are required, the best means is to measure the run-off directly by the use of hydrometric gauges at strategic locations. Here again the use of self-recording instruments is desirable.

Streamflow, or run-off, is the resultant of all the watershed characteristics, and while it indicates the combined effect of the various features on the precipitation that falls on an area, it does not indicate the effect of any single factor.

Measuring and timing of the surface flow, or direct run-off, are of great concern, since accurate data concerning them make possible a more accurate solution of the particular problems related to flood control and water supply.

Measurements of streamflow have been recorded on Sixteen-Mile Creek at two locations; one on the West Branch at Milton and one on the East Branch near Omagh, for a period of less than one year. The Milton site is the only practical one on the West Branch, but unfortunately is affected by the operation of the mill immediately above. A recording gauge will be required at this site before the records can be properly evaluated.

2. Maximum Flows

(a) Spring Freshets

Where river control works, particularly dams, are concerned, it is not the ordinary or average flows, but the unusual or exceptional ones, which have occurred in the past or may reasonably be expected to occur in the future, that are significant.

These discharges provide the basic design criteria of all major water regulating structures, whose failure could result in loss of life and large-scale destruction of property. Therefore it is necessary, in the analysis of all available data, to forecast maximum probable conditions in direct relation to the human and economic factors involved.

Unfortunately, the streamflow records available for this area extend over a period of less than a year, and the gauge located at Milton has not supplied sufficient reliable data to date, to secure accurate discharges. The gauge at Omagh has been more successful and discharges are available from December 1956. These data are shown in Figure 4 and Table 3.

From the observations available the maximum mean daily flow recorded at Omagh was 1,340 c.f.s.* for January 1956. This is equivalent to 17 c.s.m.† As this is a mean flow, it is likely that the actual peak was in the order of 2,080 c.f.s. or 27 c.s.m. as determined by Fuller's formula relating mean daily to peak flow.

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* Cubic feet per second
† Cubic feet per second per square mile

TABLE. 3

MONTH	MILTON 1956-57			OMAGH 1956-57		
	MAX.	MIN.	MEAN.	MAX.	MIN.	MEAN.
OCTOBER	–	–	–	–	–	–
NOVEMBER	–	–	–	–	–	–
DECEMBER	–	–	–	247	42	88
JANUARY	–	–	–	1340	24	113
FEBRUARY	201	8	68	1280	49	219
MARCH	158	59	105	768	27	89
APRIL	390	34	128	1290	19	117
MAY	91	58	70	487	14	55
JUNE	66	43	58	305	6	29
JULY	49	6	26	46	–	13
AUGUST	27	4	11	15	2	5
SEPTEMBER	41	4	9	43	7	13

FIG. 4

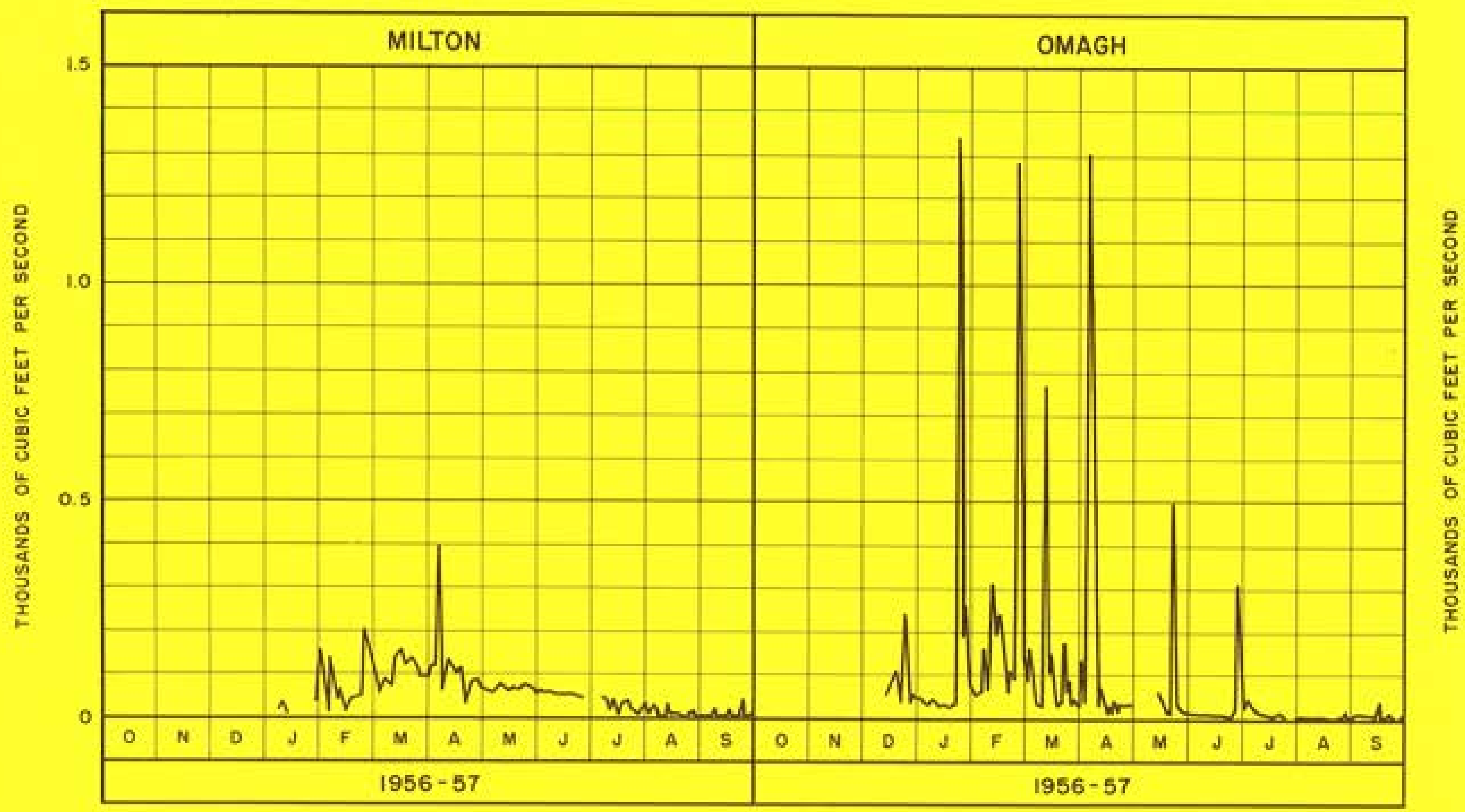

TABLE & HYDROGRAPHS

MAXIMUM & MINIMUM MEAN DAILY & MEAN MONTHLY FLOWS IN CUBIC FEET PER SECOND

FOR GAUGE AT MILTON — DRAINAGE AREA 33.0 SQ. MILES
FOR GAUGE AT OMAGH — DRAINAGE AREA 77.0 SQ. MILES

As this discharge occurred during the month of January it is probable that a fair proportion of the run-off was the result of snow-melt.

The spring break-up discharge recorded on April 5, 1957, was 1,290 c.f.s. maximum mean daily, with a probable peak of 2,000 c.f.s. or 26 c.s.m. The maximum discharge recorded for the gauge at Milton was 390 c.f.s. and occurred on April 7, 1957. Peak flow was probably near 660 c.f.s. or 20 c.s.m.

These are the only discharge figures available and, although it is known that flows of much greater magnitude have occurred in the past, it is difficult to evaluate these past flows in actual terms of cubic feet per second.

There are numerous references in newspapers, diaries and eye-witness accounts of flooding and flood damage in this area, and particularly at Milton, dating back to 1857. These accounts indicate that the area has been subjected to flooding in greater or lesser degree each year.

These flood occurrences are not restricted to the spring freshet periods alone, although these seem to have caused more frequent and serious damage, a great deal of which was due to ice jams at vulnerable locations. There are also many references to flooding due to heavy rains during periods other than spring.

The actual references are dealt with in more detail in another section of this report. Suffice to say here, that a number of local areas have been subject to flooding and flood damage in the past, and will continue to do so in the future, if steps are not taken to prevent it.

(b) Other than Spring Freshets

In recent years it has become apparent that run-off from intense rainfalls without the influence of melting snow and ice, as usually occurs in the spring freshet periods, can produce flows of greater magnitude in terms of peak stages than the usual spring flows.

The most obvious example of this is the hurricane type storm of October 1954 which caused such widespread damage and loss of life in parts of Southern Ontario. Since that time a new concept of the rainfall-run-off producing storm type has been gained. With the contribution of hydrometeorology, a more rational approach to the problems of flooding and flood control may be achieved, in the analysis and application of the run-off producing potential of the various storm types.

3. Unit Hydrographs

Where reasonably accurate rainfall and streamflow observations are available, the use of the unit hydrograph method is most adaptable to the problem of design storm flow.

Stream flow records for the gauges in the Sixteen-Mile Creek Watershed are of less than a year's duration and observations are made just once a day, except on occasions of high flows when the observers have standing instructions to take readings at lesser intervals.

For determination of actual duration of rainfall period it was necessary to rely on records of the self-recording station at Guelph.

Observations of streamflow have not been made for lesser time intervals than once a day as yet, and the problem of determining the peak unit ordinates must of necessity be resolved through the use of empirical formulae, or any other means that may appear reasonable.

From the records available for the gauge at Omagh and using the method of Langbien*, where the ratio of peak flows to maximum daily flow are shown as functions of the ratios of mean flow on the maximum day to the mean flows on the day immediately preceding and the day following the maximum day, the resulting ratio for the Omagh area is 1.97.

This is an average ratio based on three different flow periods including spring and summer periods.

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* Langbien, W.B., Peak Discharges from Daily Records, U.S. Geol. Survey Water Resources Bull., August 10, 1944.

The generalized charts from which the ratio was obtained are based on data from drainage areas in the United States, but the units used and the basic reasoning involved should make this applicable to many places outside of the areas from which the data was procured. There is no doubt that more reliable results could be obtained by developing similar charts from data from the areas under consideration, but in this case there is practically no data available and it is felt that the ratio as obtained for Omagh area, though it may appear large, will have to serve the purpose for the present until more refined data are available.

The unit peak ordinates obtained for the area above the gauge at Omagh for a rainfall of six (6) hours duration is 2,000 c.f.s., or 26 c.s.m.* and for a rainfall duration of twenty-two hours is 1,640 c.f.s., or 21 c.s.m.

With these results and by the use of extreme extrapolation, a unit peak ordinate of 1,340 c.f.s., or 18 c.s.m. was arbitrarily determined for a storm rainfall of forty-eight (48) hours duration.

These figures are not final and will be subject to adjustment when more and better data becomes available, but for the present will be used as a means of determining design flow criteria.

4. Design Storm Flow

The "design flood" flow is generally referred to as the hydrograph, or peak discharge, that is finally adopted as the basis for the design of any particular structure. This flow is dependent on a consideration of the flood characteristics of the particular area, and on economic and other pertinent practical considerations. Usually it is practical to accept a limited degree of risk in the selection of a design flood flow, except for cases where the maximum degree of protection is desirable because of the possible loss of life, or excessive damage to valuable property, should the structure fail.

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* Cubic feet per second per square mile.

Flooding on the Sixteen-Mile Creek area has been frequent over the years, and in many cases caused some damage. The extent and occurrences have been outlined in Chapter 2. Actual reports indicate that excessive flows usually occur during late winter and early spring seasons. However, it is considered that a storm such as occurred over Southern Ontario during October 1954, if concentrated on the area of Sixteen-Mile Creek, could produce run-off in excess of anything previously experienced.

(a) Hurricane Hazel

The storm known as "Hazel" occurred in October of 1954 and precipitated excessive amounts of rain over a wide area, which included the Sixteen-Mile Creek.

The amount of rain and its estimated distribution is shown in Tables 4 and 5.

It is evident from these tables that fairly large amounts of rain were experienced over the entire area of the watershed. Ground conditions were, as in most of Southern Ontario, partly saturated due to intermittent rainfall occurring during the two weeks preceding the storm.

Usually, with rainfall amounts as recorded, and with surface conditions as they were, considerable flooding would be expected, but from all reports the extent of flood damage was not excessive, with the possible exception of the area around the town of Milton.

Other areas experienced just as high stages and as great an extent of flooding, but as these areas are not inhabited, nor are there many structures within these areas, naturally there are no reports of damage.

However, it is known that the flow in all areas was excessive, but unfortunately there were no hydrometric gauges in the area at the time, and it is difficult to say whether this run-off period was the maximum experienced or not.

From the figures derived from the unitgraph determination for the gauged area at Omagh, a hydrograph was computed for the Hazel storm at Omagh.

TABLE 4

Total rainfall over the Sixteen-Mile Creek area during Hurricane Hazel, 1954

Station	Depth in Inches		
	October 14	October 15	Total 48 hrs.
Hornby	1.38	5.42	6.80
Clarkson	0.51	4.90	5.41
Morriston	1.21	3.32	4.53
Georgetown	1.45	5.02	6.47
Guelph	2.18	3.77	5.95

TABLE 5

Distribution of total rainfall over Sixteen-Mile Creek area during Hurricane Hazel, 1954

Area	Average depth in inches for 48-hour duration
West Branch above Milton	5.94
East Branch above Omagh	6.3
Total Area of Watershed	5.83

The average rainfall depth over the area of 76 square miles was found to be 6.3 inches. Using a run-off factor of 60 per cent the resulting run-off was 3.78 inches. With this volume of run-off and assuming a distribution similar to that indicated by the recording rain gauge at Guelph, the resulting peak flow was determined as approximately 5,906 c.f.s., or 76 c.s.m. for the area above Omagh.

It should be noted here that the rainfall figures used were those actually recorded by the official rain gauge observers. Unfortunately, the few months of stream flow records available for the Milton area are not sufficient to attempt to deduce any definite data relating to the Hazel storm.

However, in consideration of the area size, the general topography and physiographic features, land use, etc., of the area, in relation to the area above the Omagh gauge, it is considered that the rate of run-off would be slightly lower. On the basis of such a comparison the run-off from the area above Milton was assumed to be 20 per cent less than that for the East Branch area above Omagh which would indicate a peak rate of flow at Milton for the Hazel storm of 76 x .80 = 61 c.s.m. or a discharge of 61 x 36 = 2,190 c.f.s. This, of course, assumes further that the rainfall amounts, intensities, and distribution were approximately the same.

It is estimated that the flow at the time of Hazel reached a peak of approximately 8,900 c.f.s. at the confluence of the East and West Branches and approximately 9,300 c.f.s. at the mouth of Sixteen-Mile Creek in Oakville.

(b) "Hazel" Centred over the Area

Although the most frequent flooding and flood damage has occurred in the spring freshet period in most areas of Southern Ontario in the past, it has become apparent, and particularly so since the advent of the Hazel storm, that flooding resulting from hurricanes and thunderstorms can be more disastrous.

It is also conclusively agreed that the Hazel storm which caused such widespread destruction over the area of the nearby Humber River, could occur over the Sixteen-Mile Creek area.

To estimate this probable occurrence and effect, the total storm isohyetal map was superimposed over the area to produce the maximum rainfall in terms of depth in inches on the area.

This isohyetal map was obtained by making use of all available records which include the official observations, plus the addition of reliable unofficial observations obtained from areas where no official observation stations are maintained.

The average depths in inches on the areas as determined from the superimposed isohyetal map, were as follows:

Area	Depth on Area - Inches
Sixteen-Mile Cr. (Total area watershed)	8.6
West Branch above Milton gauge	8.71
East Branch above Omagh gauge	9.06

One of the most significant factors in the application of the unitgraph technique is the determination of a reasonable run-off coefficient. This depends on a variety of factors and combinations thereof. It is most uncertain and varies widely with the degree of perviousness of the area, season of the year, general climatic conditions, antecedent precipitation, rainfall intensity, etc.

There are not sufficient data available to arrive at any conclusive factor but, from that which is available, the highest percentage run-off from rainfall only, was approximately 55 per cent. This occurred during May, 1957 and could be considered as fairly high.

There have been other occasions when the run-off factor has been greater, but these occurred during the spring break-up period, where ice and snow, which are difficult to evaluate, were probably a contributing factor.

The next highest percentage run-off factor for rainfall alone was recorded in June, 1957, and was approximately 11 per cent.

From a study of the available data it can be seen that the run-off factor can, and does, vary widely due to the wide variation in the volume, intensity and distribution of the rainfall in each case, as well as the antecedent surface and sub-surface conditions, and other characteristics of the drainage area.

From recent studies of storm run-off behaviour, and in the light of recent experience of storms of high run-off potential, it is evident that excessive run-off potential may exist in any season of the year.

The maximum run-off experienced during the short period of record of the gauge at Omagh was approximately 55 per cent and resulted from a storm of about 7 hours duration with a total rainfall over the area, of 1.23 inches.

This percentage of run-off appears high, but it is due in part to the season of the year, which was in May, when soil conditions are usually conductive to a high rate of run-off and also to the duration of the rainfall which was short.

The only other reasonably accurate run-off factor available is that of June 1957, when rainfall of 2.74 inches on the area over a period of 22 hours produced run-off of approximately 11 per cent. This would appear low when compared to the 55 per cent factor for the May, 1957, rainfall. In general, conditions are less conducive to high run-off in June than in May, and also the rainfall in this case was less intense, being spread over a period of some 22 hours. These two instances alone, help to point out the variation in the run-off factor due to the varying influences mentioned previously.

There was intermittent rainfall during the two weeks prior to Hazel, which left the whole area of the Humber Watershed and adjacent areas, in a near-saturated condition.

If such a state were assumed for the Sixteen-Mile Creek area, it is reasonable to assume that the run-off factor for a storm of the magnitude of Hazel, even if distributed over a period of 48 hours, would exceed that of the May 1957 rainfall of 1.23 inches in seven hours. It is estimated that the run-off for a storm of this magnitude on this area, would amount to at least 70 per cent of the total rainfall.

By applying the results obtained from the unitgraph computations for the Omagh gauge area the peak for Hazel (which precipitated 9.06 inches in 48 hours) centred on the area would be 8,500 c.f.s. or 112 c.s.m. at Omagh gauge.

For the area above the Milton gauge and assuming as before that the rate of run-off would be approximately 20 per cent less, the resulting peak flow would be 3,230 c.f.s. or 90 c.s.m.

(c) Probable Maximum Storm

From a depth-duration-area analysis of hurricane-type storms* it was determined that a total rainfall of 16.85 inches in 48 hours could occur over an area of 76 square miles which is the extent of area above the Omagh gauge. Due to the greater rainfall amount and intensity for the Hazel storm centred on the area, the run-off factor would be in the order of 80 per cent.

Using the 48-hour interpolated unitgraph peak of 1,340 c.f.s. the resulting peak flow at Omagh would be .80 x 16.85 x 1340 = 18,100 c.f.s. = 238 c.s.m.

Again assuming the rate of run-off for the area above Milton as being 20 per cent less than Omagh, and taking

* Preliminary estimates of Probable Maximum Precipitation over Southern Ontario by J.P. Bruce, Cons. Br., Dept. of Planning and Development.

into consideration the greater rainfall on the smaller drainage area, the resulting peak flow for the Probable Maximum 48-hour storm would be 7,050 c.f.s. or 196 c.s.m.

In addition to the hurricane-type storms, thunderstorms are often accompanied by intense rainfall, and while their duration and extent are generally less than the hurricane-type storms, they often produce higher rates of run-off, particularly from smaller drainage areas of 500 square miles or less.

From the data available it was determined that the storm which would likely produce the most critical run-off conditions for an area the size of 76 square miles, i.e. the area above the gauge at Omagh, would be the 6-hour thunderstorm which could precipitate a total of 14.6 inches of rain.

This probable maximum thunderstorm was derived from a study of 6-hour thunderstorms which have occurred in the United States and which are considered as transposable to this area.

Because of the physical characteristics of the area and the intensity of such a rainfall, and the estimated value of run-off before-mentioned, it is assumed that the run-off for this type of storm would be about 85 per cent.

Using this factor and the determined 6-hour unit-graph peak of 2,000 c.f.s. and rainfall of 14.6 inches, the resulting peak flow at Omagh gauge would be 24,800 c.f.s. or 326 c.s.m.

For the area above Milton and assuming as before that the rate of run-off would be 20 per cent less, and taking into consideration the rainfall amount in proportion to the size of area, the resulting peak flow at Milton would be 9,700 c.f.s. or 260 c.s.m.

The foregoing peak flows and run-off rates should be treated with discretion because of the need for data of quality and quantity, and most of the deductions have been formed by arbitrary means, based on experience and expedience. However, it is felt that the figures shown will suffice for the present purposes for which they will be used.

5. Low Flows

The available flow records for the gauges at Omagh and Milton as shown in Table 3, indicate that the acute periods of low flow occur in July, August and September. (This is confirmed by the longer and more reliable records of nearby streams.)

At Omagh, nil flow was recorded on July 28 and 29, 1957.

At Milton, the minimum flow recorded was 4 c.f.s. on two occasions, August 22 and September 11, 1957.

In general it appears that the area above the Omagh gauge would experience consistently lower flows than the area above Milton. This is also consistent with the fact that the Omagh area appears to have a higher run-off rate during storm and spring freshet periods, whereas the Milton area appears to have a higher retentive capacity which tends to reduce the high flood flows and increase the river flow during the summer period.

This again is based on the few months of stream-flow observations available for the area. However, a study of the data and the area in general, tends to confirm the foregoing statements with reference to low flow.

It should be noted here, that the figures shown are for the gauge locations only, and it is quite probable that many of the smaller tributaries would dry up completely for periods during seasons when drought and near drought conditions exist, even though there may be some flow in the main stream channels which have much larger areas to draw from.

The flow of 4 c.f.s. shown for the Milton area is equivalent to 2,155,500 Imperial gals. per day.

This may appear at first glance to be a considerable amount of water and perhaps adequate for normal use in this area. However, this will depend on distribution, the present requirements, and particularly the future needs of the area in question.

CHAPTER 4

WATER PROBLEMS

1. Introduction

The Sixteen-Mile Creek Conservation Authority is located in an area which is bound to experience a considerable degree of urbanization during the next decade. The watershed is strategically located between Toronto and Hamilton with three major highways (No. 2, No. 5 and the Queen Elizabeth) passing across the southern section, and the new four-lane Highway No. 401 now being constructed across the watershed just one mile north of Milton. Highway No. 25 passes lengthwise through almost all the watershed. It is also well serviced by main lines of both the Canadian National and the Canadian Pacific railroads.

In 1958, the population of the Authority was almost 30,000. From population growth curves it is estimated that if the present trend continues, the population of Trafalgar Township will double within four years. This increase will be mainly due to industrial development in the area south of No. 5 highway. Trafalgar Township zoning maps show two large areas just south of the new Highway 401 and east of Milton as zoned for industrial development. An area east of Oakville and south of the Queen Elizabeth Highway, and another west of Oakville and on both the north and south sides of the same highway, have also been similarly zoned.

With the development of these areas, problems concerning the quantity and quality of the available water supplies will become more pronounced. The following three sections will be devoted to discussing these problems and presenting possible methods by which they may be overcome.

2. Pollution

(a) General Effects

Pollution effects are of two kinds: those affecting public health and those which are not a hazard to human health but which are offensive to people or harmful to stock or to fish and other aquatic organisms. The first type can usually be measured by the concentration of an indicator organism (the bacillus E. coli.). The second type is measured in terms of poisonous compounds which may be introduced into the river and in terms of oxygen depletion and the oxygen demand (B.O.D.)*. Silting has additional effects. Shifting sand bottoms are virtual aquatic deserts.† Colloidal clay prevents light penetration and retards the growth of aquatic organisms, making the water unsightly and undesirable for swimming. Silt from land of good fertility may occasionally fertilize the water, producing an unsightly growth of algae. More often silt covers the normal bottom fauna and destroys the stream for fish.

The most common type of pollution is that caused by the discharge of wastes containing dissolved or suspended organic compounds. Domestic sewage and most industrial wastes are predominantly of this type. Certain bacteria and other organisms cause the decomposition of these organic compounds by consuming the organic solids and combining them with oxygen. The resulting shortage of oxygen in the water is one of the chief symptoms of a polluted stream.

Aerobic decomposition of organic compounds in water, (i.e. in the presence of ample dissolved oxygen)

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* The B.O.D., of Biochemical Oxygen Demand, is a measure of the oxygen that will be demanded by the material in the course of its complete oxidation biochemically. It is determined wholly by the availability of the material as a bacterial food and by the amount of oxygen utilized by the bacteria during its oxidation.

† Tarswell, C.M. and Gaufin, A.R., "Some Important Biological Effects of Pollution Often Disregarded in Stream Surveys". Proceedings of the 8th Industrial Waste Conference, 1953, Purdue University, U.S.A.

finally results in the formation of compounds such as carbon dioxide, water, nitrates and sulphates.* Being comparatively stable, they exert no further demand for oxygen, produce no foul odours, and do not cause septic conditions in the water. They do, however, fertilize the water and stimulate the growth of plant and animal life in the stream. Dense growths of green algae are often a sign that the stream is recovering from organic pollution.

In the absence of dissolved oxygen in the water "anaerobic decomposition" of organic wastes takes place. Oxygen is then consumed from the organic materials and compounds remain such as methane gas, hydrogen sulphide gas, ammonia and others having little or no oxygen. Many of these products have highly disagreeable odours typical of polluted waters. Sometimes the decomposition products are lethal to fish and other aquatic organisms, but more often these die from lack of oxygen.

Since the amount of oxygen water can dissolve is so small†, sewage treatment facilities should be designed to turn out an effluent that is already decomposed biologically, so that the stream's oxygen reserves will not be called upon to an appreciable degree for this purpose.

Apart from bacterial pollution the types and abundance of both plant and animal species in a stream provide an excellent measure of the condition of the water. At the one extreme severely-polluted waters may contain extensive growths of gray-brown fungi, vast numbers of scavenger types of bottom-feeding organisms, a great bacterial population (or a sterile condition), and little or no dissolved oxygen. At the other end of the scale clean waters will support green

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* Proper treatment of sewage wastes should include two phases, primary treatment (mechanical removal of most solids) and secondary treatment (digestion of the remainder by aerobic decomposition, as here described).

† Less than 20 parts of oxygen per million parts of water by weight.

algae, insect larvae, snails, clams, game fish and other organisms requiring abundant oxygen.

The time and distance required for recovery of a polluted stream depend on many factors, such as the temperature and volume of flow of the water, the type of pollutant at the polluting effluent, the type of stream bed and types of obstructions such as dams.

A full report on pollution on the Sixteen-Mile Creek would require that the following work be carried out:

(1) Bacterial plate counts at all points suspected of bacterial pollution, and at regular space intervals in the courses of the various streams elsewhere.

(2) Measurement of the oxygen content in bacterially polluted sections and where industrial wastes enter the streams, with additional measurements of the Biochemical Oxygen Demand below sources of industrial and bacterial pollution in order to estimate the rate of recovery of the streams. In practice the distribution of algae, fungi and certain species of insects can give an excellent indication of the conditions in many cases.

(3) Measurement of the amount of silting and turbidity, and their effects on the life of the streams.

(4) Assessment of the present treatment plants, by relating the estimated minimum stream flow to the maximum flow of the effluent (provided that these can occur at the same time).

(5) The assessment of the present pollution sources, apart from municipal treatment plants.

(b) <u>Conditions on Sixteen-Mile Creek</u>

The conditions concerning pollution of the Sixteen-Mile Creek can be best described by summarizing the status as of June 1957, when a biological survey of the river was made, and the present status, because two major alterations have taken place since the first survey. One of these is the use of a new water supply to the town of Milton which is expected to increase the present supply greatly. The other is the construction of an addition to the present treatment plant which will provide 800,000 gallons additional capacity. So far as the effect on the biology of the stream is concerned the chief polluted sections are shown on the map "Biological Conditions of Streams" in the Wildlife section of this report. Bacterial pollution which affects human health was not examined during the biological survey.

As of June 1957, the most serious case of pollution occurred in Milton. A manufacturing plant discharges effluent into a settling basin alongside the stream, but the dike separating the settling basin from the stream was not adequate and resulted in the stream being polluted as far downstream as the Milton sewage treatment plant. This was so severe that no living vertebrates or invertebrates were found in this stretch of the stream.

For several miles downstream from the sewage treatment plant there was evidence of severe pollution from lack of oxygen. Immediately below the plant, no animal life could be found, but one mile downstream the only life present was very large numbers of various genera of the family Chironomidae. This is a common condition in the early stages of a stream's recovery from pollution. Near to the Forks of the Sixteen-Mile Creek at station AA1a13, there were several species of relatively tolerant coarse fish. Below the Forks, the stream was in fair condition down to a point below the King Paving Company's plant at Oakville. From this point to the mouth, the stream was turbid, and nearer the mouth it appeared to be polluted.

The remainder of the streams in the watershed showed very little pollution.

The Ontario Water Resources Commission is now making a study of the stream in the area near Milton. The general condition below the treatment plant at Milton will be greatly improved by the new treatment plant which is now being completed at the site of the previous one. This plant, which now serves a population of about 4,000 persons and several industries, is designed to serve a population of about 6,000 persons. However, it should not be expected that swimming would be permitted in the river anywhere in the vicinity of Milton below the treatment plant. Plans for recreation areas along the river below Milton should, of course, be made with this expected effluent in mind.

It may be expected that there will be regular checking of the bacterial and oxygen conditions of the stream below Milton by the Water Resources Commission.

The effluent from a manufacturing plant at Milton was also examined in February and March, 1958. There is a settling basin of approximately 2 acres into which the effluents pass, for settling and mixing of the acid and alkaline effluents. The conditions in this pond and those in Sixteen-Mile Creek 320 feet below the outfall are shown in Table 6. It can be seen from the table that even the concentrations in the pond appear to be much higher than is safe, since at present there is some seepage through the dike and at times it overflows.

It is felt that every effort should be made to neutralize the alkaline and acid effluents more efficiently by the maximum possible mixing of them together. The concentration of 11 parts per million of cyanides in the final effluent on March 11, is, of course, a serious condition. There should be no cyanide in the effluent. The copper and iron are also higher than the proper objectives in a trade waste. The phenol concentration of 8 parts per billion in the stream itself is, of course, far above the recommended minimum for either fish management or for use in any food industry. Since this plant may extend its operations, its wastes should be very carefully treated and the stream regularly tested by the engineers at the plant. The present settling basin should be cleaned out and deepened and proper measures should be taken to prevent the seepage through the dike and possible overtopping during the spring freshet or a severe storm. The bank was overtopped in March, 1958, at one point.

TABLE 6

EFFLUENT FROM INDUSTRIAL PLANT NORTH-WEST OF MILTON, ONTARIO

Date	Sample No.	5-Day B.O.D.	Solids (parts per million) Total	Suspended	Dissolved	p^H	Acidity as Calcium Carbonate	(parts per million) Cyanide as HCN	Total Chromium	Location
Mar.11	766	N/M	2,310	626	1,684	6.0	212	16.0	175	Effluent from plant to lagoon
Mar.11	767	22	568	334	234	5.3	40	0.5	0.9	Liquid at north end of lagoon possibly snow-melt in part
Mar.11	768	15	842	20	822	5.9	131	11.0	0.6	Actual effluent entering Sixteen-Mile Creek

Date	Sample No.	5-Day B.O.D.	Solids (parts per million) Total	Suspended	Dissolved	p^H	(parts per million) Cyanide as HCN	Iron	Copper	Parts per Billion Phenol	Location
Feb.26	N/M	N/M	N/M	N/M	N/M	N/M	0.2	11.6	Trace	8	Sixteen-Mile Creek 320' below outfall
Feb.26	N/M	N/M	N/M	N/M	N/M	5.28	N/M	N/M	N/M	N/M	Actual effluent to Sixteen-Mile Creek

N/M = Not Measured

Data by courtesy of the Water Resources Commission of Ontario

Since there will be additional industry developed in the general neighbourhood of the crossing of No.25 highway by No.401 highway north of Milton, and since the population of Milton will probably grow rapidly, it is recommended that the Conservation Authority establish an Advisory Board on Pollution. This Board could bring to the attention of the Water Resources Commission (through the Conservation Authorities) any conditions which it feels should be examined in detail.

3. Flooding

Seasonal flooding has always occurred in the rivers and streams of Southern Ontario. The steady change of land use which has occurred since the settlement of the early pioneers, however, has produced higher flood peaks than those previously experienced. The rate of surface run-off has been greatly increased by the thousands of acres which have been cleared for agricultural purposes. In urban areas, the water from the spring snow melt and the summer storms is enabled to reach the streams at a greater speed by acres of surfaced highways and rooftops, and miles of drainage ditches, storm sewers and drainage tiles. As the development in an area becomes more intensified, the rate of run-off generally increases unless special conservation measures are carried out. The extent of flood damage in an urban area is often greatly increased by the construction of buildings along the river bank and on the flood plain. The threat of a "super flood", such as Hurricane Hazel hangs over every watershed and unless special provisions are made to accommodate such a flood as it passes through urban areas the result will be disastrous.

(a) The Flood Threat at Milton

A survey was made of all areas within the Authority where flooding was know to occur. With the exception of Milton, it was found that no serious flooding problem exists. Even here, little property damage was done during Hurricane Hazel. Since that time, however, the Mountain View subdivision has been completed and a new school has been erected on the flood plain. These buildings, plus those of a proposed shopping plaza just upstream from the Main Street bridge, would increase the property damage at least thirty times should a similar storm occur when the area is fully developed.

The official rainfall recording station nearest to Milton at the time of Hurricane Hazel was located at Hornby, where 6.80 inches of rain was recorded during the forty-eight-hour period. From the isohyetal map of the storm it was determined that 5.94 inches of rain fell on the area draining into Milton. Had the storm been centred on the Sixteen-Mile Creek Watershed instead of the northern part of the Humber Watershed, which is about thirty miles north-east of Milton, the average depth in inches over the entire area would have been 8.60 inches during the forty-eight-hour period. This possibility, together with the higher peak flows in the streams which will result from the predicted urban development in the areas upstream from Milton, stresses the seriousness of the flood threat to the town. Since this threat becomes greater with each succeeding year, it is felt that the seriousness of the situation cannot be emphasized too strongly.

It is necessary for this study that the flow in the streams at Milton during the Hazel flood be established. Unfortunately, the present stream gauge at Milton was erected some time after the flood so no accurate records are available for Hazel. From high water marks recorded during the flood, it was possible to survey the approximate boundary of the area flooded and plot it as shown in Figure 5. Once these levels were established, the theoretical flow was determined by surveying the channel profiles and applying standard hydraulic formulae. Since there is a margin of error in this procedure, the flow figures given below must necessarily be considered as approximate only.

The estimated capacity of the stream channel below the Main Street bridge was determined to be approximately 1,160 c.f.s.* and the peak flows during Hurricane Hazel at the C.P.R. culvert on Tributary W-D and in the channel below the Main Street bridge were estimated to be 900 c.f.s. and 1,650 c.f.s. respectively.

Unfortunately, due to the flood occurring at night there is no available information telling exactly when the two peaks, namely, at the C.P.R. culvert and below Main Street, occurred. Two variables exist.

Firstly the rainfall was likely heavier on the Tributary W-D drainage area than on that of the West Branch upstream from Milton. Secondly, the concentration time at the Main Street bridge is approximately two hours for Tributary W-D and nine hours for the West Branch. Because of the lack of on-the-spot observations the peak of 1,650 c.f.s. could have been formed by one of the following combinations of flows:-

Firstly, the flow of 1,650 c.f.s. could have occurred when the tributary peaked at 900 c.f.s. This would have occurred before the West Branch had peaked and when its flow was only 750 c.f.s.

Secondly, the peak could have occurred at any stage when the West Branch was rising and the Tributary receding.

Thirdly, it could have occurred when the West Branch peaked (unfortunately, the peak flow of the West Branch could not be estimated due to the lack of the necessary data).

It is unfortunate that a lapse of two and a half years occurred before a survey was made of the flood problem since this requires that some assumptions must be made

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* c.f.s. = cubic feet per second.

which are subject to error. Chapter 3 covers in detail the hydrology of the area and also estimates the possible flows should the Probable Maximum Storm occur over the watershed.* These figures will be referred to later in this section when the recommended flood control works are discussed.

(b) The Flood Zones at Milton

The area inundated during Hurricane Hazel is shown in Figure 5. For the purpose of this report, the area has been divided into the following three parts:-

(1) The area at Tributary W-D (see water level profile Figure 2) lying between C.N.R. and C.P.R. tracks including the Mountain View subdivision.

(2) The area in the vicinity of the confluence of Tributary W-D with the West Branch, just upstream from the Main Street bridge and up to the C.P.R. culvert.

(3) The area on the West Branch extending downstream from the Main Street bridge to the sewage plant.

Area (1) - The flooding in this area was due to the combined peak flows of Tributaries W-D and $W-D_1$ exceeding the capacity of the C.P.R. culvert thereby causing ponding. The water level rose to the top of the hand-rail posts on the Woodward Avenue bridge and flooded an area of about 20 acres. The only damage done was the flooding of four basements, a barn and the Woodward Avenue pumping station. When the flood occurred in October 1954, the assessed value of the buildings in the flooded area amounted to approximately \$15,000. Since then the construction of 24 dwellings in the flood plain has increased this assessment to \$108,370 in 1957. This does not include the pumping station or the public school which are also located in this area.

Just upstream from the Woodward Avenue bridge the stream cuts through the rear of several properties facing River Place Cresent. In order to check erosion and reclaim

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* See Section 4(c), Chapter 3.

land for larger garden areas, some owners have individually built dry stone or concrete block retaining walls on the stream's east edge and have backfilled to depths varying from 4 feet to 7 feet. This has reduced the cross-sectional area of the channel which, in the event of high flood flows, will cause either an increased water velocity in the channel or a higher flood stage. Should the former occur, a greater eroding action will result, and since the stability of the walls is questionable due to the difference in their design, materials, line and grade, and also the backfill material and methods, it is quite possible that one or more might fail. Should this happen, the depositing of the stone and backfill material in the stream channel will have a damming effect and thereby aggravate the flood problem and increase the property damage.

This section of the stream presents a serious threat to the lives and properties of those living in the flooded zone shown in Figure 5. It is felt that serious consideration should be given to making this area safe as soon as possible by increasing the capacities of both the C.P.R. culvert and the stream channel.

Area (2) - This area takes in the flats just upstream from the "Forks" at the Main Street bridge. The only buildings which were flooded in this area at the time of Hazel were the mill and a service station. The area is still vacant. However, the town zoning map of 1956 shows this area to be developed as "commercial". In view of the area being low-lying, and its suitability for development as a conservation or park area, it is suggested that this zoning be reconsidered. A park located on the river in this vicinity would greatly enhance the beauty and aesthetic value of the town as well as allow widening and deepening the channel to accommodate the expected peak flows. Should this re-zoning be rejected, it is then recommended that no construction be allowed on the flood plain in this area until a suitable channel be constructed.

Unstable retaining walls constructed on properties facing River Place Crescent in Milton.

The high water mark for flood "Hazel" being indicated on the town pump house just west of the Woodward

Looking upstream at the C.P.R. culvert on Tributary W-D in Milton.

A corrugated arch culvert has recently been placed in the channel downstream from the C.P.R. tracks to provide an extra access to a new Brewers' retail store. This culvert lacks the capacity to handle the peak Hazel flow should the C.P.R. culvert be enlarged to prevent ponding and as such is regarded as a flood hazard which should be investigated.

Area (3) - This area stretches downstream from the Main Street bridge to below the sewage plant. Accurate details of the extent of damage and flooding caused by Hazel are unavailable since no accurate account was made at the time of the flood. The stream did overflow its banks to the extent shown in Figure 5, however, and flooded a number of buildings including the sewage treatment plant. Since sewers from homes on the west bank pass through this plant, the water backed up the pipes and flooded a number of basements when the plant was flooded. Channel improvement work and some diking is needed to confine the flow to the stream channel if complete protection is desired in this area.

(c) Proposed Remedial Work and Costs

Flood control measures are classified into two general groups, viz., conservation measures and expedient measures. The former involves proper land use practices, reforestation and reservoir storage; while the latter consists of the construction of dikes, diversion and channel improvements. Of course, these two methods can be combined in all overall flood protection programs.

Since there are no storage reservoir sites which would give sufficient protection to Milton, it is recommended that the improvement of the stream channels through the town be carried out.

Following is a table summarizing the peak flows at the Main Street bridge and at the C.P.R. culvert on Tributary W-D as calculated for flood Hazel. Flows, calculated by using the unit hydrograph method, are also shown for the stream below Main Street. These have been calculated for Hazel as it occurred; for Hazel centred on the watershed and for the maximum probable storm.

CALCULATED FLOOD FLOWS AT MILTON

Flow	Type of Storm	Method of Calculation	Flow c.f.s.	Runoff c.s.m.
Below Main Street Bridge	Hurricane Hazel Hurricane Hazel Hazel centred on Watershed Maximum Probable	Mannings Formula Unit Hydrograph* Unit Hydrograph Unit Hydrograph	1,650 2,190 3,230 9,700	44.5 59.0 89.2 261.0
At C.P.R. Culvert	Hurricane Hazel	Mannings Formula	920	168.0

* See Chapter 3 - Hydrology, Section 4 - Design Storm Flow.

The estimated channel capacity of the creek below Main Street was found to be 1,160 c.f.s. A comparison between this flow and those given above emphasizes the seriousness of the problem. It must be remembered, however, that the above flows must be used reservedly due to the lack of reliable stream flow and precipitation records. It is recommended that another study of the design flow be made should the flood control program discussed below be carried out at a later date. It is hoped that by that time more reliable data will be available.

It can be seen from this table and it is known from hydrologic theory and experience that the peak rates of run-off per unit area increase as the drainage area decreases. Based on the limited data, the following rates of run-off for the purpose of designing the channels at Milton have been selected rather arbitrarily.

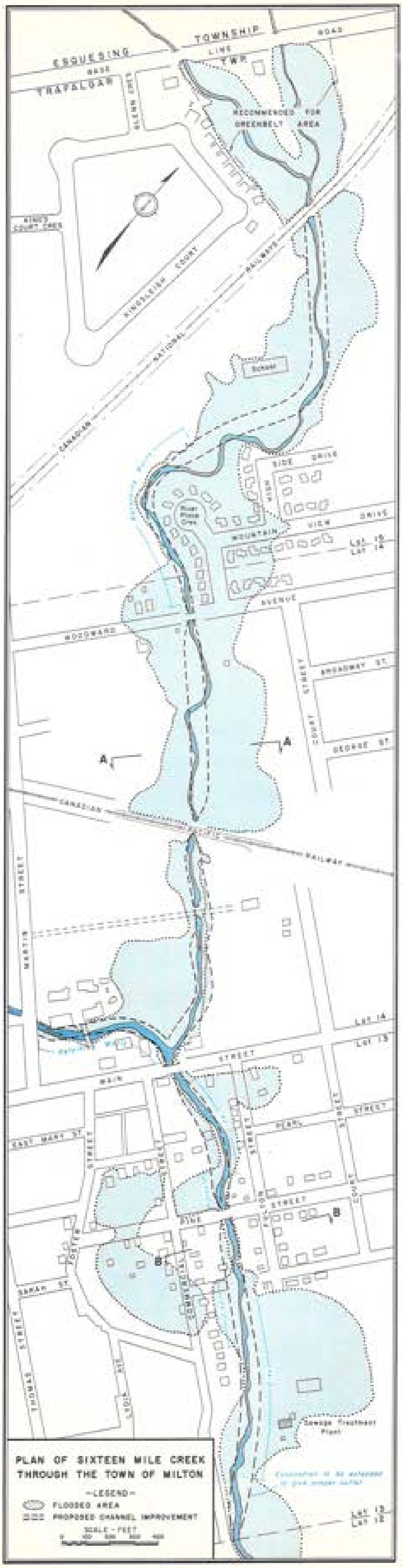
DESIGN FLOWS AT MILTON

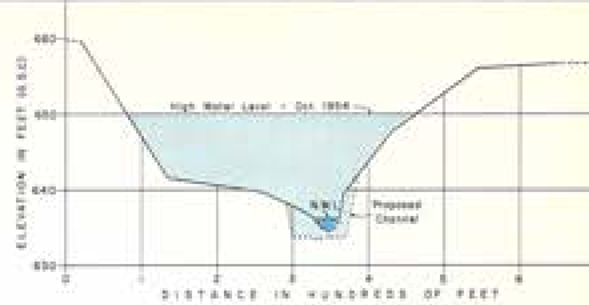
Location	Area Sq.Mi.	Run-off Selected c.s.m.	Design Flow c.f.s.
Above C.P.R. tracks on Tributary W-D	5.47	300	1,641
Above Main Street Bridge	37.10	100	3,710

These rates are 60 per cent to 75 per cent larger than those calculated for Hazel and about 10 per cent greater than that calculated for Hazel centred on the watershed and are considered to be the minimum protection that should be given to this area in view of the amount of residential development involved.

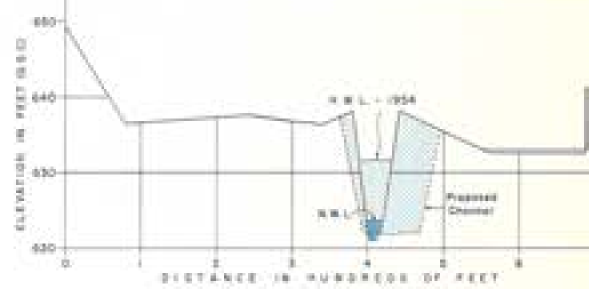
It is proposed that the channel of Tributary W-D be improved from the C.N.R. tracks to its confluence with the West Branch; and the West Branch channel be improved from the C.N.R. tracks to a point 200 feet below the sewage plant. A plan of this work is shown in Figure 5. The entire creek bed will have to be lowered between 1 and 4.5 feet in order to obtain sufficient capacity through the Woodward and Main Street bridges and the C.P.R. culvert. The transitions through these restrictions will be concreted since velocities of 16 feet per second are required. Except for two other sections of the creek, which are discussed below, the rest of the improved channel will be a straight and uniform earth cut with 2:1 side slopes. There will be a smaller channel in the centre of the main channel which will confine the low summer flows to a narrow stream. The slopes and berms of the large channel are to be grassed. The maximum momentary peak velocity in the earth sections of the channels is to be no greater than six feet per second. Profiles of these sections are shown in Figure 5.

The 850-foot length of stream in Zone (1), just upstream of Woodward Avenue will have to be confined to a



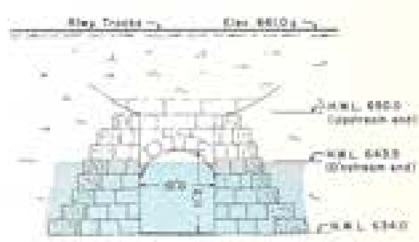


SECTION A-A
LOOKING DOWNSTREAM



SECTION B-B
LOOKING DOWNSTREAM

Woodward Ave. Bridge



C.P.R. Culvert
(Downstream End)

Main St. Bridge

Pine St. Bridge

MILTON FLOODED AREA
SHOWING
PROPOSED CHANNEL IMPROVEMENT
LOTS 13, 14 and 15; CON. II N.S.
TOWNSHIP OF TRAFALGAR
IN THE TOWN OF MILTON

FIG. 5

narrow channel by concrete retaining walls and a rip-rapped bottom. A wide channel cannot be obtained without encroaching on the gardens of the houses facing River Place Crescent. A momentary peak velocity of 10 feet per second for the design flow is expected.

The other section of the stream which will have to be concrete-lined lies on the West Branch between Main Street and Martin Street. Existing buildings seriously encroach on the watercourse thereby restricting it to a very narrow channel. The drainage area above Martin Street bridge is 31.67 square miles which would produce a peak flow of 3,167 c.f.s. should a run-off of 100 c.s.m. occur.

The West Branch from the C.N.R. tracks to the Martin Street bridge should be widened. The Martin Street bridge and the small service bridge about 100 feet further downstream would have to be replaced. The arch culvert on Tributary W-D just below the C.P.R. culvert would also have to be replaced with a bridge spanning the proposed channel.

A preliminary cost estimate of the entire project amounts to $445,000. The actual project could be constructed in stages over a period of ten years or more, but immediate steps should be taken to acquire the necessary right-of-way for the channel improvements followed by work on the crucial areas. These are the C.P.R. culvert, the lined channel behind River Place Crescent and the West Branch below Main Street, in that order.

There is another area which has been subjected to slight flooding in the past. On the east side of No. 25 highway (as it enters Milton from the south) is a ditch which carries the run-off from an area of 2.28 square miles. During the spring and heavy rainstorms this ditch frequently spills over its banks and floods parts of the highway and neighbouring farmland. It is estimated that this ditch should be designed to carry between 700 and 800 c.f.s. and every effort should be made to prevent any further encroachment or restriction of this watercourse.

4. Available Water Storage

Consideration should be given to the various methods of conserving a larger percentage of the annual precipitation in order to meet the future water demands of the area. By storing the excess run-off in either underground or surface reservoirs, we not only ensure future supplies, but also reduce soil erosion and the flood peaks. The surface reservoirs also provide facilities for recreation as well as ensuring summer flow in the streams and providing a better habitat for wildlife.

Water conservation takes many forms. It requires the knowledge of land use and forestry specialists as well as that of hydrometeorologists and engineers. The overall plan should start at the headwaters of the watercourse, where, with proper land use and forestry practices, the reliability of the source can be assured. Contour ploughing, strip cropping, mulching, reforestation and the proper care of woodlots, all combine to slow down the run-off. With proper field husbandry the infiltration rate can be increased thereby increasing the amount of water recharging the aquifer.

It must be realized, however, that the correct drainage of land being used for crop production is essential. For maximum plant growth, it is necessary that a soil has a deep rooting zone which is easily penetrated by air, water and roots. It should be able to hold sufficient water for plant growth but also allow the excess to pass through it. To achieve this condition, many lands are artificially drained by ditches or clay tiles. Urban areas are similarly planned to drain quickly during the spring thaw and heavy rainstorms.

Where the drainage of an area is severe or excessive pumping from the aquifer causes an overdraft or lowering of the water table, excess run-off should be conserved by either artificially recharging the aquifer or by constructing surface reservoirs. This chapter will deal firstly with ground-water storage and, secondly, with surface storage.

(a) Ground-Water Storage

Ground-water is only that part of the subterranean water that occurs where all the pores in the containing materials are saturated. This "saturated zone" may extend up to the land surface in some places such as swamps, stream beds, etc. At all other places, the zone extending from the saturated zone surface to the land surface, is called the "zone of aeration". A certain amount of water is always firmly held in this zone by molecular attraction and is not available for withdrawal. Wells, therefore, have to be drilled through this zone and into the saturated zone before any water is available. The depth to the available water may vary anywhere from a few inches to hundreds of feet.

The pores within the rock and soil materials, which contain all subterranean water, vary greatly in size, from microscopic interstices in clay or silt soils to huge caverns in limestone formations. The ability of a material to hold and yield water is determined largely by the characteristics of these pores and the arrangement, shape and degree of assortment of the particles. The more porous the material is, the greater is its capacity to absorb, hold or yield water.

The soil zone of the earth's crust is generally quite porous and is particularly adept to retaining water. This is of primary importance in the growth of crops and consequently good agricultural practices endeavour to build up these qualities. These practices result in the addition of organic matter to the parent rock material which is similar to that in the underlying zone. This develops a good food-and-moisture medium for plant growth which is more proficient than its parent material in both the amount of water it can hold against the pull of gravity, and in the amount it can transmit without damage to itself when the precipitation exceeds its moisture requirements. It must be remembered that the soil itself does not yield water to the wells; but through it must pass a large part of the water that eventually becomes available for man's use. The underlying strata can yield water to wells only if the soil or other surface material, which has first call on the water, is able to release a part of it to charge the water table. Thus the amount of water stored in an underground basin depends not only on the annual precipitation over the area, but also on the porosity of the underlying strata and the condition of the surface soil layer.

These vast subterranean reservoirs in the earth's crust can be drawn upon to meet man's need for water. This has been done for many centuries and until recent years this practice had little or no permanent effect on the level of the ground-water storage. Since the advent of deep well pumps of enormous capacity and the concentration of population in huge cities and towns, there have been cases of the withdrawal from the aquifer exceeding the natural recharge. Where this has been allowed to continue unchecked, the source has eventually failed.

The subterranean reservoir should be considered in the same light as a surface reservoir. The latter is filled with run-off during periods of high precipitation and the accumulated storage is used for various purposes during periods of little or no precipitation. This reduces the amount of water in storage but thereby increases the storage available to absorb future precipitation run-off. This method of "book-keeping" should also be applied to ground-water reservoirs. Where large quantities of water are being removed, observation test wells should be used to study the fluctuations of the water table so that any serious overdraft can be observed. As long as the water table rises each year to its original high level during the spring break-up, no serious problem exists. Where the withdrawal exceeds the recharge, steps should be taken to either curtail the pumping rate or recharge the aquifer artificially.

Since the Sixteen-Mile Creek Watershed has few, if any, economical surface storage sites, it is recommended that an investigation be made into the potential subterranean storage. Should a suitable aquifer be found in the upper reaches of the watershed it might be possible to store much of the excess spring run-off by recharging the aquifer through artificial seepage pits. To do this, a geological survey of the area and a study of the fluctuations of the water table by means of observation wells would be necessary in order to obtain the necessary data.

It might be argued that this is not necessary at the present time due to the adequacy of the existing water supplies. It must be remembered, however, that other communities in the nearby counties have experienced phenomenal growth during the past 15 years and there is no reason to suppose that this should not happen in the Milton area, especially since the construction of the new Highway 401 is now well under way. Milton is already having to bring water for some distance from a point west of the town, so it should appear reasonable to suggest that a study be made soon.

(b) Surface Storage

The Sixteen-Mile Creek Watershed was examined from topographic maps and it was found that there are very few, if any, suitable reservoir sites which would provide low-cost storage. This is partly due to the flat topography of the upper reaches of the watershed, and partly due to the very steep stream gradients which require a high dam in order to obtain any length to the reservoir.

An investigation of three sites selected in the lower part of the watershed, revealed a high unit cost due to the narrowness of the confining ravines and the steep stream gradients. These three reservoirs would have an approximate combined storage of 35,000 acre feet; however, the need for this storage does not justify the cost at this time. Their value as a flood control measure is minimized since they are located downstream from the flood danger point at Milton. It is possible, however, that with the urbanization of the surrounding area, the future demand for water supplies might be great enough to justify such an expenditure.

During the investigation of the flood problem at Milton, consideration was given to the possibility of constructing flood retention reservoirs upstream from the town, thereby reducing the peak flows. Two sites of small storage capacity were investigated. These, plus the three larger reservoirs mentioned above will be discussed in detail below. The reservoir data is to be found in Table 7.

Reservoir Sites:

(1) Glenorchy

The Glenorchy site lies just east of the hamlet of Glenorchy in Lot 20 of Concession II N, Trafalgar Township.

The creek flows through a deep, heavily-wooded ravine which would require a 76-foot dam wall to store 5,900 acre feet of water at a maximum depth of 70 feet. The earth fill structure would be 450 feet long and would be equipped with concrete spillways. The drainage area covers 77.3 square miles and the reservoir created will cover 155 acres. The water level would be raised to the 572-foot elevation which would require the raising of two roads.

The preliminary estimated cost is $2,773,000 which gives a unit cost of $470 per acre foot. It is felt that this high unit cost rules out the construction of the dam at this time.

(2) The Forks

The Forks is the largest dam investigated on the watershed, storing approximately 12,900 acre feet. The site is located on the Main Sixteen-Mile Creek just below the "Forks" in Lots 24 and 25, Concession I N, of Trafalgar Township.

A 126-foot earth fill dam is required, with 6 feet freeboard allowance thus giving a 120-foot depth of water. It would be 1,180 feet long and cost approximately $8,500,000. This gives a unit cost of $659 per acre foot which, once again, is far too high to prove economical.

DAM AND RESERVOIR DATA

TABLE 7

Name of Reservoir	RESERVOIR DATA			DAM DATA							APPROX. COST $	
				Elev. G.S.C.			Measurements - feet					
	Surface Area at Max. El. (ac.)	Maximum Storage Capacity (ac.ft.)	Drain-age Area (sq.mi)	Top of Dam	Max. W.L.	Stream Bed	Length of Dam	Ht. above Stream Bed	Depth to Bedrock	Max. Water Depth	Total for Dam $	Unit $/ Ac. ft.
GLENORCHY	155.0	5,900	77.80	578	572	502	450	76	10*	70	2,773,000	470.00
FORKS	299.0	12,900	127.30	556	550	430	1,180	126	10*	120	8,500,000	659.00
BOYNE	130.0	5,658	49.00	566	560	476	700	90	10*	84	4,100,000	726.00
MILTON WEST	19.2	80	2.34	-	-	-	400	12	10*	10	43,200	540.00 †
MILTON EAST	14.0	90	2.12	-	-	-	260	20	10*	15	63,300	703.00 †

* Assumed

† Excluding cost of land

The stream at this point passes through a deep heavily-wooded ravine and drains a total of 127.3 square miles. The reservoir surface would cover an area of 299 acres when the water level reached the maximum allowable elevation of 550 feet. At this elevation, five roads would have to be raised so as to prevent flooding.

(3) Boyne

The last of the big projects lies in Lot 26 of Concession II N, Trafalgar Township.

This dam is ruled out at the present time because of its high unit cost. The earth fill wall would be 90 feet high and 700 feet long and would create a 130-acre reservoir storing 5,658 acre feet. The preliminary cost is estimated at $4,100,000 or a unit cost of $726 per acre foot, which far exceeds the economical unit cost for large dams.

(4) Milton West

This site is located in Lot 2, Concession II, Esquesing Township. It was investigated mainly for flood control reasons in the hope of providing adequate protection for Milton.

This site lies north and slightly west of the town on Tributary W-D which confluences with the West Branch just upstream from the Main Street bridge in Milton.

Unfortunately, the surrounding topography is fairly flat and only a 12-foot dam could be constructed at this point. Allowing 2 feet for freeboard, it is possible that approximately 80 acre feet of storage could be obtained.

The cost of the dam is estimated at $43,200 but this figure does not include the cost of purchasing approximately 24 acres of land for the construction of the reservoir. It is quite possible that the total cost will be more than double the $43,200 figure, especially since the reservoir would flank the new 401 highway.

(5) Milton East

This site is located north of Milton and east of Highway No. 25 in Lot 1, Concession III, Esquesing Township. The dam would be a 260-foot earth fill structure and 20 feet high. The maximum water depth and the maximum reservoir water surface area would be 15 feet and 14 acres respectively, giving a storage capacity of 90 acre feet.

The surrounding area is fairly flat and lies just south of the new No. 401 highway. The preliminary cost estimated of the dam structure is $63,300 which gives a unit cost of $703 per acre foot. This cost will be greatly increased by the cost of acquiring approximately 20 acres of land in the area to be flooded.

The construction of the two small reservoirs above would provide storage for approximately 170 acre feet. The value of this storage as a flood control measure is discussed in the section of this chapter denoted to Flood Problems.

At the present time, it is felt that none of these five reservoirs can be strongly recommended. It is quite possible, however, that future demands for water will warrant the construction of these projects and therefore it is suggested that the Authority consider purchasing the required land now while land prices are reasonable. This land could be used as recreation areas until such time as it is deemed necessary to construct the reservoirs. The locations of these reservoirs are shown in Figure 1.

Looking downstream at the Glenorchy damsite from road crossing. Broken line indicates top of possible dam at this site.

Panoramic view of the area which would be flooded if the Boyne dam were constructed.

CHAPTER 5

COMMUNITY PONDS

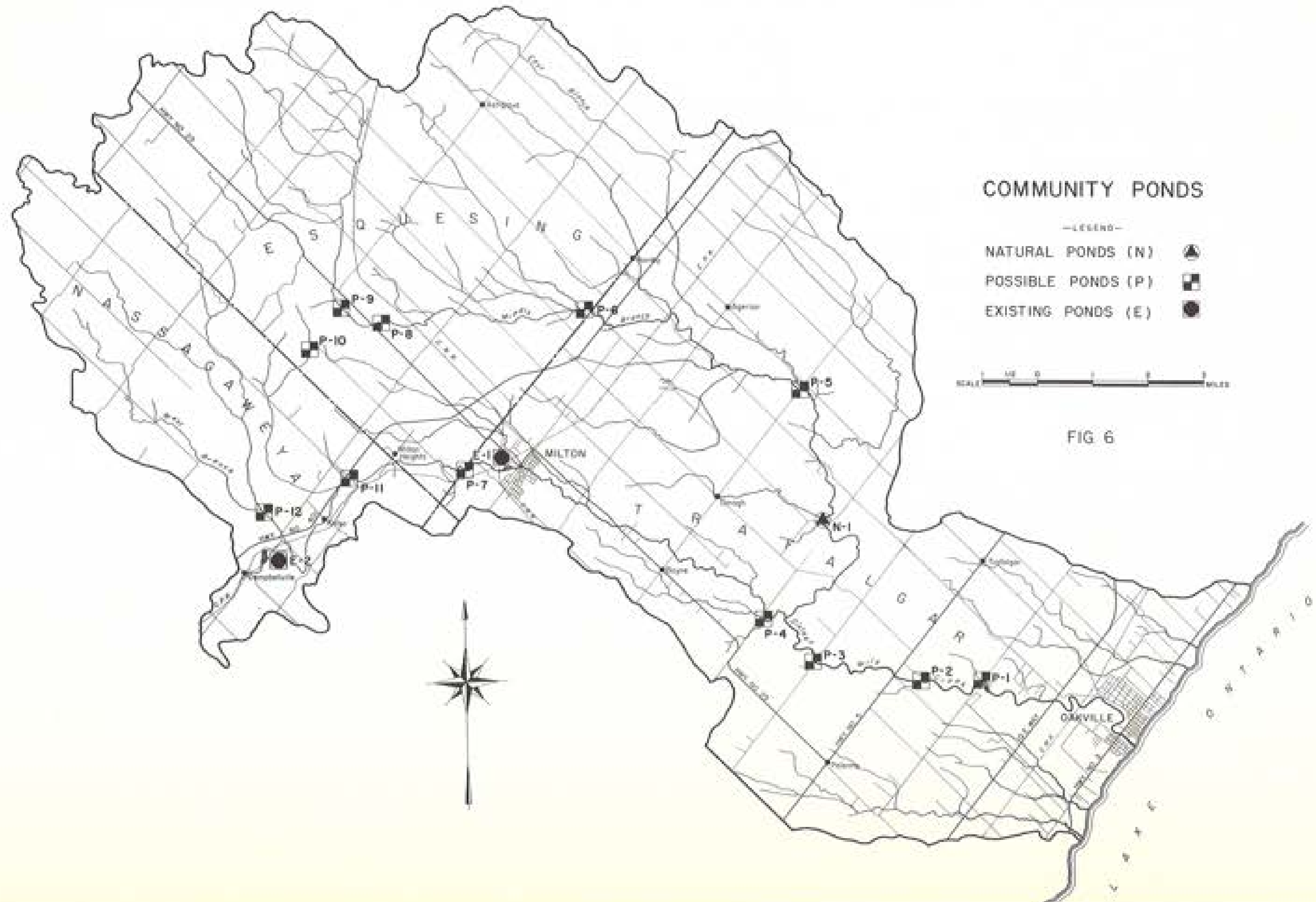
With the growth of population and greater demands being placed upon the resources of the province, it is essential that conservation planners fully appreciate the need for setting aside areas for recreation and relaxation. Too often, where new residential sub-divisions and industrial developments are taking place, the aesthetic has been sacrificed due to economic reasons. It is the Conservation Authority's duty, therefore, to take every possible opportunity to acquire and preserve, for future generations, the natural beauty of certain areas.

As part of this scheme for recreational development, it is recommended that the construction of community ponds be given serious consideration. Not only does such a pond act as a water conservation measure, but it also provides fire protection should it be located near a rural community or valuable woodlands. These ponds are not unlike farm ponds, in that, instead of providing facilities for just a single family, they serve a larger group of people. Should the location be of a suitable size, it can also be used by residents of the larger towns on the watershed where similar facilities are lacking. People enjoy "taking off" to the out-of-doors, especially during the summer months when they can go swimming, boating, fishing or picnicking. Community ponds, therefore, are necessary in order to provide citizens with such facilities which are otherwise quite often located great distances from their homes. Not only do they possess the above-mentioned assets, but they also preserve the beauties and health-giving attributes of nature, which tend to be all too fast disappearing before the rapid growth and expansion of our industrial communities. Since the Sixteen-Mile Creek Authority is strategically located in a vast potential industrial area, it is felt that steps should be taken now to build community pond areas while land prices are still within reason for such developments.

Several factors should be kept in mind when considering the selection of a community pond site. Firstly, easy accessibility and close proximity to the community is essential. Secondly, the facilities should be able to adequately accommodate the expected size of crowd. The water feeding the pond should be free from pollution, and warm enough for comfortable swimming. The surrounding land should provide adequate picnic and parking space so as to prevent the blockage of roadways. Provision should be made for sanitation and garbage facilities, and consideration given to the construction of change rooms and refreshment booths. Finally, the area should be made free of hazards which might endanger those using the area for swimming, skating, playing games, hiking, etc.

Suitable community pond sites are often found at old abandoned gravel pits or quarries which have been flooded by springs. Quite often a small dam, placed across a stream at a suitable location, will create a fair-sized pond for recreational purposes. In the past, dams were built to store water to be used for power in numerous mills located across the province. Usually these mills were built close to a town or village, and for this reason the mill-ponds offer much as a potential community recreation centre. Since electric power has replaced water power in numerous instances, many of the dams have been neglected, and in some cases have been washed away altogether. Because of their historical value, steps have been taken on other watersheds in the province to restore the mills as well as their dams, so as to provide additional interest to the area. In some cases, the mills have been converted into museums where relics of the pioneer days are on view to the public.

The following list describes a few possible community pond sites which were observed during a preliminary survey of the watershed. Figure 6 shows their location on a map of the Authority. It is hoped that the Authority will encourage the development of these and other possible sites should a more detailed survey indicate their suitability.



COMMUNITY PONDS

—LEGEND—

NATURAL PONDS (N)

POSSIBLE PONDS (P)

EXISTING PONDS (E)

SCALE 1 1/2 0 1 2 3 MILES

FIG 6

Community pond site No. P-4 from the bridge crossing immediately below.

Panoramic view looking upstream at site No. P-3 located just below the "Forks".

Panoramic view looking upstream at site No. P-6. Notice the attractive park-land referred to in Chapter 5.

LIST OF COMMUNITY POND SITES

P = possible pond sites
E = existing pond
N = natural pond

'RAFALGAR TOWNSHIP

'-1 Middle Road - Lot 19 Concession IS

An excellent site for a large recreation area. . temporary dam, (with a concrete sill and wooden flashboards) bout 60 feet wide and 5 feet high would create a pond 50-120 'eet wide and 1,000 feet long. The stream bed would have to be redged a little. There is plenty of scope for various activi- ies such as playing fields, walks, archery, etc.

'-2 Highway No. 5 - Lot 22, Concession IS

This site is about one mile upstream from site P-1 nd could be combined into one large park area if the entire alley could be acquired. The area is well wooded and quite 'lat. A pond could be created by constructing a temporary dam cross the main stream. There is plenty of parking and picnic pace and there is good access from Highway No. 5.

?-3 Lower Forks - Lot 25, Concession IIN

Another good site for a large fecreation area is ocated about a mile below the confluence of the East and West Branches (the "Forks"). A temporary dam 5 to 6 feet high and 100 feet wide would create a pond approximately 300 feet wide and 1,300 feet long containing a fair-sized island in its centre. There is adequate space for playing fields, parking, etc. The flood plain, however, is very stony and some levelling would be required.

?-4 Upper Forks - Lot 1, Concession III

This site is already developed to some extent as a private recreation area. It is located on the West Branch about half a mile upstream from the "Forks". Bathing facilities would be greatly improved by the construction of a small temporary dam. The surrounding area is very pleasant and has adequate parking facilities.

N-1 Drumquin South - Lot 1 Concession VI

There is a small natural pool at this point which is already being used as a "swimming hole". It could be improved by some dredging. There is sufficient flat land surrounding the pool which could be developed into a very pleasant small picnic area.

P-5 Drumquin - Lots 5 & 6, Concession VII

This area surrounds the confluence of the Middle and East Branches. It is possible to create one or more small ponds by constructing temporary dams. There is plenty of space available for development but unfortunately the area lacks shade trees and is not as pleasant as some of the other sites mentioned in this list.

E-1 Milton, Lot 14, Concession II.

A fairly large mill-pond is located almost in the centre of Milton. Although the location is suitable for a community pond site, it is limited by the commercial development of the area. It is doubtful whether sufficient surrounding land could be acquired at a reasonable price.

ESQUESING TOWNSHIP

P-6 Hornby West - Lot 1, Concession VI

This is a very pleasant area which has great potential as a roadside recreation area. Unfortunately, the construction of a large pond is not possible although a temporary dam, 30 feet wide and 4 feet high, would create a pool from 20 to 50 feet wide and about 300 feet long. There are about 10 to 20 acres of beautiful park land which could be easily developed. This site should be among the first given consideration.

P-7 Milton North - Lot 1, Concession II

This site is not suitable for the construction of a dam due to the flatness of the surrounding area. People do swim in the creek at this point and these facilities could be greatly improved by creating one or more pools in the stream bed by dredging. The surrounding area is quite pleasant, both on the North and the South side of the road.

P-8 Mansewood West - Lot 8, Concession III

A temporary dam, 5 feet high and approximately 50 feet wide, would create a fair-sized pool in very pleasant surroundings. There is adequate land available and the area is well wooded. It is located right on Highway 25 which would make it an ideal roadside picnic spot.

P-9 Scotch Block South - Lot 10, Concession II

The stream has quite a steep gradient at this point. However, a small pond could be created by the construction of a small weir. Unfortunately, there is not a great deal of space available for parking or playing fields. The area is well wooded and quite pleasant.

P-10 East of Halton County Forest (Cox Tract)
Lot 10, Concession 1.

This area is very thickly wooded and quite isolated and would be ideal for a camp-site development rather than a community recreation area. A pond could be created by the construction of a small weir at the site which was investigated. However, there are probably other suitable sites in the vicinity which should be considered.

NASSAGAWEYA TOWNSHIP

P-11 Milton Heights - Lot 4, Concession VI

This site has pleasant surroundings and has potentialities as a small camp site. A small pool has already been created by damming the stream with rocks; however, this could be greatly improved by dredging the stream bottom and constructing a more substantial dam. It is not recommended as a large community recreation area.

P-12 Campbellville North - Lots 7 and 8, Concession V.

This is an excellent piece of tree covered land covering approximately 200 acres which would make an ideal conservation area. An attractive waterfall (Hilton Falls) lies quite a distance from the nearest main road and just downstream from an old mill dam in Lot 8. The pond could be restored by building a seven-foot dam approximately 30 feet wide at the old site.

An alternative site lies further downstream in Lot 7 . Here, where the area is well wooded, a long concrete weir placed downstream of the confluence of the two streams, would create a large community pond. This area is quite attractive and should be among the first considered.

C-2 Campbellville East, Lot 6, Concession IV.

This mill-pond is located on a winding and picturesque county road just east of the village of Campbellville. The pond is quite large; however there are quite a large number of snags which would present a danger to swimmers and boating. The railroad to the south of the pond restricts any development in that direction, while the mill to the east, and the road to the north close off most of the pond's boundaries. There is a small acreage to the west which could provide limited recreational facilities.

The mill is still operating; a fact which should be taken into account when comparing this site with others in the area.

CHAPTER 6

SUMMARY

This report has examined the physical characteristics of the Sixteen-Mile Creek Conservation Authority and has brought to the fore some of the problems which exist and which are likely to arise in the future due to the development of the watershed.

Chapter 1 discloses that the Authority covers an area of 159 square miles and is populated by 29,967 persons. The terrain and the various water-courses are discussed, as well as the proportions of the various townships which make up the Authority.

Chapter 2 presents an interesting review of extracts from known records of former floods. These include sketchy reports taken from old newspaper files and diaries kept by the early settlers and travellers of the area, as well as more detailed reports found in later records. Although these do not supply us with reliable flood data, they do indicate that floods are known to have occurred as far back as 1797 and that the extent of damage caused is increasing as urban development increases.

Chapter 3 deals with the hydrology of the area and stresses the necessity of keeping up-to-date and reliable records of stream flow and precipitation. Unfortunately, such records have not been available for the Sixteen-Mile Creek until just recently and consequently the estimated peak flows for Hurricane Hazel had to be developed from basic hydrologic principles, coupled with past experience on other similar watersheds. Thus, the figures given have to be used with caution and it is recommended that before any major flood control works are started, a further study of the stream flows should be made.

Chapter 4 discusses the water problems arising in the area, viz. pollution, flooding and available water supplies. Generally speaking, the streams in the Authority are not badly polluted; however, it is pointed out that this might change as the expected industrial development of the area occurs. There is a manufacturing plant in Milton which is at present discharging an effluent, harmful to aquatic life, which is making its way to the stream and it is recommended that this condition be remedied. It was pointed out that, although the town's sewage plant was overloaded at the time the survey was made in 1957, the condition of the stream will be greatly improved by the completion of the new plant, which is at present under construction.

The important water problem occurring on the watershed is flooding. Even this is not too serious; however, it is pointed out that unless special works are undertaken soon, the present position will deteriorate as urbanization spreads. The only serious flooding which has occurred to date is in the town of Milton. Fortunately, the town has not yet suffered from the maximum storm which could occur in this area. It is felt that should such a storm occur the destruction caused would be disastrous. To remedy this, a system of channel improvement works and some diking is necessary. The preliminary cost estimate of these projects is $445,000.

It has been pointed out that due to the lack of sufficient reliable stream flow data and precipitation records it is important that a further hydrologic study of the area be made prior to the construction of the flood control works. It is hoped that by that time more suitable records will be available.

Chapter 4 also deals with the amount of available water storage known to exist in the Authority. It states that there are no large reservoir sites which would provide economical storage today. With a changing economy, however, it is possible that the construction of the dams listed might be justified by the increased demand for water. It is possible that underground water supplies might be exploited to a larger extent in the future. It is recommended that a study be started to find out the potential of this source and the possibility of artificial aquifer re-charge to supplement this supply.

Chapter 5 expresses the need for setting aside areas for recreation and the advantages of establishing community pond sites. These ponds not only provide recreational facilities for the local population but also act as conservation storage reservoirs which can be drawn on in times of emergency. A list of a number of suitable sites has been prepared and it is hoped these will be developed in the near future.

ABBREVIATIONS, EQUIVALENTS AND DEFINITIONS

Abbreviations

ac. ft.	is the abbreviation for acre foot which is the equivalent to 43,560 cubic feet and is the quantity of water required to cover one acre to a depth of one foot.
c.s.m.	is the abbreviation for cubic feet per second per square mile and is the average number of cubic feet of water flowing per second from each square mile of drainage area.
c.f.s.	is the abbreviation for cubic feet per second and is the unit generally used to express discharge or the rate of flow.
G.S.C.	is the abbreviation for Geodetic Survey of Canada which refers to the official datum of elevations above mean sea level as established by the Geodetic Survey of Canada.
M.P.N. or m.p.n.	most probable number
ML or ml.	millilitre
P.P.B. or p.p.b.	parts per billion
P.P.M. or p.p.m.	parts per million
PH or ph	value measure of acidity or alkalinity

Equivalents

1 c.f.s.	= 6.25 imperial gallons per second
1 c.f.s. for 1 day	= 1.98347 acre feet or approximately 2 acre feet
1 c.f.s. for 1 year	= 724 acre feet
1 ac. ft.	= 271,472 imperial gallons

1,000,000 imperial gallons per day = 1.86 c.f.s.

Definitions

AQUIFER is a water-bearing stratum or formation.

BOOST STORAGE is the storage required to increase the head of water over the discharge tubes in order that they may be able to discharge the required flow.

CHANNEL CAPACITY or "IN-BANK" FLOW is the maximum flow which is contained within the river banks and does not overflow the adjacent low lands.

CHANNEL CAPACITY STORAGE is the volume of water that must be impounded in order that the stream flow will not exceed the channel capacity flow or stage.

CONSERVATION STORAGE is that volume of water remaining in a reservoir which may be used to augment the low flows and is equivalent to the maximum storage capacity of the reservoir less the dead storage, evaporation and ice losses and the space reserved for flash floods.

DAM is a structure in and across a river valley to impound, control and otherwise regulate the river flow.

DEAD STORAGE is the amount of water kept in a reservoir at all times for the purpose of protecting the artificial and natural water seals at the base of the dam.

DISCHARGE TUBE or CONDUIT is an opening through the base of the spillway to provide means for discharging water when the water level of the reservoir is below the spillway level.

FLOOD is an overflow or inundation coming from a river or other body of water.

FLOOD CONTROL is the prevention of flooding by controlling the high water stages by means of storage reservoirs, dikes, diversions or channel improvement such as widening, deepening and straightening.

FLOOD CONTROL STORAGE is the total volume of water that must be impounded during a given flood in order that the stream flow will not exceed the channel capacity flow or stage and is equal to the sum of the channel capacity, dead, boost and operational storages.

FLOOD CREST is the maximum height or stage that the flood waters reach during any one flood period.

FLOOD HYDROGRAPH - a hydrograph which covers only the flood period or time interval during which the river flow is above the flood stage.

FLOOD RATIO is the rate of peak flow to the average flow for the flood period.

FLOOD STAGE is an arbitrary flow stage which varies from place to place and from season to season and is that flow or water level at which the water threatens to do damage.

FREEBOARD is the vertical distance between the maximum permissible water level and the top of the dam or dikes.

GROUND WATER is the portion of the subterranean water which occurs in the zone of saturation.

GROUND WATER STORAGE or RESERVOIR is a term used interchangeably with aquifer.

HYDRAULICS as applied to conservation deals with the measurement and control of run-off from river drainage basins.

HYDROGRAPH is a plot of flow against time and is a correct expression of the detailed run-off of a stream resulting from all the varying physical conditions which have occurred on the drainage area above the gauging station previous to the time which it represents.

HYDROLOGY is the science which deals with the occurrence and distribution of water in its various forms over and within the earth's surface. As applied to conservation it deals more specifically with that portion of the hydrologic cycle from precipitation to re-evaporation or return of the water to the seas and embodies the meteorological phenomena which influence the behaviour of the waters during this phase of the cycle.

OPERATIONAL STORAGE is additional storage that is required to provide a safety factor to enable the controller to regulate the discharge from a dam so as not to exceed the channel capacity flow or stage.

RATE OF RUN-OFF is the rate at which water drains from an area. Usually expressed in cubic feet per second (c.f.s.).

RATE OF RUN-OFF PER SQUARE MILE is the average number of cubic feet per second of water flowing from each square mile of area drained (c.f.s./sq. mi. or c.s.m.).

RESERVOIR is the body of water created by the construction of a dam.

RESERVOIR CAPACITY is the maximum amount of water that may be contained within the reservoir without exceeding the maximum permissible water level Usually expressed in acre feet.

RUN-OFF is the amount of water which reaches the open stream channels and may be broadly defined as the excess of precipitation over evaporation, transpiration and deep-seepage.

RUN-OFF DEPTH IN INCHES is the depth to which the area would be covered if all the water flowing from it were conserved and uniformly distributed over the surface.

SPILLWAY is that part of a dam over or through which the water is discharged.

SPILLWAY CAPACITY is the maximum amount of water that may be discharged over the spillway without exceeding the maximum permissible water level in the reservoir.

STREAM GAUGE is a measuring device used to determine the elevation of the water surface at selected points - usually a graduated rod fixed in an upright position and set to a known elevation from which the gauge readings are obtained by direct observation. Automatic type gauge is a mechanically operated recording instrument which gives a continuous record of water surface elevations.

WATER or CLIMATIC YEAR is a 12-month period from October 1 to September 30. The water year was found to be a more convenient form than the calendar year for the purpose of stream flow studies as it groups together those months in which the water losses due to evaporation and vegetation demands are at a minimum (October - March) and those during which the losses are high (April - September).

WATER TABLE is the upper surface of the zone of saturation.

ZONE OF SATURATION is the portion of the earth which is saturated with water.

SIXTEEN MILE CREEK CONSERVATION REPORT

WILDLIFE

ONTARIO DEPARTMENT OF PLANNING AND DEVELOPMENT

CONSERVATION BRANCH

CHAPTER 1

INTRODUCTION

The wildlife of the Sixteen-Mile-Creek Watershed is of no great economic importance. The money derived by the few fur trappers from sales of fur and the receipts from township licences to shoot pheasants and other game are the only direct sources of income from wildlife.* There is, of course, a fair amount of business carried on with mutual benefit to the sportsman and the sporting goods dealer.

The watershed not only includes a part of the Niagara escarpment but also an area of rough land with a high percentage of woodlands and a series of excellent springs above and below the escarpment, which provide water of good temperature for brook trout fishing.

The part of the watershed along the edge of the Niagara escarpment (or cliff) is very spectacular and lies almost midway between Toronto and Hamilton. The area is therefore visited by considerable numbers of people, including hunters looking for upland game, fishermen seeking fish, and a growing army of naturalists interested in the opportunities to see and enjoy the fine views and the varied forms of animal and plant life.

The watershed has also much agricultural land of exceptionally high quality, and two deeply carved river channels.

In the north-western part of the watershed, by careful handling of the wildlife habitat and by managing their numbers, wildlife populations should have no adverse

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* Township licences to hunt pheasant, foxes and rabbits (including the European Hare) are required in all of the three townships included in the area. In most cases this does not apply to a farmer shooting on his own land. The small section of Nelson Township in the watershed is of course now a part of Burlington, and is not subject to the same regulations.

effect on most good land use practices. Here the best farm husbandry and the best methods of handling woodlands go hand in hand with good conditions for most species of wildlife. The porcupine, the beaver and the meadow mouse (with occasional aid from other mice) seem to be the only species which come into serious conflict with man's interests.

On the exceptionally rich lands of the Peel plain it is more difficult to justify the production of wildlife, other than those insects needed for pollination and some birds which eat weed seeds or destructive insects. In such areas those who wish to have wildlife on their land have usually to sacrifice some of the land's produce or productivity.

Planning for wildlife in Ontario is already the full-time occupation of an entire division of the provincial Department of Lands and Forests. A District Biologist at Hespeler and a group of Conservation Officers strategically placed through the country provide advice to the average citizen. The present report, based on a short-term examination, deals only with a few specific problems in the watershed and a single problem, improving the farm for wildlife, which is of more general application in some parts of the watershed.

The specific subjects discussed in this report are the conditions of the streams for fish; the birds and mammals that may be found in the watershed; and the pollution of the Sixteen-Mile-Creek from Milton to Oakville. The last of these subjects, as it is so closely associated with other problems of hydraulics, will be found in the Water section of this report.

CHAPTER 2

FORMER SPECIES

At least six species of mammals which probably were found in the Sixteen-Mile Creek Watershed at the time of settlement no longer occur in it. These are the Marten, Fisher, Wolverine, Timber Wolf, Canada Lynx and the Wapiti or American Elk. The Cougar may also have been present. The Bobcat or Bay Lynx may still occur rarely in the northern forested part of the area.

Among the birds which were permanent residents at the time of settlement the Wild Turkey may have been found in the watershed. Its former range in Ontario extended north and east to Lake Simcoe. The Bobwhite was listed by Brooks* in 1906 as "occasional only". The Passenger Pigeon, whose vast flocks surprised the early settlers, is extinct. The Sixteen-Mile Creek Watershed lay almost in the centre of the Ontario nesting area. The numbers of these birds are considered to have fluctuated widely, but it is well known that they were present in very large numbers in the watershed about 1860. Bags of from a few to 130 birds with a single gunshot have been reported. The Reverend G. W. Ware, resident at Oakville wrote as follows:

> "The author himself has seen countless thousands (of pigeons) flying over his house in an immense black cloud; they fall easy prey to sportsmen, and are captured by the hundreds in their nets."†

The following account is also abstracted from Mrs. Hazel Mathews' "Oakville and the Sixteen":

> "The section of Oakville along Dundas Street between George's Square and the mill, and east through Anderson's bush, is described by Williams (J. A Williams) as'the place where we gathered in the spring and fall with our old flint-lock muskets and shotguns, to fire at the millions of wild pigeons which used to fly over the town'".

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* Brooks, Alan, "Birds of Halton County", Ontario Natural Science, Bulletin No.2, 1906.

† From Ware, G.W., "Canada as it is", London, 1847, quoted by Mrs. Hazel C. Mathews in "Oakville and the Sixteen", University of Toronto Press, 1953.

The last large flights occurred about 1869. The numbers of Passenger Pigeons declined rapidly after 1870. It is now generally considered that the decline was caused as much by the reduction of the natural habitat and food, the hardwood forest and beech "mast" which the pigeons needed, as by the intensive shooting and trapping. The last record of breeding of these birds in the watershed was of a few pairs in Nassagaweya Township, near Campbellville, in 1886.* It is not likely that the species occurred at all in the watershed after 1905, at the latest.

There are numerous references to great runs of Atlantic salmon in the Sixteen-Mile Creek. An area of land close to the river mouth was long retained by Indians under the terms of the Mississauga Purchase of 1805. This was chiefly because of the value of the river as a salmon fishery. This matter is discussed in greater detail in the Historical section of this report.

The river must originally have been excellent for the spawning of salmon. This is indicated by one of the early names, the "Gravois" or gravelly river. An early 18th century map shows it as the "Rivière au Saumon"† (salmon).

"Waggon loads of beautiful salmon taken out there" is a typical description (by Wm. Howes) of the former numbers. Mr. Howes also said, "They were speared with pitch-forks, but the dam spoiled all that."**

The major factor which caused the disappearance of salmon from Lake Ontario is not known. The chief causes are considered to be the presence of high dams, the silting of the inshore waters of the lake, the destruction of spawning

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* Michell, Margaret H., "The Passenger Pigeon in Ontario", Royal Ontario Museum of Zoology, Publication, Toronto, 1935.

† Mathews, Hazel, "Oakville and the Sixteen", University of Toronto Press, 1953.

** "Oakville Star", 1911, recollections of Wm. Howes, also quoted by Mrs. Hazel Mathews in "Oakville and the Sixteen", University of Toronto Press, 1953.

beds by the great quantities of sawdust and bark, and the intensive commercial fishing by nets and spears. Several mill-dams were built on the Sixteen-Mile Creek between 1830 and 1860. There is little doubt that salmon were rapidly declining in numbers in the creek during the forties. Salmon runs in the Credit were "only a memory" by 1855.* The same is probably true of the Sixteen-Mile Creek.

Of the former reptiles, the hog-nosed snake, (not a venomous species) was almost certainly found formerly in the Sixteen-Mile Creek Watershed. The last Toronto record was of one taken in 1907.† The Mississauga rattlesnake is also considered to have been fairly common in this part of Southern Ontario and was probably found in the watershed at least along the rocky escarpment edges.

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* Forster, J.W.L., "Under the Studio Light", 1928, p.14.

† From the records of E.B.S. Logier, Associate Curator of Herpetology, Royal Ontario Museum, Toronto.

CHAPTER 3

PRESENT SPECIES

1. Introduction

This watershed is visited by a considerable number of hunters looking for upland game birds (chiefly the Ring-Necked Pheasant) in season and also hunting for the Ruffed Grouse, the Red Fox, the European Hare, the Cottontail and the Groundhog. There is also much interest in all the animals of this area because there are a great many field naturalists living in Hamilton and Toronto and in the area between these centres of population. Hence the wildlife of the Sixteen-Mile Creek region is better known than that of most other parts of the province. The high, wooded bluffs in the northern sections and the sides of the deeply-carved valley lower down the river provide cover and food for many species. The shoreline of Lake Ontario attracts many waterfowl and shorebirds and is also on the migration route of many species of hawks.

2. Present Mammals

The following list includes those mammals which have been recently collected or observed in or near the watershed and other species which, from their general range, are considered to be certainly present. The arrangement and terminology of the list follow those of "A Provisional Check-List of the Mammals of Ontario"*. The survey is indebted to Dr. R. L. Peterson, Curator of Mammals, Royal Ontario Museum, for assistance in the preparation of this list.

MAMMALS OF THE WATERSHED

	COMMON NAME	SCIENTIFIC NAME	REMARKS
	Cinereous Shrew	Sorex cinereus	Trapped 1957
Y	Smoky Shrew	Sorex fumeus	From rattlesnake Point
Y	Water Shrew	Sorex palustris	From Freelton. Reported 1958 from a branch of the Credit River.

* Downing, S.C., "A Provisional Check-List of the Mammals of Ontario", Royal Ontario Museum 1948

Mammals of the Watershed (continued)

	COMMON NAME	SCIENTIFIC NAME	REMARKS
	Pigmy Shrew	Microsorex hoyi	
Y	Mole Shrew	Blarina brevicauda	Common 1957
Y	Hairy-tailed Mole	Parascalops breweri	From Norval
X	Star-nosed Mole	Condylura cristata	
	Little Brown Bat	Myotis lucifugus	Common
	Long-eared Brown Bat	Myotis keenii	
Y	Least Brown Bat	Myotis subulatus	From Terra Cotta
Y	Silver-haired Bat	Lasionycteris noctivagans	From Port Nelson
X	Pipistrelle	Pipistrellus subflavus	
X	Big Brown Bat	Eptesicus fuscus	Common
X	Red Bat	Lasiurus borealis	
Y	Hoary Bat	Lasiurus cinereus	From Erindale
X	European Hare	Lepus europaeus	Common 1957
	Varying Hare	Lepus americanus	
Y	Cottontail	Sylvilagus floridanus	From Lorne Park Common 1957
X	Black or Gray Squirrel	Sciurus carolinensis	Abundant 1957
X	Red Squirrel	Tamiasciurus hudsonicus	Common 1957
X	Woodchuck or Groundhog	Marmota monax	Common 1957
Y	Eastern Chipmunk	Tamias striatus	From Ferndale Common 1957
	Eastern Flying Squirrel	Glaucomys volans	
X	Northern Flying Squirrel	Glaucomys sabrinus	
	Beaver	Castor canadensis	Several removed in 1957
	Deer Mouse	Peromyscus maniculatus	Common 1957
X	White-footed Mouse	Peromyscus leucopus	Common 1957
X	Bog Lemming	Synaptomys cooperi	
	Muskrat	Ondatra zibethica	Common 1957
X	Meadow Mouse	Microtus pennsylvanicus	Very common at times
X	House Rat	Rattus norvegicus	
	House Mouse	Mus musculus	
X	Meadow Jumping Mouse	Zapus hudsonius	
Y	Woodland Jumping Mouse	Napaeozapus insignis	From Freelton
	Porcupine	Erethizon dorsatum	Several seen in 1957
	Brush Wolf	Canis latrans	
	Red Fox	Vulpes fulva	Several seen in 1957
	Raccoon	Procyon lotor	Common in 1957
	Ermine	Mustela erminea	
	Long-tailed Weasel	Mustela frenata	
	Mink	Mustela vison	
	Skunk	Mephitis mephitis	Very common
	White-tailed Deer	Odocoileus virginianus	Several seen in 1957

X Specimens from the watershed are in the collections of the Department of Mammalogy, Division of Zoology & Palaeontology, Royal Ontario Museum, Toronto.

Y Museum specimens from nearby (cited) areas are in the above museum's collections.

3. Birds

At least 220 species of birds either breed in, migrate through, or visit the watershed. Almost without exception these would be the same species which have already been listed in published reports concerning adjacent or nearby watersheds. It is therefore considered that a more useful list would include only those species which are known to spend the summer in the watershed, to visit it in winter, or to be permanent residents. All birds which merely pass over the area in migration are therefore excluded from the following list, which is based on records made by Dr. George Peck, of Oakville, Mr. Hubert Moore, formerly of Nassagaweya Township, and Mr. James L. Baillie, Research Assistant, Department of Ornithology, Division of Zoology and Palaeontology, Royal Ontario Museum.

The arrangement and names are from the American Ornithologists Union Check-List (5th edition, 1957).

A guide to the list follows:

PR = Permanent Resident
SR = Summer Resident
WV = Winter Resident or Winter Visitor
* = Breeding records available

SUMMER AND WINTER BIRDS OF THE WATERSHED

WV	Horned Grebe
*	Pied-billed Grebe
SR	Great Blue Heron
*	Green Heron
*	Least Bittern
*	American Bittern
*	Mallard
*	Black Duck
	Green-winged Teal
*	Wood Duck
WV	Canvasback
WV	Greater Scaup
WV	Barrow's Goldeneye
WV	Common Goldeneye
WV	Bufflehead
WV	Oldsquaw
WV	King Eider
WV	White-winged Scoter
WV	Common Scoter
WV	Common Merganser
WV	Red-breasted Merganser
*	Turkey Vulture
	Goshawk
*	Sharp-shinned Hawk
*	Cooper's Hawk
*PR	Red-tailed Hawk
	Red-shouldered Hawk
	Broad-winged Hawk
	Rough-legged Hawk
	Marsh Hawk
*PR	Sparrow Hawk
*PR	Ruffed Grouse
*PR	Ring-necked Pheasant
SR	Virginia Rail
*	Common Gallinule
*	Killdeer
	American Woodcock
*	Spotted Sandpiper
WV	Glaucous Gull
WV	Iceland Gull
WV	Great Black-backed Gull
WV	Herring Gull
WV	Ring-billed Gull
*	Black Tern
*	Rock Dove
*	Mourning Dove

	Yellow-billed Cuckoo
*	Black-billed Cuckoo
*	Screech Owl
*	Great Horned Owl
WV	Saw-whet Owl
	Whip-poor-will
*	Common Nighthawk
*	Chimney Swift
*	Ruby-throated Hummingbird
*	Belted Kingfisher
*	Yellow-shafted Flicker
*PR	Pileated Woodpecker
*	Red-headed Woodpecker
*	Yellow-bellied Sapsucker
*	Hairy Woodpecker
*	Downy Woodpecker
WV	Black-backed Three-toed Woodpecker
*	Eastern Kingbird
*	Great Crested Flycatcher
*	Eastern Phoebe
	Traill's Flycatcher
*	Eastern Wood Pewee
*WV	Horned Lark
*	Tree Swallow
*	Bank Swallow
*	Rough-winged Swallow
*	Barn Swallow
*	Cliff Swallow
*	Purple Martin
*PR	Blue Jay
*WV	Common Crow
*PR	Black-capped Chickadee
	White-breasted Nuthatch
*PR	Red-breasted Nuthatch
	Brown Creeper
*	House Wren
*PR	Winter Wren
*	Long-billed Marsh Wren
*	Catbird
*	Brown Thrasher
*WV	Robin
*	Wood Thrush
WV	Hermit Thrush
*	Veery
*	Eastern Bluebird
WV	Golden-crowned Kinglet
*	Cedar Waxwing
WV	Northern Shrike
	Loggerhead Shrike
*PR	Starling
	Yellow-throated Vireo
*	Red-eyed Vireo
	Warbling Vireo
*	Black-and-white Warbler
*	Golden-winged Warbler
*	Blue-winged Warbler
	Nashville Warbler
*	Yellow Warbler
WV	Myrtle Warbler
	Black-throated Green Warbler
*	Cerulean Warbler
*	Blackburnian Warbler
*	Chestnut-sided Warbler
*	Pine Warbler
*	Ovenbird
*	Northern Waterthrush
	Mourning Warbler
*	Yellowthroat
	Yellow-breasted Chat
	Hooded Warbler
*	Canada Warbler
*	American Redstart
*	House Sparrow
	Bobolink
*	Eastern Meadowlark
	Yellow-headed Blackbird
*	Redwinged Blackbird
*	Baltimore Oriole
*	Common Grackle
*	Brown-headed Cowbird
	Scarlet Tanager
*PR	Cardinal
	Rose-breasted Grosbeak
*	Indigo Bunting
WV	Evening Grosbeak
WV	Purple Finch
WV	Pine Grosbeak
WV	Hoary Redpoll
WV	Common Redpoll
WV	Pine Siskin
*	American Goldfinch
WV	Red Crossbill
WV	White-winged Crossbill
*	Rufous-sided Towhee
*	Savannah Sparrow
	Grasshopper Sparrow
*	Henslow's Sparrow
*	Vesper Sparrow
*PR	Slate-colored Junco
WV	Tree Sparrow
*	Chipping Sparrow
	Clay-colored Sparrow
*	Field Sparrow
	White-throated Sparrow
	Swamp Sparrow
*	Song Sparrow
WV	Snow Bunting

4. Amphibians and Reptiles

The watershed probably contains at least 24 species of amphibians and reptiles. Many people have an unreasoning fear of frogs, toads and salamanders, although they are harmless and useful to the gardener and farmer. Of the salamanders, the mudpuppy appears revolting to most people, but remains near the bottom of rivers and is seldom seen. The adults of the other salamanders are occasionally encountered under logs and detritus in forested land.

The Eastern garter snake is probably the commonest snake. The northern water snake is found only around ponds or near streams. The watershed is not within the known range of any venomous snake. It is extremely unlikely that any rattlesnake remains in the area.

The following list includes all those species known to occur in the adjoining Credit Watershed. Most of the species have already been reported from the Sixteen-Mile Creek area also. The writer is indebted to Mr. E. B. S. Logier, Associate Curator of Ichthyology and Herpetology, Division of Zoology, Royal Ontario Museum, for the list.

Salamanders

Mudpuppy	Necturus maculosus maculosus Rafinesque
Jefferson's salamander	Ambystoma jeffersonianum Green
Spotted salamander	Ambystoma maculatum Shaw
Newt	Diemictylus viridescens viridescens Rafinesque
Red-backed salamander	Plethodon cinereus cinereus Green

Frogs and Toads

American toad	Bufo terrestris americanus Holbrook
Spring peeper	Hyla crucifer crucifer Wied.
Tree toad	Hyla versicolor versicolor LeConte
Swamp tree frog	Pseudacris nigrita triseriata Wied.
Bullfrog	Rana catesbeiana Shaw
Green frog	Rana clamitans Latreille
Wood frog	Rana sylvatica LeConte
Leopard frog	Rana pipiens Schreber
Pickerel frog	Rana palustris LeConte

Turtles

Snapping turtle	<u>Chelydra serpentina serpentina Linnaeus</u>
*Wood turtle	<u>Clemmys insculpta LeConte</u>
Central painted turtle	<u>Chrysemys picta marginata Agassiz</u>

Snakes

Northern water snake	<u>Natrix sipedon sipedon Linnaeus</u>
De Kay's brown snake	<u>Storeria dekayi dekayi Holbrook</u>
Red-bellied snake	<u>Storeria occipitomaculata occipitomaculata Storer</u>
Eastern ribbon snake	<u>Thamnophis suaritus suaritus Linnaeus</u>
Eastern garter snake	<u>Thamnophis sirtalis sirtalis Linnaeus</u>
Eastern ring-necked snake	<u>Diadophis punctatus edwardsi Merrem</u>
Eastern smooth green snake	<u>Opheodrys vernalis vernalis Harlan</u>
Eastern milk snake	<u>Lampropeltis doliata triangulum Lacépède</u>

5. Status of Game and Fur Species

The status of the chief game species and fur bearers is as follows:

European Hare	Introduced, generally distributed and widely hunted.
Varying Hare	Probably found only in the upper part of the valley and in the woodlands above the escarpment.
Cottontail	Common wherever brushy cover and scattered agricultural land are both found.
Beaver	Abundant in the past and referred to in the records of several surveyors. A few pairs re-established themselves along the West Branch recently but most of them were removed in 1947 and relocated elsewhere by officers of the Department of Lands and Forests, because they were damaging roads, woodlands and pastures,
Muskrat	A common inhabitant of most of the marshy areas.
Red Fox	This species has been very common in recent years.
Raccoon	Common and a nuisance to farmers and all others whose houses are near a watercourse.
Mink	Tracks are commonly seen along the permanent streams.
Skunk	Common throughout the watershed.

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* Reported from near Bronte, just outside the watershed.

White-tailed Deer	A common species in the woodlands and along the main valley.
Ring-necked Pheasant	The good habitat for these birds lies close to Lake Ontario where the snow does not remain deep for more than a few days at most. However many pheasants have been planted in all of the townships in the watershed. It is probable that in winters of high snowfall no pheasants can survive in the northern part of the watershed without extra food supplied by man.
Hungarian Partridge	None were reported during the course of the survey, and it is presumed that none are in the watershed in the wild state. If it could be established, this species might do better than the pheasant.
Waterfowl	Although there are scattered records of Mallards, Black Ducks and Wood Ducks breeding in this watershed, the area does not provide any important large marshes, and there are relatively few small ones. Naturally a few of these ducks, along with several of the species listed as winter visitors - which actually are migratory species - can be shot in the watershed and along the shore of Lake Ontario. Waterfowl are not an important part of the fauna of this area.

CHAPTER 4

IMPROVING THE LAND FOR WILDLIFE

The many varied types of land in the Sixteen-Mile Creek Watershed have already been mentioned. The requirements of food and cover vary greatly for different species of wildlife. The recommendations listed here are therefore those which can be most generally applied by the landowner. It may be assumed that few farmers who work the exceptionally rich and almost flat lands of the Peel Plain will wish to improve their land for wildlife. But even in this land, where erosion is not a serious problem, there are, of course, drainage channels including the deeply-carved valleys of the East and West Branches of the river. Many farmers use, and others perhaps should use, windbreaks. These features tend to increase the potential of land for wildlife. The following remarks, therefore, apply to those whose lands include a part of the escarpment or the rough land along or above it, and to others who wish to improve the carrying capacity of the land for wildlife. As there is much land in the southern part of the watershed which is lying idle, being held for possible future subdivision for residential or industrial use, this type of land, with its weedy patches is probably now providing good habitat for upland game such as pheasants. In winters of deep snow these will need additional food in order to survive.

1. Woodlands

The elimination of grazing on the 17 per cent of the land now in woodlots would be the most useful single measure in improving the wildlife environment. In plantations, up to about the 10th year from planting, the entire planted area is valuable for wildlife. But large blocks of coniferous trees will, at least after about the 12th year from planting, have little or no undergrowth and will, apart from their edges or fire-breaks in them, be comparatively sterile as far as upland game and most forms of wildlife are concerned. The chief improvements to be expected will therefore come from good management of the farm woodlot. Selective cutting is both sound forestry practice and good planning for wildlife. Landowners who have woodlots in which the crown canopy has closed over considerable areas and who wish to produce a proper environment for wildlife will find that release cuttings, slashings to stimulate sprout growth, thinnings and felling timber for sale will improve rather than retard the carrying capacity for wildlife. Construction of brush piles from cuttings is recommended where cottontail rabbits are desired, two or three such brush piles per acre being the normal spacing.

2. Cultivation Practices

All good farming practices which make a more luxuriant vegetation will improve the farm environment for wildlife. A few special practices will give more specific benefits. Strip-cropping, described elsewhere in this report, is of particular value, since by this means no extensive area is denuded of cover at one time by harvesting. In the less flat parts of the agricultural section of the watershed filter strips, either above water diversion terraces or used as emergency waterways, provide travel lanes and nesting cover for wildlife. Cover crops such as the clovers and hairy vetch provide a habitat and food for wildlife in areas that would otherwise be barren during the winter months.

The elimination of brushy fencerows is now becoming more common in the Sixteen-Mile Creek Watershed. Those who are interested in wildlife improvement will find that the inclusion of a few field boundary hedges on the farm will moderate the effect of winds on crops, serve as travel lanes and cover for wildlife and harbour large numbers of songbirds which may help to control insect pests. Inevitably the presence of boundary hedges on a farm tends to encourage the growth of weeds. This is the price that must be paid for improved wildlife conditions.

Rosa multiflora is an excellent hedge-forming shrub. It has a tendency, in Southern Ontario, to die back in winter but rapidly forms a dense hedge, which is reported to be proof against cattle and hogs. It provides both cover and food and does not exhaust the nearby cultivated ground. However, in view of the questionable hardiness of some varieties the stock used should be known to be hardy in Southern Ontario.

The following are a few species of plants which are of particular value as food for wildlife. Those marked with a star (*) can usually be found growing on some part of every farm.

* Wild Grape - This plant provides excellent wildlife food and cover, but it forms such a dense tangle over fences and young trees that it should only be planted where it can be carefully watched and controlled.

Hairy Vetch - This plant can be grown on poor, sandy soil, and overwinters well. Cottontails and the European Hare use it for food and cover. The seeds are eaten by a great many of the ground-feeding birds.

European Millet - This plant fruits profusely and the seed attracts vast numbers of birds. It is grown commercially for bird seed.

* Elderberry - A great many species of birds feed on the small black juicy berries, and there are not often many of the fruits left in winter. However, the birds, once attracted, will return to feed on other fruits.

Corn - A few rows of uncut corn standing in a field or garden will provide excellent cover and a continual supply of food for the larger birds, including the Ring-necked Pheasant and the Hungarian Partridge. Cracked corn is useful for smaller birds. Corn left near streams will almost certainly be removed and eaten by raccoons. At present there are probably no

Hungarian Partridges reported in the watershed, although they thrive both east and west of it in various parts of Ontario. The Authority might urge an experimental introduction of the species, when the present population in other areas of the Province reaches a high level.

Buckwheat - This common crop plant is chiefly grown for its abundant seed which is mixed in with other seeds in feed mixtures. The seeds have a high fat content, while the rest of the plant is commonly ploughed under particularly to increase the soil nitrogen. Much of the seed drops off into the stubble, and buckwheat stubble is a favoured feeding ground for the Hungarian Partridge and many other birds.

Highbush Cranberry - This shrub is strongly recommended, and grows as a native species in this area.

There are many other plants that could be recommended for use as cover, food or nesting sites in gardens. The best general reference book on this subject, for birds of this area, is "Planting Your Garden for Wild Birds" by James R. Mackintosh, published by the Audubon Society of Canada, 181 Jarvis Street, Toronto, Ontario.

3. Field Corners

Field corners are frequently barren of crops, and the ground cannot be ploughed to the corner. Therefore a fence crossing which embraces the corners of four fields may be made into a haven for ground-nesting species by planting a few trees and shrubs and protecting them. It is important to rid such areas of useless weeds by crowding them out with the normal climax type of open vegetation, such as Bluegrass, (Poa pratensis L.).

4. Ponds and Streams

The importance of water to wildlife is often forgotten. Many farms have at least one low spot where a small amount of work with a scoop will create a dam and a pond to provide nesting and feeding sites for water and marsh birds. If possible, ponds for wildlife should be separate from those intended for cattle or for fish. Willow cuttings, preferably shrub species rather than tree species, can be pushed in the ground around such a hollow, and will rapidly provide wildlife cover. New water areas are usually very rapidly invaded by aquatic plants, but additional species may have to be introduced. No extensive duck food studies have been made in Southern Ontario. Wild rice may be introduced, but since it is not well adapted to wide variations in water levels during its growing season, being often sterile in fluctuating waters, it cannot be considered as certain to succeed. The seed must be kept wet from the time it is harvested until it is sown (or broadcast) on the water surface. The idea has long been current, and fostered by many sportsmen's organizations, that the growing of wild rice is the answer to the problem of how to attract ducks to any area. Wild rice is actually of little significance to ducks in Canada except in the fall, and does not provide good cover or nesting sites.

The following species, which may be easily obtained, are recommended as certain to be valuable duck foods. If none of them occur in ponds or shallows with good cover for ducks, they can be introduced. All of them are hardy in Southern Ontario.

Sago Pondweed	Potamogeton pectinatus L.
Red-Head Pondweed	Potamogeton Richardsonii (Ar. Benn.) Rydb.
Wild Millet	Echinochloa crusgalli (L) Beauv.
Japanese Millet	Echinochloa frumentacea (Roxb) Link
Wild Celery	Vallisneria americana Michx.
Knotweed	Polygonum pensylvanicum L.
Water-Smartweed	Polygonum coccineum Muhl.
Three-square	Scirpus americanus Pers.
Great Bulrush	Scirpus validus Vahl., var. creber Fern
Duckweed	Spirodela sp. and Lemna sp.

Those who are interested in farm ponds for wildlife will find very useful details of the various types of pond and methods for constructing each type in a booklet, "Farm Ponds", which is available from the Provincial Department of Agriculture.* Farm ponds differ from those intended for wildlife in that care is usually taken to prevent the growth of aquatic vegetation in a farm pond intended only for watering stock or fire protection purposes. Otherwise, the construction and details of ponds for wildlife should follow one of the types there described.

Algae in ponds are often only present for a short time and will disappear in a month or so. A concentration of 0.5 p.p.m. of copper sulphate will destroy them temporarily at least. The larger aquatic vegetation, if too abundant, cannot be removed except by cutting (a heavy chain is useful), by draining the pond or by the use of 2,4-D for emergent vegetation or poisonous compounds such as sodium arsenite for submerged plants. These compounds will of course kill fish also, and the use of this method requires permission from the Provincial Department of Lands and Forests and the Water Resources Commission of Ontario if the treated water flows into any other privately owned or public waters.

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* Applications may be made to the nearest Provincial Agricultural Representative or to the Department of Agriculture, Parliament Buildings, Toronto.

CHAPTER 5

FISH

1. Introduction

The purpose of this survey was to classify the waters of those drainage basins under the Sixteen-Mile Creek Conservation Authority as to their present suitability for fish, and to make recommendations for possible improvements.

2. Methods

The procedure here adopted followed closely that used in other surveys made by the Department of Planning and Development in other river systems. The various streams were visited at 131 different stations. The stations were from half a mile to three miles apart on each stream course. At every station the topography of the valley and the erosion, vegetation, volume of flow, turbidity, temperature and type of bottom were listed. At all suitable stations collections of the aquatic insects and other invertebrates were made. At most of the stations collections of fish were also made. The collections were later examined and classified and were used in zoning the various sections of the river, as shown on the accompanying map.

Certain insects are particularly useful for this purpose since many of them are reliable indicators of what the stream conditions will be at the critical time of year. Some species are confined to waters which remain cold and usually clear in summer, such as brook trout waters. Other species are indicators of permanent flow or of polluted water or of the maximum summer temperature of the water. The fish collections and the records of maximum-minimum thermometers substantiated these findings at their particular stations.

Since the procedure here used follows that of previous river surveys it allows close comparisons of the characteristics of many rivers. The present criteria and methods were developed from more intensive year-round research carried out by Dr.F.P.Ide* of the Department of Zoology, University of Toronto, on many streams in Ontario. The analysis by J.C.Hallam† of previous river surveys made by the Department of Planning and Development was also found extremely useful.

The streams were examined between May the 15th and June the 30th, and many of them were examined only once. The flow of the river was far above the normal minimum summer flow. It was therefore necessary to rely extensively on deductions made from the presence or absence of species known to be reliable indicators.

Five maximum-minimum thermometers were installed in the river at various points. Four of these thermometers were installed in the West Branch above Milton. One was installed in a tributary of the East Branch which was said to support brook trout. Since the water had already reached a temperature of 81° before the end of June, it is extremely unlikely that this stream would, in fact, support brook trout during an average summer.

3. <u>The River Valley</u>

The kinds and numbers of fish in a river system depend greatly on the physiographic conditions of the water-

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* Ide, F.P. The Effect of Temperature on the Distribution of the Mayfly Fauna of a Stream. University of Toronto Studies, Biology 39, Ontario Fisneries Research Laboratory, Publication 50, 1935.

Ide, F.P. Quantitative Determination of the Insect Fauna of Rapid Water. University of Toronto Studies, Biology 47, Ontario Fisheries Research Laboratory, Publication 59, 1940.

Sprules, W.M. An Ecological Investigation of Stream Insects in Algonquin Park, Ontario. University of Toronto Studies, Biology 56, Ontario Fisheries Research Laboratory Publication 69, 1947.

† Hallam, J.C. Habitat and Associated Fauna of Selected Species of Fish in Ontario Streams. M.A.Thesis, University of Toronto, 1954.

The effects of beaver dams on the appearance and vegetation of the watershed in Concession I of Nassagaweya Township. The beaver have since been removed by staff of the Department of Lands and Forests.

The main stream of Sixteen-Mile Creek meanders in a wide valley two miles west of Trafalgar. This is at Lot 15, Concession II N.D.S. Trafalgar Township.

shed. The major features determining the river's course and condition are therefore mentioned here.

Almost all of the streams in this watershed that have permanent flow are fed from the land above the escarpment. Thus the West and Middle Branches of the Sixteen-Mile Creek rise in the gravelly and sandy hills, terraces and swamps in Esquesing and Nassagaweya Townships. These areas in general have a relatively thin soil over limestone bedrock and there is a high proportion of woodlands in them. The West Branch has two tributaries which flow over wooded areas where there have frequently been impoundments made by beaver dams. The upper part of the East Branch is merely a drainage channel in the gently sloping Peel plain. The East and Middle Branches meet near Drumquin, and here the stream begins to meander in a larger valley. The valley of the West Branch or main Sixteen-Mile Creek begins to be of large size east of Boyne and meets with the rest of the river below Glenorchy. From this point on down to the mouth the Sixteen-Mile Creek continues in a large valley of which the sides are about a hundred feet high and extremely steep and eroding in many places. At the north end of Oakville the valley slopes are extremely steep, but below No.2 Highway they are neither high nor steep and the river has more the appearance of an inlet from Lake Ontario. The remaining streams which flow into Lake Ontario within the Authority boundary are not important.

There are no major obstructions in the stream between Oakville and the mill dam at Milton on the West Branch. Other major dams on the West Branch include the one at Peru Park north-west of Milton and the mill dam below Campbellville. There is also, of course, the dam which makes the upper pond at Campbellville. On the East and Middle Branches there are remnants of several old dams just as there are on the West Branch, but none of these provides important obstruction, at least as far up as Station AA2a9, (on the map "Collection Stations").

The typical condition of the west branch of Sixteen-Mile Creek in summer. The gradient is high, the stream relatively shallow, and there is a shortage of good fish cover. This stream is 2 miles southeast of Campbellville, not far from excellent spring sources.

The typical summer condition of the upper parts of the Oakville Creek in the Peel Plain. The stream is dry but there are scattered standing pools. This photograph was taken in Concession 5 of Trafalgar Township.

It may be seen from reference to the Hydraulics Section of this Report that the average gradients of the East and Middle Branches down to the Forks, are about 18 feet per mile, while that of the West Branch is slightly greater. The gradient of the main river below the Forks is about 25 feet per mile, and the gradients of the West Branch and the Middle Branch where they descend the escarpment are, of course, much greater. There are therefore, apart from the sections at the escarpment, in each branch a series of alternating small rapids and pools. There are very few deep pools in the river's course. The numbers of stations at which stones, gravel, sand, silt and clay appeared as important components were noted at 121 of the 131 stations visited.

The status may be summarized as follows:-

Stones at 83 stations
Gravel at 78 stations
Sand at 43 stations
Silt at 79 stations
Clay at 22 stations

The West Branch and the upper part of the Middle Branch, of course, had less clay and more gravel, stones and sand as components than the East Branch. The stream bottom was silted at most of the stations in the Peel plain.

4. Permanence of Flow and Temperature Conditions

The permanence of flow of the river and its tributaries is shown on the accompanying map "Biological Conditions of Streams". The permanence was based on the presence or absence of certain insect larvae which are not found except where there is permanent flow. The genus used was Hydropsyche, one of the Caddisflies. The conditions shown are applicable in any year of relatively normal precipitation and temperature. Very exceptional weather conditions would, of course, change the stream condition.

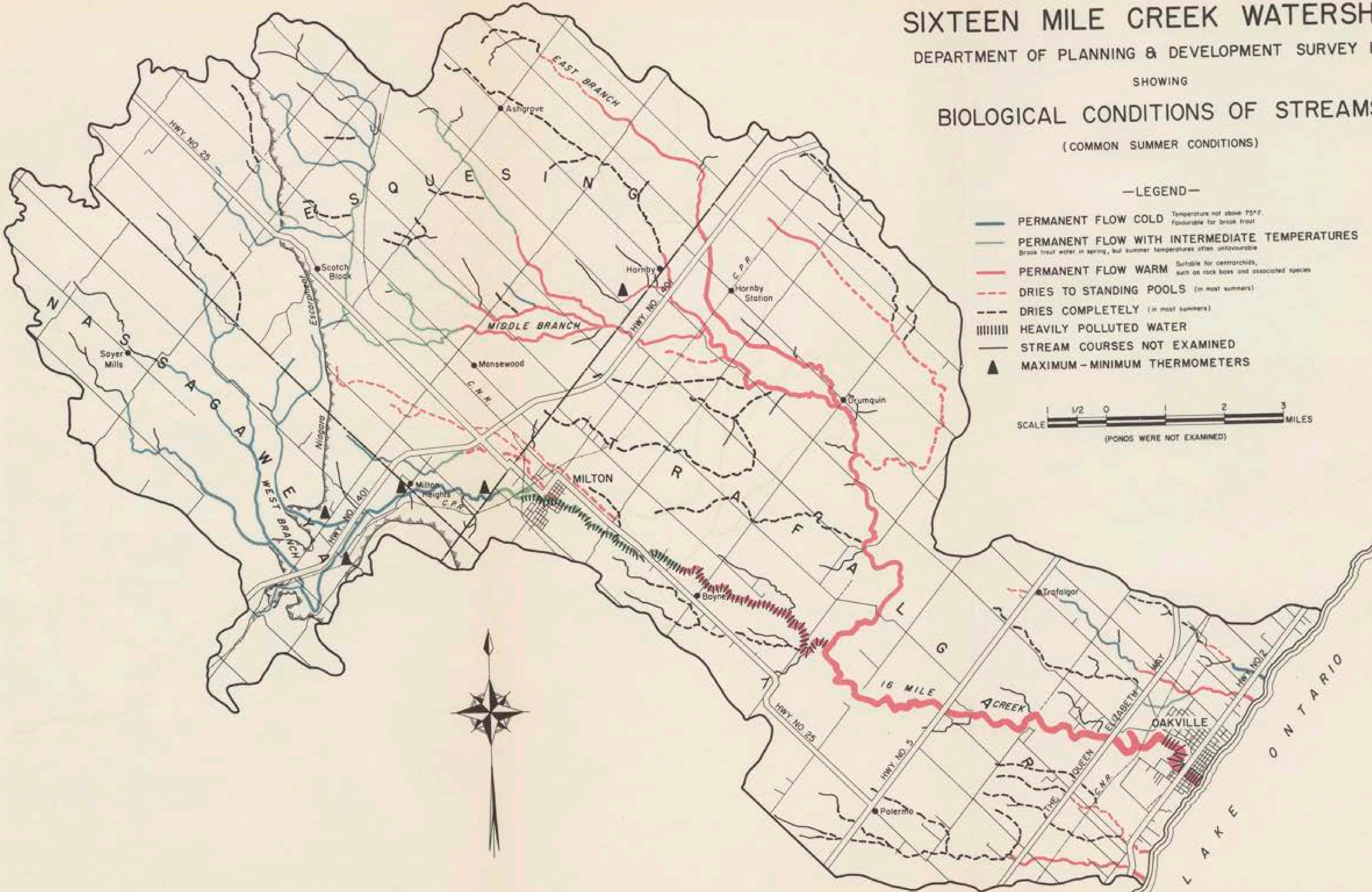
SIXTEEN MILE CREEK WATERSHED

DEPARTMENT OF PLANNING & DEVELOPMENT SURVEY 1957

SHOWING

BIOLOGICAL CONDITIONS OF STREAMS

(COMMON SUMMER CONDITIONS)



The summer temperature conditions affecting the distribution of fish are shown on the accompanying map. Adult brook trout should thrive best in the lower parts of the sections coloured blue. The greatest daily fluctuations in temperature are found in the sections coloured green. Brook trout may inhabit some of the green sections, particularly the upper parts, in early or late summer but will move out or be killed in the warm days of midsummer. Brown trout appear to adapt themselves better to the higher temperatures in these sections, i.e. they thrive in slightly warmer water than the optimum water for brook trout, but both species have approximately the same lethal or killing temperature (depending on the temperature-range to which they have been acclimatized).

The water temperatures in the area below Milton will, of course, be affected slightly by the new wells which add additional water, However, in spite of the large and well designed treatment plant now under construction, the extra load caused by the much larger population and the present and planned industrial growth may continue to inhibit the presence of game fish in the river for many miles downstream.

The runoff from Hurricane Hazel apparently had little or no effect on stream conditions affecting fish in this watershed. The removal of water for irrigation or industries may have more serious effects.

5. Fish Distribution

The following 30 species of fish were found in the rivers and streams of the watershed during the survey of 1957.

LIST OF FISHES OF THE SIXTEEN-MILE CREEK WATERSHED
(From the 1957 collections)

Common Name	Scientific Name	No. of Stations at which the Species was collected in 1957 Survey
Lampreys	Petromyzonidae	
Sea lamprey	*Petromyzon marinus*	1
Herrings	Clupeidae	
Alewife	*Alosa pseudoharengus*	1
Salmons and trouts	Salmonidae	
* Brook trout	*Salvelinus fontinalis*	7
Suckers	Catostomidae	
Hog sucker	*Hypentelium nigricans*	12
* White sucker	*Catostomus commersoni*	50
Minnows	Cyprinidae	
Golden shiner	*Notemigonus crysoleucas*	3
* Creek chub	*Semotilus atromaculatus*	82
Redside dace	*Clinostomus elongatus*	25
Northern redbelly dace	*Chrosomus eos*	17
Lake chub	*Couesius plumbeus*	2
Hornyhead chub	*Nocomis biguttatus*	9
Blacknose dace	*Rhinichthys atratulus*	74
Longnose dace	*Rhinichthys cataractae*	3
Common shiner	*Notropis cornutus*	44
Rosyface shiner	*Notropis rubellus*	10
Brassy minnow	*Hybognathus hankinsoni*	5
Bluntnose minnow	*Hyborhynchus notatus*	41
Fathead minnow	*Pimephales promelas*	61
Catfishes	Ameiuridae	
Stonecat	*Noturus flavus*	2
Mudminnows	Umbridae	
Central mudminnow	*Umbra limi*	3
Sunfishes	Centrarchidae	
* Smallmouth bass	*Micropterus dolomieui*	3
Pumpkinseed	*Lepomis gibbosus*	5
* Rock bass	*Ambloplites rupestris*	12
Perches	Percidae	
* Yellow perch	*Perca flavescens*	1
Johnny darter	*Etheostoma nigrum*	22

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* Species which may be familiar to the angler are starred.

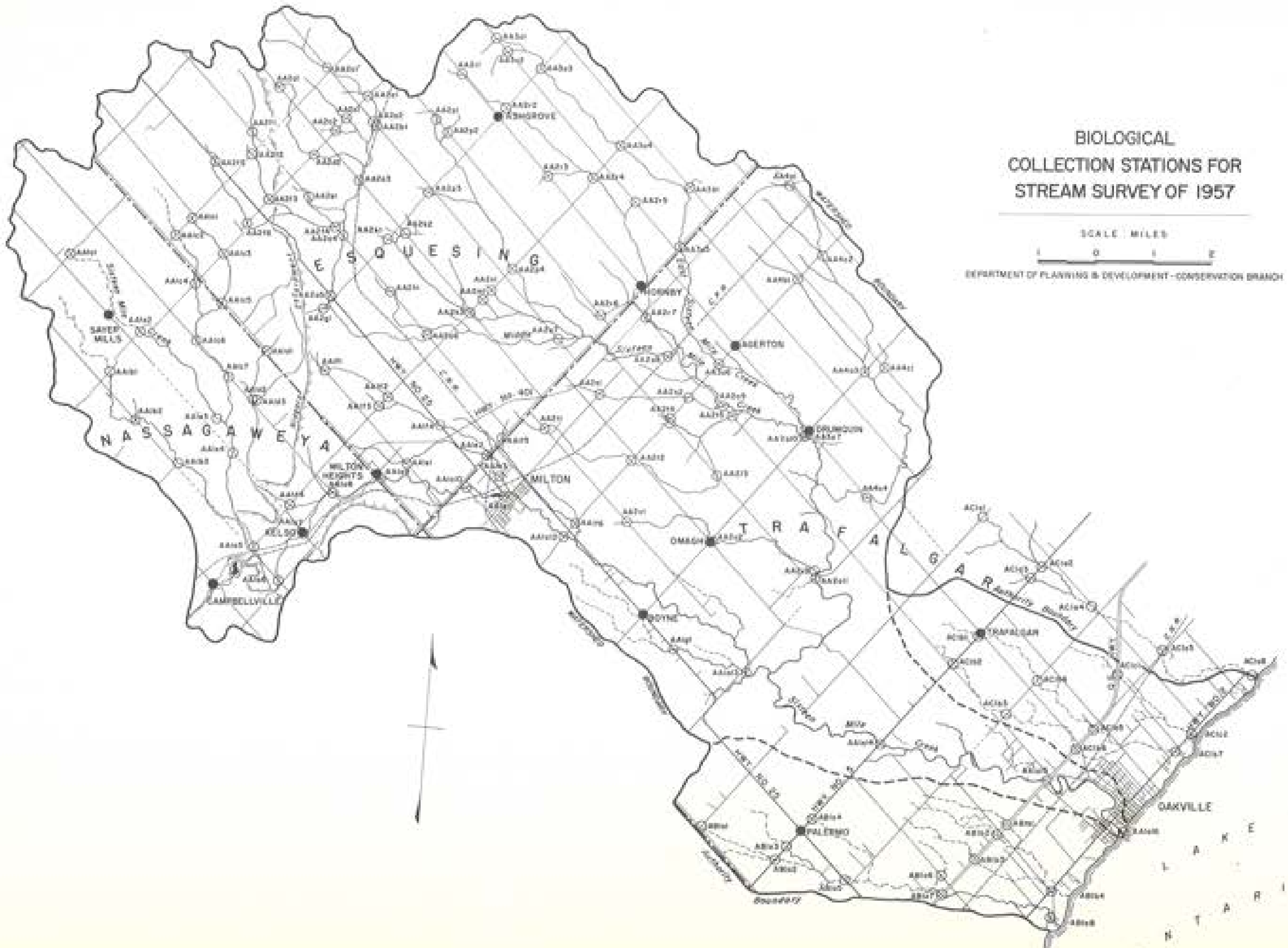
The naming or terminology in the list is that approved in February, 1958 by W.B.Scott, Ph.D., Curator of Ichthyology and Herpetology, Royal Ontario Museum, Toronto.

BIOLOGICAL
COLLECTION STATIONS FOR
STREAM SURVEY OF 1957

SCALE MILES

1 0 1 2

DEPARTMENT OF PLANNING & DEVELOPMENT - CONSERVATION BRANCH

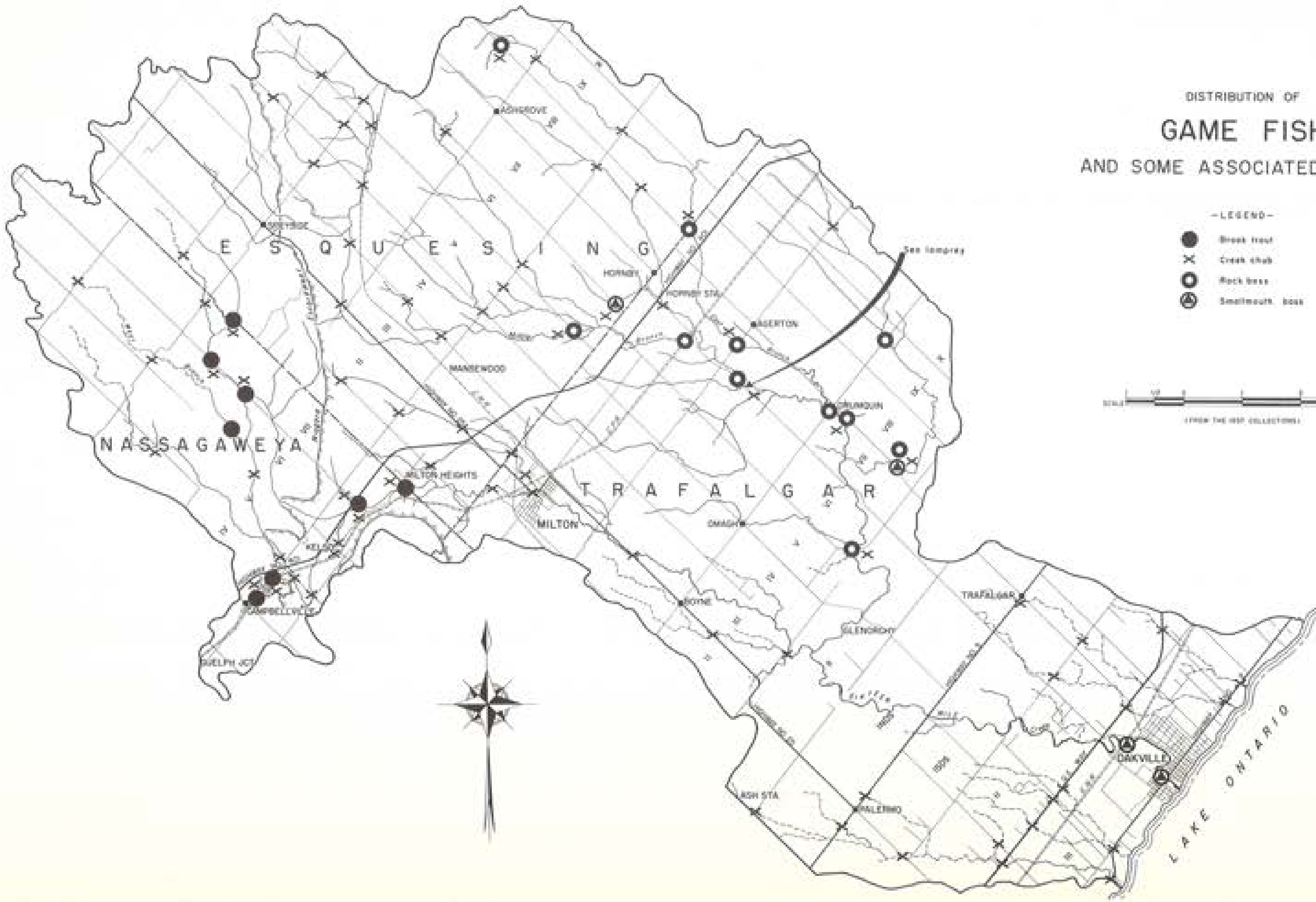


Rainbow darter	Etheostoma caeruleum	24
Fantail darter	Etheostoma flabellare	19
Sculpins	Cottidae	
Mottled sculpin	Cottus bairdi	1
Sticklebacks	Gasterosteidae	
Brook stickleback	Eucalia inconstans	52
Threespine stickleback	Gasterosteus aculeatus	2

The collections in 1957 did not turn up either a large number or variety of game species of fish. The distribution of the major game species and some associated ones, based on the 1957 collections, is shown on the accompanying map. The map is, of course, not intended to give any estimate of the relative numbers or of the locations where fish of acceptable length for angling will be found. Further collecting would, of course, increase the known range of some of the species, and there would be a few additional species. For example, the smelt presumably enters the river in spring.

Brook trout were collected at only seven stations. This may be partly because at the time of survey beaver had dammed the West Branch of Sixteen-Mile Creek between the points AA1c7 and AA1a4 shown on the accompanying map of collection stations. The dam may have raised the surface temperature of the water and also may have temporarily reduced the flow and cover for trout during the previous fall.

The most significant feature concerning the cool sections of the stream was the apparent absence of a relatively common indicator of brook trout water. The mottled sculpin (the indicator species referred to) was taken at only one station during this survey at Campbellville. For the sake of contrast, the species was found at 29 stations in brook trout water on the Humber River. The lack of trout in the Middle Branch of Sixteen-Mile Creek in those sections which are permanent and cool is probably the result of their very small volume of flow in summer. In occasional summers they may dry up completely. There is also the fact that east of


DISTRIBUTION OF
GAME FISH
AND SOME ASSOCIATED SPECIES
-LEGEND-
Brook trout
Creek chub
Rock bass
Smallmouth bass
(FROM THE 1957 COLLECTIONS)
Sea lamprey
ESQUESING
NASSAGAWEYA
TRAFALGAR
ASHGROVE
HORNBY
HORNBY STA.
AGERTON
DRUMQUIN
MANSEWOOD
MILTON HEIGHTS
MILTON
OMAGH
BOYNE
GLENORCHY
TRAFALGAR
CAMPBELLVILLE
GUELPH JCT.
ASH STA.
PALERMO
OAKVILLE
LAKE ONTARIO

provincial Highway No.25 and below Station AA2f6, the stream cascades down the bouldery bluff of the escarpment.

The distribution of the creek chub is shown on the map as indication of the frequency of a relatively tolerant species. The alewife was, of course, taken only near the mouth of the river. A single mature sea lamprey was found at Station AA2a9 on the Middle Branch. There are, however, several sections both above and below this station which might be considered suitable spawning grounds for the sea lamprey. There are also several sections on the West Branch below Milton which might be satisfactory for spawning sea lampreys if the reduction of strength of the polluting effluent (from the improved sewage treatment plant) is not offset by an increase in population and industry.

Rock bass were found only in the East and Middle Branches of Sixteen-Mile Creek. The white sucker was very common throughout the watershed, except in the heavily polluted sections. The yellow perch was found only near the mouth of a small stream which enters Lake Ontario east of Oakville. The remaining twenty-two species, many of which were very common, are chiefly small minnows and darters, of little interest to anglers except as forage fish.

6. Pollution

The pollution in Sixteen-Mile Creek is discussed in detail in the Hydraulics section of this report. The major polluted sections at the time of survey are shown on the accompanying map "Biological Conditions of Streams". Pollution from cattle was not found to be important in this river system. It is entirely possible that there will be heavy silting from gravel washing operations if the gravel supply for the extension of Highway 401 is taken from this watershed. Since there is this possibility and one of pollution from the expected industrial expansion when Highway 401 is completed north of Milton, it is recommended that the

Conservation Authority set up an Advisory Committee on Pollution.

7. Stream Improvement

It appears unlikely that the section of stream from Milton to the junction of the two branches will provide many game fish in the future, or that it will be attractive to fishermen, because of its relation to the effluent from the treatment plant at Milton and the industrial development in that area. Any useful improvements will therefore probably be made above Milton, or on the Middle Branch or between the junction of the main branches, where there is greater dilution, and the Queen Elizabeth Highway.

Almost all the water of Sixteen-Mile Creek is shallow, and there is relatively little good fish cover. The best cover observed was at or near the following stations which can be located on the map of collection stations:

AA1a2	AA1c4
AA1a3	AA2a3
AA1a5	AA2f4
AA1a8	AA2f6
AA1a10	

None of these stations lies far down the river and all of them are in sections considered suitable for brook trout. However, the only parts of the stream which have a relatively large volume of flow and which may be expected to supply good fishing without small dams or deflectors appear to be those near AA1a8 and AA1a10. Sixteen-Mile Creek does, however, provide trout water which could easily be made very productive, along a stretch of more than three miles of stream paralleling the general route of the new provincial Highway 401, which will have clover-leafs north of Campbellville and at Highway No.25. Good trout water open to the public and within easy access from the large centres of population is rapidly becoming a rarity. The Conservation Authority might therefore urge the acquisition of one or more good stretches of the

Fish
Excellent cover from alders on the banks and logs in the stream. This is a productive section of the west branch near Campbellville.

A low dam which provides good depth but little fish cover. This is a Station AA1a5 on the accompanying map.

A stone deflector increases the stream current slightly.

stream in this area for the public. Wherever necessary, deflectors and small dams could be installed.

An arrangement could probably be made with the Provincial Department of Highways concerning the management of the part of the stream and streambed which is within the boundary of property acquired by the Department of Highways for construction of the new road. Similar arrangements have been made by other Conservation Authorities in Ontario. The general area involved extends from Station AA1a5 to AA1a9. It is perhaps worth noting that many governments, for example that of New York State, have long since acquired stretches of first-class trout streams in agricultural as well as other land, so that they will not be lost to the general public.

8. Farm Fish Ponds

There is ample room for improvement of this type of fishing. The chief research on management of farm fish ponds has been carried on in southern and warmer climates, and therefore the findings cannot be applied without qualification to an area having the climate of Southern Ontario, but some definite recommendations may be made. Suitable methods for the construction of six types of farm pond are given in a bulletin, "Farm Ponds", which may be obtained from the Ontario Department of Agriculture.

From the fisherman's point of view, farm ponds are of two main kinds:

(a) Trout Ponds

The first is the cool pond with continuous inflowing water and maximum temperatures at the surface of about 75° Fahrenheit with cooler bottom. Ponds of this type are adapted to the production of speckled or brown trout. They are usually placed near the headwaters and may range in size from about an acre to 8 or 10 acres. Depth should be 10 feet or more in the deepest part. Spring flow of as low as half a cubic foot per second will maintain a pond of one acre.

The outlet of each dam should be a pipe (with a screened inlet at the bottom of the pond) rising close to the normal surface level and there passing through the dam, so that cold water is drained from the bottom and the warmed surface water is not allowed to flow over the dam. The surface water in the pond serves as an insulating layer, and the water below the pond has scarcely been heated by its passage through the pond. The pipe should be of such a size as to discharge the minimum summer flow. In time of flood the additional flow would pour over the dam at a suitable outlet, or be carried around it by a grassed spillway.

The by-pass type of pond has two particular advantages for the production of either speckled or brown trout. A pond of this class is built close to but not on a permanent stream and gets its name from the fact that the water supply is by-passed through a pipe from the stream to the pond. The first advantage is that there is no danger of the pond filling up with silt, because any excessive run-off goes down the permanent stream channel and not through the pond. The other advantage is that by controlling the amount of cold water entering the pond the temperature of the pond may be adjusted to give the maximum growth rate in the fish kept there.

However, trout ponds do not normally have spawning beds for trout and, therefore, must be managed on a put-and-take basis, i.e. stocked artificially.

(b) Warm-Water Ponds

The second and commoner type of farm pond is the warm-water pond. Most farms have at least one low spot suitable for a fish pond. It is frequently good practice to have separate ponds devoted to wildlife and fish and to control the aquatic plants in the fish pond.

In managing warm-water ponds for fish the following points should be kept in mind.

(1) A minimum depth of 12 feet over at least 25 per cent of the pond should be planned to avoid excessive winter kill,

probably the critical factor in fish survival in farm ponds in Ontario.

(2) If suckers, carp or large numbers of minnows are already present in the pond, it is usually best to destroy all fish in the pond before stocking.

(3) It is often necessary to control existing aquatic vegetation. There are both mechanical and chemical methods available.*

(4) Since many of the species commonly recommended for introduction grow very slowly in Ontario waters, research to determine the most satisfactory species will be needed. New ponds and those in which the previous fish have been destroyed might be stocked experimentally with a combination of large-mouth bass (Micropterus salmoides) and one of the forage fish species. The most suitable forage fish for farm ponds in the Sixteen-Mile Creek would probably be the fathead minnow (Pimephales promelas), which is very common in the watershed. It was collected at 61 collection stations on the river, and does well in ponds.

If it is found necessary to control the numbers of young largemouth bass, a pure race of the bluegill might be used instead of the minnows, but these would probably have to be imported from the United States, as those found here commonly include hybrids with the pumpkinseed. Those importing fish should have the arrangement approved by the provincial Department of Lands and Forests.

The fertilizing of ponds for the increased growth of plankton (the smaller aquatic invertebrates) to provide food for fish, should be approached with caution. Those considering fertilizing ponds should apply to the local District Biologist at Hespeler for advice.

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* Speirs, J.Murray. Summary of Literature on Aquatic Weed control. Canadian Fish Culturist, 3:(4); August 1948. (Many other chemical compounds have been developed for this purpose since the publication of the above summary).

SIXTEEN MILE CREEK CONSERVATION REPORT

RECREATION

ONTARIO DEPARTMENT OF PLANNING AND DEVELOPMENT

CONSERVATION BRANCH

CHAPTER 1

RECREATION PLANNING

In the area lying between Metropolitan Toronto and Hamilton, which is rapidly becoming urbanized by the encroachment of industry and residential building on what was formerly agricultural land, there is an urgent and ever-increasing need for recreation facilities. The situation is made more acute by the fact that nearly all the lake-front property is privately owned and so inaccessible to the general public.

The most suitable areas for recreational development existing at the present time lie along the valleys of the streams flowing into Lake Ontario, and particularly where the larger streams such as Sixteen-Mile Creek descend the Niagara escarpment to the till plain. Sixteen-Mile Creek lies midway between the two great metropolitan centres mentioned above. Within the watershed are lands eminently suitable for Conservation Areas and the Authority should make every effort to develop such facilities.

In Milton, Oakville and the southern portion of Trafalgar Township there are areas set aside as municipal parks, but the program of the Authority should include the development of Conservation Areas where recreation facilities, serving a broad area, will introduce the public to the subject of conservation and keep it advised of the work the Authority is doing.

1. The Need for Recreational Facilities

Two factors combine to increase the need for recreation facilities in the Sixteen-Mile Creek Watershed. One of these is the great increase in leisure time available, particularly to adults. The other is the enormous increase in population and the certainty that the population will continue to grow rapidly.

More and more adults and children are now seeking for outdoor recreation land which is rapidly being withdrawn for home sites and summer retreats.

2. Population Increase

The urban population increase in the watershed is already spectacular, as the following table shows:

Urban Area	Population		Per Cent Increase
	1952	1957	
Milton	2,550	4,525	77
Oakville	6,758	9,995	48
Trafalgar Twp.	6,477	15,083	133
Total	15,785	29,603	87

The predicted populations present an even more striking picture. Halton County's population is shown both alone and as a part of the total population of the Metropolitan Region, as follows:

PROJECTED POPULATION OF ECONOMIC REGIONS OF ONTARIO - CENSUS DATA FOR 1956 PROJECTED TO 1961, 1966, 1971 AND 1976*

	1956	1961	1966	1971	1976
Halton County	68,297	99,000	132,000	174,000	216,000
Metro. Region	1,700,446	2,062,000	2,357,000	2,694,000	3,089,000
(Counties of Halton, Ontario, Peel and York) including Brampton, Oshawa and Toronto					

"The provincial populations in this report represent a revision of the projections made in the Ontario Submission to the Gordon Commission. The county population projections are based on the assumption that the present pattern of industrial growth in Ontario will continue." *

* Population Projections for The Economic Regions, Counties and Urban Areas of Ontario, 1956 to 1976, Department of Economics, Province of Ontario, September, 1957.

It must not be expected that these projected populations will closely approximate the actual populations on the given dates. They are merely the best available estimates, and the spectacular trend which they show is so far justified by the known population gains in this area since 1956. Studies made by the Community Planning Branch of the Department of Planning and Development show that there have been more than 230 new applications for subdivisions in Trafalgar Township and Nelson Township (now the town of Burlington) between January 1947 and January 1957, and that these cover a total area of about 5,100 acres. It is very unlikely that even 10 per cent of these will remain long undeveloped. The major area in which development is proceeding either for industry or for dwellings is of course south of Provincial Highway No. 5, but there are also many subdivisions in the Milton area.

3. Features of the Watershed

The chief attention in recreation planning is naturally focussed on lands which are easily accessible and which have a combination of spectacular scenery, adequate parking space, water and shade, areas that may be developed for picnicking, swimming and possibly camping, and interesting or rare vegetation, fauna or rock formations. The river valleys and the northern rough or forested lands are therefore the chief areas of interest.

Sixteen-Mile Creek has three main branches, all joining in the lower half of the watershed to flow through a spectacular, steep-sided ravine into Lake Ontario.

The two eastern branches called the East and Middle Creeks flow through open country, most of it good farmland. The streams are warm and slow-flowing and at intervals they form pools of fair depth, suitable for swimming.

The West branch starts above the escarpment in the many marshes there and near Campbellville. This is a woodland and limestone rock area and the water is clear and cool. It flows very rapidly down the steep descent of the escarpment. There are few deep sections except where it has been artificially checked by beaver dams or by man.

Accessibility is not a serious problem in the watershed, since there are four provincial highways crossing the watershed from east to west and one from north to south. The township roads are also in very good condition. The lands along the cliff edge on the Nassagaweya-Esquesing Township boundary comprise the only area in which some improvement of the road system might be needed in the future.

CHAPTER 2

PUBLIC AND SEMI-PUBLIC PARKS

1. Milton Area

(a) Milton

The town has 39 acres of parkland, of which 14 acres belong to the municipality. None of the municipal land is developed as parks since it is in new subdivisions or has been acquired recently. The one public park in the centre of town consists of 1 acre and belongs to the county, although looked after by the town. It contains swings and a sand box as well as picnic tables and waste cans. It is well shaded and attractive.

Two other areas in Milton are the 17-acre Halton County Agricultural Society Grounds and the 7-acre Rotary Club Park. Both are used by the public, the former mostly for organized recreation since it contains fair buildings, a race track, dance pavilion and stands; while the Rotary Club Park has a wading pool for children and a baseball diamond.

Use of both parks is limited since the Agricultural Society derives revenue from park use; at the time of visiting, the Rotary Club Park lacked shade or conveniences of any kind and there was a considerable growth of weeds. However, many children were using the wading pool.

PARKS IN MILTON

Park	Area in Acres	Condition
County Park	1	Developed - good
Halton County Agricultural Society	17	Developed - good
Rotary Club	7	Developed - fair
Unnamed	6	Undeveloped subdivision
"	5	North of Milton - low - poor shade
"	2	Woodland - undeveloped
"	1	Open undeveloped subdivision
	39	

(b) Milton Scout Camp

This is on No. 25 Highway north of Milton on land owned by George Elliott of Milton and is the Milton Boy Scouts' Camp.

There are 5 huts, an outdoor fireplace, a flag-pole and a bridge. The land is pleasantly wooded and on a good section of the Creek with limited swimming available.

Milton until recently was a small municipality with enough open country about that it little needed public recreation areas. As shown, it has almost doubled in size in the last 5 years. In keeping with this, park land has been acquired within the town limits. While this no doubt could be developed into good parks it is felt that better natural areas in and around Milton are being overlooked and these are included, as in the case of the rest of the watershed in Chapter 4.

2. Oakville Area

There are approximately 36 acres of parkland in Oakville. Nearly all of this is developed and in use. The eleven parks are scattered through the town and vary in size from less than half an acre (Stansbury Park) to over 15 acres (Trafalgar Park).

To outline the parks individually, their use and equipment, would be beyond the scope of this report. However, in summary, the parks provide for swimming, organized baseball, hockey, football, cricket and other sports, they contain beaches, picnic areas and gardens, and in general provide for all facets of local recreation.

Oakville is well supplied with parks which are well developed and used. Of necessity, however, the parks if small are either local unorganized playing fields or ornamental in nature. If large, they cater to organized sports and in many cases part of the land has been leased to private clubs such as the Bowling Club, the Curling Club, etc.

Access to Lake Ontario is possible at four points and swimming is possible at three of these. However, swimming is limited due to the cold temperature of the lake and the considerable quantity of algae present in warm weather. Because of these factors the Lions Club of Oakville is planning a swimming pool in Trafalgar Park.

PARKS IN THE TOWN OF OAKVILLE

Park	Area in Acres	Condition
Forrester Park	4.0	Undeveloped - intended ornamental
Holyrood Ave. Park	0.4	Access to lake - undeveloped
Reservoir Park	2.1	Playground
Town Hall Park	1.2	Leased to Bowling and Oakville Clubs
Jingle Park	0.4	Benches and swimming
Lakeside Park	1.64	Picnics - bandstand
Wallace Park	6.27	Organized sports - some leased
George's Square	2.239	Ornamental park
Busby Park	2.31	Organized sport - some leased
Stansbury Park	0.4	Local development
Trafalgar Park	15.5	Arena - organized sports

3. Trafalgar Township

There are about 233 acres of land set aside for parks in Trafalgar Township. Of this area, one farm of 117 acres, near Drumquin is undeveloped, while another 50 to 60 acres in scattered subdivision parks also remains undeveloped. The largest developed park, Coronation Park, lies outside of the watershed to the west, but is included since it is of major importance in the area. The descriptions of the three major township parks that have been developed are given here.

(a) Coronation Park

This park of 19.4 acres, on Lake Ontario, has a stone beach and wide grassy play areas. Shade is ample and there are many picnic tables and waste containers distributed over the entire area. Fireplaces are provided as well as water and clean outside toilets. The parking area is large, but on warm week-ends the park is filled with many hundreds in attendance.

(b) <u>Henderson (Base Line) Park</u>

Henderson Park consists of 11.3 acres north of Bronte off No. 25 Highway on the West Branch of Sixteen-Mile Creek. There are 27 picnic tables and ample refuse containers. Fireplaces and clean toilets are provided. No water for drinking is available. Shade is limited except in the evening. There is a scenic bridge across the creek, which in turn is shallow and unsuitable for swimming, except for smaller children, where rock dams have been built.

(c) <u>Hornby Park</u>

This park comprises 12 acres west of Hornby, and as it was started this year it has not yet been fully developed. A branch of the Middle Sixteen flows through one corner of the property and, although scenic, the creek is too small and turbid for swimming. Most of the park is open grassland newly seeded, but the corner near the entrance has some shade, picnic tables and trash units, though no other conveniences are present as yet. The park is to serve Esquesing as well as Trafalgar Township.

Other township parks have not been developed, and two are worthy of special note. Wedgewood Park off Morrison Road, a 20-acre area, appears as quite attractive (although on an intermittent stream); while another area of 5 acres east of the 9th line and on the lake is under arbitration at present.

(d) <u>Pine Ridge Camp</u>

This camp, owned by the Rotary Club of Oakville camp, consists of 6.45 acres adjoining Henderson Park. There are good flush toilets, a main kitchen and dining room, a staff hut, while other cabins are being built all with log siding. Parking is ample. Drinking water is available but consists of

Henderson Park is one of the best of Trafalgar Township's parks. Picnic tables, fireplaces and clean toilets are provided.

This camp, owned by the Rotary Club of Oakville, provides facilities for many groups such as boy scouts.

creek water chlorinated and filtered. This camp site is used for camping by the Oakville and Trafalgar Scouts and is in use this summer along with Henderson Park as a site of the Day Camp for children 7 to 14 years of age.

(e) Drumquin Park

The park area of 117 acres at Drumquin is owned by Trafalgar Township. Although on the Creek it cannot be considered attractive or a good choice compared to the much better areas which the Conservation Authority might obtain.

(f) Palermo and Omagh Parks

These are sports fields only. Palermo Park is 5.6 acres and Omagh Park 3.3 acres.

Trafalgar, like the other urban municipalities, has a large area of parkland. As in the case of Milton much of it is the result of subdivision allotments and is as yet undeveloped. The developed parks such as Coronation and Henderson are very successful, particularly because of natural attractiveness and location.

Other parks when developed will probably take the form of green areas, ornamental parks or local baseball fields. Their size and location will not permit swimming, camping, family picnics or naturally attractive development, with the possible exception of Wedgewood Park off Morrison Road.

County Land

Halton County owns between 900 and 1,000 acres of land in the county forest. Most of this is in the watershed and above the escarpment in Nassagaweya Township. In all about 740 acres of second growth woodland and swamp are in the watershed.

An excellent farm, that of John Coulson, just north of Hornby has been deeded to the County with the provision that the land be reforested. At present the will is being contested by the next-of-kin. There would be about 95 acres in this parcel.

There is a possibility of using some of the above property as park area in conjunction with reforestation, especially one piece consisting of 400 acres in lots 11 and 12 of the 6th Concession of Nassagaweya.

A considerable area of land for park purposes is already in public hands. Much of this land is undeveloped at present and is not the most suitable recreational land in the watershed. This is probably because the choice of land has been limited by political rather than natural boundaries and a great percentage has been acquired through laws governing subdivision.

CHAPTER 3

COMMERCIAL PARKS AND PRIVATE CAMPS

1. Milton Area

Two commercial parks are located near Milton.

(a) Peru Park

This park of approximately 5 acres of a 60-acre farm was begun this year by the owner Mr. A. Reichert. Considerable work and enterprise have been shown and Mr. Reichert has put a well-built dam on the creek, brought in sand and fill, reforested a large area, built outside toilets and picnic tables, and sells soft drinks, candy etc.

The pond created by the dam is about 1 acre in area and 6 feet at its maximum depth. It provides the only good swimming close to Milton.

The charge of admission to the grounds is 10 cents on foot or 50 cents for cars, and from all observations and reports the park is well attended and well appreciated by the public.

Mr. Reichert intends to develop the park further as money and time permit and it may eventually include all of the farm.

(b) Hawthorn Lodge

Original plans for development have not been fulfilled. At present the Lodge serves meals and has room for 5 overnight guests. It has a swimming pool and 2 small ponds on the property. It is included here because of possible future expansion.

2. Oakville Area

There are no commercial parks in the immediate vicinity of Oakville.

3. Trafalgar Township

Two Ukranian camps are located on the watershed, both on the creek west of the Dundas Street bridge.

(a) Palermo Camp

The largest camp is north of Highway No.5 and is called the "Palermo Camp". It consists of about 109 acres including both sides of the creek.

There are many private cottages, which will become the property of the camp in 10 years, also a large kitchen and dining hall, recreation hall and museum. Branch units, namely Toronto, Dunnville and Hamilton, have cottages scattered along the creek. While the camp is Ukranian, the public are not barred from admission.

(b) Kiev Camp

The Kiev Ukranian Camp is opposite the above and is an Orthodox Catholic Camp owned by the Church. The camp owns 100 acres and has accommodation for 165, mostly children, who stay for two weeks at $12.00 per week. Swimming, hiking, organized games, etc., are included in the program by the 8 camp counsellors.

(c) Omagh Bible School

This area of 5½ acres is on the west side of the Middle Creek at the Base Line and belongs to the Church of Christ Corporation. A summer camp for boys and girls 10 years old and up is held here. Buildings include 2 dormitories for boys and 2 for girls. The swimming hole is used by the school although not on their property.

(d) Santaland

This enterprise is located just north of the Queen Elizabeth Highway about ½ mile east of the Bronte - Palermo road. It consists of 100 acres of farmland of which about 5 acres in a pleasant creek valley, has been developed as "Santaland".

About 15 buildings including Santa's Castle, the Elves' Workshop, etc., have been built in a fairy-book type of architecture. Rabbits, ponies and other animals add to the picture.

The enterprise has not been successful, an auction sale being held there over a year ago. It is still operating. Entrance is not permitted off the Queen Elizabeth Highway.

CHAPTER 4

CONSERVATION AREAS

Five areas are recommended as particularly suitable for multiple use conservation. The importance of public ownership of key sections of the top of the escarpment or cliff has already been stressed. It should be the hope of the Authority that eventually all of the edge of this great natural geological and scenic feature would be available to the public, apart from such sections as are needed for the quarrying of the limestone. It has long been mentioned by planners that a scenic route, making use of many of the existing roads, but with frequent sorties, in the route, to the edge of the cliff, should be laid out. This would be of interest to all of the people of Ontario. In this report only two sections of the cliff edge which are of special interest to residents of the watershed are recommended.

Recent investigation has shown that there are options giving the rights to mine or remove the limestone on the face of the escarpment, or near it, contained in many of the present property deeds. This situation poses a great threat to the retention of most of the escarpment edge for future generations, and makes it all the more important that the Conservation Authority should acquire sections of the cliff edge immediately.

The remaining three areas recommended for recreation use lie along the permanent streams. The five areas are scattered through the watershed so that they provide the maximum of convenient local access and are also near to the main arterial roads such as Provincial Highways Nos. 2, 25, 5, 401, and the several proposed routes of No. 403.

1. Halton View Conservation Area

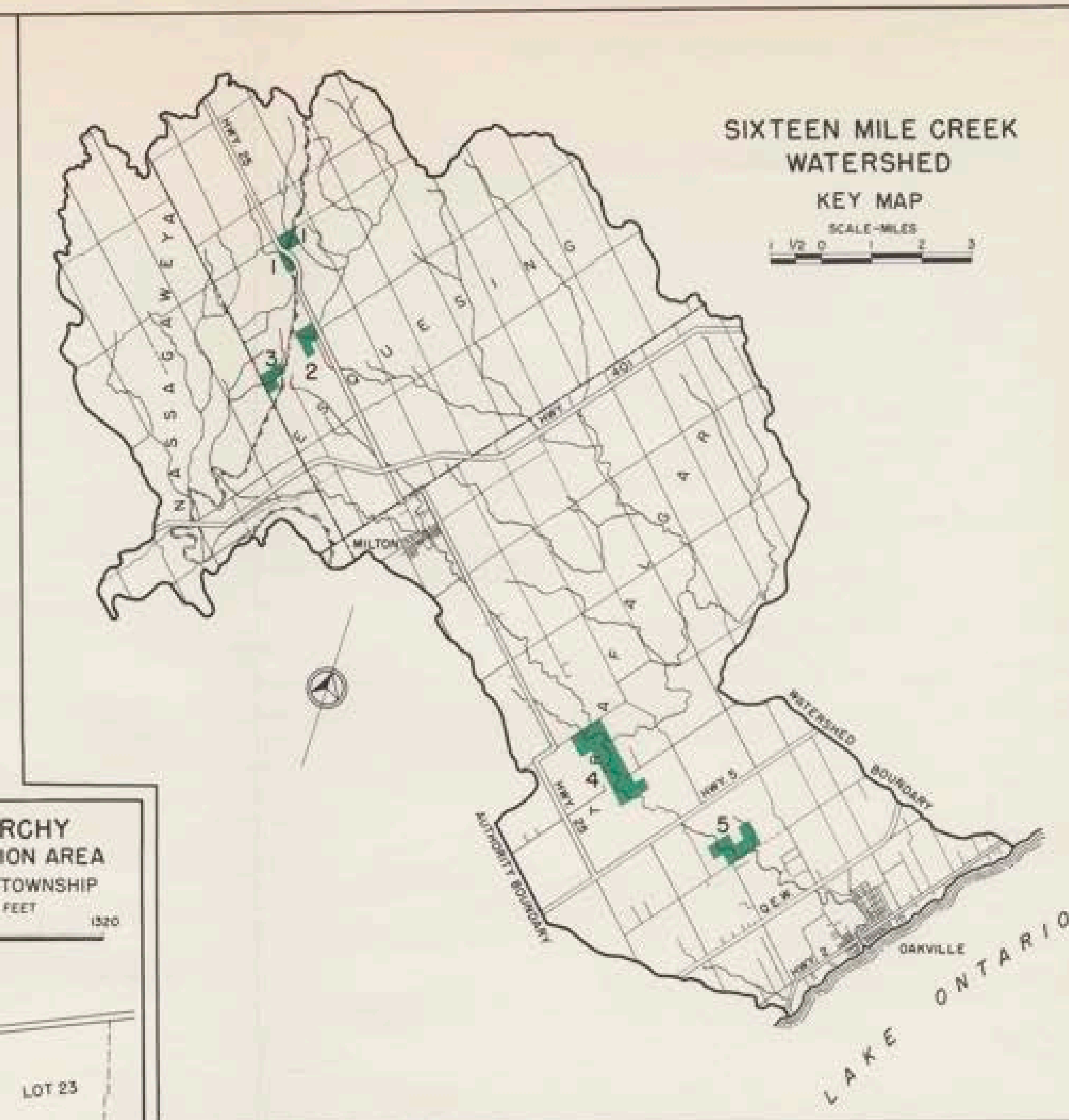
This is an area which consists of two adjacent parcels of land, one on each side of Provincial Highway No. 25. The section to the east of the highway includes 75 acres,

RECREATION
RECOMMENDED CONSERVATION AREAS

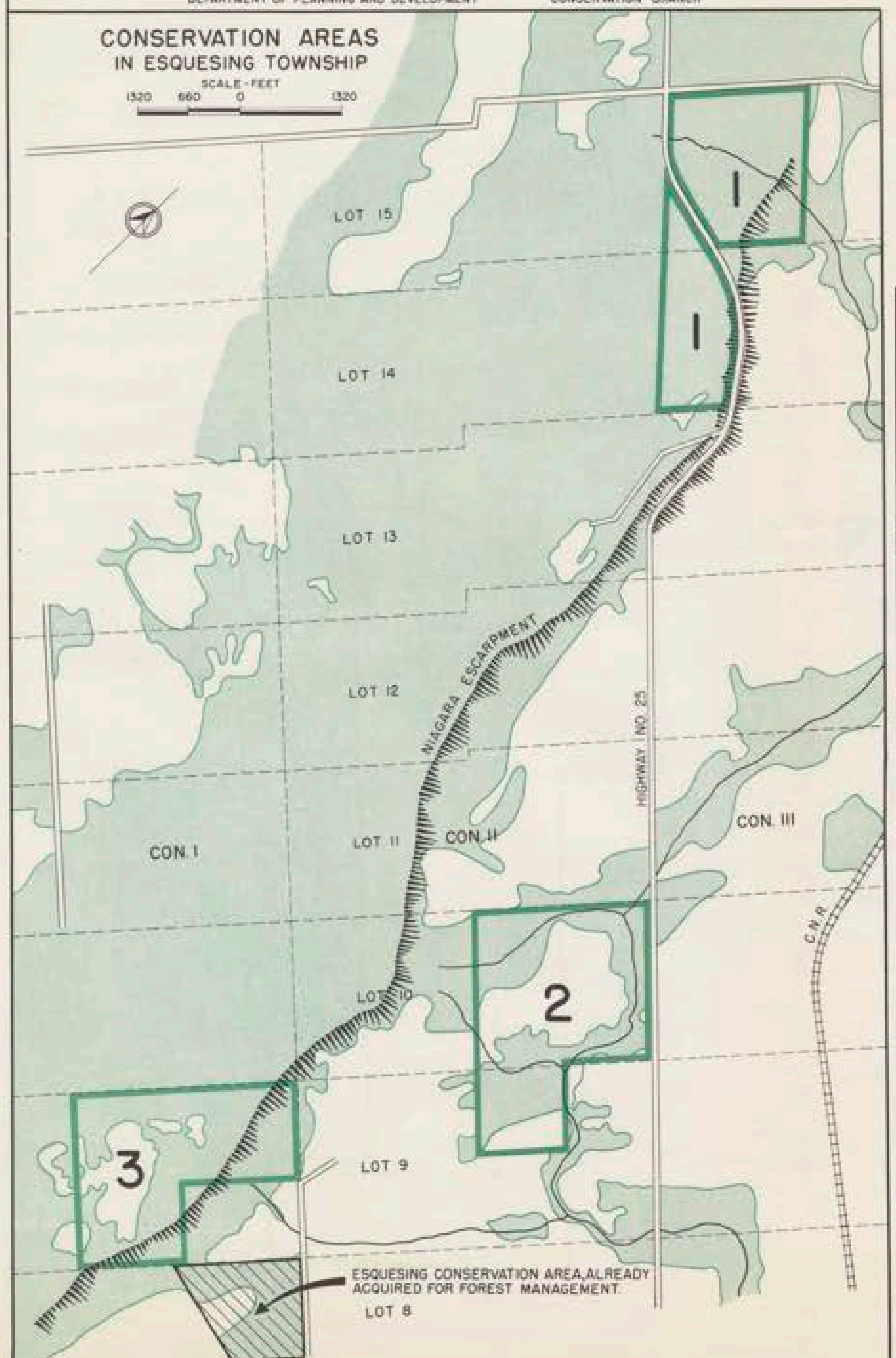
LEGEND

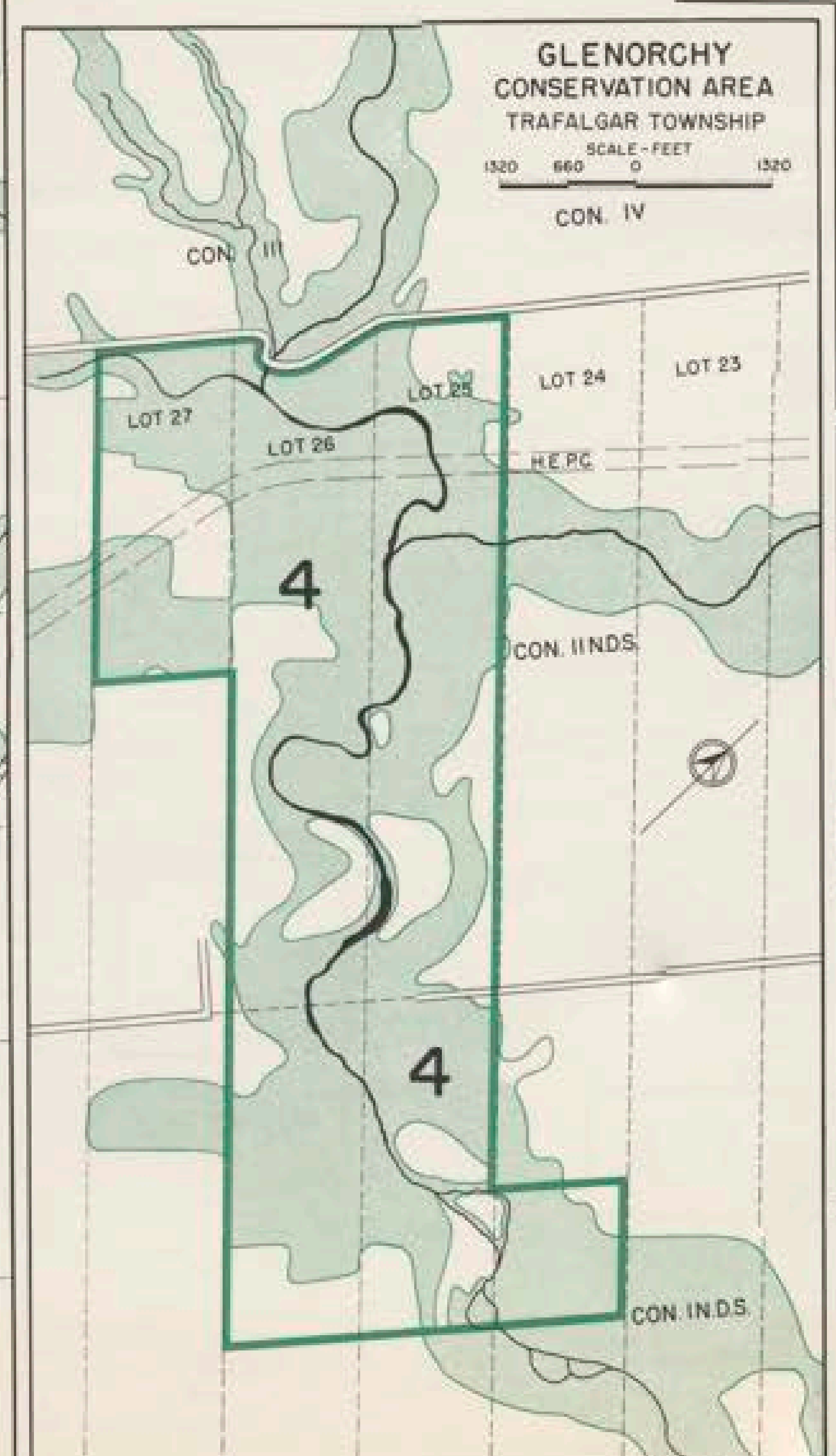
1. HALTON VIEW
2. SCOTCH BLOCK
3. ESCARPMENT
4. GLENORCHY
5. OAKVILLE

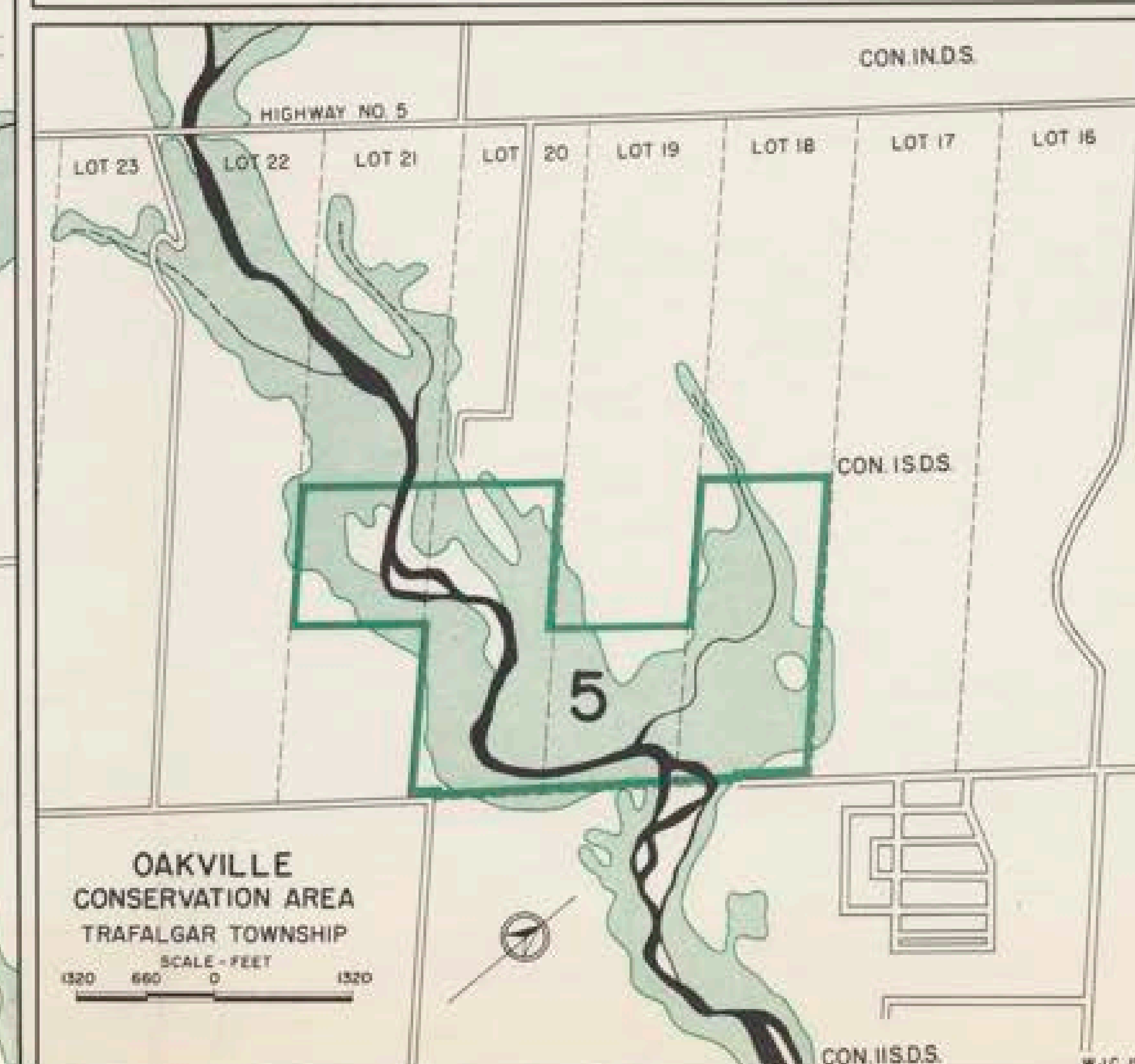
WOODLAND



DEPARTMENT OF PLANNING AND DEVELOPMENT CONSERVATION BRANCH







and that on the west side is 50 acres, making a total of 125 acres. On the west side the area borders a part of the proposed Authority Forest. The boundary here is the 3rd Concession Line of Esquesing Township. The east side borders No. 25 Highway in part and the edge of an old gravel pit below the escarpment.

A very large part of Halton County can be seen from the edge of the escarpment above No. 25 Highway, and the view is spectacular throughout the year.

The whole of the Conservation Area is now classified as under forest cover, but most of the woodlands, particularly near the cliff edge, are young second growth. The sugar maple forest cover type is the major one in the western parcel of land, while the eastern one consists of two cover types, hemlock and white cedar. A permanent cold stream which has a very small flow but which could be improved to produce brook trout, flows through the property.

The land in the western parcel is relatively level and includes a cleared area which could be easily developed for parking, picnicking and if necessary for games. The view might be improved by the judicious cutting of a few trees.

2. Scotch Block Conservation Area

This is an area of 133 acres including the eastern half of Lot 9, Concession II, and the north-western quarter of the east half of Lot 8, Concession II, Esquesing Township. This is an attractive piece of rolling land, much of it in maple woods. The Middle Branch of Sixteen-Mile Creek flows in an attractive pasture through this property. The banks of the creek are flat on one side, steep on the other.

Swimming is now possible, but a small dam would greatly enlarge the available area. Although large elms and other trees shade the creek, a flat grassy play area lies west of this.

The attraction of this area is enhanced by the fact that it lies just below the escarpment. Those who picnic or swim here have a fine view of the adjacent cliffs and hills. The most important feature of all in this proposed park is its perfect location, directly on Highway No. 25, only two and a half miles from the cloverleaf of No. 25 and No. 401 Highways. If acquired it would very rapidly return a profit, at the same time providing the local residents with a superb playground.

3. Escarpment Conservation Area

This is an alternative or additional site for a recreation area at the edge of the escarpment. The area shown on the map is 93 acres, lying in the east half of Lots 9 and 10, Concession I of Esquesing Township.

As in the Halton View Conservation Area, there are extremely spectacular views from the top of sheer cliffs or steep slopes at several points.

Although at present not accessible by car via a recognized road it is accessible through the McTrash porperty off the sixth line of Nassagaweya Township and could be made accessible from the north via an extension of the seventh or township line. Below the escarpment the first Concession Road of Esquesing Township touches the property on its north-east side and this road, although rough and impassable at present, does go up the escarpment and could be improved.

The area itself is largely covered with second-growth trees, birch, maple and poplar, with several large open pasture areas suitable for camping, playing fields or, if desired, for reforestation. One point in particular on a rocky hill near the escarpment edge affords a view in three directions and an excellent lookout tower could be erected here. The creek through the area is spring fed but does diminish in warm weather and may cease flowing at certain times.

4. Twin Waters Conservation Area

This area of woodland, ravines, and bottomland lies in the centre of Trafalgar Township, midway between Milton and the town of Oakville and the surrounding built-up area.

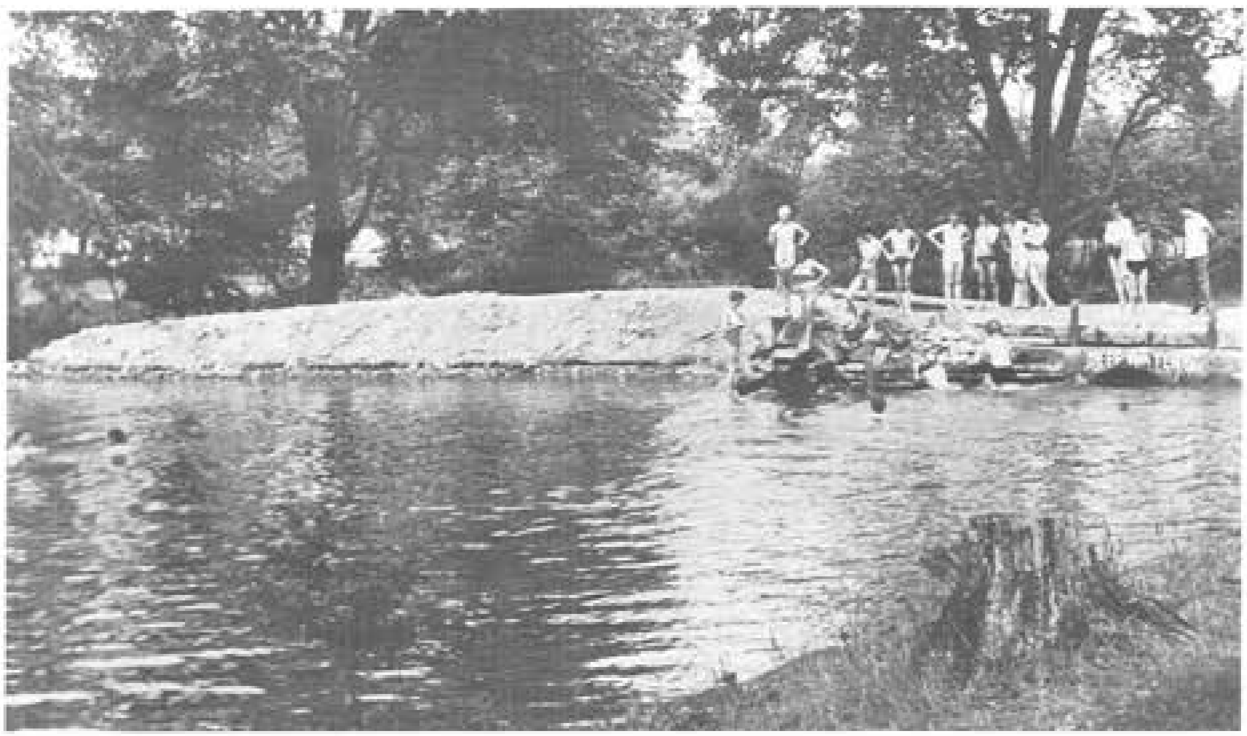
It is not suggested that the Conservation Authority could acquire all of the acreage shown, in one purchase or even in several years. However, all the lands shown (totalling 750 acres) are particularly attractive. The key areas for acquisition for the public are Lot 26, Concession II, NDS, and the north half of Lot I NDS, less the two or three acres north of the Base Line Road, where it curves over the Sixteen-Mile Creek.

A high voltage transmission line of the Ontario Hydro-Electric Commission crosses the property at the point shown and it might be necessary for the Authority to negotiate an easement allowing passage across this area.

The ravine is well wooded with hard and soft maple, birch and oak. Most of the residents of Trafalgar know the attractive ravine at its northern end where there are two recreation areas which are not open to the general public, but few know of the spectacular scenery, useful sand bars and wide flat areas for games one to two miles further south.

The whole width of the ravine along its entire length is zoned as land usable only for conservation in the Official Plan of the Township of Trafalgar, approved by both the Planning Board and the Township Council of Trafalgar. There are only a few acres of arable land in the area recommended, and these could easily be subtracted from any scheme for land acquisition. Arrangements might be made with those farmers who do use the river for stock watering. However, more than 90 per cent of the lands recommended are now either woodland or ravine and bottomlands.

Recreation areas with a pond will provide fishing, swimming and boating.



With little effort they can be made attractive as well as useful.

At least part of the maintenance cost may be recovered by making a small charge for parking and the use of other facilities such as boats.

The actual parcels of land recommended (from which the Conservation Authority would choose specific sections for acquisition) are as follows:

Trafalgar Township

Concession I NDS	North ½ Lot 26 North ½ Lot 25 South ½ of the North ½ of Lot 24
Concession II NDS	Lot 25 Lot 26 North ½ of Lot 27

5. Oakville Conservation Area

This large area is of exceptional importance because it lies adjacent to the most densely populated part of the watershed. The whole area recommended for possible acquisition would include both sides of the Sixteen-Mile Creek and land both above and below the ravine on each side. The area shown on the accompanying map amounts to 300 acres, almost entirely in woodland, ravine or bottomland pasture. Since the Conservation Authority could hardly expect to acquire such a large area in one purchase, it is recommended that the "key" sections be acquired first. The whole area is therefore summarized as follows:

Trafalgar Township

Concession I SDS	Lot 21 North ½ of South ½ of Lot	50 acres
	Lot 20 South ½ of Lot	100 "
	Lot 19 South ½ of South ½ of Lot	50 "
	Lot 18 South ½ of Lot	100 "
		300 acres

The key sections which are of greatest importance are the parts of Lots 20 and 19 referred to above, totalling 150 acres. About 75 per cent of these sections are already zoned as "Conservation" land by the Township of Trafalgar.

To the west of the creek the land has been and is used by young people from Oakville for weiner-roasts, hikes and swimming, while that in the east is used for camping and hiking.

The park is accessible from either side of the creek along the Upper Middle Road, but the ravine area is more easily reached from the west side off the fourth line of Trafalgar Township. Here an open, flat field would provide excellent parking and sufficient room along the ravine edge for sanitary conveniences, kitchens, snack-bar or any similar development including picnic tables.

More large trees are met as one enters the ravine - known locally as the "King's Hole". The ravine area itself has some excellent specimens of pine and maple plus many other large trees. In the ravine there is a very good, flat rock swimming area of about 5' average depth, which could be increased by a temporary or permanent dam. Most of the ravine area already looks like parkland with scattered trees and with some brushy "wild" spots.

On the east there is a heavier growth of trees above the escarpment which is densely wooded with oak, maple and pine. This area would be suitable for camping, nature trails, and a lookout at the ravine edge.

SIXTEEN MILE CREEK WATERSHED

SHOWING

RECOMMENDED AUTHORITY FOREST AND EXISTING WOODLAND

ONTARIO DEPARTMENT OF PLANNING AND DEVELOPMENT
CONSERVATION BRANCH

SIXTEEN MILE CREEK WATERSHED
SHOWING
RECOMMENDED AUTHORITY FOREST
AND
EXISTING WOODLAND
LEGEND
RECOMMENDED AUTHORITY FOREST
RECOMMENDED FOR PRIVATE REFORESTATION
RECOMMENDED WOODLOT IMPROVEMENT PROJECT
FOREST COVER TYPE
SCRUB LAND WET SCRUB DRY SCRUB
PLANTATION
HALTON COUNTY FOREST
WATERSHED BOUNDARY
SCALE-MILES
DEPARTMENT OF PLANNING AND DEVELOPMENT
CONSERVATION BRANCH
FOREST COVER TYPES
4. ASPEN
6. PAPER BIRCH
8. WHITE PINE-RED OAK-WHITE ASH
9. WHITE PINE
10. WHITE PINE-HEMLOCK
11. HEMLOCK
12. SUGAR MAPLE-BEECH-YELLOW BIRCH
13. SUGAR MAPLE-BASSWOOD
14. SUGAR MAPLE
14a. BLACK CHERRY
24. WHITE CEDAR
26. BLACK ASH-WHITE ELM-RED MAPLE
45. BUR OAK
49a. WHITE OAK-BLACK OAK-HICKORY
50. WHITE OAK
51. RED OAK-BASSWOOD-WHITE ASH
52. RED OAK
57. BEECH-SUGAR MAPLE
58. BEECH
59. ASH-HICKORY
60. SUGAR MAPLE-WHITE ELM
60a. WHITE ELM
NASSAGAWEYA
ESQUESING
TRAFALGAR
LIMEHOUSE
CAMPBELLVILLE
MILTON HEIGHTS
MILTON
HORNBY
PALERMO
TRAFALGAR
OAKVILLE
LAKE ONTARIO