SOIL SURVEY OF

FRONTENAC COUNTY

Report No. 39 of the Ontario Soil Survey

Prepared jointly by The Research Branch,
Canada Department of Agriculture and the Ontario Agricultural College

ONTARIO DEPARTMENT OF AGRICULTURE, TORONTO
CANADA DEPARTMENT OF AGRICULTURE, OTTAWA

THE SOILS OF FRONTENAC COUNTY

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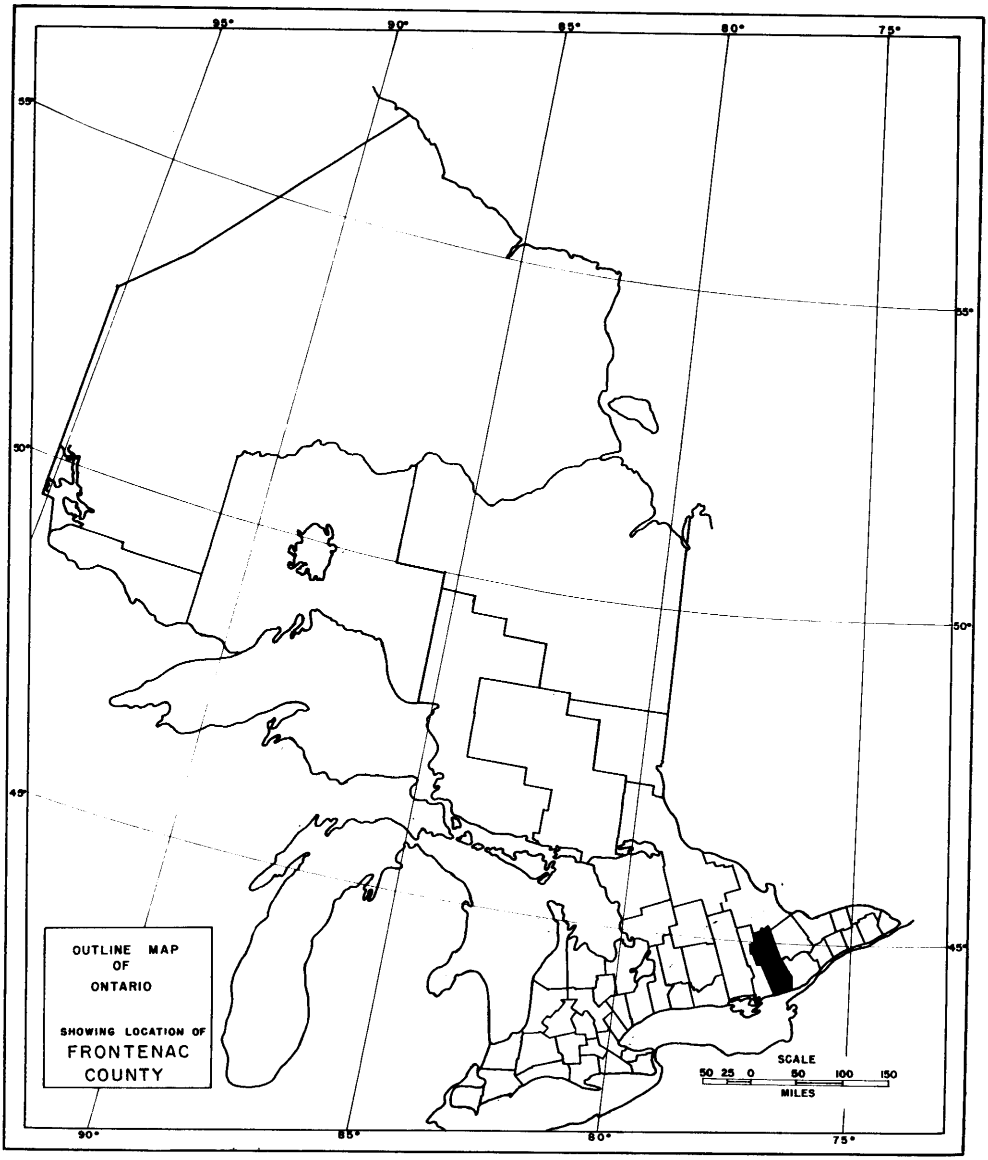


Figure 1. Outline Map of Ontario Showing Location of Frontenac County.

The Soils of Frontenac County

INTRODUCTION

This report and the accompanying soil map provides an inventory of the soil resources of the county at a reconnaissance level of detail. The project included the mapping of the various soils and the gathering of information about their characteristics and environment from which to judge their adaptability and use in the growing of agricultural crops. It is for this reason that the reader will find sections in the report dealing with the climate, bedrock geology, and other factors influencing the use of land.

A section is included in the rating and suitability of the various soils that occur in the county for agricultural use. The ratings are made chiefly on the basis of the physical and chemical characteristics of the soil.

The aim of the survey is to supply basic information about the soil such as its location, origin, characteristics, present use and suggestions for its future use.

GENERAL DESCRIPTION OF THE AREA

Location and Size

The location of the county within the province is shown in Figure 1. It borders on the eastern end of Lake Ontario where it joins the St. Lawrence River and is bounded on the west by the county of Lennox and Addington and on the east by Leeds and Lanark Counties.

The total land area of the county is 1,023,360 acres.*

County Seat and Principal Towns

The County Seat is Kingston (population — 53,526).*

Kingston is a noted educational, industrial, military and tourist center. It is the home of Queen's University, and the Royal Military College. Kingston is an important training center for the Canadian Militia. It is at the terminus of the Rideau Canal system and is closely linked with early Canadian history.

Smaller centers serving rural communities in the county are Collins Bay, Sunberry, Harrowsmith, Sydenham, Hartington, and Verona.

Geology

Bedrock Geology

A major division in the bedrock formations of Frontenac County occurs between the Precambrian and Ordovician rocks. In the northern part of the county the Precambrian rocks are composed of igneous and metamorphosed sedimentary rocks. Large masses of granite and granitic gneiss are found in the area and crystalline limestone occurs in lesser amounts.

*Canada Census — 1961.

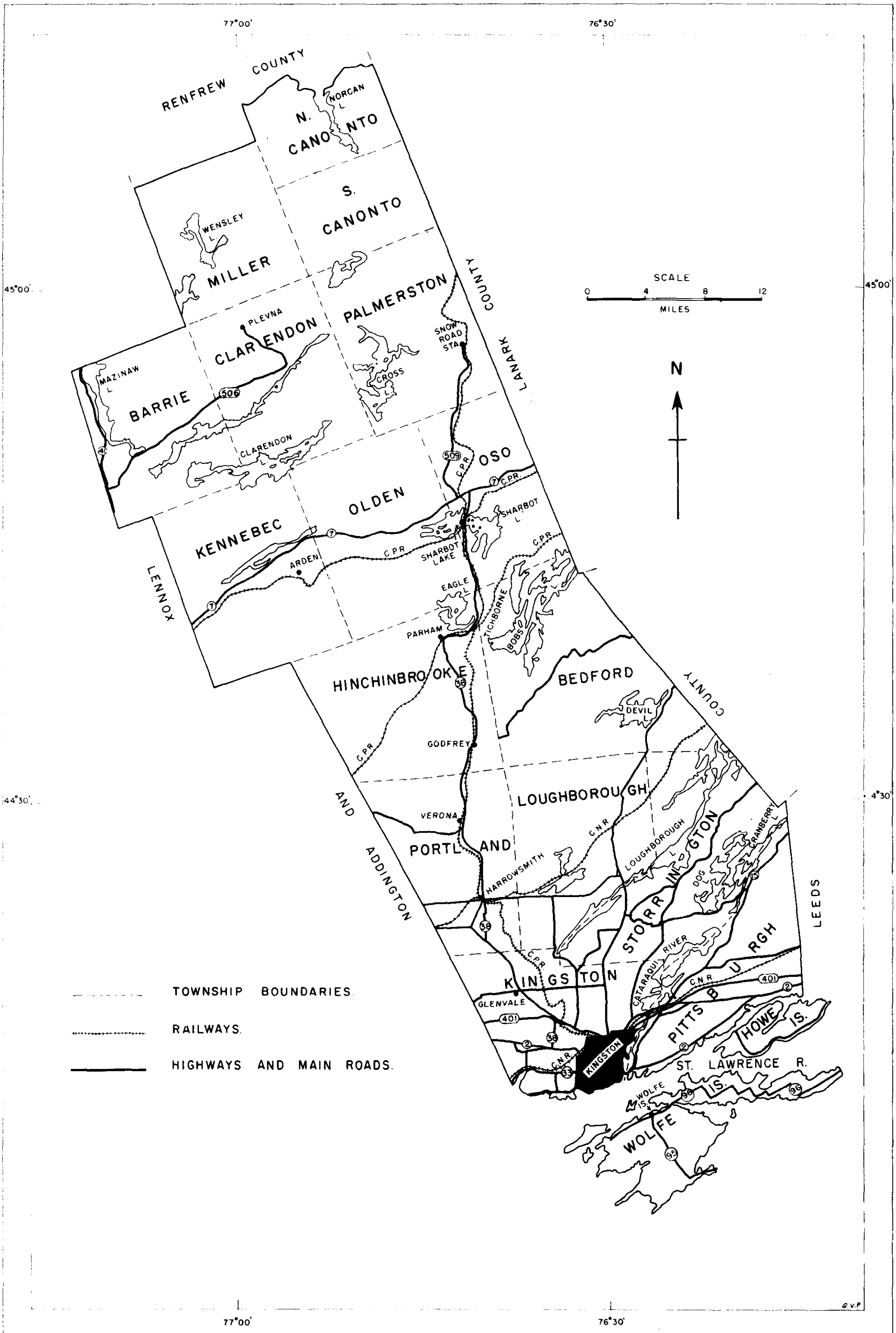


Figure 2. Townships, Principal Towns, Highways and Railroads in Frontenac County.

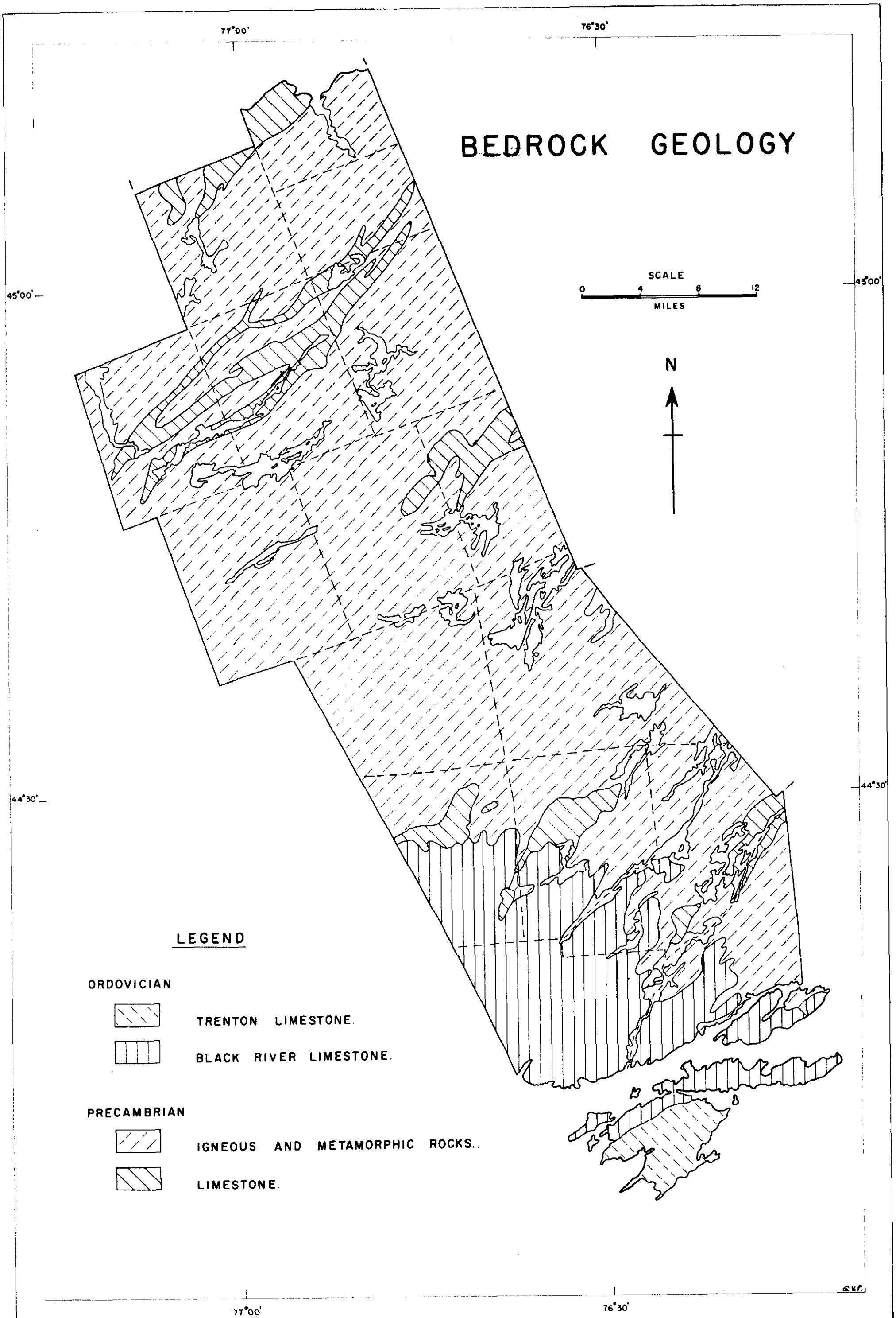


Figure 3. Outline Map Showing the Bedrock Geology of Frontenac County.

Ordovician limestones occur in the southern part of the county. The Black River group forms the bedrock in the south with the exception of the southern part of Wolfe Island where the bedrock belongs to the Trenton group. Cambrian sandstones are also known in the area.

Surface Deposits

The surface deposits that occur in a given region owe their origin to the action of one or two combinations of three forces, namely ice, wind or water. In this region of Ontario the surface deposits have originated almost entirely as the result of the work of glacial ice and of water. The unsorted deposits laid down by moving ice, and which are called till, cover the greatest area in the county. This material varies greatly from the northern part of the county to the southern part, depending upon the nature of the underlying bedrock. The hard rocks of the Precambrian Shield resisted the abrasive action of ice with the result that much of the soil overlying these rocks is thin and very stony. The till soils overlying the Precambrian are therefore generally thin and the nature of the relief is a reflection of the bedrock relief. Most of the till deposits overlying the Black River limestone are also thin and of limited value for agriculture.

The soil materials along the southern border of the county consist of stone-free calcareous clay deposits broken in places by numerous outcroppings of Precambrian rock. These deposits have been dissected by streams and the resulting slopes are often irregular, moderate to steep. Most of these clay materials are found at 275 to 300 foot elevations.

It has been established that the Champlain Sea extended as far west as Brockville but its ultimate western boundaries are unknown (Karrow)*. Tidal water undoubtedly would affect the characteristics of clay deposits, and the clay deposits in Leeds, Frontenac, and Lennox and Addington Counties appear to have a common origin. They are lower in carbonate content than the Lake Iroquois clay sediments to the west and higher in carbonate content than the clay sediments attributed to Lake Champlain and found in the far eastern counties of the province. It is possible that these soil materials are at least partly marine in origin.

Silt-textured lacustrine materials cover an area from Kingston to Battersea enclosed by limestone escarpments on the west and by Precambrian rock to the north and east. These materials may have been deposited in a shallow embayment at some later stage of Lake Frontenac or the Champlain Sea.

Coarse-textured soils, sands and gravels are found in small areas scattered over the county. A number of these form a discontinuous crescent from Glenburnie to Brewers Mills and may be shorelines of Lake Frontenac or Champlain.

Drainage

Frontenac County might well be named "the Land O' Lakes". There are close to one hundred large lakes within its boundaries and countless small ones. Several important rivers rise in the northern part of the county. The Mississippi River has its headwaters in Palmerston and Clarendon Townships and flows east through Lanark County to the Ottawa River. Several tributary streams of the Madawaska River flow north through Canonto N. and Millar Townships.

The Salmon River rises in Kennebec Township flowing southwest through Lennox and Addington County into the Bay of Quinte. The headwaters of the

*Karrow, P. F. The Champlain Sea and its sediments. Proc. Royal Soc. Can.

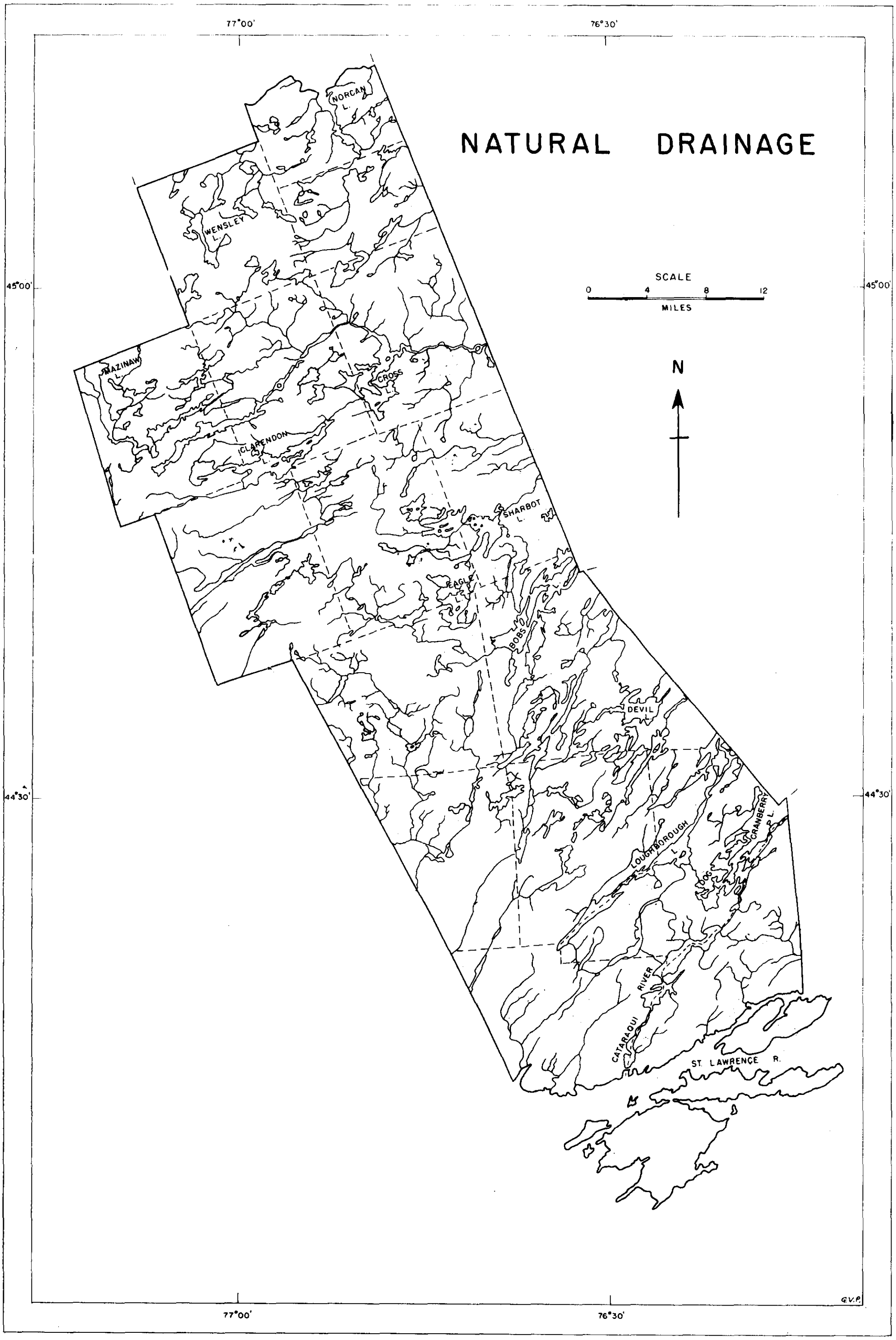


Figure 4. Outline Map Showing the Natural Drainage Courses in the County.

Napanee River are in Portland and Loughborough Townships and this drainage is southwest into the Bay of Quinte. The Cataraqui River at Kingston is the southern end of the Rideau Lakes drainage system.

Climate

The factors that control the climate of a region are latitude, altitude, relief, and proximity to large bodies of water.

Frontenac County extends from Lake Ontario for a distance of 80 miles due north and this results in a difference of one degree in latitude between the southern and the northern part of the county. The difference in latitude can account for a difference in 1°F in mean annual temperature.

There is a general rise in altitude from 300 feet above sea level in the south to 1000 feet above sea level in the north and according to climatologists this can account for a difference of about 3°F between the southern part of the county and the north.

Relief may affect the climate of deep valleys by producing wide ranges between day and night temperatures. The climate of the southern part of the county is moderated by the proximity of Lake Ontario.

Figure 5 is a chart taken from *The Climate of Southern Ontario* by Putnam and Chapman. It divides the province into 15 climatic regions. These may to a certain extent be regarded as crop regions. The chart is reproduced here to show the different climatic regions of Frontenac County and their relationship to other areas of Ontario.

The South Slopes

A small area of Frontenac County bordering the lake enjoys a climate similar to the South Slopes region shown in Figure 5. This region encompasses a large, rich farming area in Ontario where dairy farming is the dominant agricultural endeavor. The climate is suitable for a wide range of crops including fall wheat and grain corn. The mean annual temperature ranges from 43° to 45°F and the growing season varies from 192 to 200 days.

Simcoe and Kawartha Lakes Region

This region includes the Sydenham—Battersea area of Frontenac County. It has a colder winter and more backward spring than the South Slopes region. The agricultural history of this region has been general farming with an emphasis on beef production. Hay, spring grain, and ensilage corn are the main crops grown. The mean annual temperature ranges from 42° to 44°F and the growing season varies from 188 to 195 days, about 5 days shorter than the South Slopes region.

Eastern Ontario

A large area comprising the central part of the county is in this climatic region. The winter temperatures are cold and similar to more northerly areas. The winter temperatures place this region outside of the winter wheat growing areas. The soils of Frontenac County in this climatic region are within the Precambrian Shield and are generally more important to forestry than agriculture. The mean annual temperature varies from 41° to 43°F and the growing season varies from 191 to 197 days.

Renfrew

The northern portion of the county has a climate similar to this region of Ontario. This is a cool, inland region with moderate rainfall. The climate is suit-

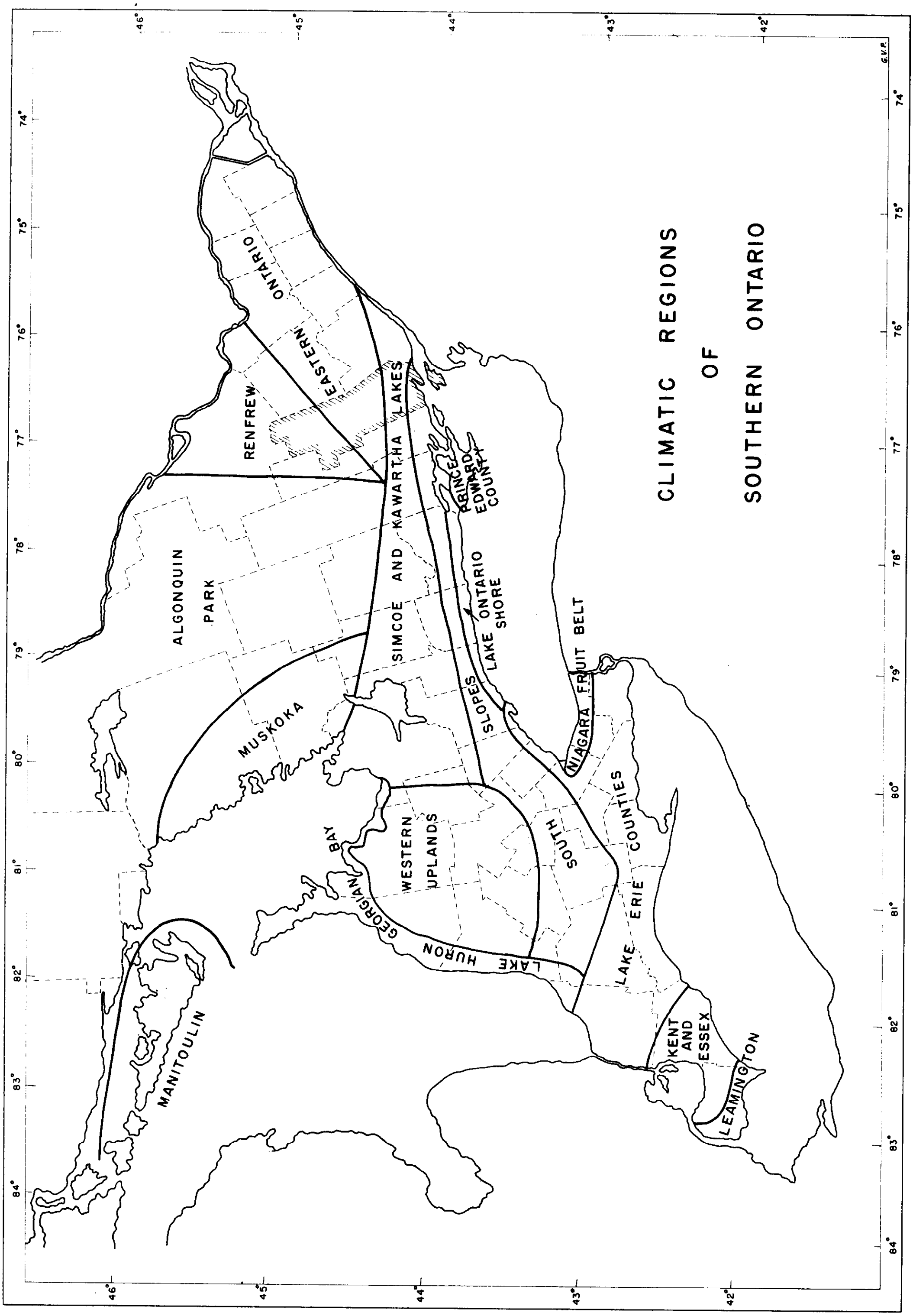


Figure 5. Outline Map of Ontario Showing the Climatic Regions of Southern Ontario.

able for general farming if hardy varieties of crops are used, but there is little soil suitable for cultivation in this part of Frontenac County. The mean annual temperature varies from 39° to 41°F and the growing season from 185 to 190 days.

The data given in the following tables is taken from *The Climate in Southern Ontario* by D. M. Brown (in press). The Kingston data provides weather data for the eastern end of the South Slopes region. Peterborough represents the Kawartha Lakes region. Bancroft represents the Renfrew region and Ottawa, the Eastern Counties region.

TABLE 1

TEMPERATURE

Month		Kingston	Peterborough	Ottawa	Haliburton
January	Max.	26.0	26.7	21.0	24.0
	Min.	10.4	8.8	4.2	3.4
April	Max.	52.2	52.5	50.3	50.0
	Min.	34.2	32.4	32.4	28.5
July	Max.	80.0	80.0	79.9	78.3
	Min.	60.0	57.7	57.9	52.4
October	Max.	58.7	58.4	55.9	56.0
	Min.	40.3	37.2	37.5	34.9
Annual	Max.	53.6	53.5	51.3	51.7
	Min.	36.2	34.0	32.7	29.5

TABLE 2

PRECIPITATION

	Kingston	Peterborough	Ottawa	Haliburton
May 1 to September 30	14.9	13.6	15.5	15.9
Annual	35.0	30.2	34.1	35.6
Snowfall	65.4	65.5	77.2	80.3

TABLE 3

MEAN DATE OF FROST AND ELEVATION ABOVE SEA LEVEL

	Kingston	Peterborough	Ottawa	Haliburton
Last in Spring	May 3	May 15	May 13	June 9
First in Fall	Oct. 11	Sept. 27	Sept. 29	Sept. 14
Elevation	300 ft	680 ft	260 ft	1050 ft

The climatic data were determined from the 1931-60 weather records.

According to the January temperatures winters are quite severe in the county with mean minimum temperatures approaching 0°F in the northern parts. Summer nightime temperatures are fairly cool, the mean minimum in July is around 52°F in the north to 60°F in the south. The mean length of the frost-free period is just over 5 months in the south and around 4 months in the north.

Historical Development

The construction of Fort Frontenac at the mouth of the Cataraqui River in 1673 by Count de Frontenac, then Governor of Canada, was the first permanent establishment by the white men in this part of the country. The settlement of Frontenac County really commenced in 1783 when the survey of the lands in the Bay of Quinte was carried out to prepare for the influx of United Empire Loyalists.

The first boat loads of Loyalists arrived the following year and took up lands in the township of Kingston.

Kingston was originally a garrison town and has remained to this day an important military center. Following the war of 1812-14, the Rideau Canal was built providing a military supply route between Ottawa and Kingston. It was a great engineering accomplishment and it now attracts thousands of pleasure craft annually to navigate its many miles of scenic beauty.

The historical sites, the St. Lawrence River, and the numerous lakes throughout the entire length of the county have provided the base for the development of a vigorous tourist industry. This industry provides a large summer market for local produce, especially dairy, poultry and hog products.

Early Farm Houses Were Commonly of Stone Construction.

Transportation and Markets

Most of the agricultural products of Frontenac County are marketed through Kingston and all the main roads in the county converge on Kingston. Highways 2 and 401 traverse the southern end of the county while highway 7 crosses the county farther north. Highway 38 runs from Kingston and connects with highway 7 at Sharbot Lake. Good roads are scarce in the northern townships although gravel roads provide access to most of the numerous lakes in the district.

The main line of the Canadian National Railway runs across the southern end of the county through Kingston with a branch line running north from Kingston through Harrowsmith, Verona, Hinchinbrooke and Tichborne, then east to Perth in Lanark County. A Canadian Pacific branch line enters the county north of Verona and travels northeast to Sharbot Lake. The mainline of the Canadian Pacific crosses the county roughly parallel to highway 7, passing through Sharbot Lake.

Present Agriculture

The main agricultural soils of the county are found in the southern five townships and on Wolfe and Howe Islands. There are 125,096 acres shown in the

1961 census as improved, cleared land in the areas listed above, while the total for the county is given as 155,054 acres.

The total acreage of occupied farmland in the county is given as 383,984 acres which represents a crop of 71,720 acres from the 1956 census figure of 455,704 acres.

Photo — Ontario Dept. of Agriculture

Dairy farming is an important agricultural endeavor in Frontenac County

The main crops are grown for feed to support a livestock industry which is predominantly dairy farming. The kind, acreage and yield of crops grown in the county are shown in Table 4.

TABLE 4

CROP PRODUCTION IN FRONTENAC COUNTY

(1961 Census)

crop	Acreage	Yield Per Acre
Hay	65,245	2.4 tons
Oats	22,432	44.7 bu
Corn (ensilage)	2,233	10 tons
Mixed Grain	700	46.3 bu
Winter Wheat	607	31.5 bu
Barley	288	33.0 bu

The 1961 census set the total population of cattle in the county at 46,839. This represents one animal per 9 acres of occupied farmland. The population of swine is listed at 7,329 and sheep at 4,975.

Cheese production in the county given as 3,653,576 lbs for 1961 has dropped about 100,000 lbs since 1957. Butter production has increased 482,611 lbs to 1,236,724 lbs in 1961 in the same period.

Wolfe and Howe Islands are economically important areas incorporated within the county. The two islands have a combined acreage of 44,460 acres and carry a total of 7,283 head of cattle and 2,152 head of sheep. Wolfe Island supports a cheese factory while most of the milk produced on Howe Island is processed at Gananoque.

Transportation to and from the Islands is by ferry in the summer and over the ice during the winter months.

THE CLASSIFICATION AND DESCRIPTION OF THE SOILS OF FRONTENAC COUNTY

The surface deposits previously described are the parent materials on which the soils of the county have developed. Differences in the kinds of soils are primarily due to differences in the parent materials but may also be due to differences in natural drainage and vegetation.

Under cool, humid climate and forest vegetation, Ontario soils tend to become acid. The acidity is the result of the removal of bases, particularly calcium from the surface layers of the soil by percolating water. The products of weathering may be transported through the soil either in solution or suspension, to be deposited in lower layers or horizons and this leads to the development of horizons within the soil that differ from one another in thickness, color, structure, and frequently in texture.

The vertical sequence of horizons in a soil is called the soil profile. In agricultural practice it is customary to refer to the different horizons in surface soil, subsoil, and parent material. However, because many soils have more than three horizons or layers, it is convenient to use the specific pedological terms, A horizon, B horizon, and C horizon which are further subdivided into A_0, Ae, B_1, B_2, C, etc. These terms and symbols are used in the detailed soil descriptions given in the appendix.

The A horizon is the horizon of maximum weathering and from which bases are removed. In many soils the A horizon can be subdivided into Ah and Ae. The Ah horizon contains the largest amounts of organic matter and the Ae is the horizon with the lightest color. Some of the constituents (caly, iron, organic matter) leached from the Ah and the Ae accumulate in the B horizon. Hence the B horizon is often finer in texture than other horizons in the profile. The C horizon, generally referred to as parent material, may be unaltered or only slightly altered by the soil-forming processes.

A Gray-Brown Podzolic Soil Profile

Most of the soils in the southern part of the County are classified in the Gray-Brown Podzolic Great Group. These soils have a dark, grayish-brown Ah horizon, relatively high in organic matter, underlain by a yellowish-brown Ae horizon that becomes lighter in color with depth. The B horizon is brown and finer in texture than any other horizon. It contains translocated concentrations of clay minerals and sesquioxides. The parent material is calcareous.

A Brown Forest Soil Profile

The Brown Forest Soils occur in calcareous till materials. These soils have a very dark brown Ah horizon, high in organic matter, which is underlain by a brown B horizon containing some accumulation of sesquioxides and often some clay. The parent material is calcareous.

A Podzol Soil Profile

The Podzol soils have a L-F-H horizon, which is underlain by a gray or white Ae horizon. The B horizon is reddish-brown grading to yellow-brown and contains accumulations of sesquioxides or organic matter or both.

A Gray Wooded Soil Profile

The Gray Wooded soils have a thin Ah horizon not more than 2 inches thick underlain by an almost white Ae horizon. The B horizon can be subdivided into two horizons, a Bt_1 having white coatings over the blocky aggregates, and a Bt_1 horizon in which the aggregates are coated with dark, gray-brown, clay skins. Soil reaction ranges from a pH of 5.2 in the A horizon to pH 8.2 in the parent material.

A Humic Gleysol Soil Profile

The Humic Gleysol are poorly drained. They have a dark-colored surface soil, high in organic matter, and a grayish subsoil with yellow and orange mottling.

Series, Types, Phases and Complexes

The principal unit of soil classification is the soil series which in turn may be subdivided into two or more soil types or phases. Each soil series is defined in terms of the characteristics of the soil horizons; the soils included in a given series having similar horizon development. The series is given a geographic name usually taken from an area where its occurrence is most common, e.g. Otonabee series, a name taken from Otonabee Township, Peterborough County. A soil series may include two or more soil types. These are separations that are based on variations in the texture of the surface horizon. The name of the soil consists of the series name and the surface texture, for example, Otonabee loam. Phases are usually subdivisions of soil types and are used to indicate external characteristics of the soil that affect the cultivation, such as slope, depth to bedrock, amount of stones on the surface, for example, Otonabee loam — shallow phase.

Some of the map units used in this survey are shown as soil complexes, i.e. a combination of two or more soil series. Such map units are used where two or more soil series occur in such an intricate pattern in the field that their boundaries cannot be delineated on the map. The names of the two dominant soil series are used in designating a soil complex.

Soil Key

	Acreage
A. Soils developed on glacial till.	
I. Calcareous loam and sandy loam parent material.	
(a) Well drained.	
1. Bondhead loam (Bl)	4,450
2. Bondhead loam — shallow phase (Bl-sh)	19,800
3. Bondhead sandy loam (Bsl)	5,700
4. Bondhead sandy loam — shallow phase (Bsl-sh)	6,400
5. Tennyson sandy loam (Tsl)	1,150
6. Otonabee loam — shallow phase (Ol-sh)	150
(b) Imperfectly drained.	
1. Guerin loam (Gul)	6,000
2. Guerin loam — shallow phase (Gul-sh)	7,050
(c) Poorly drained.	
1. Lyons loam (Lyl)	1,150
2. Lyons loam — shallow phase (Lyl-sh)	1,150
3. Lyons loam — rocky phase (Lyl-R)	550
II. Calcareous stony loam and sandy loam parent material.	
(a) Well drained.	
1. Dummer loam — shallow phase (Dl-sh)	50
2. Tweed sandy loam (Tws)	200
III. Non-calcareous stony sandy loam parent material.	
(a) Well drained.	
1. Monteagle sandy loam (Msl)	750
B. Soils developed on lacustrine deposits.	
I. Calcareous clay parent material.	
(a) Well drained.	
1. Gananoque clay (Gc)	3,400
2. Gananoque clay — shallow phase (Gc-sh)	10,250
3. Gananoque clay — rocky phase (Gc-R)	450
(b) Imperfectly drained.	
1. Lansdowne clay (Lac)	46,500
2. Lansdowne clay — shallow phase (Lac-sh)	1,650
3. Lansdowne clay — rocky phase (Lac-R)	1,050

(c) Poorly drained.	
1. Napanee clay (Nc)	28,150
2. Napanee clay — shallow phase (Nc-sh)	400
3. Napanee clay — rocky phase (Nc-R)	750
II. Calcareous silty clay loam parent material.	
(a) Well drained.	
1. Seelys Bay silt loam (Sbsil)	1,050
2. Seelys Bay silt loam — rocky phase (Sbsil-R)	1,000
(b) Imperfectly drained.	
1. Battersea silt loam (Btsil)	5,950
(c) Poorly drained.	
1. Moscow clay (Mc)	1,350
2. Moscow clay — shallow phase (Mc-sh)	100
III. Calcareous fine sandy loam parent material.	
(a) Well drained.	
1. Newburgh silt loam (Nusil)	600
2. Newburgh fine sandy loam (Nufsl)	4,600
(b) Imperfectly drained.	
1. Picadilly fine sandy loam (Pfsl)	450
(c) Poorly drained.	
1. Hinchinbrooke loam (Hl)	600
2. Hinchinbrooke loam — rocky phase (Hl-R)	5,850
3. Hinchinbrooke silt loam (Hsil)	2,300
IV. Clay deposits overlying calcareous loam till.	
(a) Poorly drained.	
1. Lindsay clay (Lc)	1,150
2. Lindsay clay loam (Lcl)	1,450
V. Sand deposits overlying calcareous clay.	
(a) Imperfectly drained.	
1. Berrien sandy loam (Bes)	650
(b) Poorly drained.	
1. Wauseon sandy loam (Was)	500
C. Soils developed on sand and gravel outwash.	
I. Non-calcareous sand parent material.	
(a) Well drained.	
1. Wendigo loamy sand (Wes)	2,550
2. Wendigo loamy sand — rocky phase (Wes-R)	10,600
3. Eastport sand (Es)	100
II. Non-calcareous gravel parent material.	
(a) Well drained.	
1. St. Peters gravelly sandy loam (SPg)	1,850
2. St. Peters gravelly sandy loam — rocky phase (SPg-R)	1,550
III. Calcareous gravel parent material.	
(a) Well drained.	
1. White Lake gravelly sandy loam (WLs)	10,100
2. White Lake gravelly sandy loam — rocky phase (WLs-R)	2,350
D. Soils developed on thin deposits on limestone bedrock.	
(a) Well drained.	
1. Farmington loam (Fl)	54,900
E. Soils developed on organic materials.	
(a) Very poor drainage.	
1. Muck (M)	36,350
2. Peat (P)	9,950
F. Soil complexes.	
1. Gananoque clay — Napanee clay (Gc-Nc)	2,650
2. Monteagle sandy loam — rocky phase — Muck-Peat (Msl-R)	303,400
3. Otonabee loam — Moscow clay (Ol-Mc)	750
4. Tweed sandy loam — rocky phase — Muck-Peat (Tws-R)	296,050

G. Miscellaneous mapping units.

1. Marsh (Ma)	8,200
2. Rockland — Rock Outcrop — Monteagle sandy loam — Muck-Peat (R.L.)	88,300
3. Rock Outcrop (R.O.)	4,150
4. Rock Outcrop — Marsh (R.O.-Ma)	10,800

Battersea Series

A fairly large acreage of soil (5,950 acres) mapped as Battersea silt loam is located in the Sunberry—Battersea area. The soil materials were deposited in an embayment either at the time of glacial Lake Frontenac or later in brackish water during the time of the Champlain Sea. This embayment extended northwards from the Cataraqui River and apparently included the present-day lakes of Dog, Loughborough, and Cranberry.

The topography of these soils is gently sloping. They generally overlie Ordovician limestone but along the northern boundaries of the series they may overlie Precambrian rocks.

Granular Surface and Gently Sloping Topography That Is Common To The Battersea Soil Series

The plow layer is dark gray-brown in color. The small to medium sub-angular blocky structure is friable. The soil is slightly acid to a depth of 12 inches or more and becomes calcareous at a depth of 24 inches.

The subsurface and subsoil horizons carry mottled colors indicative of imperfect drainage. There is no practical method of improving this condition and apart from delaying seeding operations in the spring it is doubtful that its effects are deleterious after the commencement of crop growth.

The Battersea soils are mostly under cultivation and are used chiefly for the production of hay and grain.

Bondhead Series

The Bondhead soils are important agricultural soils in Central and Eastern Ontario because they are suitable for the production of a wide range of crops and are easy to cultivate. The Bondhead soils occur in the Harrowsmith—Sydenham area. Out of a total of 36,350 acres, 10,150 acres are deep till soils while the remaining 26,200 acres are shallow till deposits that overlie limestone bedrock.

The topography of the Bondhead soils is moderately sloping with occasional short, steep slopes at the rounded ends of drumlins.

The soil parent material is a gray-brown calcareous sandy loam or loam till that contains numerous fragments of limestone and large boulders of granite. On some of the till ridges the soil materials have been sorted by wave action that has produced sandy surfaces.

There is a fairly wide variation in the profiles found on the Bondhead soil in Frontenac County because of the lack of uniformity of the parent materials. The underlying till frequently has pockets of lacustrine materials.

The cultivated surface of the Bondhead soil generally contains a fair content of organic matter. It is friable and well aggregated, and about 6 inches thick. On the eroded slopes however the brown-colored B horizon becomes the surface layer, The B horizon is a brown to dark brown clay loam, 5 to 7 inches thick. Since it contains a greater quantity of clay than the surface it is less permeable to water.

Legume hay crops, spring grains, fall wheat, silage and grain corn grow well on the Bondhead soil, although barnyard manure and commercial fertilizers are necessary for optimum yields. Erosion losses may be serious on slopes that are

Photo — Ontario Dept. of Agriculture

Corn Can Be Grown Profitably on Well-Drained Soils in the Southern Portions of the County left bare over winter; hence the steeper slopes should be protected by permanent grass vegetation.

Two soil types namely, Bondhead loam and Bondhead sandy loam were mapped in the survey areas.

Shallow phases of both soil types are also present in areas where the soil has a depth of 1 to 2 feet overlying the limestone bedrock. The shallow phase soils are generally cultivated. Alfalfa grows well and apparently roots well in the thinly bedded limestone. The chief limiting factor in the production of high yields of hay and grain is the lack of moisture.

Berrien Series

These soils have developed on calcareous sand of medium texture overlying lacustrine clay.

The topography of the Berrien soils is gently sloping. This slope is insufficient to carry away all surplus water and imperfect drainage conditions exist in the soil.

The cultivated surface is fairly dark in color indicating a fair level of organic matter. The subsurface layers of the Berrien soil are yellowish-brown sandy loam over a mottled reddish-brown Bf horizon usually located at the sand-clay junction.

These soils are being used for general farming and producing fair crops of red and alsike clover, timothy and oats. The Berrien soils have a low natural fertility and require applications of barnyard manure and other fertilizer supplements

Dummer Series

The Dummer soils occupy a very small acreage in Frontenac County but they are very widely distributed throughout South Central Ontario.

Dummer Loam Can Provide Good Pasture If Well Managed

The soil parent materials consist of very stony calcareous till which constitutes the eastern end of the great terminal moraine that stretches across Peterborough and Victoria Counties.

The landscape is irregular, steeply sloping so that the steepness of slope and coarseness of the material combine to produce a soil with very rapid internal drainage. The depressions contain deep accumlation of silt and fine sand that have been eroded from the surrounding slopes.

The surface horizon is 3 or 4 inches thick, very dark in color and alkaline in reaction. The subsoil is gray-brown to dark brown and may have some clay concentration in the B horizon. The total thickness of the solum ranges from 9 to 12 inches.

A large portion of the Dummer soils are not suitable for cultivation because of excessive stoniness and hilly topography. Most of these soils are suitable for pasture but some method of controlling weeds is necessary. Most of the present range areas are extremely weedy.

The Dummer loam—shallow phase has a thin layer of soil over the limestone bedrock and a very steep topography. It has very limited value as pasture land.

Farmington Series

The Farmington soils have a wide distribution in Eastern Ontario. They are found only in the southern half of Frontenac County on large continuous blocks of limestone table lands or on isolated segments of such table lands.

As shown on the geological map, Figure 3, the southern border of the Precambrian Shield, which is a region of hard, granite-like rocks, cuts across Portland Township. This portion of the township lying to the south of this border is a region with limestone bedrock. Nearly all of the agricultural soils in the township are on this limestone plain. This particular pattern of distribution of soil materials is a result of the nature of the bedrock and the distinctive action of the continental glacier. The main movement of the continental glacier was from north to south. In the area of hard Precambrian rocks little soil material was produced, but in the area of soft limestone the glacier ground the rock and produced the materials for the agricultural soils of the southern portions of the county. Adjoining the Precambrian border there is a belt of limestone that was either scraped bare of soil materials or on which little of the disintegrated rock material was deposited. The Farmington soils occur on areas that have only a thin covering of soil materials of limestone origin. This thin covering extends over much of Kingston Township also.

The limestone rock surface is flat, hence the soil surface is also flat, except for local breaks or scarps in the rock surface. Variations in the soil are mainly variations in depth of till deposit. Thus, it is possible to find areas of considerable size that have a soil coverage of 4 inches and others with 12 inches of soil materials and these differences in depth may constitute the difference between an agricultural and non-agricultural soil. In this area soils with a depth of 12 inches do not have sufficient moisture reserve to ensure crop production. However, it is only during the wettest seasons that the Farmington soils will give an adequate return for spring seeded grains or hay. As a consequence, most of these soil areas are used as grazing land. Native grasses such as Canada Blue and to a lesser extent Kentucky Blue and Brown Top constitute the principal grass species.

These soils have little profile development. Because of proximity to bedrock the soil material has a high content of bases and may be calcareous even at the surface. The organic matter content is generally high and is present even in the

A Landscape Scene of Farmington Loam

The vegetation is typically cedar, low spreading juniper, and sparse native grasses.

subsoil so that the entire profile is dark brown. Only rarely do these soils show the mottled effects that are so commonly produced by imperfect drainage. It is possible that there are sufficient fractures and crevices within the rock surface to permit the excess water to seep away from the soil.

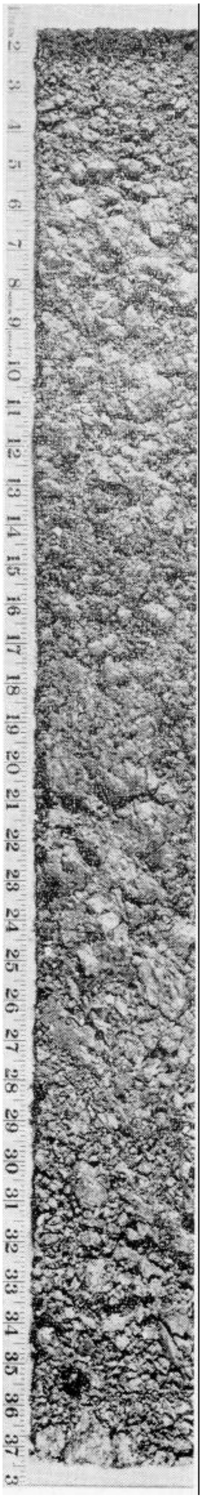
The Farmington soils constitute the problem soils in this as well as many other counties in the province. They have limited use for agricultural purposes and have a low carrying capacity as grazing land for livestock. Their potential for forestry is limited. The plant species that occur most commonly are Eastern Cedar and Dwarf Juniper and Creeping Juniper. These trees soon become prevalent on abondoned land.

Gananoque Series

The Gananoque soils are developed in clay soil material having good to moderately good surface drainage. They occur exclusively in the southern portion of the county. A part of this region was covered by salt waters of the Champlain Sea and it is assumed that these fine clay sediments originated at this time. When first deposited these sediments must have been calcareous but the process of profile development has removed the lime from the surface layers to a depth of 36 to 48 inches.

The topography of the Gananoque soils is variable. In some areas the moderate slopes are bedrock controlled; in other areas the parallel rolling ridges are probably the result of wave action and in still other areas the irregular sloping topography has resulted from stream erosion.

The surface of the soil is slightly acid and is gray in color, particularly so when seen in a cultivated field. The subsurface soil is also gray or when dry is almost



A profile picture of the Ganonoque showing the horizontation and bedding planes.

white in color. This is the most severely leached portion of the soil and has a low organic matter content. The remaining depth of subsoil consists of a brown clay with a medium to large blocky structure and neutral reaction. The calcareous parent materials contain many hard lime concretions.

The Gananoque soils are among the best agricultural soils in the district. The application of commercial fertilizers or of barnyard manure is beneficial for all cultivated crops. Organic matter in some form must be regularly incorporated with the soil; otherwise it loses its friable structure.

The Gananoque clay - shallow phase is mapped in areas where bedrock occurs within 2 feet of the surface. These soils are used similarly to the deep Gananoque soils but are affected to a greater degree by drought.

The Gananoque clay - rocky phase has numerous outcroppings of Precambrian rock which restrict cultivation and these areas are generally used for pasture although some hay is harvested.

Guerin Series

The Guerin soil series is imperfectly drained, and is generally found associated with the Bondhead soils. The largest acreages of these soils are mapped in the Fellows area. About 50 percent of the Guerin soil areas are underlain by bedrock at depths ranging from 1 to 3 feet. These areas are classified as Guerin - shallow phase and are found in association with the Farmington soils in slightly depressional troughs in the limestone plain.

The Guerin soils in Frontenac County have pockets of lacustrine material incorporated in them which were not delineated at the scale of mapping.

The topography is gently sloping, hence erosion is not a serious hazard. Surface drainage is slow and internal drainage is often impeded by the underlying bedrock.

The organic matter content of the cultivated layer is higher than that of the Bondhead soils. Soil horizons below this surface layer are less well developed than corresponding horizons of the well-drained soils.

The Guerin soils are used successfully for the growing of hay (including clovers), oats, corn, and pasture but are less satisfactory for alfalfa and fall wheat than are the well-drained Bondhead soils.

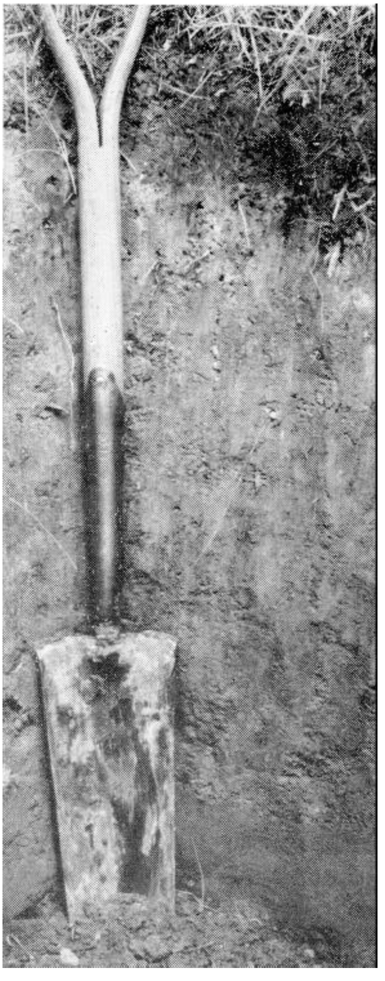
Hinchinbrooke Series

The Hinchinbrooke soils are poorly drained soils that have developed on calcareous fine sandy loam and silt loam lacustrine materials. They are fairly extensive in Frontenac and Leeds Counties and seem to have developed from deposits in old shallow lake basins.

The major areas of these nearly level soils occur in Hinchinbrooke Township. They are associated with present-day lakes and their boundaries indicate the original extent of these lakes.

The Hinchinbrooke soils have a thick, dark surface ranging from loam to silt loam in texture. This horizon grades into gleyed grayish-brown loam to silt loam underlain by silty calcareous parent material. The sand fraction containing large amounts of fieldspars, quartz, crystalline limestone and other rocks and minerals reveals its relation to the surrounding Precambrian rocks.

These soils have a good potential for agriculture when adequately drained. Under natural drainage they are fair to poor agricultural soils suitable for hay, pasture and spring grains.



The Hinchinbrooke series is a poorly drained medium-textured soil.

Hinchinbrooke loam - rocky phase has numerous outcroppings of Precambrian rocks which restrict its use for agriculture. It is generally used as permanent pasture.

Lansdowne Series

The Lansdowne soils comprise the imperfectly drained clay soils occurring in the most southerly portions of the county, in the townships of Kingston, Pittsburgh, and on Wolfe Island. Associated with them are the Napanee clay soils which are derived from the same kind of soil materials but are poorly drained.

The Landsdowne soils are found on gentle slopes that probably represent the rising elevations to a limestone plain. In some locations islands of rock occur completely surrounded by these clay sediments. The positions occupied by the Lansdowne soils is therefore the upper limits of the sediments laid down in the former glacial lake. There are two conditions that contribute to the natural drainage on these clay soils namely, the natural slope of the surface, which assists in water runoff, and the slope of the underlying sediment or base material.

A Landscape of the Lansdowne Series Showing the Gently Sloping Topography.

Natural drainage of these soils is not completely satisfactory since clay texture restricts the movement of percolating water. These soils are therefore saturated with water for many months of the year and only dry out thoroughly during the summer season.

The surface cultivated soil has a low content of organic matter. This low organic matter content is a natural condition brought about through soil development. The surface of cultivated fields is light gray in color and contrasts sharply with the soils in depressions that have a higher content of organic matter and are dark in color. Plowed soils therefore tend to be cloddy and difficult to cultivate. The general farm practice is to plow these soils in the fall and thus permit freezing and thawing during the winter to break down the large clods.

These soils are moderately acid to a depth of 24 inches and at that depth are neutral in reaction and within 30 inches are highly calcareous. Applications of ground limestone are not necessary for cereal crops and corn, but in the establishment of legumes such as alfalfa and red clover it may be necessary to apply lime at the rate of 2 tons per acre.

The common crops grown on these soils are cultivated hay, spring grains, fall wheat, and corn. The productivity of the Lansdowne soil is good, and for these common crops it rates among the best of the clay-textured soils in this region. Some difficulty is encountered in the production of alfalfa because of losses through winter killing, and the practice is to substitute red clover which has a better chance of survival.

The Lansdowne - shallow phase soils that are indicated on the soil map are usually found in close association with the Farmington soils. They consist of clay deposits of 12 to 18 inches underlain by limestone bedrock. Natural drainage is imperfect and the characteristics of the soil are similar to those of the deeper soils. These shallow soils are used principally for pasture and only occasionally for the growing of cultivated crops.

The Lansdowne clay - rocky phase has numerous outcroppings of Pre-cambrian rocks which restrict its use for agriculture. These areas are generally used for pasture although some hay is harvested.

Rock Knob Outcrops Surrounded by Clay Sediments.

Lindsay Series

The Lindsay soils have developed on shallow lacustrine clay deposits, about 15 inches thick, over stony calcareous till. The topography of this series is nearly level; hence external and internal drainage is slow.

The cultivated surface is dark, usually stonefree, clay loam and neutral in reaction. The subsoil layers are gleyed and mottled.

The Lindsay soils are used generally for hay and pasture. They are late soils and unreliable for the production of cereal grains, and unsuitable for alfalfa although legumes such as alsike, birdsfoot trefoil, and ladino may be grown on these soils.

Lindsay clay and Lindsay clay loam are two series types mapped in the county. Under natural drainage conditions there is little to choose between the types.

Lyons Series

Soils of this series occur on level or slightly depressional areas that are associated with the Bondhead and Otonabee soils. These soils are developed from stony calcareous till materials of loam texture. They are poorly drained and have a thick (6 to 8 inches), dark surface horizon that is rich in organic matter. Soil horizons underlying the surface grade from those having a drab gray color to those of intense mottling. Free carbonates are usually found about 2 feet below the surface.

The Lyons soils are not suitable for spring grain crops but are satisfactory as pasture land. Most areas are used for this purpose but some still remain in forest. Oats or ensilage corn are grown in favorable seasons but crop yields are generally low.

There are 1,150 acres of Lyons loam - shallow phase, i.e. soils with less than 2 feet of soil material over bedrock. These occur in the southern part of the County in close association with the Farmington series. The soil parent material is a calcareous glacial till that contains thin fragments of limestone. The surface soil is a very dark gray color underlain by mottled gray moderately stony soil resting on limestone bedrock. The entire solum is alkaline in reaction. This shallow phase is generally used for pasture. It is a wet soil in late spring and crops may suffer from lack of moisture in July and August.

The rocky phase occurs near the Precambrian-Ordovician border line and numerous outcroppings of Precambrian rock are associated with Lyons soils. The area is used for hay and pasture.

Marsh

Marshes are generally flooded areas supporting water-loving plants but have not as yet developed into organic bogs. These areas have less than a foot of organic accumulation.

Their chief value at present is as a wildlife habitat.

Muck

The organic soils in the county are designated as Muck or Peat. The Muck soils are the black, fairly well decomposed organic materials that occur in the limestone plain area of the southern half of the county and in certain portions of the Precambrian Shield. The occurrence of this soil appears to be associated very largely with the distribution of limestone or of calcareous soils.

A boring made through a body of Muck usually reveals various layers of other materials such as silt, woody remains of trees, and layers of peaty material that have not thoroughly decomposed. These layers are frequently a foot or more in thickness. The thickness of Muck deposits may vary from one to several feet. These deposits occur in the depressions in all soil areas and therefore may be underlain by limestone of Precambrian bedrock or by soil materials.

Since these soils are located in depressional areas they are always poorly drained and there is little opportunity to improve their drainage by artificial means. The larger areas of Muck soils usually have some natural drainage outlet such as streams, and all that may be required to improve the drainage is to deepen and extend the outlet into the main body of Muck.

The Muck soils in this county have not been developed for agriculture. To assess their value for agriculture it would be necessary to investigate each individual area in regard to its vegetative cover, composition of the Muck, and possibilities of drainage.

Monteagle Series

The Monteagle series is one of the major soil groups occurring in the Precambrian Shield. The parent material consists of a stony, gravelly, sandy loam till derived from hard Precambrian rocks such as granite, gneiss, etc. These soils surround the Tweed soils and have none of the crystalline limestone incorporated in the soil parent material. The mantle of till overlying the bedrock is usually very thin but there are some localities where the till mantle is thick and where its value as an agricultural soil is very much improved.

A mantle of soil material, 3 feet or more in thickness, has permitted the development of a soil profile. Such a mantle occurs occasionally in areas of mappable size but most frequently mapped as part of a complex that includes Monteagle soils, organic soils (either Muck or Peat) and rock outcrop.

The areas that occur on the soil map as Monteagle sandy loam constitute the areas with deeper soil materials and in which rock outcrop occupies less than 25 percent. These soils have a dark-colored surface which originally developed under a mixed forest vegetation of deciduous and coniferous trees. During the last half-century logging operations and forest fires have depleted the forest, and grass vegetation is well established in all areas, except under the denser canopy of trees where the surface consists of a leaf mat only. The region is therefore a combination of grassy areas alternating with patches of forested areas in which there is no grass vegetation. This alternating pattern of vegetation must be recognized when assessing the potential of this region for grazing.

A Profile of Monteagle Sandy Loam.

The lack of lime in the soil material has permitted the development of Podzol soil profile. The surface leaf mat is underlain by a gray bleached layer, 1 or 2 inches in thickness. This layer is discontinuous in the southern limits of the series. Under grass vegetation it is generally destroyed. The subsoil which is brown, loose, and very porous, grades into the parent material at 14 to 22 inches. All horizons of the profile including the parent material have an acid reaction.

The Monteagle soils in Frontenac County have little if any potential as agricultural land. Areas suitable for cultivation are too small and scattered to form an economic unit.

The areas under cultivation produce fair to poor crops of oats and hay.

Monteagle - Rock - Peat Complex

This complex of soils and rock outcrop covers a very large percentage of the county. It predominates over the major part of the Precambrian Shield. Coarse gravelly soil materials are irregularly distributed among the granite and metamorphic rock outcrop and may be several feet in depth or may be a thin veneer of soil overlying bedrock. Muck and Peat occur in the poorly drained depressions.

Monteagle Sandy Loam - Rock Complex.

The soils that occur in pockets within this region belong to the Monteagle sandy loam and are too irregular to be of any agricultural value. Some small areas are used as grazing land but most of it is forested. Future possibilities for grazing are also limited.

Moscow Series

The Moscow soils are poorly drained clay soils. The soil materials from which these soils developed originated in a local lacustrine basin separated by limestone plains and morainic ridges from the Lake Iroquois basin in which the Gananoque clay and Napanee clay soils occur. Camden Lake and Varty Lake in Lennox and Addington County are remnants of a large lake that occupied an irregular-shaped basin extending east into Frontenac County.

This is one of the best agricultural sections in these counties and is a reflection of the soil combinations that occur in this area. The Moscow soils are interspersed among rolling upland areas on which till soils occur. Farm properties may therefore consist of variable combinations of these two types of soils. Although these are the principal agricultural soils in the area, large acreages of Peat and Muck soils are also present.

The surface of these soils has a clay texture (the clay percentage varying from 35 to 45 percent), is friable, and has good structure in contrast to the Napanee soils. The subsoil and parent material is silty and ranges from silty clay loam to silty clay.

The poor internal drainage of these soils is a result of their position in the landscape rather than to impervious subsoil material. They occupy the level flats and depressions between the rolling morainic ridges. Stream drainage through the adjacent Peat and Muck areas is very sluggish and the high water table in these areas probably extend into the adjacent Moscow clay. It is doubtful that any effective drainage improvement in the Moscow soil is possible without also improving that of the organic soil areas.

The Moscow clay soils are used principally for hay and spring grain crops. Since these are the principal crops grown in this dairy farming area, no data is available regarding the production of other crops on the Moscow clay.

The Moscow clay - shallow phase soils have limestone bedrock at depths of 1½ to 2 feet. These shallow soils are used for agricultural purposes in much the same way as the normal Moscow clay.

Napanee Series

The Napanee soils are the poorly drained clay-textured soils that occupy the level and depressional areas eastward from Napanee along the lakeshore front to Leeds County. They are found in the townships of Kingston, Pittsburgh and on

Photo — Ontario Dept. of Agriculture

P1owing Down Crop Residue Aids Soil Structure

Wolfe Island. Since much of the agricultural production of the county is dependent upon the productivity of the clay-textured soils the present and future use of the Napanee soils is of considerable importance.

The Napanee soils are known locally as "the white clays". This descriptive term characterizes the color of the surface cultivated soils but the subsoil becomes darker with depth. Chemical analyses show that the surface horizons are low in organic matter and have lost most of their soluble constituents through leaching. In this respect they are similar to the Lansdowne clay soils. The average clay content of the cultivated surface soil is 45 percent.

The features that make this soil difficult to cultivate are (1) high clay content, (2) low organic matter content and (3) poor drainage. An increase in the organic matter content will improve the structure of the clay and in addition aid drainage by allowing freer movement of soil water. Perhaps the most serious handicap of these soils is the poor drainage. Up to the present time artificial drainage by the use of tile is not a common farm practice in this region. Investigations* on crop returns obtained from the use of tile drainage have shown some improvement through tiling, but the results have not been too successful. Until such time as drainage can be improved these soils will be used for hay and pasture crops mainly, or crops that can survive under excess moisture conditions.

The Napanee clay - shallow phase soils, indicated on the soil map, consists of those areas in which clay deposits rest upon limestone bedrock, within 12 to 18 inches of the surface. Fortunately such soils are not very extensive and only occur adjacent to limestone outcrop and limestone plains. These soils are suitable only for hay and pasture.

The Napanee clay - rocky phase has numerous outcroppings of Precambrian rocks which restrict its use for agriculture. These areas are most suitable for pasture although presently some hay is harvested.

Newburgh Series

The Newburgh soils are well-drained soils and are found associated with lakes or rivers and are thought to be deltaic in origin. The soil materials are fine sandy loam with or without silt layers. Two soil types have been mapped in the county, namely Newburgh silt loam, which contains silt bands, and Newburgh fine sandy loam, which has a uniform texture throughout the soil profile.

The Newburgh soils are scattered in small areas in the southern part of the county, the largest single area occurs around Wilmer.

The surface soil is a fine sandy loam, friable and slightly acid in reaction. The profile has developed to a depth of 24 inches and maintains a fine sandy loam texture down to the parent material. The parent material is calcareous and may be either fine sandy loam or silt loam. Soil drainage is free in all seasons of the year, which combined with ease of cultivation, make these soils more versatile in the choice of agricultural crops than any other soils in the county. Slopes, however, are a serious limitation and the use of hay and pasture crops are necessary to conserve this highly erodible material.

Otonabee Series

The Otonabee soils occupy a large area in central Ontario and extend to the western boundary of Frontenac County. These soils are commonly found on oval-

*Tile drainage in Ontario. Agric. Economics Dept.

shaped hills having long moderate slopes or with short slopes in areas of ground moraine. It is in these latter areas that loam and clay soils are found in close association and hence are mapped as a complex of Otonabee loam and Moscow clay.

The soil parent material is a calcareous gray loam till that commonly contains some stone and occasionally is very stony. These latter areas are designated on the soil map as Otonabee-stony phase. The solum is thin having a depth of 12 or 14 inches. All horizons in these soils have a high base saturation. The reaction of the surface soil is neutral and free carbonates are present in the B horizon which occurs generally within 8 to 10 inches from the surface.

Otonabee soils are suitable for the production of a wide variety of farm crops and are similar in productivity to the Bondhead soils. The principal type of farming is dairying. Spring grains, corn, and hay crops alternate in the rotation.

The principal variations in the Otonabee soils which affect the agricultural use and to some extent productivity, is the depth of soil that overlies the bedrock, the steepness of the slope, and the amounts of stone that occur at the surface. These variations occur in specific areas and have been mapped separately as phases, namely Otonabee - shallow phase, Otonabee - stony phase, and Otonabee - steep phase.

The shallow phase soils have 1 or 2 feet of soil material overlying the bedrock and are most common in the Camden Lake region where the till plain merges with the limestone rock plain. Although the soil covering is thin, these areas can be cultivated and will produce spring grains as well as cultivated hay. These soils are more droughty than the normal Otonabee soils and therefore are used mainly for hay and pasture.

Picadilly Series

The Picadilly series are soils that have developed on a mixture of silt loam and fine sandy loam deposits under imperfect drainage. They occur in two areas in the county, namely the Picadilly and the Godfrey areas. Fine sandy loam soils and silt loam soils mapped as Newburgh, Picadilly, and Hinchinbrooke, occur in the area and are no doubt deltaic in origin.

The soil materials are much the same as those on which the Newburgh soils developed but in comparison with the latter constitute a much shallower depth of deposit, the total depth of soil being less than 6 feet over bedrock.

The surface soil is most commonly fine sandy loam although local areas of silt loam are also present. The soils are friable, easy to work and are slightly acid in reaction. The subsoil texture is friable, porous, silt loam, a material with mottled color indicative of imperfect drainage. The subsoil is saturated with water for many months of the year and probably dries out only in the summer months. The calcareous silt loam parent material occurs at a depth of 18 inches.

The principal crops grown are spring grains and hay. Because of the friable nature of these soils and their good workability, they are suitable for a variety of crops, including vegetable crops. Where internal drainage of the soil is a problem, tile drainage could be installed provided that the soil is sufficiently deep over the bedrock to permit a satisfactory installation.

Peat

The Peat soils occur only in the northern part of the county. The surface of the Peat is generally brownish in color. They are less decomposed than Muck soils and the plant remains are usually fibrous and relatively fresh. Sedges and sphagnum moss are common components of the Peat bogs.

The Peat areas are not used for agriculture and most carry little if any commercial wood products.

Rockland

A large acreage in the northern part of the county has been mapped as Rockland.

This land was differentiated from Monteagle sandy loam - rocky phase on the basis that it has a much smaller percentage of Monteagle soils among the rocks and therefore has no potential for any type of agricultural endeavor.

A View of Map Areas Designated as Rockland, Consisting of Numerous Rock Outcrops and Sparse Vegetation.

The area contains over 50 percent of rock outcrop together with shallow Monteagle soils, Muck, and Peat. There may be small areas of Wendigo sand included in this mapping unit.

Most of this area is-under tree cover and should be considered only as forestry and recreational land.

Rock Outcrop

A small acreage has been mapped in Frontenac County as Rock Outcrop. Bare rock constitutes over 75 percent of the area and it has no potential as either forestry or agricultural land.

Rock Outcrop - Marsh

This area is mapped in Hinchinbrooke Township and is an area of uneven Precambrian bedrock of low relief with marshy depressions and numerous outcroppings rising a foot or two above marsh level.

Seelys Bay Series

The Seelys Bay soils are well-drained silty soils found along the northern fringe of the lacustrine deposits in Frontenac and Leeds Counties. They are relatively shallow lacustrine deposits in contrast to the deep clay deposits mapped to the south as Gananoque, Lansdowne, and Napanee.

The soil parent material is a calcareous stone-free silty clay to silty clay loam. The topography of the Seelys Bay soils is irregular, moderately sloping and is bedrock controlled.

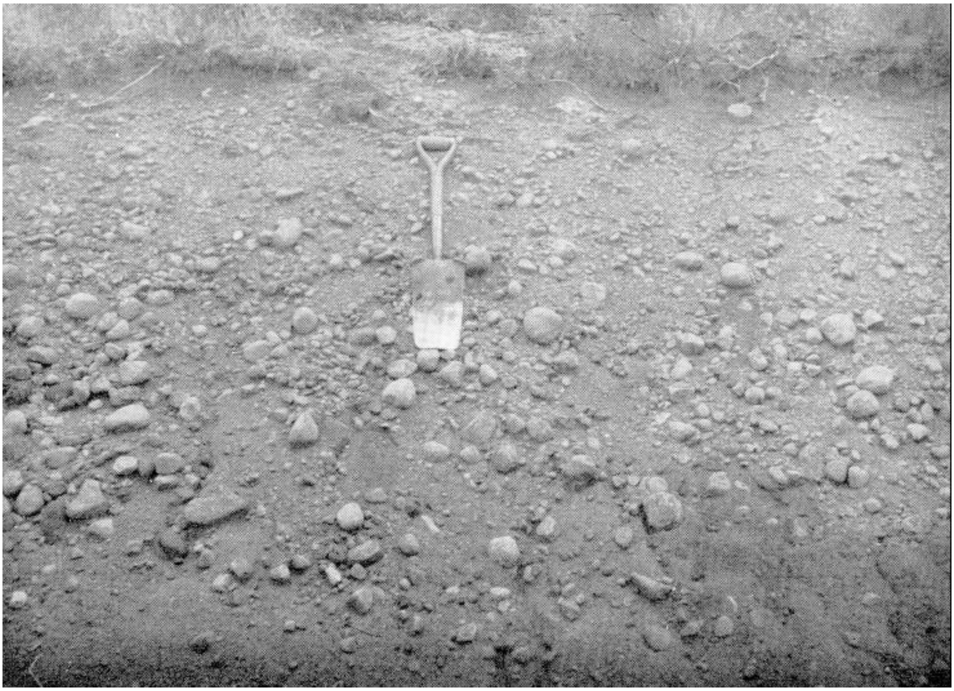
The surface of these soils is dark and contains a fair level of organic matter. It is slightly acid in reaction. The subsoil consists of a pale brown Ae horizon about 4 inches thick underlain by a brown silty clay B horizon about 8 inches thick. This overlies the dark gray silty clay loam parent material. The soil has subangular blocky friable aggregates in the upper parts of the solum but the B and C horizons have angular blocky aggregates which become hard when dry.

The Seelys Bay soils are good agricultural soils and produce good yields of hay, ensilage corn, and spring grain. They are easier to work than the Gananoque clay and have a much better structure in the plow layer.

The Seelys Bay silt loam - rocky phase has numerous outcroppings of Precambrian rocks which restricts its use for agriculture. It is generally used for permanent pasture.

St. Peters Series

The St. Peters soil is a coarse gravelly soil that occurs exclusively within the Precambrian Shield. The soil materials consist of gravel and sand deposited by fast-flowing streams and form much of the river terrace deposits and alluvial flood plains of the Mississippi River.



Poorly Sorted Gravel Deposits That Constitute the Soil Material of the St. Peters Series.

These are granitic materials and soil development has produced a typical Podzol soil profile. Although most of the surface horizon has been destroyed by various man-made activities, the reddish-brown B horizon is always present. The total depth of the soil profile is less than 12 inches.

Some agricultural use is made of these soils because in many areas they are the only boulder-free soils that exist. Cultivation however is limited to a few acres per farm and the crops that are grown are chiefly hay and oats.

The rocky phase consists of gravel outwash in and around Precambrian outcrop. The outcroppings are generally so numerous as to make the phase non-agricultural.

Tennyson Series

The Tennyson soils are mapped in Bedford Township adjoining Leeds County near the town of Westport and are part of a larger area mapped in Leeds County. These soils have developed from glacial till derived from the underlying limestone bedrock mixed with liberal quantities of Precambrian till carried by the ice from the adjoining Precambrian region.

The Tennyson soils in this county have smooth moderately sloping topography. They are well-drained and classified as Brunisolic-Gray-Brown Podzolic soils.

The soil parent material is a gray-brown calcareous sandy loam till of mixed materials.

The dark brown friable sandy loam surface is 6 inches in cultivated areas and is underlain by a dark yellowish-brown sandy loam horizon (Ae_1) of about 3 inches thickness. The yellowish-brown Ae_2 horizon is sandy loam in texture and about 7 inches thick. The Gray-Brown Bt horizon is 6 inches thick, loam-textured and subangular blocky in structure. The B/C horizon is thick with a 2 foot depth to free carbonates. Soil reaction ranges from nearly neutral at the surface to alkaline at 3 feet. Carbonates are leached to a depth of 4 feet in non-eroded locations.

The Tennyson soils are stony and these must be removed before cultivation can be carried on. These soils are used extensively for cultivation and a considerable farming community has become established in the area.

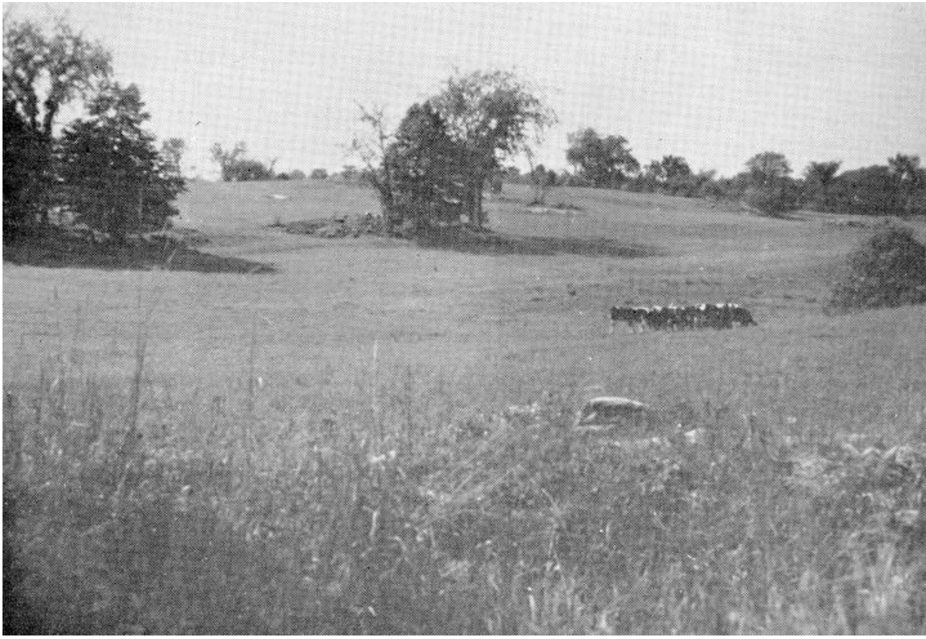
Alfalfa and clover hay, spring grain and ensilage corn are the main crops grown and good to fair yields are obtained.

Tweed Series

The Tweed soil series is closely associated with crystalline limestone, a rock formation that is somewhat unevenly distributed over the Southern Ontario portions of the Precambrian Shield. This rock material was ground by glacial action sufficiently to produce a sandy loam calcareous till. The soil parent material is a stony sandy loam, in which the stone fragments are both limestone and granites derived from the Precambrian rock formations.

The Tweed soil generally occurs as one member of a complex, the other parts of the complex being the Monteagle soils, organic soils and bare rock outcrop. In some areas the Tweed soils occur in sufficient size to map as an individual unit, whereas in other areas it is shown as being part of a complex.

These soils have an irregular moderately sloping topography. The slope and the coarseness of the soil material combine to produce a well-drained soil. The cultivated surface soil is a gray-brown sandy loam, friable, and ranging in reaction



Tweed Sandy Loam. Rocky phase is generally shallow with numerous rock exposures.

from moderately acid to neutral. The subsoil horizons are neutral to alkaline and become calcareous as they approach the unweathered parent material.

The Tweed sandy loam is one of the soils used for farming in the Precambrian Shield area, but does not rate high when compared with the agricultural soils that occur in the southern parts of the county. Legume crops such as alfalfa grow very well, so that hay and spring grains constitute the principal crops in the farm crop program. The soils are normally very stony and most cultivated fields are lined by stone fences that are added to every year. Individual fields are small and are limited in size by the frequency of rock outcrop and the discontinuity of the soil material.

Tweed Sandy Loam - Rock Outcrop - Monteagle Sandy Loam

Numerous outcroppings of crystalline limestone and granite occur frequently. The soil in this area contains a large amount of limestone materials. The topography of the area which is irregular, moderately to steeply sloping, reflects the bedrock relief.

The Tweed sandy loam is formed on calcareous sandy loam till. The surface soil is dark and fairly well supplied with organic matter. The B horizon is 6 to 8 inches thick and reddish-brown in color. The combined thickness of A and B horizons varies from 1 foot to 18 inches.

Cultivation is restricted to small fields by the numerous rock outcrops and for this reason the Tweed is poor farm land. However, it is the best pasture land within the Shield and could be used for the establishment of large pasture farms.

Wauseon Series

The Wauseon soils have developed on a calcareous sand that overlies calcareous lacustrine clay at 20 to 24 inches.

The topography is level or depressional. Surface drainage is poor and the drainage conditions within the soil are poor.

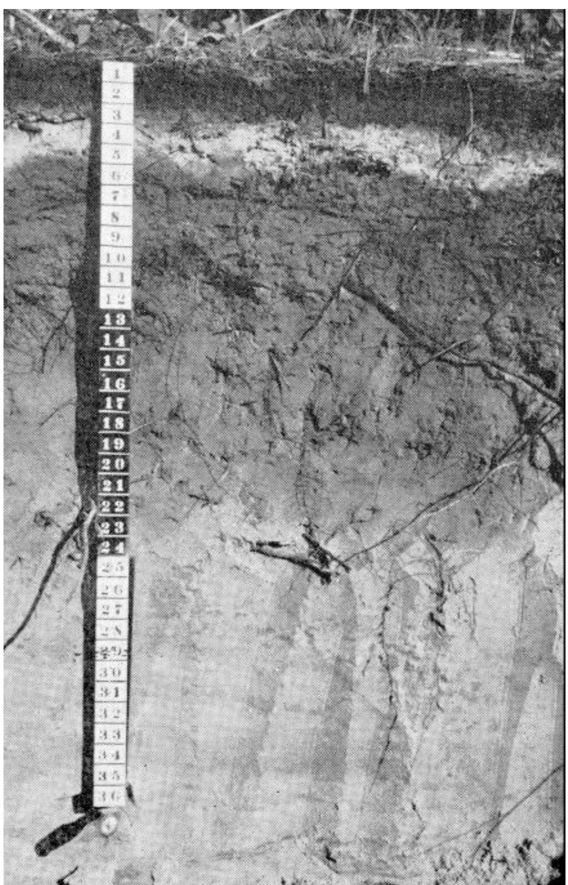
The cultivated surface horizon is thick and dark, indicative of a high organic content level. Soil reaction is alkaline. Underlying layers are gray and mottled.

The Wauseon soils are used mainly for hay and pasture. They are late cold soils and not satisfactory for general farming.

Wendigo Series

The Wendigo soils are sandy-textured soils developed from sand parent materials that occur almost exclusively within the Precambrian Shield area. Most of the Wendigo soils in this county are found in Kennebec Township.

The parent materials of these soils originated as glacial outwash and to a lesser extent as river deposits associated particularly with the Skootamata River. These deposits are generally shallow and poorly sorted with the result that gravels and various grades of sand occur together in stratified layers. This is a region of thin soils and frequent rock outcrops. The sand deposits occur as individual pockets, having only a few acres of size or as a broad continuous area, with many rock knobs and small undrained depressions.



The Wendigo Soils arc Classified as Orthic Podzols.

These sandy materials are non-calcareous and the soils that have developed on them are strongly acid and with a typical podzol profile. Since many of the areas of these soils have not been cultivated the features of the podzol profile still remain and the gray-colored surface horizon occurs continuously in grassy open areas and in the wooded or forested areas.

These should be considered as non-agricultural soils. It is evident that in the early settlement of this region these sandy areas were chosen as possible sites for farming and many of the roads that exist at the present time tend to join together the various small sand plain areas. After some attempt was made to farm these soils, they were eventually abandoned and some natural reforestation has taken place. Information gathered from local residents points to the fact that many of the best native stands of pine were to be found on these sandy soils.

In the survey the areas that consisted predominantly of sand were mapped as Wendigo loamy sand. Other areas, however, are shown on the map as Wendigo-rocky phase. The latter areas consist of small pockets of Wendigo loamy sand together with rough knobs and hills of rock outcrop. This procedure of mapping helps to delineate some of the major areas in which sand is a major component of landscape.

White Lake Series

Most of the White Lake soils in Frontenac County are found in the northern half of the county. The soil is developed on calcareous gravel derived from limestone rocks of Precambrian age.

The soil parent materials are composed of gravel formed from many kinds of rock such as granite, sandstone, and crystalline limestone. The gravel is poorly sorted, ranging in size from fine gravel to large boulders. The topography is irregular, moderately to steeply sloping. The soils has developed the characteristics of a thin Podzol in the surface horizons with evidences of a Gray-Brown Podzolic textural horizon in the lower part of the profile. Soil reaction in the upper part of the profile is moderately acid but reaches the neutral point at about 15 inches.

The White Lake soil is commonly used for the production of cereals, hay and pasture. It is one of the few soils in the Precambrian Shield that can be cultivated although it is low in fertility and tends to be droughty. The gravelly materials are extensively used for construction purposes. The rocky phase has numerous outcroppings of Precambrian rocks which inhibit cultivation.

SOIL CAPABILITY CLASSIFICATION FOR AGRICULTURE

This capability classification is one of a number of interpretive groupings for agricultural or other purposes that may be made from soil survey data. In this classification the mineral soils are grouped into seven classes on the basis of their suitability and limitations for agricultural use. The first three classes are considered suitable for sustained production of common field crops, the fourth is physically marginal for sustained arable agriculture, the fifth is capable of use only for permanent pasture and hay, and the sixth is capable of use only for wild pasture. While the soil areas in Classes 1 to 4 are suited for cultivated crops they are also suited for permanent pasture. Soil areas in all classes may be suited for forestry, wildlife, and recreational uses. For the purpose of this classification trees, tree fruits, cranberries, blueberries, and ornamental plants that require little or no cultivation are not considered as cultivated or common field crops.

Assumptions

This soil capability classification is based on certain assumptions which must be understood by those applying this interpretive classification, if the soils are to be assigned consistently to the various classes; and if those using the soil capability maps and statistical data are to derive full benefit from such information and avoid making erroneous deductions. These assumptions follow:

1. The soil capability classification is an interpretive one based on the effects of combinations of climate and soil characteristics on limitations in use for agriculture, risks of soil damage, and general productive capacity for common field crops. Shrubs, trees, or stumps are not considered as limitations to use unless it it entirely unfeasible to remove them. While present forest cover is not generally considered a factor in this soil capability system, it may be used in the placement of soil areas in Class 7 where costly clearing will only result in placing the areas in Class 6.

2. Good soil management practices that are feasible and practical under a largely mechanized system of agriculture are assumed.

3. The soils within a capability class are similar only with respect to degree but not to kind of limitations in soil use for agricultural purposes or hazard to the soil when it is so used. Each class includes many different kinds of soil and many of the soils within any one class require unlike management and treatment. The subclass provides information on the kind of limitation and the class indicates the intensity of the limitation. Capability Class 1 has no subclasses. Information for specific soils is included in soil survey reports and in other sources of information.

4. Soils considered feasible for improvement by draining, by irrigating, by removing stones, by altering soil structure, or by protecting from overflow, are classified according to their continuing limitations or hazards in use after the improvements have been made. The term "feasible" implies that it is within present-day economic possibility for the farmer to make such improvements and it does not require a major reclamation project to do so. Where such major projects have been installed, the soils are grouped according to the soil and climatic limitations or risks that continue to exist. A general guide to what is considered a major reclamation project is that such projects require cooperative action among farmers or between farmers and governments. (Minor dams, small dykes, or field conservation measures are not included).

5. The capability classification of soils in an area may be changed when major reclamation works are installed that permanently change the limitations in their use or reduce the hazards of risks of soil or crop damage for long periods of time.

6. Distance to market, kind of roads, location, size of farms, characteristics of land-ownership and cultural patterns, and the skill or resources of individual operators are not criteria for capability groupings.

7. Capability groupings are subject to change as new information about the behavior and responses of the soils become available.

8. Research data, recorded observations, and experiences are used as the basis for placing soils in capability classes and subclasses. In areas where such information is lacking, soils are placed in capability classes and subclasses by interpretation of soil characteristics in accord with experience gained on similar soils elsewhere.

9. The level of generalization of the soil capability classification is indicated by the scale on which the information is published.

Soil Capability Subclasses

Subclasses are divisions within classes that have the same kind of dominant limitations for agricultural use as a result of soil and climate. Twelve different kinds of limitations have been recognized to date at the subclass level. They are: climate (C); structure and permeability (D); erosion (E); nutrient deficiencies (F); overflow (I); soil moisture deficiencies (M); salinity (N); stoniness (P); lack of depth of soil (R); adverse inherent soil characteristics (S); topography, slope or pattern (T); excess water rather than due to overflow (W).

The soils of the county can be grouped into classes and subclasses as follows:

Class I

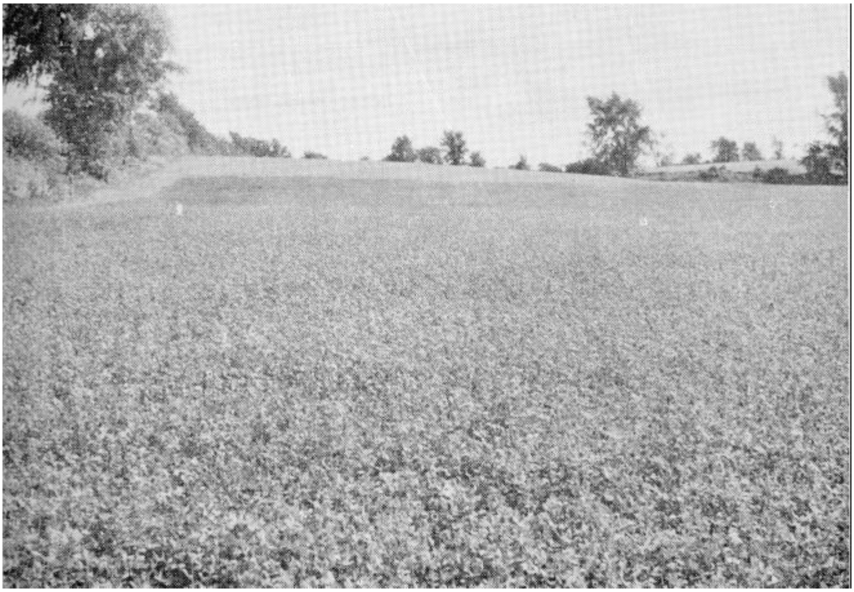
Soils in this class have no significant limitations that restrict their use for crops.

Class I Land

Soil Series	Subclass	Acreage
Battersea silt loam		5,950
Guerin loam		6,000
Picadilly loam		450
		12,400

Class II

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices.

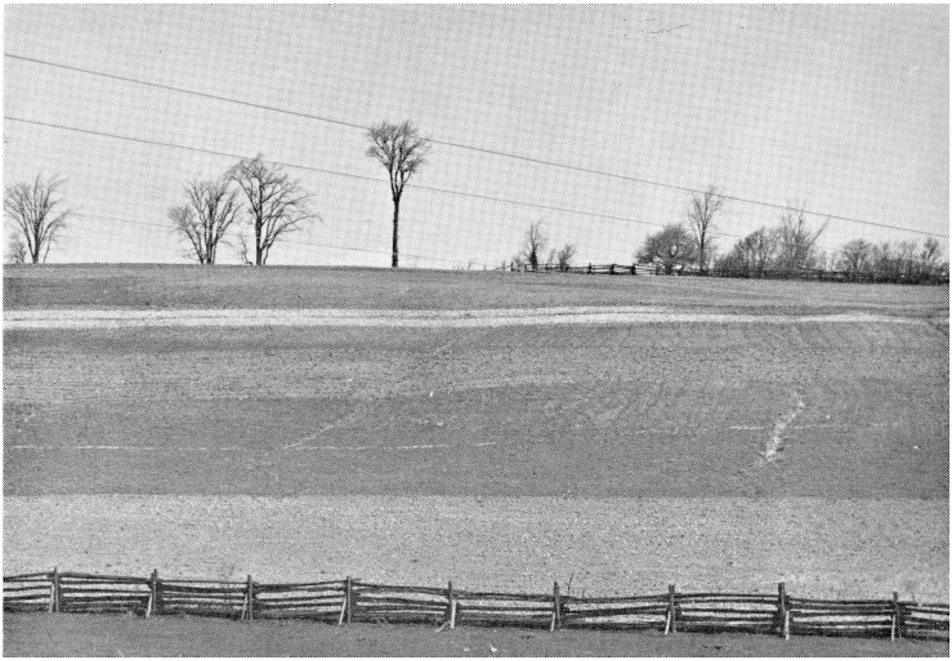


Class II Subclass 2T

Soil Series	Subclass	Acreage
Hinchinbrooke loam	2W	600
Hinchinbrooke silt loam	2W	2,300
Lansdowne clay	2D	46,500
Lindsay clay	2W	1,150
Lindsay clay loam	2W	1,450
Moscow clay	2W	1,350
Newburg fine sandy loam	2T	4,600
Newburg silt loam	2T	600
Seeleys Bay silt loam	2T	1,050
Tennyson sandy loam	2F	820
Otonabee-Moscow complex	2W	750
		61,150

Class III

Soils in this class have severe limitations that reduces the choice of crops or require special conservation practices.



Class III Subclass 3T

Soil Series	Subclass	Acreage
Gananoque clay	3T	3,400
Napanee clay	3W	28,150
Tweed sandy loam	3P	200
Gananoque-Napanee complex	3T	2,650
		34,400

Class IV

Soils in this class have severe limitations that restrict the choice of crops and require very special conservation practices or very careful management or both.

Class IV Subclass $4\frac{T}{P}$

Soil Series	Subclass	Acreage
Bondhead loam	4P	4,450
Bondhead sandy loam	4P	5,700
Guerin loam — shallow Phase	4R	7,050
Lansdowne clay — shallow phase	4R	1,650
Monteagle sandy loam	4S	450
Moscow clay — shallow phase	4R	100
Napanee clay — shallow phase	4R	400
Otonabee loam --shallow phase	4P	150
Tennyson sandy loam	4P	330
White Lake sandy loam	4F	7,000
		27,280

Class V

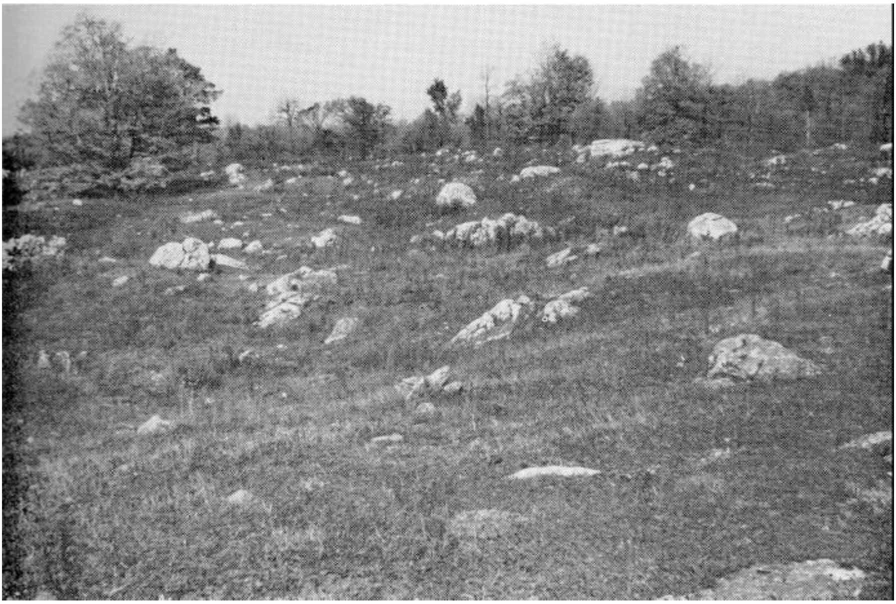
Soils in this class are unsuited for cultivated crops except perennial forage crops and are responsive to improvement practices.

Class V Subclass $5\,\frac{T}{p}$

Soil Series	Subclass	Acreage
Bondhead sandy loam — shallow phase	5P	6,400
Bondhead loam — shallow phase	5P	19,800
Lyon loam	SW	1,150
Lyons loam — shallow phase	SW	1,150
St. Peters gravelly sandy loam	5S	1,850
Wendigo sandy loam	SF	2,550
Gananoque clay—rock	5R	450
Hinchinbrooke loam — rock	5R	5,850
Hinchinbrooke silt loam — rock	5R	800
Lansdowne clay — rock	5R	1,050
Napanee clay—rock	5R	750
Seeleys Bay—rock	5R	1,000
		42,800

Class VI

Soils in this class are unsuited for cultivation but are capable of uses for improved pasture.



Class VI Subclass 6P

Soil Series	Subclass	Acreage
Dummer loam — shallow phase.......................................	6P	50
Farmington loam	6R	54,900
White Lake sandy loam...	6T	3,100
Lyons loam — rock complex...	6R	550
Monteagle sandy loam..	6T	300
		58,900

Class VII

Land unsuited for agriculture.

Class VII Subclass $7\frac{E}{S}$

Soil Type, Phase or Complex	Subclass	Acreage
Marsh	7W	8,200
Rockland	7R	88,300
Rock outcrop	7R	4,150
Monteagle — rock	7R	303,400
Rock — Marsh	7R	10,800
St. Peters — rock	7R	1,550
Tweed — rock	7R	296,050
Wendigo — rock	7R	10,600
White Lake — rock	7R	2,350
		725,400

TABLE 5

SOIL RATINGS FOR PRINCIPAL CROPS

Soil Types and Phases	Ratings For						
	Hay			Oats	Corn		Pasture
	Alfalfa	Trefoil	Timothy		Ensilage	Grain	
Battersea silt loam	F-P	G	G	G-F	F	F	G
Berrien sandy loam	F-P	G	G	F	F	F	G
Bondhead loam	G	G	G	G	G	G-F	G
Bondhead loam — shallow phase	F-P	F	F	F-P	P	P	F-P
Bondhead sandy loam	G-F	G-F	G	G	G-F	G-F	G
Bondhead sandy loam — shallow phase	F-P	F	F	F-P	P	P	F-P
Dummer loam — shallow phase	P	P	P	P	P	P	F
Eastport sand	—	—	—	—	—	—	—
Farmington loam	P	P	P	P	P	P	F-P
Gananoque clay	G-F	G	G	G	G-F	G-F	G
Gananoque clay — shallow phase	F-P	F	F	F-P	P	P	G-F
Gananoque clay — rocky phase	F-P	F-P	F-P	F-P	P	P	F
Guerin loam	F	G	G	G-F	G-F	F	G
Guerin loam — shallow phase	P	F	F	F-P	P	P	G-F
Hinchinbrooke loam	P	G-F	G-F	F	P	P	G-F
Hinchinbrooke loam — rocky phase	P	P	P	P	P	P	F
Hinchinbrooke silt loam	P	G-F	G-F	F	P	P	G-F
Hinchinbrooke silt loam — rocky phase	P	P	P	P	P	P	F
Lansdowne clay	F	G	G	G-F	G-F	F-P	G
Lansdowne clay — shallow phase	P	P	P	P	P	P	G-F
Lansdowne clay — rocky phase	P	F	F	F-P	P	P	G-F

Lindsay clay	P	F	F	F	F-P	P	G-F
Lindsay clay loam	P	F	F	F	F-P	P	G-F
Lyons loam	P	F	F	P	P	P	G-F
Lyons loam — shallow phase	P	P	P	P	P	P	F
Lyons loam — rocky phase	P	P	P	P	P	P	F
Monteagle sandy loam	P	P	P	P	P	P	F-P
Moscow clay	F-P	G-F	G-F	F	F	P	G-F
Moscow clay — shallow phase	P	F-P	F-P	P	P	P	F
Muck	—	—	—	—	—	—	—
Napanee clay	P	G-F	F	F	F-P	P	G-F
Napanee clay — shallow phase	P	P	P	P	P	P	F
Napanee clay — rocky phase	P	F-P	F-P	P	P	P	F
Newburgh fine sandy loam	F	F	F	F	G-F	G-F	G-F
Newburgh silt loam	F	F	F	F	G-F	G-F	G-F
Otonabee loam — shallow phase	P	F-P	F-P	P	P	P	F
Peat	—	—	—	—	—	—	—
Picadilly fine sandy loam	F-P	G-F	G-F	F	F	P	F
Seeleys Bay silt loam	G-F	G	G	G	G-F	F	G
Seeleys Bay silt loam — rocky phase	P	F-P	F-P	P	P	P	F
St. Peters gravelly sandy loam	P	P	F-P	F-P	P	P	F-P
St. Peters gravelly sandy loam — rocky phase	P	P	P	P	P	P	P
Tennyson sandy loam	G-F	G-F	G-F	F	F	F-P	G
Tweed sandy loam	G-F	G-F	G-F	F	F	F-P	G-F
Wauseon sandy loam	P	P	P	P	P	P	F-P
Wendigo loamy sand	P	P	P	P	P	P	P
Wendigo loamy sand — rocky phase	P	P	P	P	P	P	P
White Lake gravelly sandy loam	P	P	P	P	P	P	F-P
White Lake gravelly sandy loam — rocky phase	P	P	P	P	P	P	P

TAXONOMIC CLASSIFICATION, PROFILE DESCRIPTIONS AND ANALYTICAL DATA

Battersea Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Gleyed Gray-Brown Podzolic
Family — Tuscola

Horizon	Depth Inches	Description
Ap	0 - 6	Very dark gray (10YR 3/1) silt loam; small subangular blocky and granular structure; friable consistency; pH 6.4.
Ae	6 - 10	Gray-brown (10YR 5/2) silt loam; mottled; small subangular blocky structure; friable consistency; pH 6.5.
Bt	10 - 15	Dark yellowish-brown (10YR 4/4) silty clay loam; small to medium angular blocky structure; firm consistency; some yellowish mottles; pH 7.0.
BC	15 - 24	Dark gray-brown (10YR 4/2) silty clay loam; medium angular blocky aggregates; hard consistency; pH 7.2.
C	24 +	Gray (10YR 5/1) silty clay loam; medium angular blocky aggregates; calcareous; pH 7.8.

Berrien Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Gleyed Gray-Brown Podzolic
Family — Berrien

Horizon	Depth Inches	Description
Ap	0 - 7	Very dark gray, (10YR 3/1) sandy loam; crumb structure; very friable consistency; pH 7.1.
Ae	7 - 24	Yellow-brown (10YR 5/4) sandy loam; mottled in lower part of horizon; granular structure; friable; pH 7.2.
Btg	24 - 25	Dark brown (10YR 4/3) loam; subangular blocky structure; friable consistency; mottled; pH 7.4.
IIC	25 +	Gray clay; stonefree; calcareous; pH 8.2.

Bondhead Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Brunisolic, Gray-Brown Podzolic
Family — Guelph

Horizon	Depth Inches	Description
Ah	0 - 3	Very dark grayish-brown (10YR 3/2) sandy loam; crumb structure; friable.
Ael	3 - 8	Dark brown (10YR 4/3) sandy loam; fine crumb structure; very few stones.
Ae2	8 - 17	Dark grayish-brown (10YR 4/2) sandy loam; fine crumb structure; few stones.

BC	17 - 21	Dark grayish-brown (7.5YR 4/2) clay loam; subangular blocky; friable; some stones.
C1	21 - 28	Grayish-brown (10YR 5/2) moderately stony till, with some thin strands of B horizon.
C	28 - 36	Grayish-brown (10YR 5/2) moderately stony till.

TABLE 6

PROFILE ANALYSIS

Horizon	Sand 2-0.05 mm	Clay <0-002 mm	pH	O.C. %	Exchangeable Cations me/100 gm Ca	Mg	K	C.E.C.	Base Saturation %
Ah	54	16	6.0	4.3	9.4	1.5	.33	12.7	88
Ae1	53	17	5.55	.62	2.9	0.8	.16	5.8	54
Ae2	57	18	6.45	.20	4.9	0.4	.13	5.8	93
Bt	45	33	7.1	.52	16.9	0.6	.29	16.4	100
BC	56	22	7.8	.12	12.8	0.4	.14	5.5	100
C2	54	24	7.8	.08	12.8	0.6	.13	4.8	100

Dummer Series

Classification:

Order — Brunisolic
Great Soil Group — Brown Forest
Soil Group — Degraded Brown Forest
Family — Osprey

Horizon	Depth Inches	Description
Ah	0 - 3	Black (10YR 2/0) loam; crumb structure; friable consistency; stony; free carbonates present; pH 7.4.
Bml	3 - 5	Very dark gray-brown (10YR 3/2) loam; granular structure; friable; stony; free carbonates present; pH 7.4.
Bm2	5 - 9	Brown (7.5YR 3/2) clay loam; subangular blocky structure; friable; stony; free carbonates present; pH 7.8.
C	-	Gray-brown (10YR 5/2) loam; very stony; calcareous; pH 8.3.

Gananoque Series

Classification:

Order — Podzolic
Great Soil Group — Gray Wooded
Soil Group — Orthic Gray Wooded
Family — Haileybury

Horizon	Depth Inches	Description
L	1 - 0	Undecomposed twigs, leaves, etc.
Ah	0 - 2	Light brownish-gray (10YR 6/2) clay; medium subangular blocky structure; friable.
Ae	2 - 6	Light gray (10YR 7/2) clay; medium subangular blocky with some indications of platy structure; firm consistency.
BA	6 - 12	Light gray (10YR 7/2) coating over dark brown (10YR 4/2) clay, medium blocky structure; hard consistency.
Bt	12 - 22	Very dark grayish-brown (10YR 3/2) clay; strong medium blocky structure.

TABLE 7

PARTICLE SIZE DISTRIBUTION PERCENT BY WEIGHT

Horizon	Depth	<.5u	.5-1u	1-2u	2-4u	4-8u	8-16u	16-32u	32-64u	64-125u	125-250u	250-500u	500-1,000u	1,000-2,000u	Total
Ah	0 - 2″	16.4	10.3	18.1	21.2	12.0	10.5	4.3	1.2	2.0	1.6	1.2	.4	.9	99.2
Ae	2 - 6″	39.4	15.0	19.4	13.6	5.7	3.7	1.0	1.0	.5	.3	.5	.2	—	10.3
BA	6 - 12″	49.8	12.3	18.2	11.1	4.4	2.0	0.8	.3	.5	.3	.2	.2	—	100.0
Bt	12 - 22″	39.7	14.0	19.7	14.8	5.9	4.4	0.2	.3	.4	.3	.1	.1	.1	99.9
BC	22 - 28″	26.4	14.2	17.6	14.5	7.7	7.3	5.9	4.7	.9	.3	.2	.2	.1	100.0
CK_1	28 - 36″	24.8	13.0	19.2	17.8	9.3	7.2	4.6	—	1.5	1.1	.3	.5	.5	99.8
Cca	36 - 48″	22.3	12.7	18.4	15.2	11.0	8.3	3.6	2.8	3.4	.2	.1	.3	.3	98.6
CK_2	48″ +	21.7	13.1	19.8	19.1	10.8	7.2	4.4	1.4	.3	.5	.2	.2	.2	98.9

TABLE 8

CHEMICAL AND BULK DENSITIES DATA

Horizon	Depth	Dithionite Fe%	Oxalate Fe%	Carbonate Equivalent $CaCO_3$%	Cation Exchange Capacity me/100 gms	Bulk Density gm/cc	Organic Matter %
Ah	0 - 2″	1.25	.74	.65	24.8	1.17	4.6
Ae	2 - 6″	1.18	.56	.21	16.2	1.34	1.45
BA	6 - 12″	1.56	.64	.63	20.2	1.39	0.46
Bt	12 - 22″	.58	.54	.63	26.0	1.32	0.32
BC	22 - 28″	.60	.30	.83	16.8	1.48	0.18
CK_1	28 - 36″	.64	.22	12.6	15.8	1.47	0.10
Cca	36 - 48″	.56	.26	16.3	12.4	—	—
CK_2	48″ +	.78	.32	12.6	15.6	1.38	0.10

BC	22 - 28	Grayish-brown (10YR 5/2) clay; coarse blocky structure tending to columnar; hard consistency.
CK1	28 - 36	Gray (10YR 5/1) clay; fine to medium blocky structure; hard consistency; calcareous.
Cca	36 - 48	Gray (10YR 5/1) clay; carbonate enriched.
CK2	48 +	Grayish-brown (10YR 5/2) clay; calcareous.

Guerin Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Gleyed Gray-Brown Podzolic
Family — Guerin

Horizon	Depth Inches	Description
Ap	0 - 8	Very dark gray (10YR 3/2) loam; crumb structure; very friable consistency; pH 7.2.
Ae1	8 - 15	Yellowish-brown (10YR 5/8) loam; crumb structure; very friable consistency; pH 7.2.
Ae2	15 - 20	Yellowish-brown (10YR 5/6) loam; mottled; crumb structure; very friable; pH 7.2.
Bt	20 - 26	Yellowish-brown (10YR 5/8) loam; mottled; weak subangular blocky structure; friable; pH 7.4.
C	-	Gray-brown till; calcareous; pH 8.2.

Hinchinbrooke Series

Classification:

Order — Gleysolic
Great Soil Group — Humic Gleysol
Soil Group — Orthic Humic Gleysol
Family — Osgoode Family

Horizon	Depth Inches	Description
Aa	0 - 8	Dark gray-brown (10YR 3/1) loam; subangular blocky structure; friable consistency; pH 6.8.
Aeg	8 - 12	Gray (10YR 5/1) sandy loam; mottled; subangular blocky structure; very friable; pH 6.5.
Bmg1	12 - 22	Gray-brown (10YR 4/2) fine sandy loam; mottled; crumb structure; very friable; pH 6.6.
Bmg2	22 - 28	Gray (10YR 5/1) silt; severely mottled; subangular blocky structure; friable; pH 6.8.
C	-	Gray-brown (10YR 5/2) silt; calcareous; pH 7.8.

Lansdowne Series

Classification:

Order — Podzolic
Great Soil Group — Gray Wooded
Soil Group — Gleyed Gray Wooded
Family — Renfrew

Horizon	Depth Inches	Description
Ap	0 - 6	Light gray (10YR 7/2) (dry) clay; hard angular blocky structure.
Ae	6 - 9	White (10YR 8/1) (dry) clay; hard thick platy aggregates; mottling at junction with B.
Btg	9 - 17	Pale brown (10YR 6/3) clay; small to medium blocky aggregates; more readily crushed than those above; mottled.
BC	17 - 48	Very pale brown (10YR 7/3) clay; medium blocky aggregates; firm consistency.
C	-	Light gray (10YR 7/2) clay; medium blocky aggregates; hard concretions; free carbonates.

TABLE 9

PROFILE ANALYSIS

Soil Horizons	Depth	pH	O.M.	Clay <2u
Ap	0 - 6″	5.2	5.6	52
Ae	6 - 9″	5.2	0.8	73
Btg	9 - 17″	7.1	0.3	79
BC	17 - 48″	—	—	—
C	48″ +	7.9	0.2	77

Lindsay Series

Classification:

Order — Gleysolic
Great Soil Group — Humic Gleysol
Soil Group — Orthic Humic Gleysol
Family — Lindsay

Horizon	Depth Inches	Description
Ap	0 - 6	Very dark gray (10YR 3/1) clay loam; subangular blocky structure; friable consistency; stone-free; pH 7.4.
Bmg	6 - 12	Pale brown (10YR 6/3) clay loam; mottled; subangular; blocky structure; friable; few stones; pH 7.6.
IIC	-	Gray clay loam; mottled; stony; calcareous; pH 8.2.

Moscow Series

Classification:

Order — Gleysolic
Great Soil Group — Humic Gleysol
Soil Group — Orthic Humic Gleysol
Family — Brookston

Horizon	Depth Inches	Description
Ap	0 - 7	Very dark gray-brown (10YR 3/2) silty clay; angular blocky structure; friable consistency; pH 7.0.
Bmg	7 - 23	Dark gray-brown (10YR 4/2) silty clay; mottled, subangular blocky structure; friable; pH 7.5.
C	-	Light brown-gray (10YR 6/2) silty clay; subangular blocky structure; very friable; pH 8.0.

Monteagle Series

Classification:

Order — Podzolic
Great Soil Group — Podzol
Soil Group — Orthic Podzol
Family — Wabi

Horizon	**Depth Inches**	**Description**
F	1 - 0	Organic layer containing leaves, twigs, and moss.
Ae	0 - 3	Light gray (10YR 6/1) sand; single grain structure; loose consistency; pH 4.6.
Bhf1	3 - 12	Dark reddish-brown (5YR 3/4) sandy loam; granular structure; friable; some iron concretions; pH 4.8.
Bhf2	12 - 22	Yellowish-brown (10YR 5/6) sandy loam; weak granular structure; friable; stony; pH 5.3.
C	22 +	Light olive-brown (2.5YR 5/4) sandy loam; very stony; pH 5.4.

TABLE 10

MONTEAGLE SANDY LOAM

Horizons	Sand 2-.05 mm	Silt .05-.002 mm	Clay .002 mm	pH	O.C. %	Exch. Cations me/100 gm Soil Ca	Mg	K	H	C.E.C.	Base Saturation %
F				4.5							
Ae	63	26	11	4.75	1.17	1.0	0.08	0.06	4	4.9	23
Bhf1	65	21	14	4.75	2.40	0.6	0.48	0.04	11	12.0	9
Bhf2	81	8	11	5.3	0.69	0.3	0.24	0.02	4	5.0	11
C	70	19	11	5.4	0.09	0.25	0.16	0.07	2	2.0	20

Napanee Series

Classification:

Order — Gleysolic
Great Soil Group — Humic Gleysol
Soil Group — Orthic Humic Gleysol
Family — St. Rosalie

Horizon	**Depth Inches**	**Description**
Ap	0 - 6	Dark gray-brown (10YR 4/2) clay; mottled; angular blocky structure; hard consistency; pH 5.8.
Bmg1	6 - 16	Very dark gray (10YR 3/1) clay; mottled; angular blocky structure; hard consistency; pH 6.2.
Bmg2	16 - 25	Dark gray (10YR 4/1) clay; mottled; angular blocky structure; hard consistency; pH 7.0.
C	-	Gray (10YR 5/1) clay; mottled; calcareous; stone-free; pH 7.9.

TABLE 11

PROFILE ANALYSIS

Horizon	Depth	Sand %	Silt %	Clay <2u %	Organic Matter %	pH
Ap	0 - 6″	3.1	43	54	5.9	5.4
Bmg1	6 - 20″	1.8	10	88	0.6	6.0
Bmg2	20 - 36″	1.3	15	84	0.5	7.2
C	36″ +	1.2	21	78	0.2	7.6

Newburgh Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Brunisolic Gray-Brown Podzolic
Family — Honeywood

Horizon	Depth Inches	Description
Ap	0 - 6	Dark gray-brown (10YR 4/2) fine sandy loam; subangular blocky structure; very friable consistency; pH 6.3.
Ae	6 - 12	Light gray (10YR 7/2) fine sandy loam; platy structure; very friable; pH 6.6.
AB	12 - 17	Brown (10YR 4/3) silt loam; subangular blocky structure; friable consistency; pH 6.3.
Bt	17 - 25	Very dark gray-brown (10YR 3/2) silty clay loam; angular blocky structure; friable; pH 6.6.
C	-	Dark gray-brown (10YR 4/2) silt loam; pH 8.0.

Otonabee Series

Classification:

Order — Brunisolic
Great Soil Group — Brown Forest
Soil Group — Degraded Brown Forest
Family — Otonabee

Horizon	Depth Inches	Description
Ah	0 - 4	Very dark gray (10YR 3/1) loam; granular and crumb structure; soft; pH 7.2.
Bm	4 - 8	Brown (7.5YR 4/4) loam; small weak subangular blocky structure; very friable consistency; pH 6.8.
Btj	8 - 12	Very dark brown (10YR 2/2) clay loam; small subangular blocky structure; firm consistency; few stones, calcareous; pH 7.4.
BC	12 - 16	Dark gray-brown (10YR 4/2) loam; weak subangular blocky structure; friable; calcareous; pH 7.6.
C	-	Gray-brown (10YR 5/2) loam; stony; calcareous; pH 8.3.

Picadilly Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Gleyed Gray-Brown Podzolic
Family — Tuscola

Horizon	Depth Inches	Description
Ap	0 - 4	Gray (10YR 5/1) loam; subangular blocky structure; friable consistency; pH 6.2.
Aeg	4 - 10	Light gray (10YR 7/2) silt loam; mottled; platy structure; friable; pH 6.2.
Btg	10 - 16	Dark gray-brown (10YR 4/2); silty clay loam; mottled; subangular blocky structure; friable; pH 6.8.
Cg	-	Dark gray (10YR 4/1) silt loam; mottled; stone-free; pH 8.0.

Seeleys Bay Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Orthic Gray-Brown Podzolic
Family — Huron

Horizon	Depth Inches	Description
Ap	0 - 6	Very dark gray (10YR 3/1) silt loam; small subangular blocky and granular structure; friable consistency; pH 6.5.
Ae	6 - 10	Pale brown (10YR 6/3) silt loam; small to medium subangular blocky structure; friable consistency; pH 6.4.
Bt	10 - 18	Dark yellow-brown (10YR 4/4) silty clay; medium angular blocky aggregates; firm consistency; pH 6.8.
BC	18 - 24	Dark gray (10YR 4/1) silty clay loam; medium angular blocky aggregates; hard when dry; pH 7.0.
C	24 +	Gray (10YR 5/1) silty clay loam; medium angular blocky aggregates; calcareous; pH 8.0.

St. Samuel Series

Classification:

Order — Gleysolic
Great Soil Group — Gleysol
Soil Group — Orthic Gleysol
Family — Granby

Horizon	Depth Inches	Description
Ap	0 - 6	Black (10YR 2/1) sandy loam; fine crumb structure; very friable consistency; pH 5.5.
Bmg1	6 - 10	Gray-brown (10YR 5/2) sand; single grain structure; loose consistency; pH 5.5.
Bmg2	10 - 15	Gray-brown (10YR 5/2) sand; severely mottled with yellowish-red mottles; single grain structure; loose consistency except for mottles; pH 6.0.
C	15 +	Light gray-brown (10YR 6/2) sand; structureless; pH 6.4.

Tennyson Series

Classification:

Order — Podzolic
Great Soil Group — Gray-Brown Podzolic
Soil Group — Brunisolic, Gray-Brown Podzolic
Family — Vasey

Horizon	Depth Inches	Description
Ap	0 - 6	Dark brown (10YR 3/3) sandy loam; crumb and granular structure; friable; moderately stony; pH 6.5.
Bhf	6 - 9	Dark yellowish-brown (10YR 4/4) sandy loam; crumb structure; friable; moderately stony; pH 6.4.
Ae	9 - 16	Yellowish-brown (10YR 4/4) sandy loam; crumb structure; friable; moderately stony; pH 6.4.
Bt	16 - 22	Dark brown (7.5YR 3/2) loam; medium subangular blocky aggregates; friable; moderately stony; pH 7.0.

BC	22 - 36	Brown (7.5YR 4/4) sandy loam; weak subangular blocky structure; friable; stony; pH 7.2.
C	36 +	Gray-brown (2.5Y 5/2) sandy loam; slightly calcareous; stony; pH 7.4.

Tweed Series

Classification:

Order — Brunisolic
Great Soil Group — Brown Forest
Soil Group — Orthic Brown Forest
Family — Tweed

Horizon	Depth Inches	Description
A1	0 - 4	Very dark gray-brown (10YR 3/2) sandy loam; crumb structure; friable consistency; pH 6.8.
B	4 - 12	Dark reddish-brown (5YR 3/4) sandy loam; granular structure; friable consistency; pH 7.2.
D	-	Crystalline limestone; the surface usually broken and weathered.

Wauseon Series

Classification:

Order — Gleysolic
Great Soil Group — Gleysol
Soil Group — Orthic Gleysol
Family — Granby

Horizon	Depth Inches	Description
Ap	0 - 8	Very dark gray (10YR 3/1) sandy loam; crumb structure; free carbonates present; pH 7.4.
Bmg	8 - 20	Gray (10YR 5/2) sand; mottled, single grain structure; loose consistency; free carbonates; pH 7.6.
C	-	Gray-brown (10YR 5/2) clay; mottled.

Wendigo Series

Classification:

Order — Podzolic
Great Soil Group — Podzol
Soil Group — Orthic Podzol
Family — Wendigo

Horizon	Depth Inches	Description
F	1 - 0	Loose covering of needles, moss, twigs.
Ae	0 - 2	White (10YR 8/1) sand; single grain structure; loose consistency; pH 4.7.
Bhf1	2 - 6	Very dark gray-brown (10YR 3/2) sandy loam; crumb structure; pH 5.0.
Bhf2	6 - 11	Dark yellow-brown (10YR 4/4) sandy loam; crumb structure; very friable; pH 5.4.
BC	11 - 17	Yellow-brown (10YR 5/6) sand; single grain structure; loose consistency; pH 5.6.
C	-	Pale brown (10YR 6/3) sand; pH 5.6.

TABLE 12

WENDIGO SANDY LOAM

Horizons	Sand	Silt	<2u Clay	pH	O.C.	Exch. Cations me/100 gm Soil Ca	Mg	K	H+	C.E.C.	Base Saturation %
O				5.3							
Ae	60	28	12	4.7	0.99	0.7	0.6	0.06	4	5.6	22
Bhf2	60	28	12	5.0	2.2	1.7	0.08	0.03	12	14.4	12
BC	66	28	6	5.4	0.6	0.7	0.2	0.01	4	4.4	19
C	92	4	4	5.6	0.06	0.3	0.1	0.02	4	0.8	47

GLOSSARY OF HORIZON DESIGNATION

Organic Horizons

L — an organic layer in which structures are definable.
F — an organic layer in which structures are definable with difficulty.
H — an organic layer in which structures are undefinable.

Master Mineral Horizons

A — Horizons formed at or near the surface in the zone of maximum removal or materials in suspension or solution and/or maximum accumulation of organic matter it includes:
1. Horizons in which organic matter has accumulated (Ah) or which have been cultivated (Ap).
2. Horizons that have been eluviated of clay, iron, aluminum, and/or organic matter (Ae).
3. Horizons transitional to the underlying layer (AB) (AC).

B — A mineral horizon or horizons characterized by one or more of the following
1. An enrichment of clay (Bt), iron (Bf), or organic matter (Bh).
2. A horizon altered by oxidation to give a change in color and/or structure only (Bm).
3. Horizons transitional to the underlying layer (Bc).

C — A mineral horizon comparatively unaffected by the pedogenetic processes in A and B.
1. Material of similar lithologic composition to that of the solum (C).
2. Material of different lithologic composition to that of the solum (II C).