SOIL DIFFERENCES IN RELATION TO LAND USE IN GRENVILLE COUNTY, ONTARIO, CANADA

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Norval R. Richards

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Major professor

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SOIL DIFFERENCES IN RELATION TO LAND USE IN GRENVILLE COUNTY, ONTARIO, CANADA

By

Norval R. Richards

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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Introduction

A sound knowledge of the quality and quantity of land resources is a valuable and necessary requirement in determining the use for which an area is best suited. To classify soil and delineate on a map salient differences that affect its use is one approach through which this information can be obtained. Although soils are continually changing, when considered in light of other criteria that might be used to indicate the capabilities and shortcomings of an area, the soil appears as something fairly stable. Certainly when compared to economic factors it is very stable indeed. This is not surprising since soils are mapped in the field on the basis of definable characteristics which reflect the effect climatic and vegetative factors have exerted on the parent materials during the process of soil formation. In their development they have been only slightly influenced by the action of Man or by economic factors.

It would appear that once an area was classified and mapped and the characteristics of the different units of separation or soil types were defined it should be relatively easy to develop a land use pattern. This is true provided the classification is sufficiently easy of interpretation to be readily understood and used. However those who use soil survey maps frequently criticize them because they are difficult to interpret. If the soil type can be broken down into the various elements of which it is composed the map can then serve as a flexible instrument in the hands of those who are interested in studying the effect of soil differences in relation to land use.

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Soil is the great resource trusted to our custody, to be used with diligence, intelligently protected and conserved and passed on to future generations so that it will be to them as great an asset and resource as it has been to us. It is the purpose of this study to discuss some of the significant soil differences that were observed and mapped in Grenville County, Ontario, Canada, during the summer of 1945. A series of maps are presented indicating the factors affecting soil formation and the soil differences that influence the agricultural use of Grenville County soils. Assuming that the experience of the past can well be our guide in the future a suggested plan is included based on present knowledge of the soil resources of the county and their potentialities and limitations for agricultural use.

Geography of Grenville County

Grenville County is located in Eastern Ontario and is bounded on the south by the St. Lawrence River and by the Rideau River to the north. The County of Dundas adjoins it on its eastern side while Leeds County adjoins it to the west. The city of Ottawa, capital of the Dominion of Canada is located some thirty-three miles north of the town of Kemptville. According to the 1931 Census of the Dominion of Canada (5), the total land area of the county is 296,000 acres.

Prescott with a population of slightly over 3200 and situated directly across the St. Lawrence River from the city of Ogdensburg, New York is the largest town in the county. Kemptville, a flourishing agricultural town of some 1330 citizens, is located in the northern section of Grenville County and serves one of the larger agricultural areas. The representative of the Provincial Department of Agriculture and the Kemptville Agricultural School are located here. The other important urban centres of Grenville County are Cardinal, located on the St. Lawrence River in the southeast corner of Edwardsburg Township, and Merickville on the Rideau River in the northwest section of Wolford Township. The population of Cardinal is 1645 while Merickville has 794 citizens. In addition to these incorporated urban centres there are several small villages, Oxford, Bishop's Mills, Roebuck, Algonquin, Spencerville, Miller and others that serve small agricultural communities.

Grenville County is well supplied with railways and highways connecting the predominantly agricultural communities with the more densely populated urban centres of Ottawa, Montreal and Toronto. The main lines of the Canadian National and Canadian Pacific railways

Figure (1) - Showing location of Grenville County within the Province of Ontario, Canada

traverse the southern section of the County and run parallel to the St. Lawrence River. Two other lines of the Canadian Pacific Railway serve the area, one cutting across the northern section of the County while the other line runs through Edwardsburg and Oxford townships supplying railway accomodation for the eastern section. Prescott and Cardinal are located on the much travelled and scenic Provincial Highway No. 2 which parallels the St. Lawrence River. Provincial Highway No. 16 which leaves Highway No. 2 a few miles east of Prescott and proceeds through Grenville County and the adjoining county of Carleton to the north, thus linking Ottawa, the Capital city, with the main artery of travel. In addition to the Provincial highways there are several hard-surfaced and well maintained county highways. The township road system of Grenville County presents an irregular and complicated pattern. This is due in no small part to the presence of several peat bogs and the Kemptville and South Nation Rivers. For the most part, however, the roads are maintained in very good condition and there are few indeed that cannot be passed over by automobile.

The total population of Grenville County, according to the latest census figures, is 15,989 persons. Of this number 9095 (approximately 57%) were considered rural population, while the remaining 6894 were included as urban population. The British are by far the dominant racial class with several others being represented in minor proportions. The following figures from the Dominion of Canada Census indicate the racial class proportion:

Total Population	15,989	100%
British.	13,927	87.1%
English.	.4542	
Irish.	.6811	
Scotch	.2484	
Others	90	
Total.	13927	
French	1081	6.7%
Others	981	6.2%

The Agriculture of Grenville County

The following table indicates the use that is being made of Grenville county soils under present conditions. These figures presented are taken from the Census of the Dominion of Canada. (1931)

Total land area - - - - - - - - 296320 acres

Area of occupied farms - - - - 261182 acres

% of total land area occupied - 88.1

Improved land - - - - - - - - - 150991 acres

Pasture - - - - -	39264
Field Crops - -	107997
Market Garden - -	115
Orchard - - - - -	1057
Small Fruit - - -	71

Unimproved Land

Woodland- - - - -	39120
Natural Pasture -	52196
Marsh and Wasteland- - -	18155

Dairying is an important industry in Grenville County. There are several cheese factories and the county has developed an

enviable reputation for the high quality of dairy products manufactured in it. The breeding and raising for export to the United States of holstein cattle is a business that has reached sizeable proportions in recent years. In prewar years, cheese manufacture was carried on largely during the summer months, the factories closing for the winter in the early fall of the year. However, during the period of the war with an increased demand for cheese for the export market, a year around cheese-making programme was conducted. Whether or not this programme will survive remains to be seen. It is significant, however, that dairying is a dominant industry in an area where the soils are predominantly light textured and maintenance of organic matter is a problem of concern. The manure obtained from the feeding of the dairy herds can be used to a very good advantage in assisting in maintaining the organic matter level. Then too, as will be pointed out later, a large proportion of the soils of Grenville County can serve a very useful purpose when growing pasture crops so that dairying fits very well into the development of a land use programme for the area.

Fruit growing is carried on to a limited extent along the St. Lawrence River, but due to climatic factors does not extend very far inland. Vegetables, other than those grown for home consumption, are produced for sale in the vicinity of Prescott and close to the western boundary of the county. They are grown usually to satisfy the demands of the local markets which are noticeably increased during the summer months because of the influx of tourists.

Mixed farming, with a predominance of dairying, is the chief agricultural occupation throughout the county. For the most part the

farm income is derived from the production of dairy cattle, dairy products, hogs, poultry, cereal grains, and to a limited extent, fruit and vegetables.

Climate of Grenville County

The influence of climate is very important in that it affects fundamental physical, chemical and biological relationships in the soil. Temperature influences the speed of chemical reactions and even after soil development has advanced to a considerable degree there continues to be weathering of mineral particles. Too, of great importance to soil weathering and soil development is the amount of water that actually percolates through the soil which is influenced by rainfall, relative humidity and frost free period. The characteristic features expressed in the soil profile are a reflection in part of climatic influences.

Now that an agricultural economy has been established in Grenville County, the effect of climate on the use that is being made of the soils is an important consideration. The suitability of soils for growing different crops, the effect of the temperature-precipitation relationships on crop production and the limitations climate places on the use of soils are all factors that merit attention.

Grenville County has a cool humid climate. Chapman and Putnam (4), in their article dealing with the climate of southern Ontario, include this county, for the most part, in the Eastern Ontario region. On the whole they consider Eastern Ontario as having a

climate of temperature extremes with very cold snowy winters and warm summers with adequate rainfall and little likelihood of drought. They also consider the climate as being unsuitable for the production of winter wheat, fruit or tender crops. According to the above authors, the factors that affect Grenville County climate are presented in the following table:

Summary of Factors Affecting Grenville County Climate

(Eastern Ontario Region)

Altitude	200 - 400 feet
Mean Annual Temperature	42°
Mean Winter Temperature	16°
Mean Spring Temperature	41°
Mean Summer Temperature	66°
Mean Fall Temperature	46°
Extreme Low Temperature	-40°
Extreme High Temperature	104°
Daily Range of Temperature	19°
Average Date of Last Frost in Spring	May 18
Average Date of First Frost in Fall	Sept. 26
Average Length of Frost Free Period	131 days
Beginning of Growing Season	April 15
End of Growing Season	Oct. 26
Average Length of Growing Season	194 days
Average Annual Precipitation	34.0 inches
Average Annual Snowfall	87 inches

Average Rainfall April 1 - Sept. 30. . 17.5 inches

Average June, July, August Rainfall. . 9.2 inches

P/E Index, June, July, August. 13.5

The only meterological station located within the county is at Kemptville where climatic data have been collected for a rather short and broken period of time. However, weather data is also recorded at Morrisburg, located on the St. Lawrence River, a few miles to the east of the Grenville County boundary. The climatic data from these two stations are presented herewith, the Kemptville records indicating the temperature and precipitation trends for the area north of the St. Lawrence River and the Morrisburg records representing the area immediately adjoining it.

Mean Monthly Temperature for Kemptville and Morrisburg

	Kemptville*	Morrisburg**		Kemptville*	Morrisburg**
January	14.8	15.6	July	69.7	67.2
February	14.3	15.2	August	67.1	64.9
March	25.4	26.8	September	59.8	62.7
April	42.2	40.0	October	46.1	46.6
May	56.6	52.8	November	33.3	34.3
June	65.2	62.4	December	17.5	19.9
			Year	42.6	42.4

The above figures indicate that there is a tendency for the winters to be slightly colder and the summers slightly hotter at Kemptville

* Period 1930-37 and 1940-41-42-44
** Period 24 years

than at Morrisburg. The maximum temperature on record at Kemptville is 94.3°F and the lowest -18.4°F.

Mean Monthly Rainfall in Inches for Kemptville and Morrisburg

	Kemptville*	Morrisburg**		Kemptville*	Morrisburg**
January	2.09	3.69	July	2.57	3.12
February	1.41	2.97	August	2.13	3.34
March	2.05	3.09	September	3.08	2.83
April	2.31	3.28	October	2.24	3.42
May	2.31	3.22	November	2.58	3.35
June	2.90	3.20	December	2.50	3.09
			Year	28.17	38.60

* Period 1930-37 and 1940-41-42-44
** Period 24 years

The above figures indicate that the southern section of the area, lying in close proximity to the St. Lawrence River receives considerably more rainfall that the Kemptville area. Both the temperature and precipitation figures are significant in view of the fact that it is in this area the fruit growing endeavours are concentrated.

The main features of the climate of the region is an average annual precipitation of 34 inches, mean annual temperature of about 42°F, and an average frost free period of 130 days. The average date of the last killing frost in the spring is May 18 with the average date of the first killing frost in the fall September 26. The growing season begins from April 15-18 and ends about October 25.

Materials from which Grenville County Soils have been Formed

Grenville County lies within the Eastern Ontario section of the physiographic region known as the Lowlands of the St. Lawrence. The underlying bedrock, except for one small Precambrian outcrop in the Oxford Station area, is of Beekmantown limestone. The following chemical composition of a sample of Beekmantown limestone obtained from a quarry located on Lot 17, Concession 11, Augusta Township, Grenville County is reported by Goudge in his publication "Limestones of Canada, Their Occurrence and Characteristics" (3):

Insoluble mineral matter	2.61%
Ferric Oxide	.98%
Alumina	.82%
Calcium Carbonate	63.88%
Magnesium Carbonate	31.51%

Drift deposited by the melting ice during the Wisconsin glaciation covers a large part of the county. The deposit of drift over the underlying bedrock is shallow, particularly in the central west and north west half of the area and occassional shallow deposits also occur in the eastern half. In the vicinity of Kemptville there is a fairly extensive drift plain where the till deposits are characterized by lack of sorting, and contain stones of varying size and proportions scattered through the matrix of sand silt and clay. It would appear that the till composition has been strongly influenced by the underlying bedrock. It effervesces freely with dilute hydrochloric acid, as do the majority of the stones and boulders found on

the surface and scattered through the profile. Only a few granitic boulders were present in the stony sections of the county.

Deposits of stonefree heavy clay are frequently found in close proximity to the river. The areas are not very extensive and it is rather difficult to trace their origin. By far the most extensive materials from which the soils of Grenville County have been formed are the deep stonefree outwash sands. In several areas and particularly along the rivers and streams there is a shallow deposit of sand underlain by heavy stonefree clay at depths of three feet and less. The presence of this heavy clay layer has influenced soil development to the extent that it is considered of sufficient import to receive separate consideration. There are several extensive deposits of organic materials in Grenville County.

Map No. 1 shows the distribution of materials from which Grenville County soils have been developed.

Forest Associations

Most of the area has been cleared and it is rather difficult to reconstruct the original forest pattern of the county. This is particularly true of the better agricultural sites where a very large percentage of the woodland has been removed and the land is now under cultivation. Five distinct forest associations were recognized and their distribution is shown on Map No. 2.

White Cedar, Red Cedar, Sugar Maple Association

This association is found on the shallow soils overlying the limestone bedrock. On the very shallow soils the vegetation is largely white and red cedar but when the depths reach a foot or more a fair proportion of sugar maple appears. A fairly large percentage of the original vegetation remains on these soils since they are not well suited to the growing of cultivated crops.

Sugar Maple, Beech, White Cedar Association

This association is commonly found on the soils that have been formed from the loamy limestone till. Sugar maple and beech predominate on the better drained portions with the white cedar occurring in the less well drained areas. From observations it would appear that the white cedar on the imperfectly to poorly drained limestone till soils is found in denser stands than on the shallow limestone soils over bedrock. A large percentage of the white cedar on the shallow soils is hollow and the quality is not of as high a calibre as that produced on the imperfectly drained till soils. When used for fence posts there appears to be a good deal of preference in the district for "swamp" cedar.

Pine, Soft Maple, Birch Association

The pine, soft maple, and birch combination formed the dominant forest cover of the well drained sands. There is only a very small proportion of this association left at the present time. From the pine stump fences that occur on the sandy lands it would appear that at one time there was considerable pine forest in the county. On the areas that still support a forest cover, the pines dominate with soft maple and birch being found in lesser amounts.

Elm, Ash, Soft Maple Association

Elm, Ash and soft maple are found on the imperfectly drained areas. Elm is prevalent on the heavy textured soils particularly along the stream courses.

Tamarack, Black Spruce, Alder Association

The above association is found on the poorly drained organic deposits of the county. On the deep peat deposits the tree growth is scanty and scrubby having given over to a predominantly moss vegetation.

The Soils of Grenville County

The soils of Grenville County have developed under a forest cover of mixed deciduous hardwoods and conifers and a cool humid climate. On the well drained, slightly calcareous loamy till, the soil profile exhibits the characteristics of the Gray-Brown Podzolic soils. The A_0 horizon is thin and most of the organic matter mixes with the underlying mineral matter to form the A_1 horizon. The yellow brown leached A_2 horizon does not show the intensity of leaching that is evident in the Podzol soils. The B horizon is usually fairy compact. A Gray-Brown Podzolic profile located on a 4% slope under hardwood vegetation in Grenville County is described as follows:

A_0 - Very thin mat of partially decomposed organic matter.

A_1 - 3½ inches dark brown friable loam stones and boulders present.

A_2 - 8½ inches yellow brown friable loam containing stones.

B_1 - 2½ inches reddish brown compact stony loam.

B_2 - 2½ inches brown compact stony loam.

C_1 - Yellow gray stony loam.

The soils which reflect the most intensive leaching are located on the coarse, well drained sands. Where the water table is low the sands are excessively drained. They are imperfectly to poorly drained when the water table is closer to the surface. Podzols are found on each of these drainage conditions. The well drained sands have an ashy-gray leached sand layer ranging in depth from 1½ to 3 inches. This is underlain by a yellow brown thin loamy sand layer. On the imperfectly drained sands the ashy-gray sand layer is deeper,

ranging from 3 to 6 inches and is underlain by 4 to 6 inches of reddish brown loamy sand frequently indurated.

Soils are broadly classified by the type of soil formation which is common on the well drained sites, because these reflect the normal effect of the regional climate and the vegetation associated with it. These are the normal or zonal soils. Because of imperfect drainage or some other local variation, the type of soil development within a zone may differ from that of the zonal soil. The heavy lacustrine soils of Grenville County, because of imperfect drainage, may be considered as intrazonal soils. Even the well drained soils in this County are not weathered as deeply as the zonal soils of southwestern Ontario. This, in all probability, reflects the shorter length of time which the soils of Eastern Ontario have been subjected to weathering.

St. Lawrence County New York, U. S. A., is located across the St. Lawrence River from Grenville County. According to Marbut (1) and Soils and Men (6) (Kellogg), St. Lawrence County is in the Podzol and Gray-Brown Podzolic Region. It would appear that a similar condition exists in Grenville County, Ontario. According to Marbut the soils of St. Lawrence County are derived from marine deposits of sands, clays and limestones and slightly or non-calcareous unconsolidated drift. Referring to Map No. 1, this is comparable to the materials from which Grenville County soils have been formed. According to Coleman (2), interglacial marine shells are found at Norwood near Oggensburg. It is probably safe to assume that the clays of Grenville County may be of marine origin deposited during the period of the Champlain Sea invasion.

In reviewing the report of the Soil Survey of St. Lawrence County, New York (7), one is impressed by the marked similarity that exists between the soils of the two areas. The soil pattern of the two counties takes practically the same form, namely that of shallow soils over bedrock, loamy limy till soils, and lacustrine soils of varying textures. The description offered for the Madrid loam of St. Lawrence County is similar to the commonly occurring Gray-Brown Podzolic profile of Grenville County already described. It would appear that similar soils in the two countries serve about the same use and the problems confronted in Grenville County are to be contended with in St. Lawrence County.

Soil Groups

Twenty six soil types were recognized and mapped in Grenville County. These soil types have been placed in ten groups depending on texture, drainage and stoniness characteristics. A description of the soil groups and a discussion of the type of agriculture they support follows. Their distribution within the County is indicated on Map No. 3.

Group 1 Limestone Till Soils

These soils have been developed on materials which contain fairly large proportions of Beekmantown limestone. Included in the group is a range of drainage conditions depending on topographic location. On the rolling sections the till soils present a well developed profile while on the lower lying more level areas imperfect drainage dominates.

The parent material consists of rough unassorted till. Stones of varying size and proportion are found scattered throughout the profile. The texture of the limestone till soils ranges from a sandy loam to a loam in the surface soil with the latter texture predominating. With the exception of the lower lying level to depressional troughs, the topography of the soils included in Group 1 is rolling.

Originally supporting good stands of hardwoods most of the area has been cleared. General farming, especially dairy farming, is the chief use to which these soils are put. Clovers grow well on the rolling better drained sections and are used to advantage in the rotations in helping to maintain and replenish the organic matter supply and in adding nitrogen to the soil. Since dairy farming is commonly practiced on these soils, a good supply of barnyard manure is usually available and aids in maintaining satisfactory organic matter levels.

Most of the till soils are now used for agricultural purposes for which they appear to be well adapted. In some areas where the soil mantle is shallow, adverse moisture relationships exist. These areas, as well as the lower imperfectly drained areas, are usually used for pasture and woodlot purposes.

Group 11 Stonefree Silts and Clays

The stonefree silts and clays are for the most part located in close proximity to the rivers and streams of the county. The surface texture ranges from silt through clay loam to clay.

Level to slightly undulating topography characterizes the areas in which the heavy textured soils are found. Due to topographical and textural properties, they are imperfectly to poorly drained.

Dairying is the chief agricultural endeavour practiced on farms located on the stonefree silts and clays. Drainage appears to be the greatest limitation to more successful farm achievements. Good crops of cereal grains are produced provided the weather conditions permit sufficiently early cultivation to permit planting. Alfalfa is grown with difficulty because of the imperfect drainage.

Group 111 Stonefree Sands - Well Drained

The soils contained in this group have been developed from well drained coarse, stonefree sandy materials. The topography varies from undulating to steeply rolling. Texturally the surface soil ranges from a coarse sand to a sandy loam. In many areas these coarse sands support a sparse vegetative cover, in fact so sparse in some areas it has not been sufficiently dense to protect the soil from the ravages of wind erosion.

The soils contained in Group 111 are used for general farming purposes. There has been a few attempts made to grow apple trees but these have not been successful. Because of the loose open nature of the sands they have a tendency to be excessively drained and to lack stamina for the successful production of agricultural crops. A few farmers grow potatoes on a commercial scale and it would appear that it might be possible to increase the acreage because these soils are fairly well adapted for the production of this crop.

Some fine farms have been developed on the sandy loam areas, particularly where dairy farming is practiced. The ability of the sandy loam texture to better utilize and retain soil moisture and to supply plant nutrients is reflected in the increased plant growth over that obtained on the coarse sands. These soils contain sufficient lime for the growth of legumes provided other nutrient levels are adequate. The manure supplied from the dairy herds helps to maintain an adequate organic matter content.

Group IV Stonefree Sands - Imperfectly Drained

Developed from materials similar to those of Group III these soils differ in that they are imperfectly drained. The topography for the most part is undulating. Frequently the knolls will be well drained while the hollows and troughs between the knolls are imperfectly to poorly drained. Well developed ground water podzols are commonly found on the soils contained in this group.

The utilization of the imperfectly drained sands is similar to that of the soils of Group III, although the range of crops that can be grown is more limited. Because of the variability in drainage conditions, they are somewhat more difficult to handle. The open nature of the sand materials makes retention of moisture difficult on the knolls. The depressions usually require drainage, but once this is accomplished the problem of moisture control on the knolls is accentuated. Should the imperfectly drained conditions in the depressions be the result of the proximity of a clay layer, the drainage is frequently very difficult to improve.

Group V Stonefree Sands - Poorly Drained

Occurring on level to depressional topography the poorly drained sands are developed from deep stonefree sand materials. Drainage is the chief limitation to the successful use of these soils for agricultural purposes.

Because of the drainage problem very few good farms in the county have been entirely developed on the soils contained in Group V. Large acreages are devoted to pasture land in which Red Top grass predominates. Frequently it was noted that in pastures on the poorly drained sands there is an encroachment of willow trees and scrub tree growth thus lessening their usefulness as pasture land. Where drainage and fertility have been improved, good crops of hay and pasture and fair crops of cereal grains are produced.

Beginning of cultivation operations in the spring are usually later on Group V soils than any other group in the county on which there is an attempt made to grow cultivated crops. The water table is slow at lowering and the surface drainage is very poor. Because of their lateness, fairly large acreages of buckwheat are grown on these soils. The drainage problem is frequently aggravated by the occurrence of clay layers at three to four feet. This along with the level to depressional topography augments the drainage problem.

Group VI Well Drained Sands Over Clay

Along the stream courses sand deposits ranging in depth from one to three feet and underlain by heavy plastic clay frequently occur. Characterized by rolling topography and a sandy loam texture,

these stonefree areas are well suited to the production of most farm crops commonly grown in Grenville County. The lighter textured surface soils allows for fairly good drainage and the sandy loam is not so deep that plants cannot utilize the nutrient supply in the underlying clay.

Mixed farming, with a predominance of dairy farming, and to a small extent orcharding are the chief agricultural endeavours practiced on Group VI soils. Good yields of most farm crops are obtained and there appears to be little difficulty in the production of legumes.

Group VII Imperfectly Drained Sands Over Clay

The soils contained in this group differ from those of Group VI in that they occur on level to depressional topography and are imperfectly to poorly drained. The impeded drainage condition limits their use for the production of most farm crops and for this reason a fairly high proportion of these soils are used for pasture purposes. Drainage will be difficult to improve because of the depressional topography which commonly occurs. Where the sand deposits thin out over the underlying clay the management problem is increased because of the different treatments required for the light and heavy textured soils. Due to the topographical and drainage conditions, the soils in this group exhibit highly mottled and poorly developed profiles.

Group VIII Good to Excessively Drained Stony Sands

For the most part the soils contained in Group VIII occur on the west side of the county in South Gower Township. Developed from gravel materials, these soils are characterized by rolling topography and good to excessive drainage. The profile, although exhibiting well developed characteristics, is frequently shallow.

The soils are used for general farming purposes. Although the acreage of potatoes grown in Grenville County is small, there is a greater concentration of this crop on the stony sands than on any other soil group. It would appear that there is room for expansion in potato production on the soils of Group VIII and those of Group III. The rolling topography and loose open nature of the soil materials present a soil management problem in erosion control and organic matter maintenance to provide adequate moisture retention.

Group IX Shallow Soils Underlain by Limestone Bedrock

The shallow soils underlain by limestone bedrock occupy a sizeable portion of the land area of Grenville County. For the most part, they occur in the western half of the area although the occassional outcrop is to be noted in the eastern half as well. The depth of soil overlying the bedrock seldom exceeds one foot. The topography is undulating to depressional and the area can well be described as a broad flat tableland. The drainage of these soils is much influenced by the depth to bedrock. In seasons of high rainfall they are wet and imperfectly drained. However, in droughty periods,

because of their low capacity to hold any quantity of moisture they usually suffer greatly for the want of it.

For the most part these soils have been left in either pasture or woodland. Attempts made to grow farm crops have been rather unsuccessful because of the unusual moisture relationships. Fair pastures containing Kentucky Blue grass, Canada Blue grass and in the lower depressional areas, white clover are produced on the shallow soils. Good stands of white cedar are also supported and there appears to be a ready market for it in the form of fence posts. Frequently ridges of deeper till areas, too small to be included on the map, are found on the shallow limestone till plains. Their characteristics and capabilities are more closely related to the limestone till soils of Group 1 than to the shallow soils of Group IX.

Group X Organic Soils

Extensive and deep deposits of Organic Soils are found scattered throughout Grenville County. From Map No. 3 it can be noted that the largest areas are located in the northwest and central section of the county. Little agricultural development has taken place on the organic soils. Although the mucks and peats were separated during the progress of the survey, they have been regrouped here for purposes of discussion.

Factors Affecting the Use of Grenville County Soils

The factors contributing to the formation of the soils of Grenville County have been discussed thus far. Now those characteristics that affect the use of the soils are discussed and their distribution indicated on maps. The factors here presented may well be considered physical features. They are features recognized and mapped in the field and are an attempt, in so far as possible, to break the soil group down into its component parts. True, for a complete picture it would be well to have other characteristics which might include a map of fertility levels, a map showing the need of lime in certain areas within the county, and other features that affect the use of soils.

Care must be exercised not to break the soil down into too many elements of which it is composed. The first consideration should be to analyse the many factors and deal with the salient determinants as they affect the use of land. To use too many differentia could easily result in clouding the picture to the extent that the purpose for which it was intended would be defeated.

For this study, in light of available information the choice of salient features with reference to Grenville County soils include a, stoniness, b, drainage, c, erosion, d, texture in so far as they affect their use for agricultural purposes.

Stoniness

Four classes have been established to express the stoniness factor in Grenville County soils and their distribution is shown on Map No. 4.

Class 1 Stonefree

Comprised of the stonefree sand, silts and clays, this class contains by far the largest portion of the soils of Grenville County. Soil Groups II, III, IV, V, VI, VII, and X are contained in the stonefree class.

Class II Few Stones

Soil Group VIII is the only representative in this class. Stones are found on the surface and distributed in varying amounts and proportions throughout the soil profile. They are well rounded and for the most part range in size from less than an inch to four to six inches in diameter. Stones are not present in sufficiently large numbers to interfere with cultivation and seldom should it be necessary to pick and draw them from the fields.

Class III Numerous Stones

This class is made up largely of soils contained in Group I. The stones are rough and angular, a large percentage of them being fragments of the underlying limestone bedrock. Frequently they occur in quantities large enough to make picking and hauling necessary. Stone fences are common on the soils contained in this class. Stoniness in many cases is a detriment to cultivation and

occassionally they occur in quantities sufficiently great to become the deciding factor as to whether the soils will be used for permanent pasture purposes or for the growing of cultivated crops.

Class IV Bedrock Outcrop and Boulders

Soils of groups 1 and IX are the chief components of class IV stoniness. Frequently in the shallow soils over bedrock the underlying limestone bedrock occurs as outcrops. In the Group 1 soils where large and frequent boulders occur in an area the land serves the same purpose as that of the shallow limestone soils. The presence of boulders make cultivation practically impossible.

Drainage

In the production of most cultivated farm crops soil drainage is an important factor in deciding if and how successfully a particular crop can be grown. The soils of Grenville County have been grouped into six classes to indicate the effect different drainage conditions may have on the use of soils. The extent and distribution of the different drainage classes is shown on Map No. 5.

Class 1 Excessive Drainage

The soils of Group VIII, together with the excessively drained stonefree sands of Group III, comprise the components of this drainage class. The coarse open sandy materials cause them to be poorly adapted to moisture retention.

Class II Good Drainage

Most satisfactory drainage for the production of cultivated farm crops is exhibited by the soils contained in Class II. Both the external and internal drainage can be best described as good. Production of cultivated crops is not limited by the drainage factor on these soils. The soil profile is well developed and little or no mottling occurs.

Class III Imperfect Drainage

Soil Groups II, IV, and VII are contained in the imperfectly drained class. The number of cultivated crops that can be grown on Class III drainage is small. Alfalfa is established with difficulty and winters poorly once established. These soils should

respond to artificial drainage although there appears to have been very few tile drains installed in the county. Mottling frequently occurs at depths ranging from eight to twelve inches from the surface and increases in intensity with increase in depth.

Class IV Poorly Drained Soils

The stonefree poorly drained sands of Soil Group V dominate Class IV drainage. Because of the high water table the soils cannot be cultivated until rather late in the spring with the result that the range of crops that can be successfully grown is limited and narrow. In wet springs it is frequently too late to sow cereal grains, with the result that a large percentage of the buckwheat grown in the county is planted on the poorly drained soils. Large acreages remain in pastures of only mediocre value. The profile exhibits characteristics common to a poorly drained soil. Occassionally mottlings occur but more often the profile presents a drab dull grey colour directly under the eight to ten inches of surface soil. In all probability drainage would increase the usefulness of these soils for the production of cultivated crops but it would be difficult to obtain outlets because of the depressional topography in which they occur.

Class V Very Poorly Drained Soils

The Peat and Muck deposits of Grenville County are the largest components of the very poorly drained soils. In many cases, for part of the year at least, the organic soils are submerged under water. No attempt has been made to drain the bogs and swamps

artificially. They serve a useful purpose in the forest vegetation produced and the hunting and trapping areas provided. Up to the present they are of little value agriculturally.

Class VI Variable Drainage

Although a variation to a certain degree exists within all the drainage classes the shallow soils over limestone bedrock present a more variable range than any of the other classes. Class VI drainage includes the shallow soils over limestone bedrock of Soil Group IX. Because of the shallowness of soil covering over bedrock they are very sensitive to temperature and precipitation relationships. In the spring of the year they are frequently too well supplied with moisture but during July and August they dry out badly and become very droughty. Although they are used for the production of cultivated crops to only a small extent, the crops usually suffer for moisture during the summer months. This lack of moisture is also reflected in the pastures as indicated by their brown and dry appearance in June, July, and August.

Texture

Map No. 6 shows the distribution of textural groups in Grenville County. Light textured soils predominate and are present in large amounts in the east and southern sections. On the basis of textural characteristics the soils have been grouped into three broad classes. Organic soils are shown on the map to indicate their proportion and distribution in the area.

Class 1 Heavy Clays and Clay Loams

The heavy textured water deposited soils are contained in this class. The presence of large amounts of clay give the group the characteristic of being well supplied with plant nutrients but cause them to be somewhat difficult to manage. They have a tendency to be very sticky and plastic in periods of wet weather and consequently rather difficult to cultivate. Internal drainage is slow. The high clay content and heavy texture increases the amount of power required to cultivate them. Where they occur in conjunction with lighter textured sands and sandy loams the management problems are increased because of the different technique required for the heavy as compared to the light texture.

Class 11 Loams, Fine Sandy Loams and Silt Loams

The soils contained in this group might well be referred to as medium textured soils. They exhibit those textural characteristics which adapt them to the production of most cultivated farm crops. They are easily cultivated and in an area where the number of farm tractors used is small the medium textured soils are better

suited to the use of horse power than are the heavy textured soils of class 1. The rate of moisture movement within the soil profile depends upon the topographic location.

Class III Sands and Sandy Loams

The coarse textured, light, sandy soils dominate in Grenville County. Depending on location and topography the drainage varies. The light texture is reflected in both vegetative cover and crop response. The greatest limitation to successful crop production on the light textured soils is their inability to supply adequate amounts of plant nutrients.

Organic Soils

The Organic Soils are delineated on Map No. 6 merely to show their distribution and location within the county.

Erosion

The topography of Grenville County in general ranges from undulating to gently rolling. In only a few locations does it reach rugged proportions. For the most part the area has suffered very little from the ravages of water erosion. However, the rolling light textured sand hills show signs of serious wind erosion and the problem should be one of concern. Map No. 7 illustrates the extent of water and wind erosion in the area.

Class 1 Little or No Erosion

For the most part the soils contained in this class will have slopes of 3% and less. Included are the level outwash sand plains, the level to undulating sands over clay, the shallow limestone soils over bedrock and the organic soils.

Class 11 Slight Erosion

Water erosion has affected the soils of this class only slightly. The limestone till soils and the stony sands are contained in class 11 erosion. Most of the soils have slopes ranging from 5-8%. In the case of the stony sands some 10% slopes occur but the nature of the soil materials allow for ready penetration of water and this along with the shortness of the slopes reduces the amount of runoff. Although the extent to which erosion has taken place is not great the thinning of the soil on the sidehills is an indication that the menace is at work. For this reason it was deemed advisable to sound a warning note and draw attention to the necessity of employing measures that will reduce and if possible eliminate the

hazard. The limestone till soils of Grenville County are potentially the best agricultural soils in the area. It is well to attempt to keep them in that preferred category.

Class III Moderate to Severe Wind Erosion

The excessively drained stonefree rolling sands have suffered extensively from the ravages of wind erosion. In their natural state they posses low fertility levels as reflected in their inability to provide a vegetative cover sufficiently dense to prevent wind erosion. Although under present conditions the percentage of moderately to severely eroded soils is small when compared with the total land area of the county, nevertheless this eroded area is increasing. The slow and relentless action with which erosive forces operate makes it difficult for people living in a community to realize the magnitude of the hazard. The denuded shifting sand hills bespeak the necessity for action to overcome the problem.

Problem Areas

Thus far the development of the soils of Grenville County have been discussed and the various salient factors that affect their use for agricultural purposes have been indicated. Map No. 8 is presented at this time to illustrate the location and distribution which, in light of present knowledge, the writer considers as the main problem areas affecting the agricultural use of Grenville County soils. These factors have been discussed elsewhere in the report and Map No. 8 may act as a summary indicating the distribution of the problems in Grenville County.

A Plan for the Use of Grenville County Soils For Agricultural Purposes

The purpose of this study is to analyse the effect of various soil differences on the use of Grenville County soils. The results of such a study may be expressed by presenting a suggested plan for the use of the soils for agricultural purposes. In developing a suggested plan the writer has been guided by observations made while mapping the soils of the area. Too, he has been able to note the experience of the past and the effect it has had on the agriculture of the area and this is valuable aid when planning for the future.

Only indirectly are we able to note what the influence of Man's presence has been. He was first responsible for upsetting the natural balance that originally existed by denuding the area of its forest cover. That this was justified is granted, because to maintain an adequate standard of living and to care for our increased numbers of people it appears necessary that the soil be cultivated

and revenue in excess of what forest cover can produce be provided. The destruction of the natural harmony has not been without its ill effects. The shifting, wind eroded sand hills appear to be the result of an attempt on the part of Man to change the natural pattern and force it into one that would better serve his immediate requirements. Under natural conditions the moisture content of the soil was in harmony with the type of vegetation provided for the area. On the high moisture soils the tamarack grew while the pines located on the low moisture well drained sands. When the land was cleared the moisture-vegetation balance provided by Nature was changed and for Man's purpose it became one of drainage that would grow crops to his satisfaction and advantage. Thus Man's influence is again reflected, necessitating the need for tile draining if the area is to produce adequate yields of cultivated farm crops.

That Grenville County will continue to be a basically agricultural community in Eastern Ontario is not doubted. That it has close to a century of experience to its credit is certainly to its advantage. If, through this presentation and suggested plan, a warning note can be sounded that all is not entirely well for the future the purpose of the study will be served in part. In light of observations and information collected, a plan indicating to what purpose the soils of Grenville County might be utilized if it is to continue as a progressive and sound agricultural community, is herewith presented.

The soils of the area have been divided into seven land types. A plan or suggestion indicating what is considered the most

useful purpose the soils can serve is built up around these land types. Their distribution throughout the county is indicated on Map No. 9, and a description and discussion of each land type follows.

Land Type 1

In percentage of land area of Grenville County, Land Type 1 is by far the largest.

Dominated by sand and sandy loam materials it contains several other components. Wet clay and clay loam troughs are contained in this type as well as the occassional well drained stony ridge. In the flat depressional areas muck and peat occur. Topographically the type varies from level to strongly rolling.

Most of the land type is cleared. Roads, schools and churches have been established and an agricultural community of sizeable extent now exists. However the chief problems limiting the use of the soils contained in this land type for continued agricultural endeavours are (a) drainage, (b) erosion, (c) low fertility.

The poorly drained depressional sandy areas under present conditions are used largely for pasture purposes. If drained, more nutritious and satisfactory pasture mixtures could be introduced and the capacity of the poorly drained areas to fit into an agricultural programme would be increased. Erosion has reached serious proportions on the rolling sandy knolls. It is doubtful if a sound agricultural programme can be established on these areas. Probably a very useful purpose for such areas would be the re-establishment to tree cover. As previously indicated, the dominant textural class of the area is sand and sandy loam. The coarse texture is reflected in the frequent hunger and low fertility signs indicated in the crops that grow on the sandy soils. This is a problem of considerable magnitude and concern. The organic soils included in this land type are for the most part too

poorly drained for the production of cultivated crops. Under present use they are growing tree cover and it would appear that in this capacity they are serving their most useful purpose.

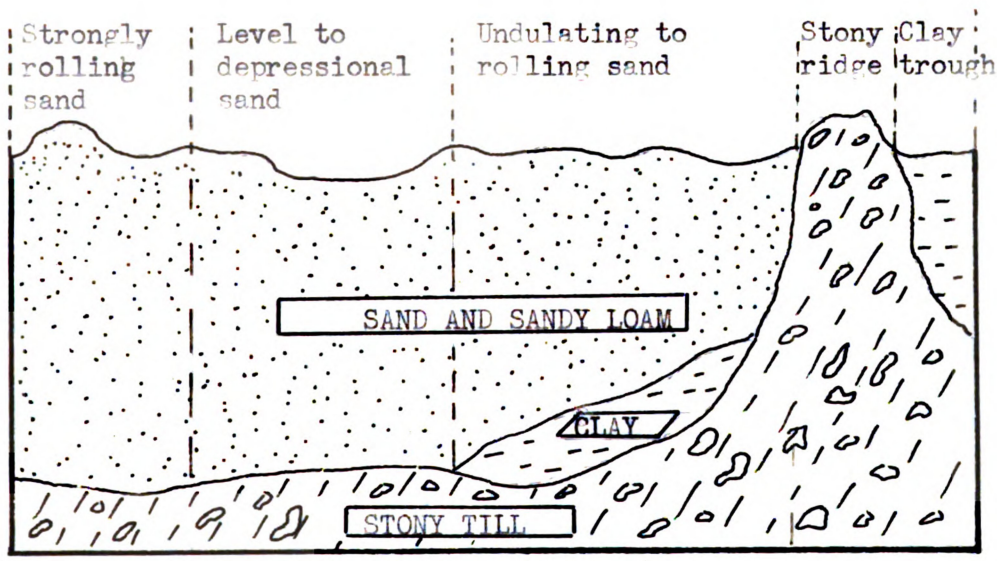

Figure (2) Diagrammatic representation of the components contained in LAND TYPE 1.

Land Type 2

Land Type 2 is characterized by undulating to level topography. The texture in the surface soil ranges from loam to clay loam. Level clay loam areas form the principal component with the occassional included well drained stony loam ridge. In the north-western section of the county, near Eastons's Corners, the veneer of heavy textured stonefree material is of variable depth. Underlain by stony till, the lacustrine wash occassionally thins out and the underlying till protrudes.

In this district where the clay loam is underlain by till, the internal drainage of the soil profile is improved on the undulating topography. Land Type 2 is well suited to the growing of most cultivated farm crops and some of the better farms of the area are located on it. Its chief limitation is imperfect drainage on the level heavy textured areas.

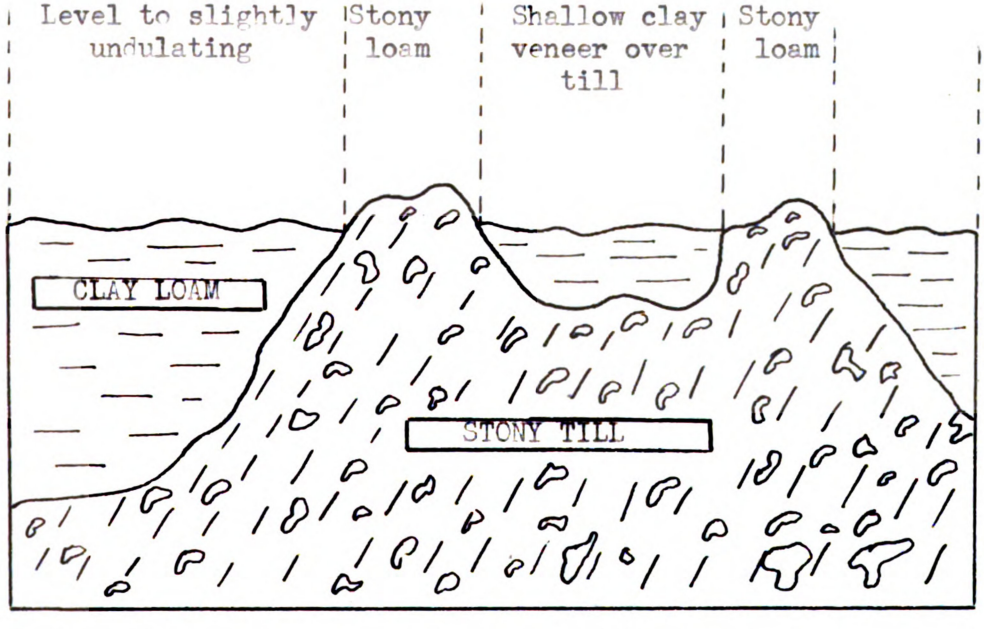

Figure (3) Diagrammatic representation of the components contained in LAND TYPE 2.

Land Type 3

Rolling topography with included areas of imperfectly drained sandy troughs, and depressional areas of muck and peat are the chief components of Land Type 3. The texture varies from a sandy loam to a loam on the surface. This land type contains the limestone till soils

and these occassionally thin out over the underlying bedrock. When such a condition occurs the soils act in much the same way as the shallow soils over limestone bedrock.

Some of the best farms in the district are located on this land type. Well suited to the production of the crops commonly grown in the district, the chief problem to be considered is the susceptibility of the soils to erosion. Although as indicated earlier in the discussion erosion as yet has not reached serious proportions, yet the dominant component of this land type has the highest potential value for agricultural purposes of any land type in the county. It would be well to attempt to conserve it and have it continue to serve its most useful purpose as valuable agricultural land.

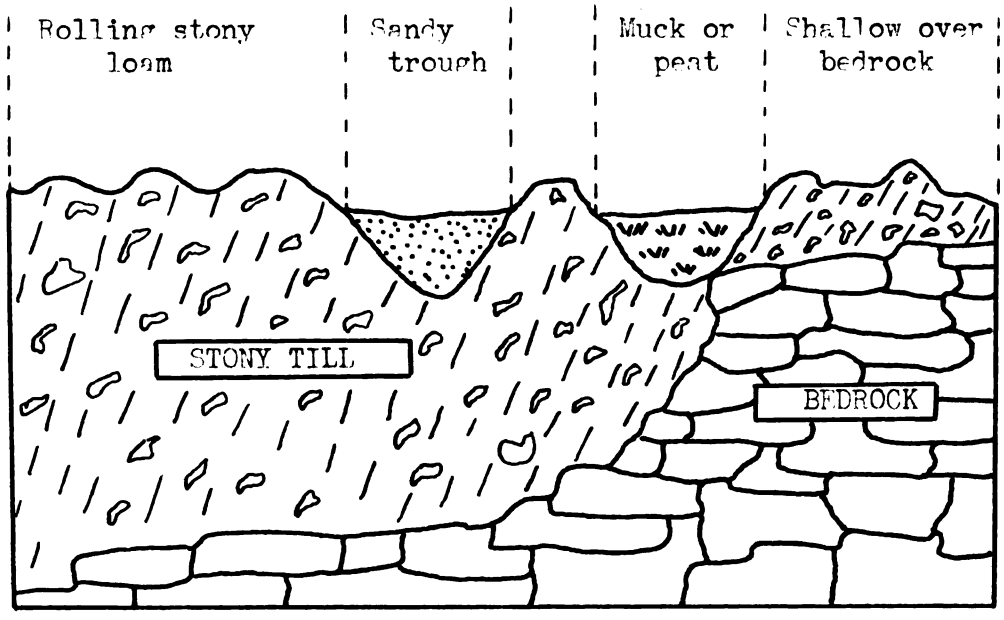

Figure (4) Diagrammatic representation of the components contained in LAND TYPE 3.

Land Type 4

Limited by shallowness over bedrock, variable drainage, excessive stoniness, in most casses the soils contained in Land Type 4 are ill-suited to the production of cultivated crops. Soils with depths less than one foot dominate the land type. Included are depressional areas of peat and muck and the occassional loam ridge. The topography varies from level to gently undulating.

Land Type 4 occupies a considerable area in Grenville County. As has been indicated, it has definite limitations for the production of farm crops. Probably if used in large units it could be well utilized for pasture purposes. Dairy farming is a large and important industry in the county. The shallow limestone soils produce fair coverage of Kentucky and Canada Blue grass and would provide pasture land in the early spring season. The included muck and peat areas might well serve the same purpose as that indicated for Land Type 7.

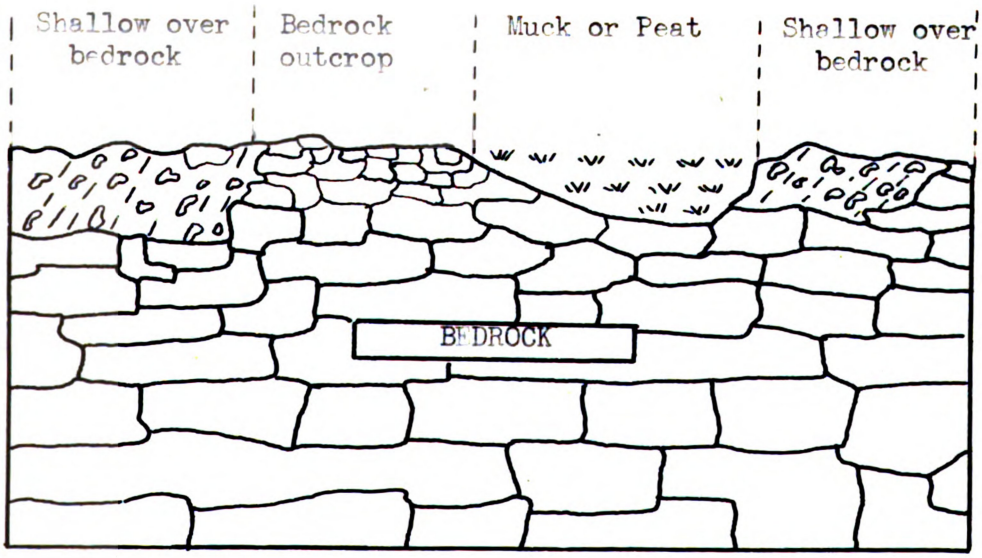

Figure (5) Diagrammatic representation of the components contained in LAND TYPE 4.

Land Type 5

The soils making up land Type 5 are underlain by clay at depths of three feet and less. The texture of the surface soil ranges from a sandy loam to a fine sandy loam. Level to gently undulating topography dominates the type. Included with this land type in minor proportions are areas of wet clay land. The drainage varies from imperfect to poor depending on topographic location and the proximity of clay to the surface.

Only a small percentage of woodland remains on Land Type 5. Most cultivated farm crops are grown on the soils contained in this type but the range of different crops is somewhat limited by imperfect drainage conditions. Provided good farming practices are employed, the type is suited to agricultural endeavours. Its chief limitation is imperfect drainage and tile draining should merit attention and consideration. In areas where wet clay land is included, the potentialities and possibilities are similar to those indicated for Land Type 2.

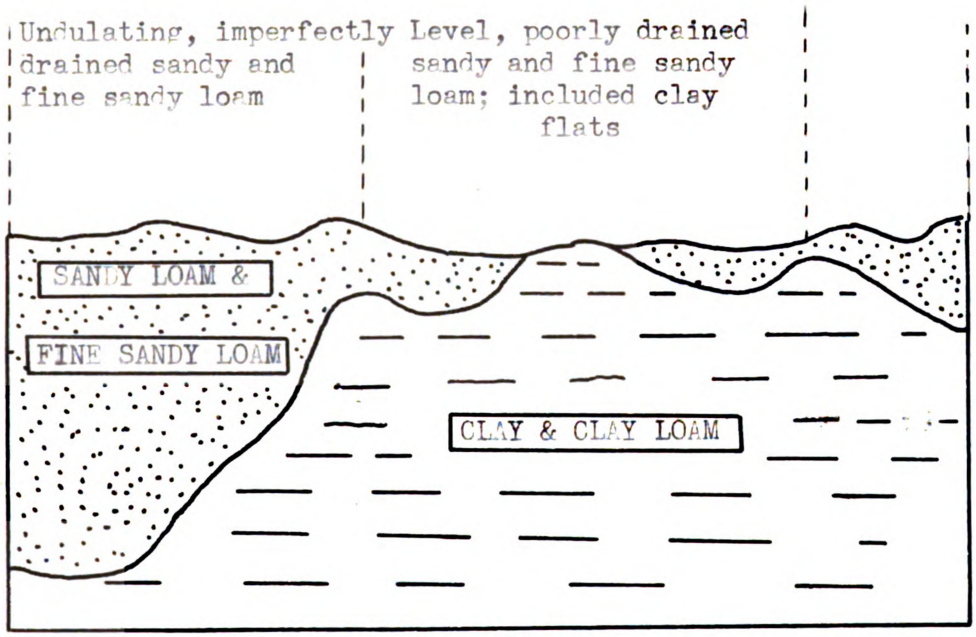

Figure (6) Diagrammatic representation of the components contained in LAND TYPE 5.

Land Type 6

Land Type 6 occupies only a small area in Grenville County but it occurs extensively in the adjoining county of Dundas. Characterized by undulating to strongly rolling topography, the sandy loam surface is underlain by substratum of sand and gravel. Provided fertility is maintained and consideration is given to the control of erosion the soil of Land Type 6 should adequately repay the efforts of individuals to successfully operate farm units.

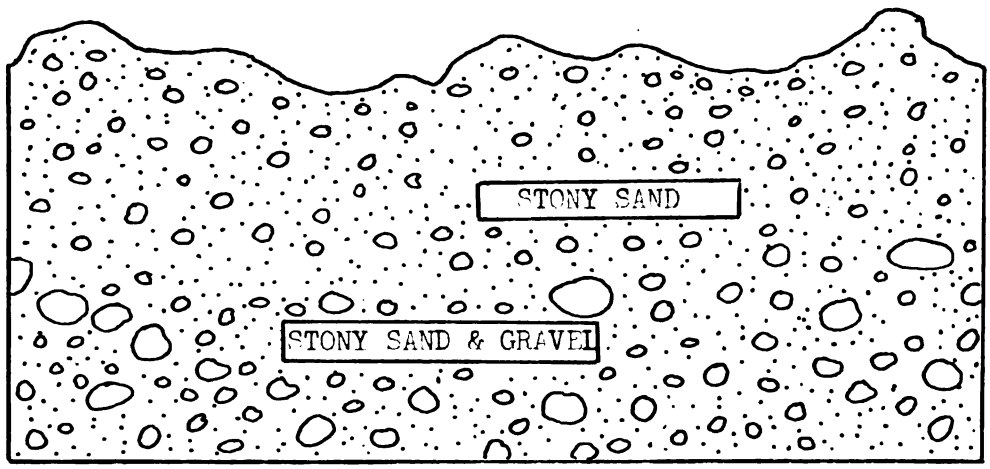

Figure (7) Diagrammatic representation of the components contained in LAND TYPE 6.

Land Type 7

Comprised largely of muck and peat swamps the organic soils have been little developed for agricultural purposes. The peat swamps support a cover of moss and tamarack while on the mucks there is a noticeable increase in the percentage of elm that occurs. Occasional ridges of well drained stony loam and streaks of poorly drained sands occur in Land Type 7. Because of their association with the poorly drained organic soils and the fact that they occur in small isolated areas it does not appear economically sound to attempt to cultivate these small included areas. Whatever may be considered the best use for the organic soils might well be applied to the loam ridges and

sand streaks. Under present conditions because of the cost involved in draining and developing the organic soils of Grenville County, it is considered they serve their most useful purpose for timber production and for industries other than agriculture.

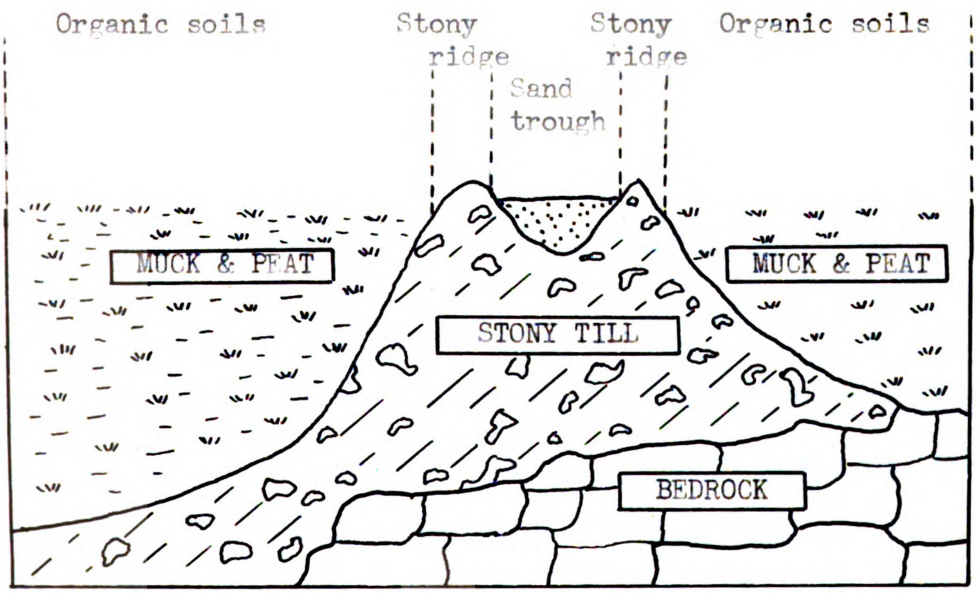

Figure (8) Diagrammatic representation of the components contained in LAND TYPE 7.

Suggested Land Use Plan for Grenville County

A. AGRICULTURAL LAND

(i) Suited for the growing of cultivated crops provided

(a) erosion control practiced Land Type 3

(b) drainage improved Land Type 2

(c) adequate fertility levels maintained, well drained components of Land Types 1 and 5 and Land Type 6

(d) drainage improved and adequate fertility levels maintained, imperfectly and poorly drained components of Land Types 1 and 5.

(ii) Suited for pasture land

(a) Poorly drained components of Land Types 1, 3 and 5

(b) Shallow soils of Land Type 4 and the bouldery and shallow components of Land Type 3

B. NON AGRICULTURAL LAND

(a) Land Type 7 and the organic components of all other land types.

(b) Shallow over bedrock of Land Type 4

SUMMARY

(1) Grenville County, Ontario, Canada is located in Eastern Ontario and occupies approximately 296,000 acres.

(2) Slightly over 88% of the total land area of the county is in occupied farms. Woodland occupies about 13% of the land area. Dominant type of agriculture from which the farm income is derived is the production of dairy cattle, dairy products, hogs, poultry, cereal grains and to a limited extent fruit and vegetables.

(3) Grenville County soils have developed from stony till, stonefree sand, stony sand and heavy stonefree clay and clay loam. Climatic characteristics of the area are average precipitation of 34 inches, mean annual temperature of 42°F, average frost free period of 130 days. The average date of the last killing frost in the spring is May 18, and the first killing frost in the fall is September 26.

(4) Sands and sandy loam texture dominate in the area. Light textured soils when used for agricultural purposes usually do not contain adequate plant nutrients to provide satisfactory yields of most cultivated farm crops.

(5) Stones are present in sufficiently large numbers to limit the use of certain areas for agricultural purposes. On the bouldery limestone till soils and the shallow soils over limestone bedrock the presence of stones and boulders or the influence of the underlying bedrock makes cultivation impossible.

(6) Imperfect and poor drainage affects the use of a large proportion of the soils for agricultural use. Tile drainage should greatly

improve the use capability of these soils. Inadequate drainage is one of the greatest limitations affecting the use of Grenville County soils for agricultural purposes.

(7) Wind erosion has reached serious proportions on the well to excessively drained sandy knolls. It is doubtful if successful agricultural endeavours can be established on the eroded areas. To control wind erosion and at the same time have such areas serve a more useful function it is suggested they be reforested. Water erosion has not affected the area seriously.

(8) Because of existing drainage conditions and the cost involved in drainage improvement, reclammation and development, the organic deposits are considered more useful for endeavours other than agriculture. The use of the shallow limestone soils over bedrock for agricultural purposes, other than pasture, is limited by depth of soil over bedrock and inadequate moisture retention relationships.

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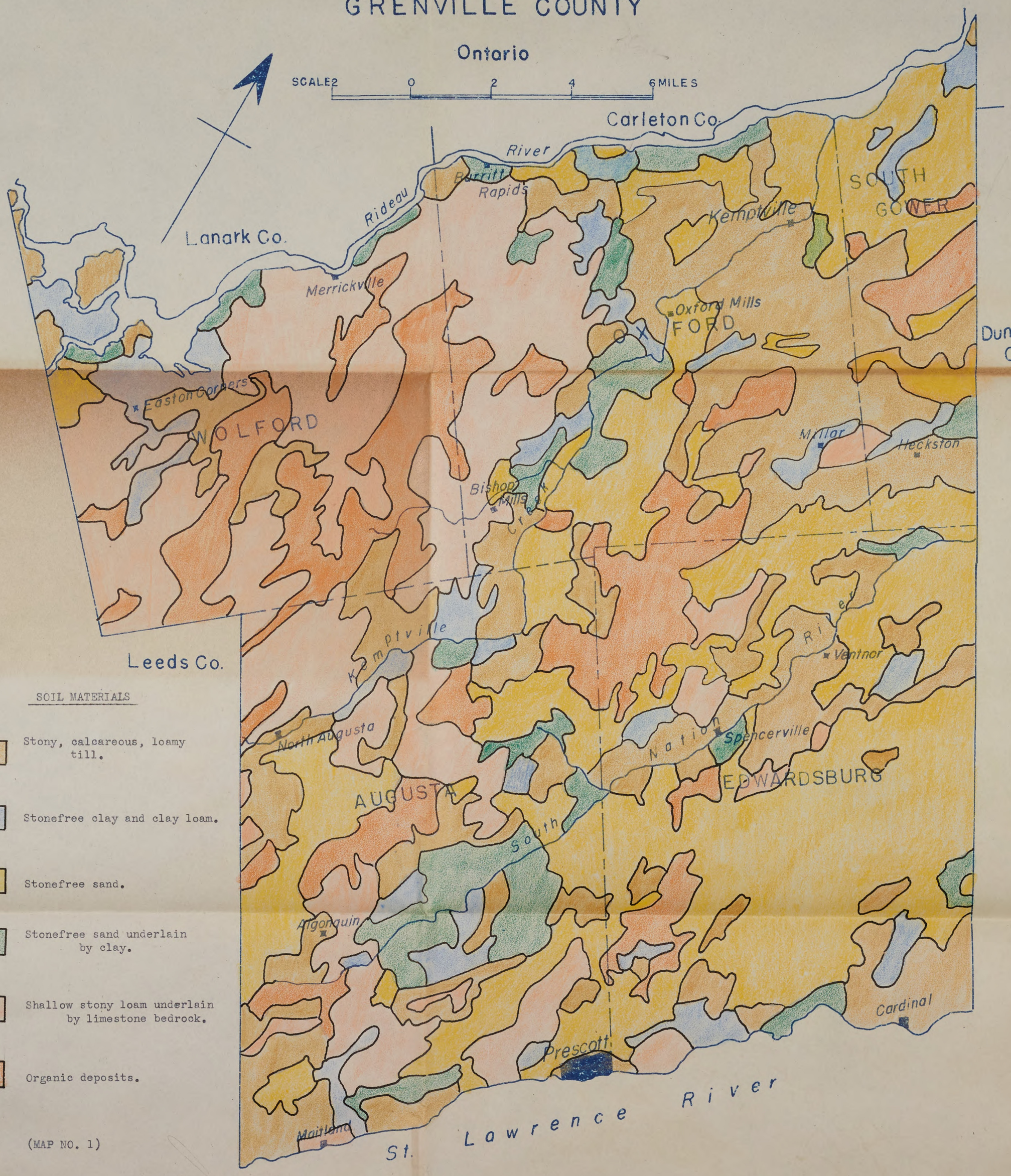
GRENVILLE COUNTY

Ontario

SCALE 2 0 2 4 6 MILES

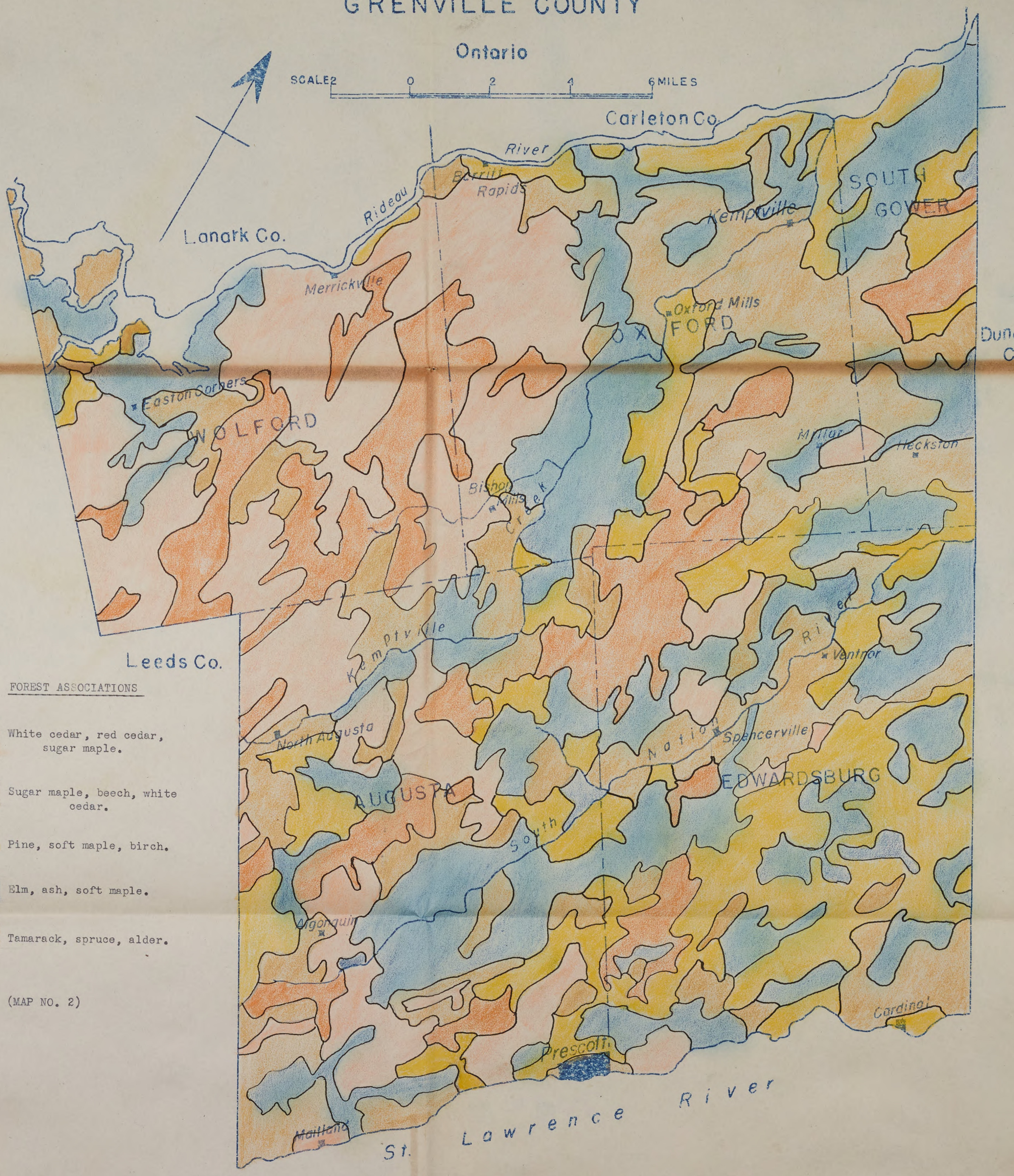


SOIL MATERIALS

- Stony, calcareous, loamy till.
- Stonefree clay and clay loam.
- Stonefree sand.
- Stonefree sand underlain by clay.
- Shallow stony loam underlain by limestone bedrock.
- Organic deposits.

(MAP NO. 1)

GRENVILLE COUNTY

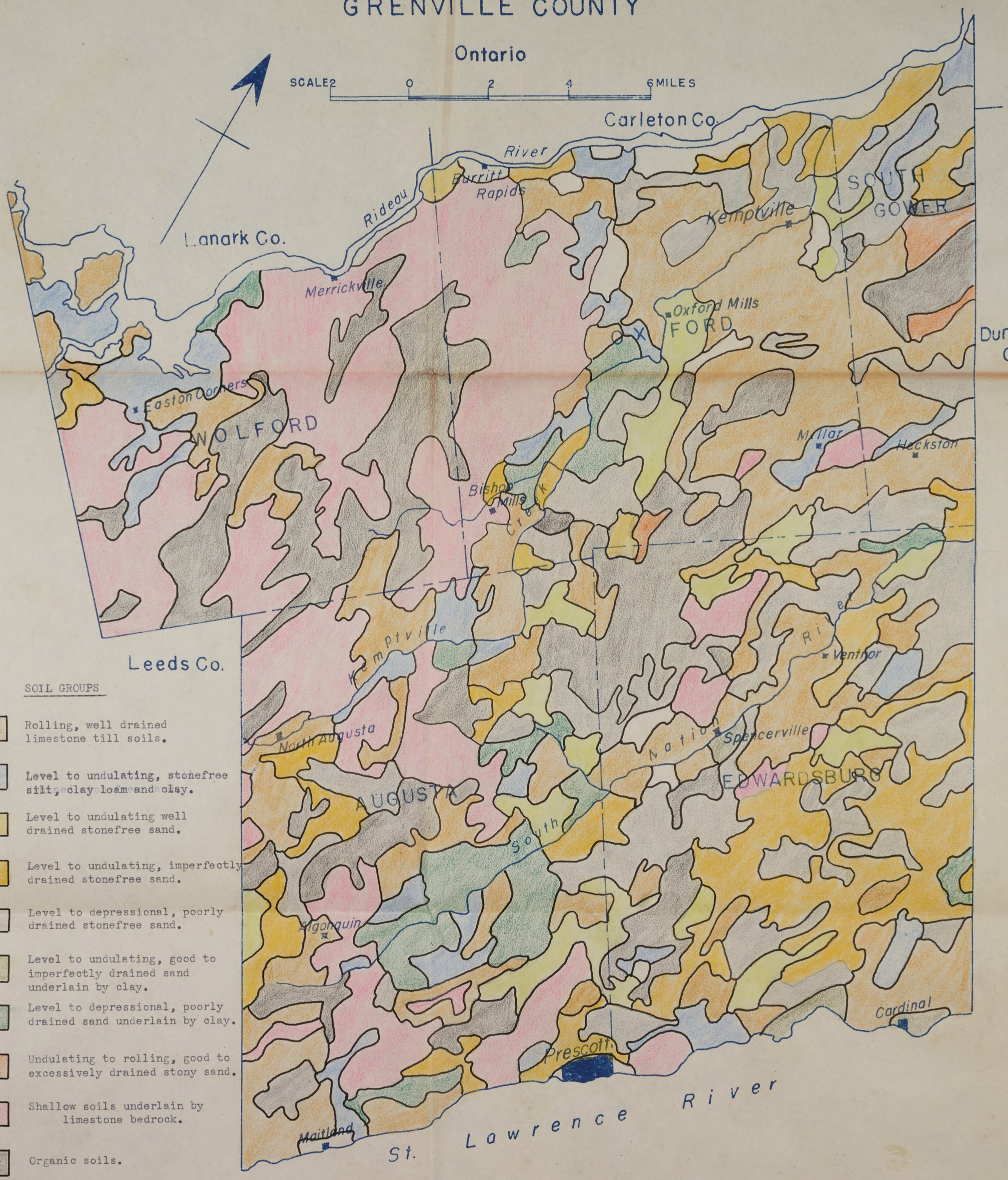


FOREST ASSOCIATIONS

- White cedar, red cedar, sugar maple.
- Sugar maple, beech, white cedar.
- Pine, soft maple, birch.
- Elm, ash, soft maple.
- Tamarack, spruce, alder.

(MAP NO. 2)

GRENVILLE COUNTY

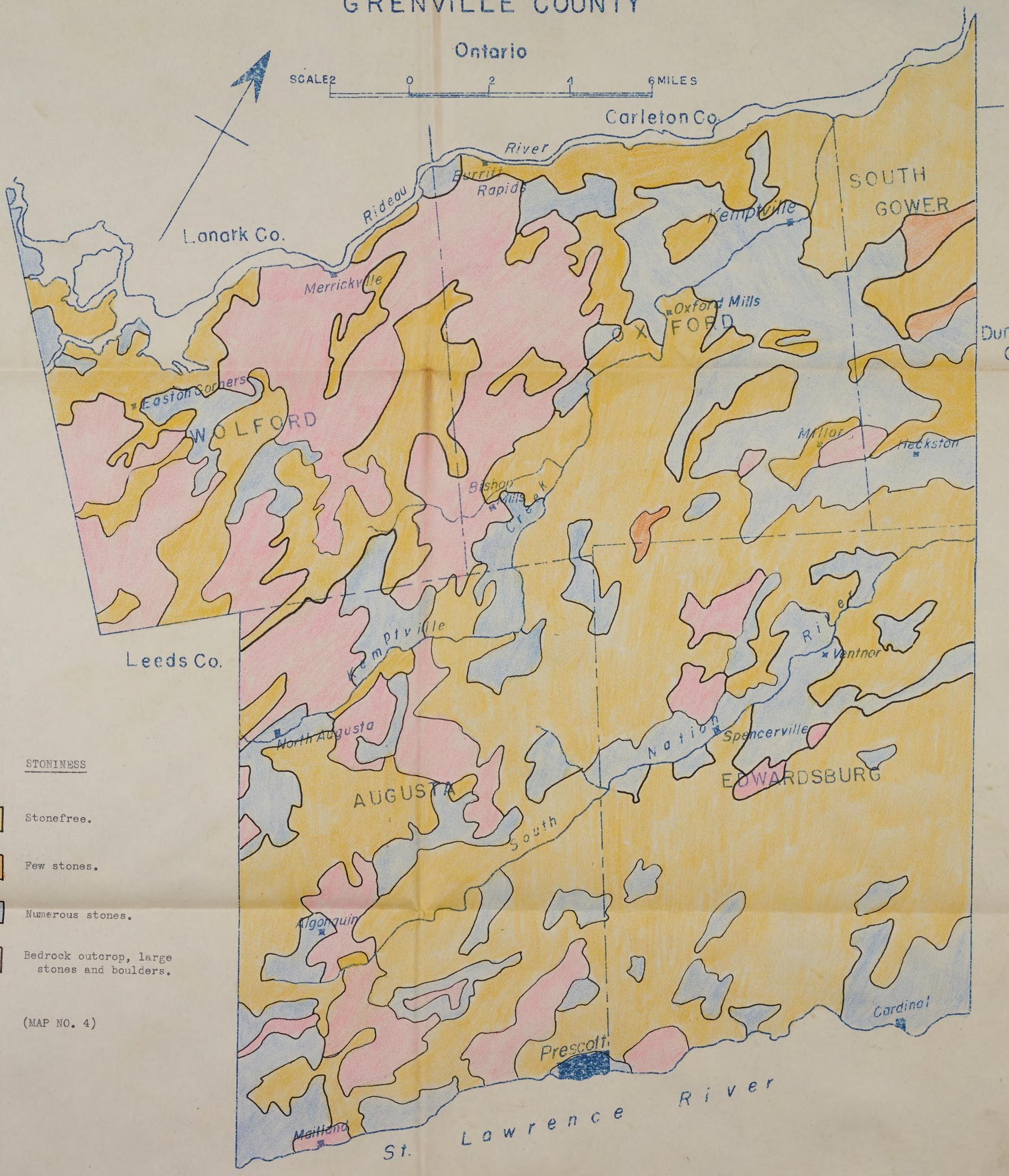


SOIL GROUPS

- Rolling, well drained limestone till soils.
- Level to undulating, stonefree silty clay loam and clay.
- Level to undulating well drained stonefree sand.
- Level to undulating, imperfectly drained stonefree sand.
- Level to depressional, poorly drained stonefree sand.
- Level to undulating, good to imperfectly drained sand underlain by clay.
- Level to depressional, poorly drained sand underlain by clay.
- Undulating to rolling, good to excessively drained stony sand.
- Shallow soils underlain by limestone bedrock.
- Organic soils.

(MAP NO. 3)

GRENVILLE COUNTY



STONINESS

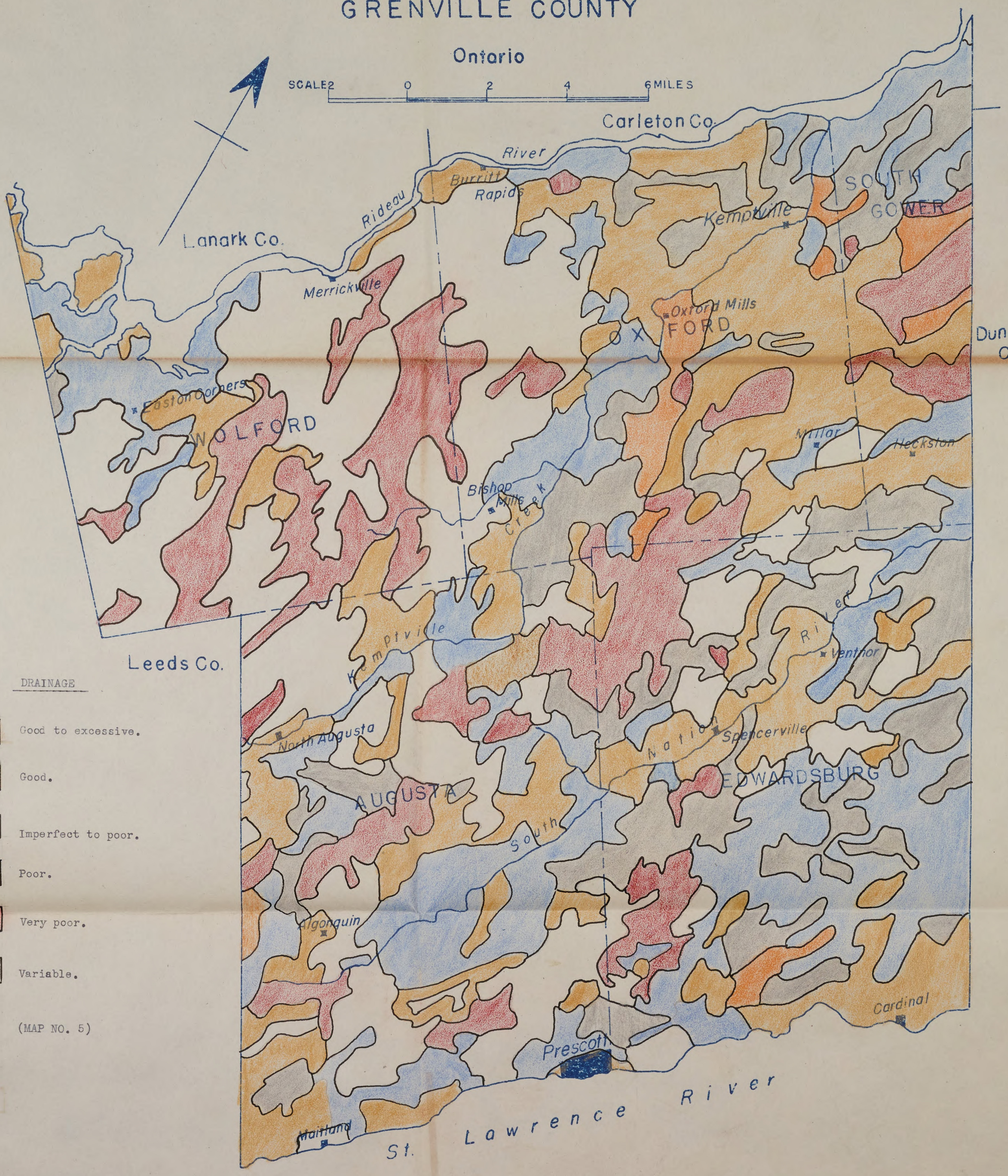
- Stonefree.
- Few stones.
- Numerous stones.
- Bedrock outcrop, large stones and boulders.

(MAP NO. 4)

GRENVILLE COUNTY

Ontario

SCALE 2 0 2 4 6 MILES

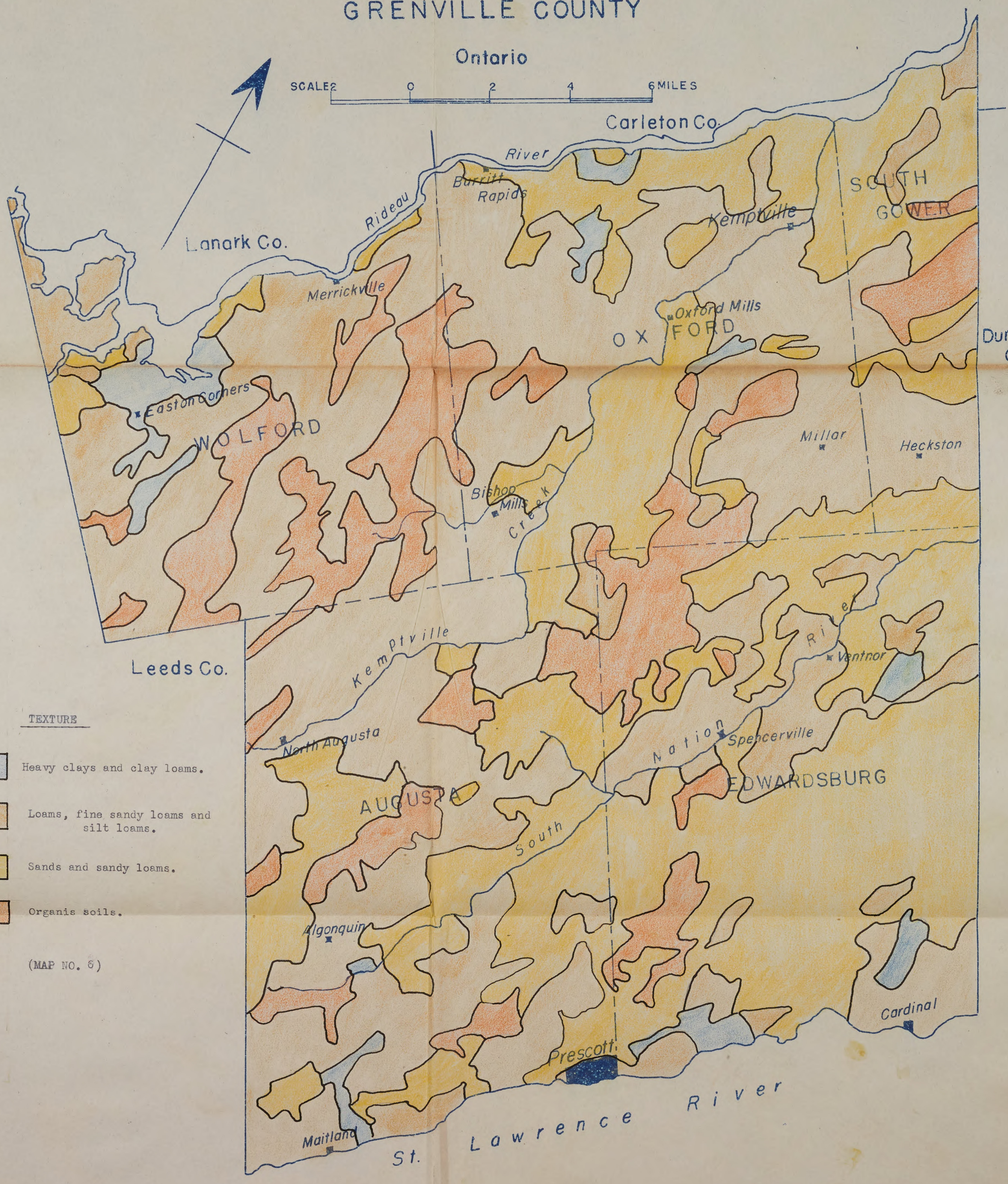


DRAINAGE

- Good to excessive.
- Good.
- Imperfect to poor.
- Poor.
- Very poor.
- Variable.

(MAP NO. 5)

GRENVILLE COUNTY



TEXTURE

Heavy clays and clay loams.

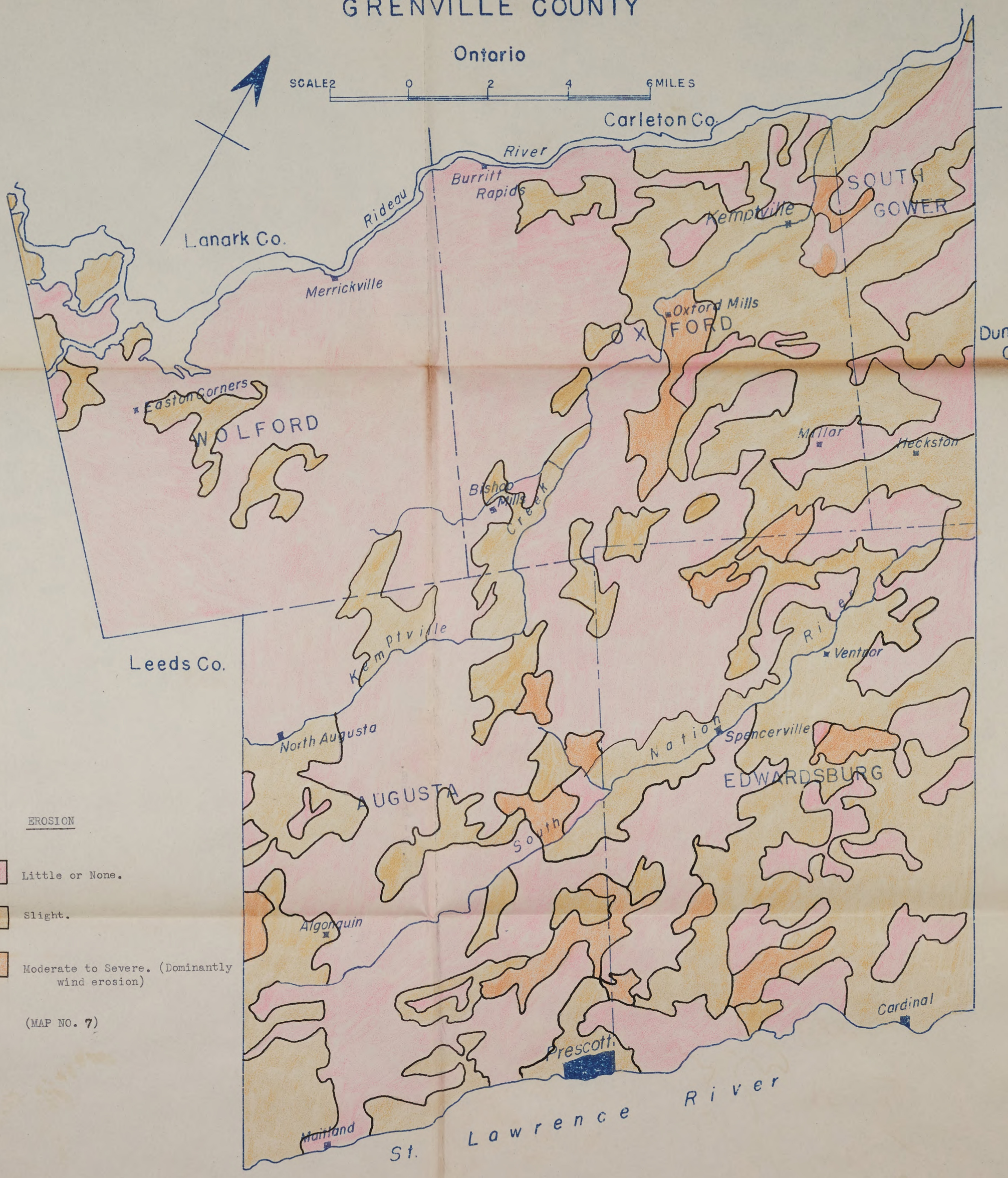
Loams, fine sandy loams and silt loams.

Sands and sandy loams.

Organis soils.

(MAP NO. 6)

GRENVILLE COUNTY



EROSION

Little or None.

Slight.

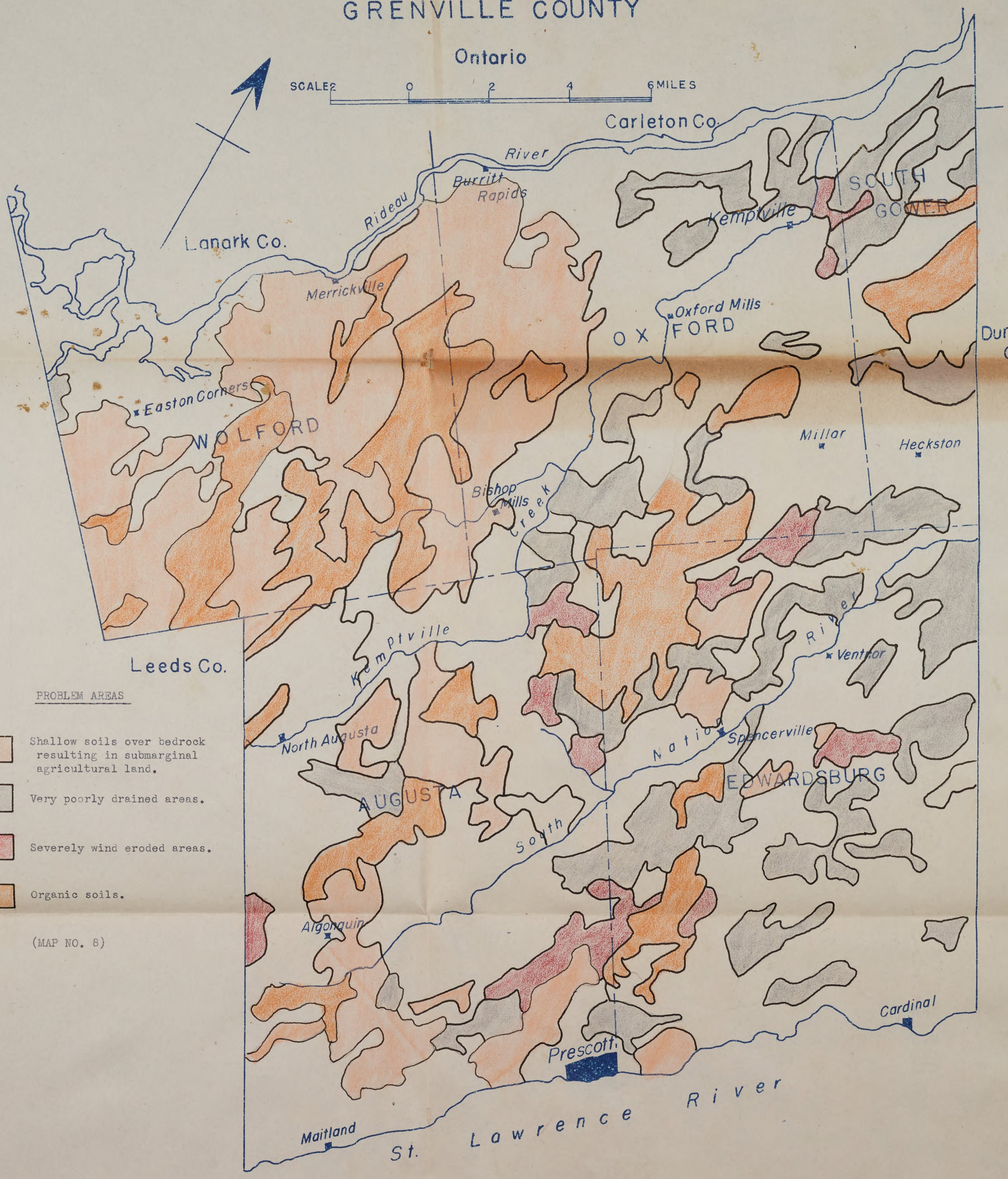
Moderate to Severe. (Dominantly wind erosion)

(MAP NO. 7)

GRENVILLE COUNTY

Ontario

SCALE 0 2 4 6 MILES

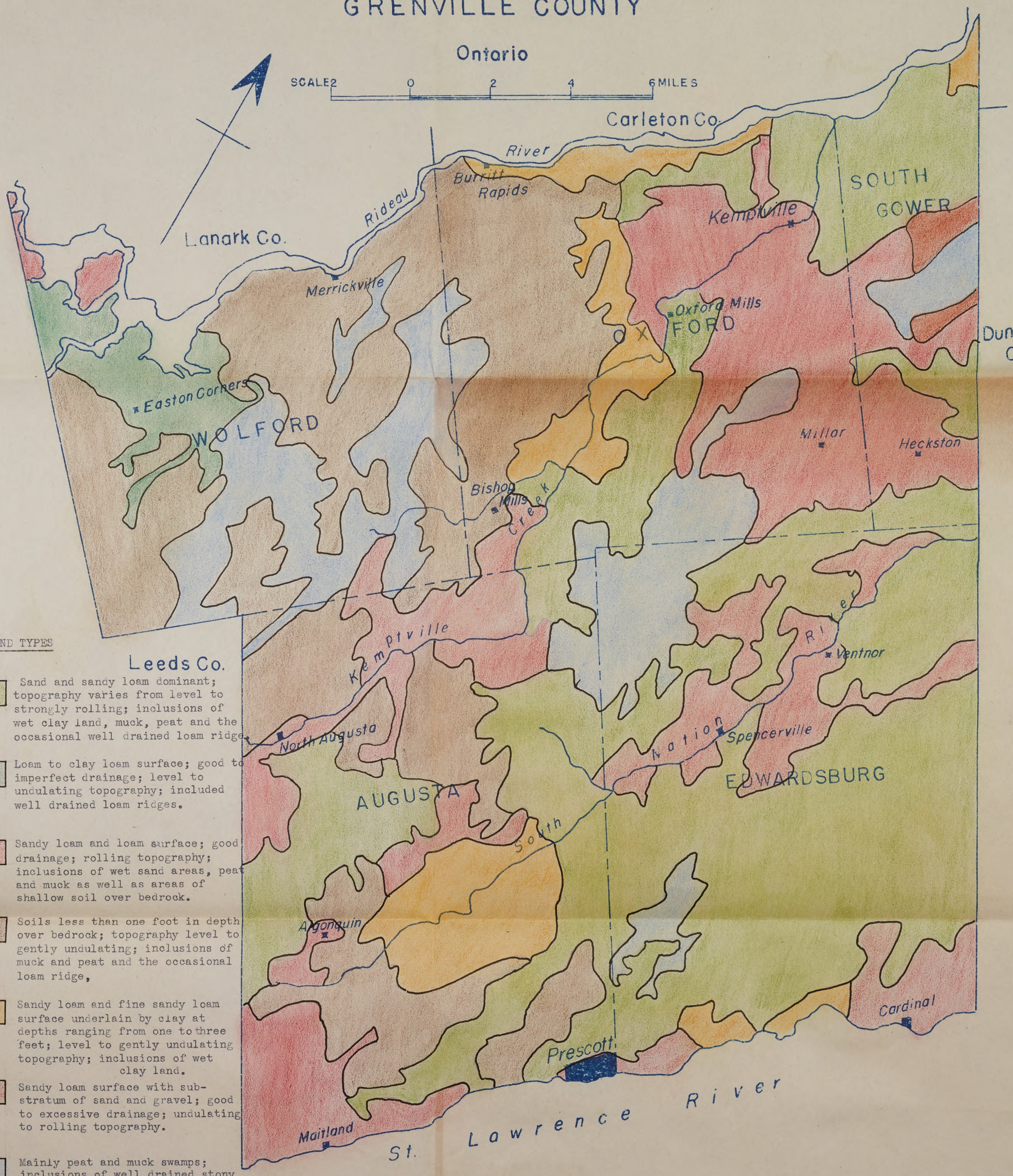


PROBLEM AREAS

- Shallow soils over bedrock resulting in submarginal agricultural land.
- Very poorly drained areas.
- Severely wind eroded areas.
- Organic soils.

(MAP NO. 8)

GRENVILLE COUNTY



LAND TYPES

Sand and sandy loam dominant; topography varies from level to strongly rolling; inclusions of wet clay land, muck, peat and the occasional well drained loam ridge.

Loam to clay loam surface; good to imperfect drainage; level to undulating topography; included well drained loam ridges.

Sandy loam and loam surface; good drainage; rolling topography; inclusions of wet sand areas, peat and muck as well as areas of shallow soil over bedrock.

Soils less than one foot in depth over bedrock; topography level to gently undulating; inclusions of muck and peat and the occasional loam ridge,

Sandy loam and fine sandy loam surface underlain by clay at depths ranging from one to three feet; level to gently undulating topography; inclusions of wet clay land.

Sandy loam surface with substratum of sand and gravel; good to excessive drainage; undulating to rolling topography.

Mainly peat and muck swamps; inclusions of well drained stony loam ridges and streaks of poorly drained sand.

(MAP NO. 9)