SOILS REPORT No. 6 APRIL, 1956

REPORT OF
RECONNAISSANCE SOIL SURVEY
OF
ROSSBURN AND VIRDEN MAP SHEET AREAS

By
W. A. EHRLICH
L. E. PRATT AND E. A. POYSER

With two Soil Maps, one covering Townships 15 to 22 in Ranges 19 to 29 west (inclusive), designated as the "Rossburn Area Map Sheet", and one covering Townships 8 to 14 in Ranges 19 to 29 west (inclusive), designated as the "Virden Area Map Sheet", prepared by the Manitoba Soil Survey.

MANITOBA SOIL SURVEY
CANADA DEPARTMENT *of* AGRICULTURE, PROVINCIAL DEPARTMENT *of* AGRICULTURE AND SOILS DEPARTMENT, THE UNIVERSITY *of* MANITOBA

Report published by the Manitoba Department of Agriculture.
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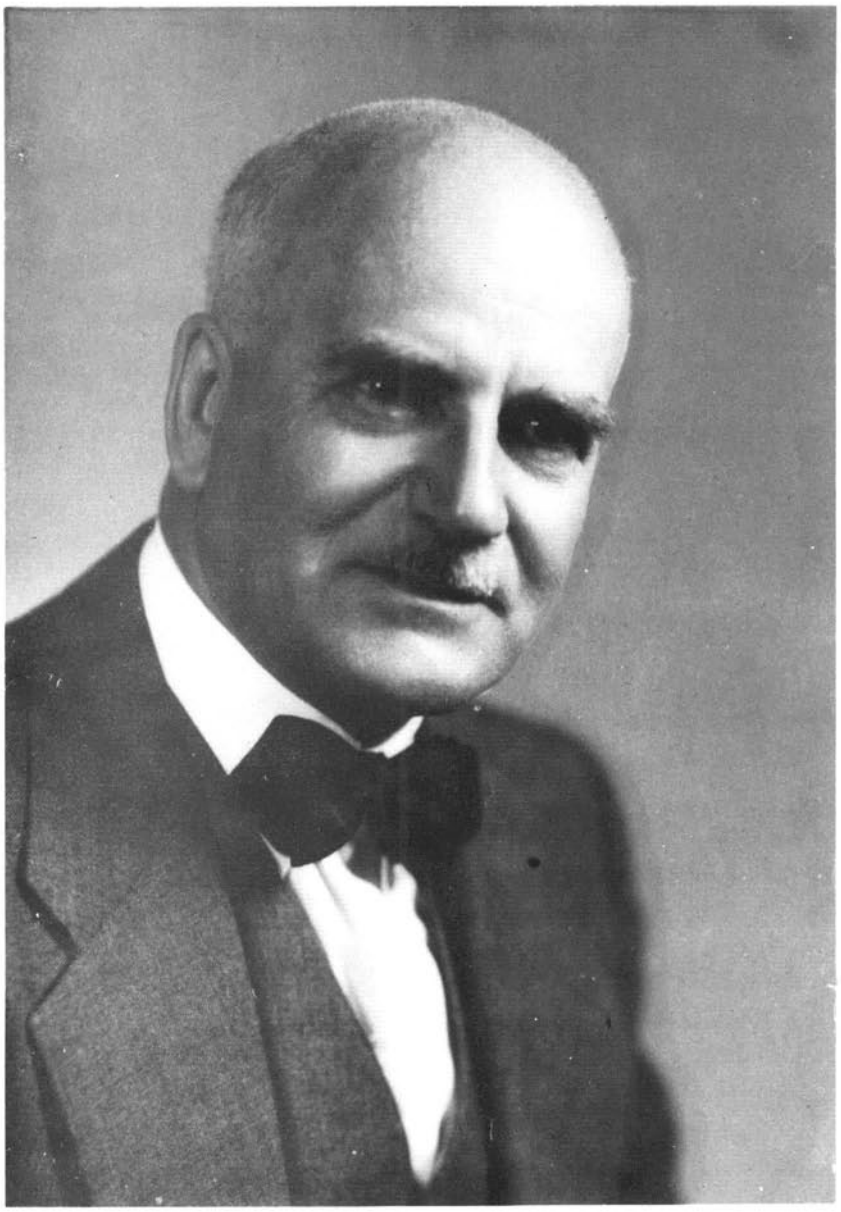

J. H. Ellis, Chairman of the Department of Soils, The University of Manitoba, and Director of the Manitoba Soil Survey retired in August, 1955. Professor Ellis who is one of our pioneers in soil classification in Canada, inaugurated the systematic soil survey in Manitoba in 1927. His tireless efforts in the pursuance of a knowledge of the soils in Manitoba have been an inspiration to all who have had the privilege of working under him. The teachings and leadership given by J. H. Ellis to the Manitoba Soil Survey men will not be forgotten.

Acknowledgments

The soil survey of the Rossburn and Virden Map sheet area was conducted as a joint project by the Canada Department of Agriculture, the Manitoba Department of Agriculture; and the Soils Department, The University of Manitoba.

The writers of this report gratefully acknowledge the financial assistance provided by the Canada and Manitoba Departments of Agriculture for the pursuance of this project, and desire especially to acknowledge the interest in and support given to the work by the Director of the Experimental Farms Service, and by Dr. P.O. Ripley, Chief, Field Husbandry Division, Ottawa; and also by the Manitoba Minister of Agriculture and his Deputy, Mr. J.R. Bell.

Acknowledgment is made to Dr. A. Leahey, Dr. P.C. Stobbe, Canada Department of Agriculture and to Dr. R.A. Hedlin, Department of Soils, University of Manitoba, for their critical review of the report.

The soils were mapped in the field by Wm. H. Shafer, O.G. Caldwell, H.A. Scott, J.M. Parker, R.E. Wicklund, J A. Hobbs, R. Glentworth, G.C. Gamey, M. Abey, and W.A. Ehrlich under the direction of J.H. Ellis. The writers hereby gratefully acknowledge the services rendered by these men in the field and in the laboratory, and the assistance by Rose M. McLaren for the recording of field and laboratory data, statistical data, and the preparation of the report. Assistance during correlation work was given at various times by F.P. Leclaire, R.E. Smith and J.A. Robertson.

Two colored maps accompany this report both of which were initially drafted by Wm. H. Shafer. The final drafting and printing of these soil maps were undertaken and financed by the Experimental Farms Service, Canada Department of Agriculture, Ottawa, and the printing of the report was undertaken and financed by the Manitoba Department of Agriculture.

Acknowledgment and thanks are due to C.W. Lowe of the Botany Department, University of Manitoba for information in respect to native vegetation of the area; and also for Agricultural data and other information obtained from Provincial and Federal publications which have been freely used in this report.

Preface

This report is the sixth of a series devoted to the description of the soils of Manitoba as determined through the work of the Manitoba Soil Survey. This publication records the information obtained through a reconnaissance soil survey of the Rossburn and Virden map sheet areas. The object of this reconnaissance soil survey was to obtain the essential facts about the soils of the area as a whole, ascertaining their characteristics, problems and possibilities, and defining their distribution. This type of survey was adopted because it provides adequate information for a study of the soils from a regional standpoint, and at the same time permits the acquisition of sufficient detail for practical purposes (in view of the regional agriculture) at a cost much below that required for a detailed survey.

The primary object of this report is to provide descriptions of the individual soils occurring within the area and these descriptions occupy the major portion of the publication. Other information pertaining to the physical features of the area and the type of agriculture practised is included, as these features have a direct bearing on the nature and utilization of the soils.

The Rossburn and Virden map sheet areas occupy approximately 5,768 square miles in western Manitoba. The larger part of this total area is occupied by extensive glacial till plains, while the remainder of the area lies within the glacial Lake Souris Basin. Thus the surface deposits, which form the parent material from which the soils have been developed, are chiefly of glacial origin, but they vary in form and composition according to their method of deposition. The climate of the area as a whole is sub-humid with an average annual precipitation of about 17 inches. However some local variations in climate occur, due mainly to relative elevation, and these differences are reflected by the native vegetation and regional soil types. In the southern portion of the area, Blackearth soils have developed under grassland vegetation; while in the northern portion, on the upper slopes of the Riding Mountain, Grey Wooded soils have been formed under the influence of mixed woods. Between these two zones, a broad belt occurs where the soils which were originally Blackearths have been modified by the invasion of trees into the grassland area.

The soils in the Rossburn-Virden area are generally fertile. They vary in productivity and adaptability for different crops in accordance with their texture, topography, drainage, and effects of eluviation. Grain production is the principal farm enterprise in the area as a whole, with grain crops constituting more than 90 percent of the crops sown on the farm fields. Wheat is the chief crop in the Blackearth soil zone, but barley outranks wheat in seeded acreage in the Grey-Black and Grey Wooded zones. Substantial amounts of oats also are grown, particularly in the northern portion of the area. The general cropping practice throughout the area is one year of fallow followed by two crops of grain. Appreciable numbers of livestock are found on the majority of farms and in some portions of the area the raising of beef cattle constitutes the major farm enterprise.

This type of farming conducted in the Rossburn-Virden map areas has developed as a result of regional crop adaptation, economic conditions and practical experience. However the general cropping system has predisposed many of the soils to severe loss of fertility through removal of a part or all of the surface horizons by water and wind erosion. This depletion of fertility through erosion has markedly lowered the productivity of the highly susceptible soils, such as those of the Carroll, Souris, Miniota, Rackham, and Onanole associations, and is presently affecting the more resistant soils, such as those of the Newdale, Erickson and Oxbow associations.

The writers submit this report in the hope that it will contribute to a better understanding of the soils and land-use problems in this area, that it will focus attention on the necessity for soil and water conservation, that it will stimulate individual and collective action in combating regional and local soil problems, and that it may be a useful guide in planning future land-use policies.

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MUNICIPALITIES OF THE ROSSBURN AND VIRDEN MAP SHEET AREAS

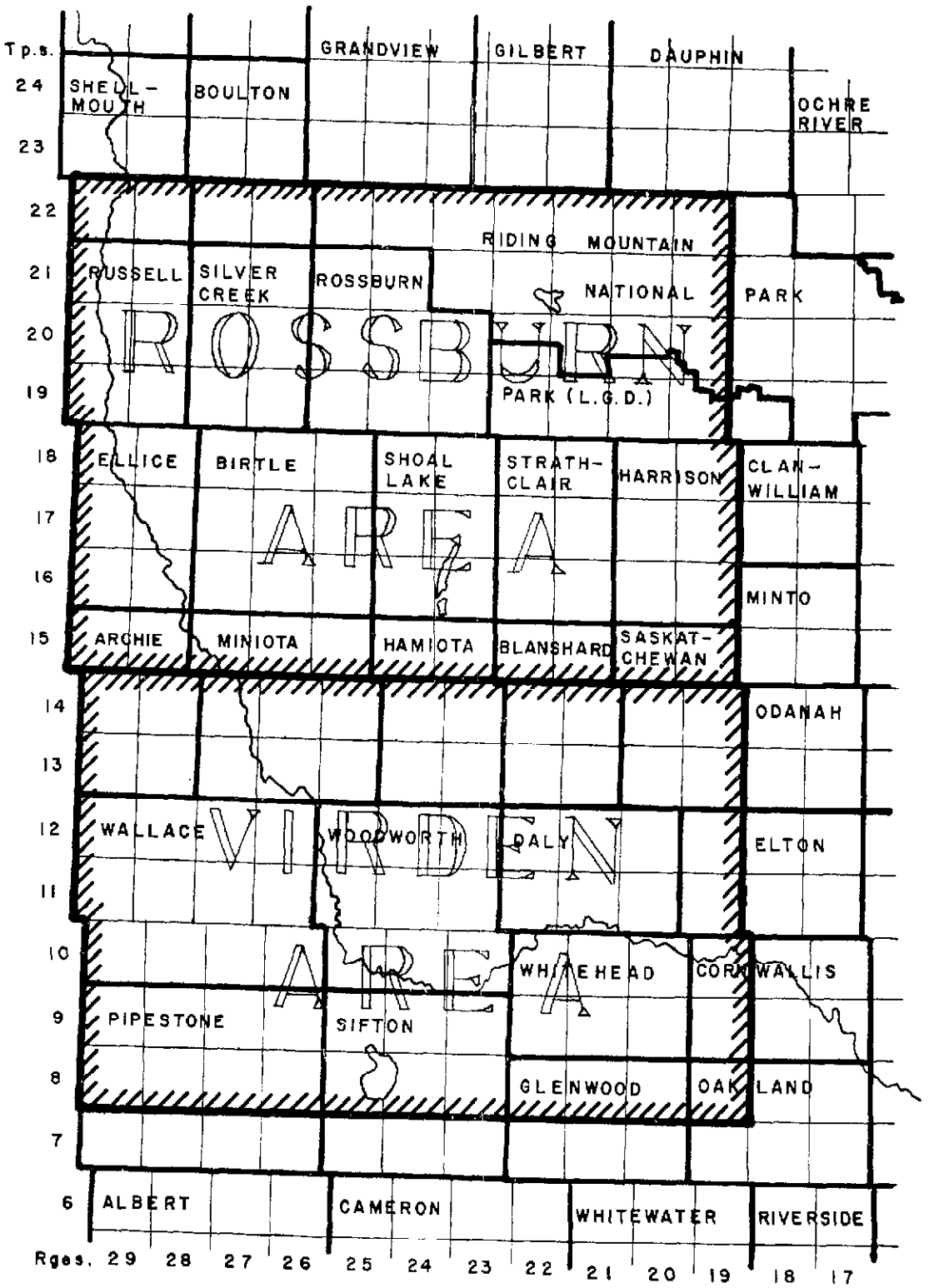


Figure 1

Scale — 16 miles = 1 inch

1. GENERAL DESCRIPTION OF THE AREA

A. LOCATION AND EXTENT

The area covered by this report of the reconnaissance soil survey of the Rossburn-Virden map sheets occupies approximately 3,430,880 acres exclusive of road allowances and the area covered by the Riding Mountain National Park. The map sheets include Townships 8 to 22 in Ranges 19 to 29 West of the Principal meridian, and cover the Municipalities of Rossburn, Silver Creek, Russell, Ellice, Birtle, Shoal Lake, Strathclair, Harrison, Saskatchewan, Blanshard, Hamiota, Miniota, Archie, Wallace, Woodworth, Daly and Whitehead; part of the Municipalities of Shellmouth, Boulton, Elton, Cornwallis, Oakland, Glenwood, Sifton and Pipestone; and portions of the Local Government District of Park and the unorganized territory within the Riding Mountain National Park (Figure 1).

B. RELIEF AND DRAINAGE

The area covered by the Rossburn-Virden map sheets is situated above the Manitoba Escarpment on what is sometimes referred to as the Second Prairie Steppe of the Great Plains Region and locally known as the Western Uplands of Manitoba. The map sheet areas lie entirely within the watershed of the Assiniboine River system. This drainage system extends over an area of approximately 62,000 square miles and drains most of south-eastern Saskatchewan and south-western Manitoba. The Assiniboine River is the largest tributary of the Red River, which it joins at the City of Winnipeg.

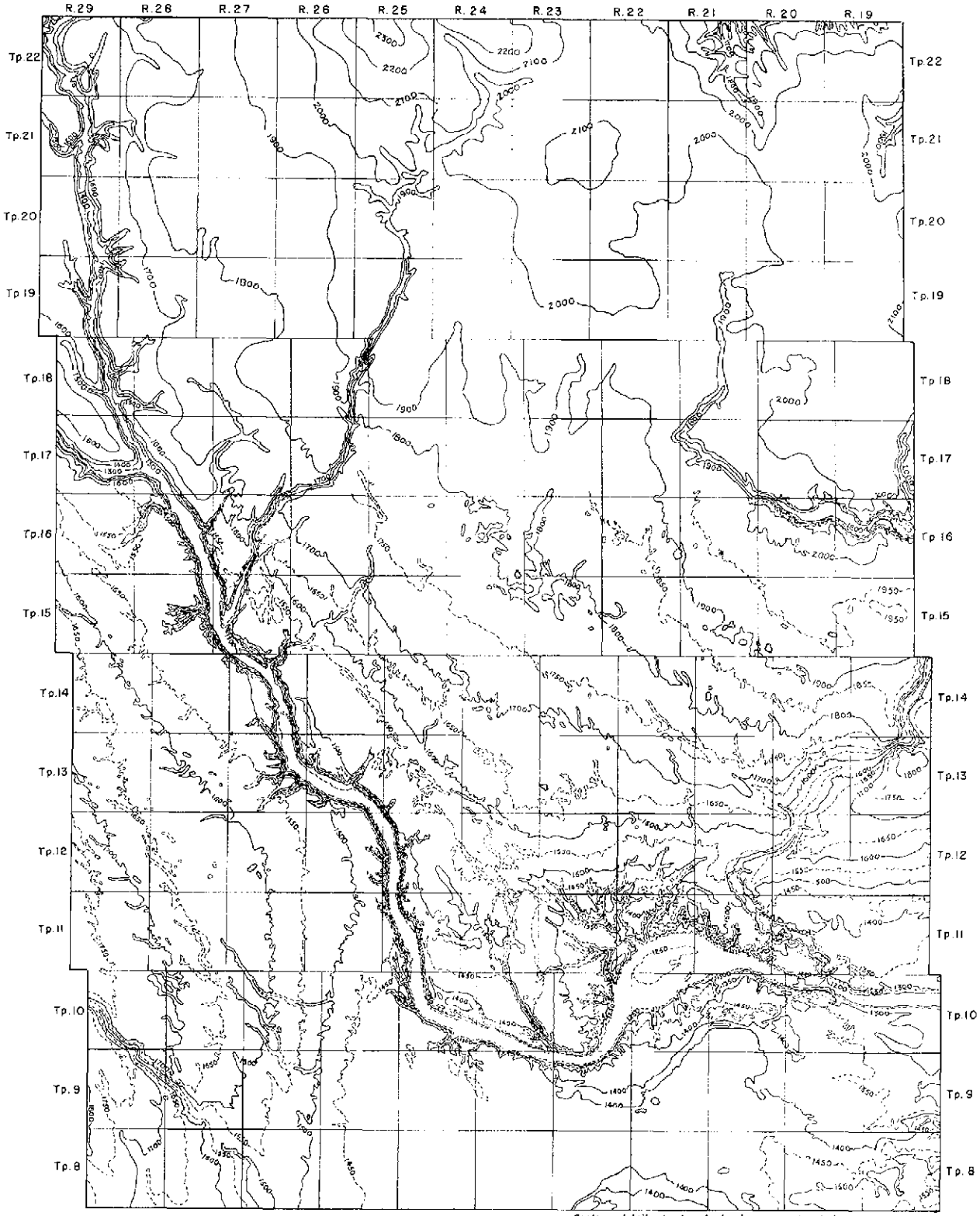
The Assiniboine River system includes the glacial Lake Souris Basin, which in Manitoba has an approximate area of 2,300 square miles. About 1,000 square miles of this glacial lake basin are located in the Rossburn-Virden map area. The lake bed lies below the 1,500 foot contour level in an area that extends westward from Brandon to Virden and southward from Virden to the International border. The Lake Souris Basin is bounded on the north and west by glacial till plains. Westward from this lake basin the terrain rises gradually reaching a maximum of 1,800 feet above sea level at the Saskatchewan border in Townships 8 and 9, Range 29. Northward from the basin an irregular but gradual rise to 2,300 feet (A.S.L.) is culminated on the Riding Mountain in Township 22, Range 25. The lowest elevation in these map areas is just below 1,200 feet (A.S.L.) and occurs in the Assiniboine River valley in Township 10, Range 19. (See Figure 2.)

Drainage of the Lake Souris Basin and the uplands is facilitated by the network of streams contributary to the Assiniboine River. The Assiniboine River enters the map area in Township 22, Range 29, and flows in a south-easterly direction to a point five miles east of Virden in Township 10, Range 25, from whence it flows eastward to leave the map area in Township 10, Range 19. The Assiniboine River flows in a U-shaped, glacial valley with a depth of approximately 200 feet throughout its course within these map areas (Figure 3). It is joined on both sides by a number of smaller rivers and creeks. Chief among these are: from the west, the Qu'Appelle River and Niso, Bosshill and Gopher creeks; and from the north and east, the Arrow, Oak and Minnedosa rivers and Thunder, Conjuring, Silver, Birdtail and Minnewasta creeks. These rivers and creeks, with their tributary streams and drainage channels, provide the surface drainage for most of the area within the map sheets. Pipestone Creek in the south-west corner of the area flows into the swampy land surrounding Oak Lake which is partially drained by Plum Creek, a tributary of the Souris River.

While these numerous watercourses facilitate the flow of water through the area and provide for the escape of excess runoff from the Riding Mountain during spring

CONTOUR MAP OF ROSSBURN-VIRDEN MAP SHEET AREAS

Figure 2



Contour detail showing feet above sea level from sectional maps No. 21, 22, 71, 72, 121, and 122 Topographical Survey of Canada.

FIGURE 3

Assiniboine River valley showing river channel meandering through the alluvial plain on the floor of the U-shaped valley (north-east of Virden).

thaws, most of the surface drainage on the undulating till plains is local in nature. Runoff water from the knolls and ridges accumulates in the intervening depressions to form sloughs and marshes, or collects in larger basins to form intermittent or permanent lakes. The removal of water from these local catchbasins is largely through evaporation and seepage.

Within the basin of glacial Lake Souris, surface drainage is variable. The area of fine textured deposits in the northern part of this basin is generally well drained. Severe erosion during the post-glacial period left much of this portion of the basin with a rolling topography and provided numerous channels by which runoff water finds ready access to the Assiniboine River or its tributaries. However, within the area of sandy deposits to the south, drainage is usually restricted. Except where duning has occurred, these coarser textured deposits have a flat topography and are underlain by finer sediments. A high water table is characteristic of this area and large tracts of land are occupied by swamps and marshes.

C. GEOLOGY OF THE UNDERLYING ROCKS

The area covered by the Rossburn-Virden map sheets is entirely underlain by Cretaceous shales of the Riding Mountain formation. However, due to transportation of powdered rock and rock fragments by the continental ice sheets which completely covered Manitoba in recent geological times, the surface deposits of this area contain material from many of the rock formations which underlie the Riding Mountain shale and which reach the surface to the east and north of the map areas. These formations include other shales of the Cretaceous period; sandstones, shales, and evaporites of the Jurassic period; limestones and dolostones of the Devonian, Silurian, and Ordovician periods; and acidic intrusive rocks of the Pre-Cambrian era. Figure 4 shows the present approximate location of the contacts between these formations with the overlying surface deposits.

D. SURFACE DEPOSITS AND SOIL PARENT MATERIAL

The surface deposits in the Rossburn-Virden area are chiefly of glacial origin and these deposits form the parent material from which the soils have been developed. The nature of the surface deposits has a strong influence on the natural fertility of the soils. In a large measure, the surface deposits also determine the variations in texture relief, and drainage.

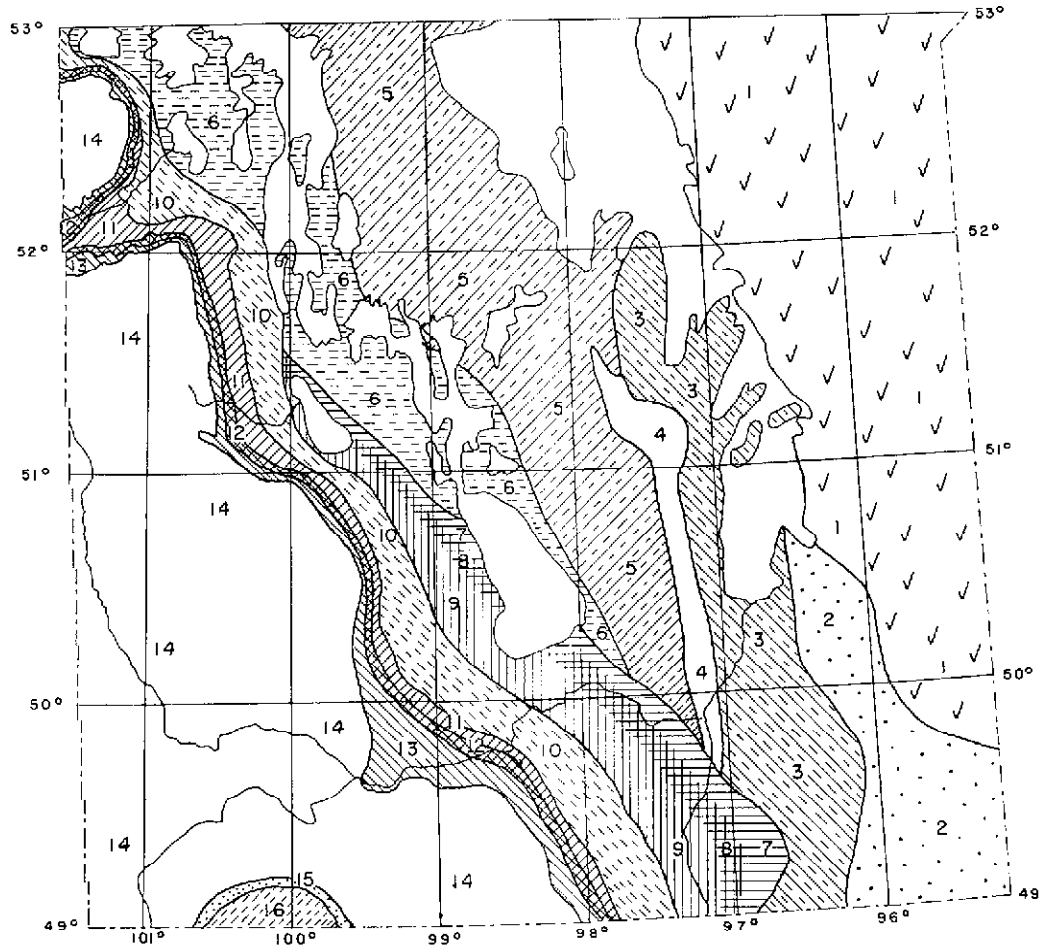
The principal types of surface deposits in the Rossburn-Virden area are described in Table 1 and their distribution is shown in Figure 5.

The nature of the surface deposits listed in Table 1, as they occur in the Rossburn-Virden map sheet areas, is described as follows:

Glacial Till:

In the Rossburn-Virden area glacial till materials occur extensively as surface deposits north and west of the Lake Souris Basin and also as underlying deposits below the lacustrine and alluvial materials of the various basins and depressional areas. Glacial till consists of a heterogenous mixture of boulders, cobbles, gravel, sand, silt and

SURFACE CONTACTS OF ROCK FORMATIONS IN SOUTHERN PORTION OF MANITOBA



KEY TO ROCK FORMATIONS

CENOZOIC

TERTIARY

- 16 — TURTLE MTN. FORMATION: Mottled shales and lignite beds

MESOZOIC

CRETACEOUS OR TERTIARY

- 15 — BOISSEVAIN FORMATION: Sandstone

UPPER CRETACEOUS

- 14 — RIDING MTN. FORMATION: Light grey hard shale and soft greenish shale
- 13 — VERMILION RIVER FORMATION: Acid and calcareous shales, some bentonite
- 12 — FAVEL FORMATION: Grey shale, some limestone and bentonite

LOWER AND UPPER CRETACEOUS

- 11 — ASHVILLE FORMATION: Dark grey shale with lime and sandy beds

LOWER CRETACEOUS AND EARLIER

- 10 — SWAN RIVER GROUP: Sandstone, shale and low grade coal

JURASSIC AND EARLIER

- 9 — SUNDANCE FORMATION: Glauconitic sandstone, shale, limestone and gypsum
- 8 — GYPSUM SPRINGS FORMATION: Red shale and gypsum
- 7 — SPEARFISH FORMATION: Red to brown shales and red argillaceous sandstone

PALAEOZOIC

DEVONIAN

- 6 — UNNAMED DEVONIAN: Limestone and dolostone

SILURIAN

- 5 — INTERLAKE GROUP: Dolostone

ORDOVICIAN

- 4 — STONY MTN. FORMATION: Limestone and dolostone, red shale
- 3 — RED RIVER FORMATION: Limestone and dolostone
- 2 — WINNIPEG FORMATION: Sandstone, minor shale

ARCHEAN OR PROTEROZOIC

- Chiefly acidic intrusive rocks

Figure 4

clay. In the Rossburn-Virden area these materials have formed loam to clay loam soils, with various degrees of stoniness and an irregular topography which varies from gently sloping to hilly.

Ground moraine, which is by far the most extensive till deposit in this map area, is characterized by low knolls and numerous sloughs. The end moraine, on the other hand, is usually rough, normally consisting of a narrow range of hills that were formed at the terminus of the glacier when it melted back as rapidly as it advanced. A classical example of an end moraine in Manitoba is the range of hills of which the Brandon and Tiger hills are a part. In the Rossburn-Virden area several end moraines or remnants of this type of deposit are quite distinct. One of the moraines extends along the southern slopes of the Riding Mountains from Hilltop in Township 17, Range 17, through Erickson, Rackham and northwest to Glen Elmo in Township 20, Range 25. Remnants of other end moraines in this area occur along the eastern side of the Assiniboine Valley trending north and west from the village of Arrow Hills, and as a disrupted chain of low hills extending westward from the Brandon Hills to Souris, north-west to Alexander, across the Assiniboine River to the east side of the Minnedosa River and then north-east to Bethany in Township 15, Range 17.

Another form of glacial till deposit is the elongated hill or drumlin. Some of the more prominent drumlins may be noted southeast of the village of Arrow Hills, west of Foxwarren, and along the southern slope of the Riding Mountain westward from the village of Erickson. In most cases, the drumlins in the Rossburn-Virden area have a shale core on the northern side and thick glacial debris on the southern side.

The soils developed on glacial till deposits vary in agricultural value in accordance with their topography. The best soils are found on the smoother topography, in areas where salinity is not a serious problem, and on rolling topography which is characterized by long, gentle slopes. These soils are generally thicker, more uniform in texture and less susceptible to water erosion than those in the strongly undulating areas and areas in which end moraines and drumlins predominate.

Glacio-Fluvial:

The glacio-fluvial deposits are represented by coarse material sorted from glacial till by rapidly-flowing glacial streams. In the process of sorting, the fast flowing water removed most of the silt and clay and left a residue of sand, gravel, cobbles and boulders. These coarse textured materials were laid down in running water in patterns which are recognized as outwash plains, alluvial terraces, kames, eskers and eroded glacial till.

Outwash plains and alluvial terraces are gravelly areas that have a nearly level topography but are frequently marked by deep enclosed basins (ice-block holes) and often contain some moderately deep ravines. These deposits are common to valley borders of the Shell, Assiniboine, Minnedosa, Qu'Appelle and Birdtail rivers, as well as to the smaller streams entering the Lake Souris Basin from the west and those flowing down the southern slopes of the Riding Mountain.

Kames are deposits of gravel in the form of short hills. Some of the more prominent kames are found on the southern slopes of the Riding Mountain and near the village of Arrow Hills. In general these hillocks of gravel are associated with the rough topography of end moraines. Eskers are long ridges of gravel formed by streams that flowed under the glacial ice. The most prominent example of this type of deposit is the long ridge east of Lenore that runs more or less continuous from the village of Arrow Hills southeastward to the Assiniboine Valley.

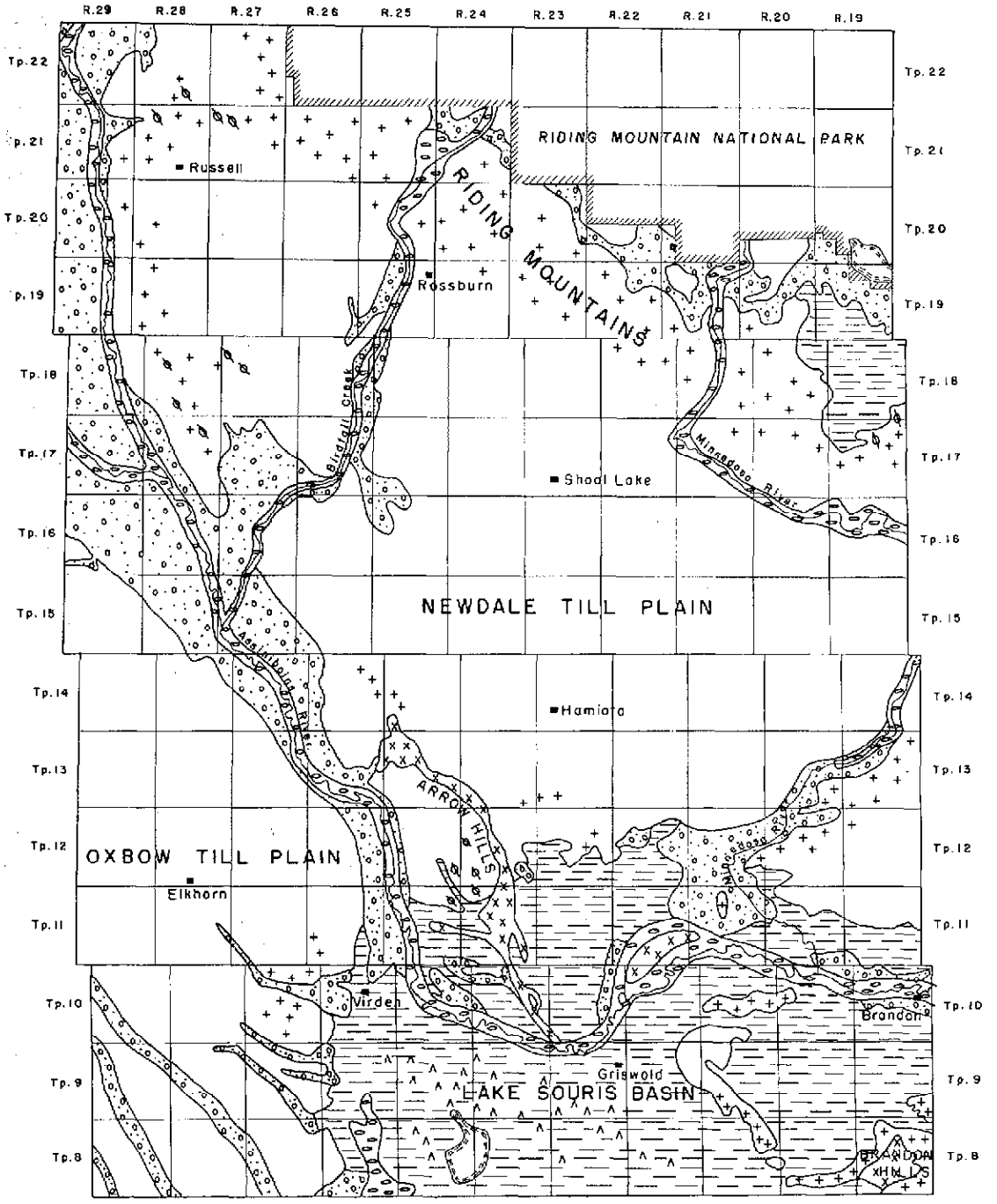
Stream-eroded glacial till deposits are found along the many stream channels in the Rossburn-Virden areas. These deposits are usually coarse materials ranging from sands to boulders and are underlain with unstratified till at depths varying from six inches to two or more feet.

The glacio-fluvial deposits are widely distributed throughout the area and form the parent material of droughty soils of low agricultural value.

TABLE 1: SURFACE DEPOSITS OCCURRING IN THE ROSSBURN-VIRDEN MAP SHEET AREA.

Deposit	Description
1. GLACIAL TILL:	
Ground Moraine	Generally unsorted material. Topography is characterized by a succession of low knolls and depressions. Textures are loam to clay cloam -- contains stones and boulders.
End Moraine	Often modified or resorted. Topography is rough to hilly. Textures range from sandy loam to clay loam -- stonier than ground moraine.
Drumlin	Elongated hill lined in the direction of ice advance, usually unsorted. Textures loam to clay loam. Contains stones and boulders.
2. GLACIO-FLUVIAL:	
Outwash Plain.....	Sandy and gravelly area occurring on a nearly level plain but may be marked by enclosed depressions and by incised ravines. Often cobbly but is usually boulder-free.
Alluvial Terrace	Sandy and gravelly bench along a valley. Topography is gently sloping to the main valley. May contain incised runways and enclosed depressions -- often cobbly but is usually boulder-free.
Kame	Short hill of sand and gravel -- may contain resorted till. Contains some stones and boulders.
Esker	Winding elongated ridge of sand, gravel and cobbles laid down by a rapidly flowing stream under the ice.
Stream-Eroded..... Glacial Till	Eroded till along streams or runways -- usually stony and bouldery. A very cobbly and stony erosion layer occurs either on the surface of the ground or under a thin covering of sandy or gravelly material.
3. LACUSTRINE:	Clays, silts and sands laid down in glacial lakes. Topography is usually very gently sloping, although moderately steep slopes are encountered in some areas. Stones are few to absent except in areas where thin lacustral deposits are underlain with till.
4. AEOLIAN:	
Dune	Fine sand textured material blown up into hillocks or dunes. Stones are absent.
Loess	Silty materials deposited by wind in a blanket over the surface terrain. Stones are absent. None positively identified in Rossburn-Virden areas.
5. RECENT ALLUVIAL:	Post-Glacial deposits of sands, silts and clays along streams, meadows, sloughs and marshes. Also includes mucks and peats. Soils are immature; topography is nearly level to depressional. Stones are rare.

SURFACE DEPOSITS IN THE ROSSBURN AND VIRDEN MAP SHEET AREAS



LEGEND

GLACIAL TILL DEPOSITS

- GROUND MORAINE
- END MORAINE
- DRUMLIN

LACUSTRINE DEPOSITS

- CLAYS, SILTS AND SANDS

GLACIO-FLUVIAL DEPOSITS

- OUTWASH PLAIN
- ESKERS AND KAMES

ALLUVIAL DEPOSITS

- RECENT ALLUVIUM AND ALLUVIAL TERRACE

AEOLIAN DEPOSITS

- SAND DUNES

Figure 5

Lacustrine:

The lacustrine deposits in the Rossburn-Virden areas occupy the beds of Lake Souris and several minor lakes which existed during glacial times. Most of the glacial lake deposits have smooth gently sloping topography although some dissection by runways and streams, and to some extent duning by wind, have caused an unevenness of the terrain in many places. An exception to the normal topography found in glacial lake beds in the Rossburn-Virden areas is the rough terrain around Rackham where a thin mantle of lacustrine material was deposited over morainic glacial till in a short-lived glacial lake.

The textures of lacustrine deposits vary considerably from one locale to another. Extensive areas of sandy materials occur in the Lake Souris Basin westward from the town of Souris to the Oxbow Till Plain, and in the vicinity of Proven Lake southwest of Clear Lake. Silty and clayey sediments are common to the Souris basin and are found around Carroll, Beresford, Harding, Kenton, and other points. Smaller areas of fine textured soils are found on the southern slopes of the Riding Mountains, particularly around Rackham and Proven Lake.

Most of the lacustrine deposits are free of stone, particularly where the water-laid materials are thick. Where more than an occasional boulder is encountered the lacustrine deposit is usually thin and the underlying glacial till is close to the surface. Occasional stones or boulders may have been rafted into the laked areas by ice.

The soils developed on the fine textured lake deposits are usually good agricultural soils because of their favorable water-holding capacity and high fertility. Those formed on the sandy materials are usually less fertile, are lower in water-holding capacity and are more susceptible to wind erosion than the finer textured types.

Aeolian:

Aeolian deposits are derived from glacial alluvial and other lacustrine sediments that have been transported by wind. In the Rossburn-Virden areas, the only recognized materials moved by wind are the sandy deposits occurring as dunes. These dunes are widely distributed in the Lake Souris Basin and in areas east of the map sheets covered by this report. The duned areas contain soils of low agricultural value because of rough topography, droughtiness, low organic matter content, and great susceptibility to wind erosion when brought under cultivation.

Recent Alluvial:

Recent alluvial deposits in the Rossburn-Virden area are post-glacial, flood-plain materials occurring adjacent to streams which periodically overflow their banks. The soils formed on the flood plains vary in development according to the periodicity of floods. Those that are flooded annually are immature (lack profile development) whereas those that are flooded less frequently show progressively greater maturity. In general, the alluvial soils in the Rossburn-Virden areas are fine textured and highly fertile, except in small local sites. Where flooding is not an annual incident, these soils are highly rated from an agricultural standpoint.

E. CLIMATE

Within the area covered by the Rossburn-Virden map sheets there have been a number of meteorological stations in operation for varying periods since 1881. A few of the stations have excellent records for a portion of the period from 1881 to 1952, other stations have reported for a few years only, and still others have only recorded observations made during the summer months. Moreover, many of the annual records are incomplete. Hence, to obtain a continuity of data for the region as a whole, the mean monthly precipitation and temperature figures for all stations were averaged for each year from 1881 to 1952. The data recorded at Minnedosa, which is located 5 miles east of the map sheets in Township 15, Range 18, were included in these calculations because they are the only long-term records available which may be taken as representative of the east-central portion of the area covered by the map sheets.

(1) PRECIPITATION

To obtain a generalized picture of the atmospheric moisture conditions throughout the region as a whole, the mean monthly precipitation in the Rossburn-Virden map areas of Manitoba has been compiled from the monthly means of all stations (including Minnedosa, Birtle, Russell, Strathclair, Shoal Lake, Brandon, Virden, Souris, Hamiota, Rivers, Rapid City, Oak Lake, Hillview, Elkhorn, and Griswold), and the results are given in Table 2. The highest and lowest monthly means also are given to show the highest and lowest departure from each of the average monthly means.

The annual precipitation figures available for the 72 years indicate that the yearly precipitation for the Rossburn-Virden map area averages 17.57 inches. Figures given in Table 2 also indicate that the yearly fluctuations in precipitation range from 10.01 to 25.93 inches. During the period covered by the records there were 22 years in which the precipitation was between 10 and 15 inches, 40 years in which the precipitation was between 16 and 20 inches, and 10 years in which the precipitation was between 21 and 25 inches. Thus, on the basis of past records, it may be expected that throughout the Rossubrn-Virden map area as a whole the precipitation will range between 16 and 20 inches in four years out of seven; between 10 and 15 inches, two years in seven; and between 21 and 25 inches, one year in seven.

The average annual precipitation figures for the various stations (that have records extending over more than two decades) in the Rossburn-Virden map area of Manitoba indicate that the rainfall is highest in the south-eastern portion of the area and decreases slightly to the north and west. The respective mean annual precipitation figures for these stations are as follows: Hillview (25 years), 19.15 inches; Souris (25 years), 18.78 inches; Rapid City (53 years), 17.81 inches; Brandon (62 years), 17.86 inches; Minnedosa (65 years), 17.19 inches; Birtle (36 years), 16.71 inches; Russell (26 years), 16.71 inches. These stations are all located in the prairie and aspen grove regions. The only precipitation records available for the forested region on the Riding Mountain are those that have been compiled during recent years at the various ranger stations in Riding Mountain National Park. These records are limited to the four summer months and cover the period from 1940 to 1953. A comparison of the mean summer precipitation at the South Gate of Riding Mountain National Park with that recorded for the same period at Minnedosa indicates a slightly higher rainfall in the forested region. The respective mean summer precipitation figures for these locations are: South Gate, Riding Mountain National Park (10 years), 12.48 inches; Minnedosa (10 years), 11.43 inches.

For reference purposes and to facilitate the comparison of precipitation with crop yields, the records for the various meteorological stations are expressed as seasonal means in Table 3. This table shows the winter precipitation during November to March; the spring, summer, and fall precipitation during April to October; and the yearly precipitation for the 12 months from November to October. The precipitation during the months when the ground is not frozen has been grouped and expressed as fall precipitation for the months of August to October prior to the season in which the crops are grown, and in addition the precipitation from April to July in each crop year is shown. The total precipitation for the previous August to October, plus that of April to July, is listed also for comparison with the yields of cereal crops.

The figures in Table 3 bring out the fact that the precipitation which falls during April to July in most years is not sufficient to produce high yields of grain, unless supplemented by a moisture reserve from the previous fall and winter. The precipitation during the fall and winter months plus the rainfall during the four grain-growing months of April to July are usually adequate for the production of satisfactory crops, and severe or long continued droughts are of rare occurrence. However, conservation practices which help to maximize the carryover of moisture from the previous fall are essential, particularly on the coarser textured soils of the area.

Table 2: Mean Monthly Precipitation in Rossburn-Virden Map Area of Manitoba, and the Highest and Lowest Monthly Means, Compiled as the Average of All Stations for the Years 1881 to 1952 Inclusive. *

Months	Number of Years Recording	Mean Monthly Precipitation In Inches	Mean Monthly Precipitation Range In Different Years			
			Highest Average Mean		Lowest Average Mean	
January	72	0.82	2.23	(1916)	0.15	(1881)
February	72	0.71	2.70	(1881)	0.05	(1928)
March	72	0.89	2.18	(1935)	0.17	(1915)
April	72	1.11	4.49	(1924)	0.20	(1943)
May	72	1.30	4.49	(1927)	0.08	(1917)
June	72	3.18	6.72	(1947)	0.41	(1912)
July	72	2.58	5.76	(1935)	0.91	(1921)
August	72	2.21	5.78	(1900)	0.56	(1929)
September	72	1.61	5.18	(1900)	0.05	(1948)
October	72	1.10	3.38	(1882)	0.14	(1952)
November	72	0.86	2.46	(1922)	0.06	(1928 & 1939)
December	72	0.70	2.52	(1948)	0.07	(1913 & 1931)
		Yearly Mean 17.57	Highest 12 Months November to October 25.93	(1935)	Lowest 12 Months November to October 10.01	(1889)

* The precipitation and temperature data were obtained from the published records of the Dominion Meteorological Service.

Table 3: Seasonal Precipitation in Rossburn-Virden Map Area of Manitoba in Inches, Expressed as the Seasonal Means for All Stations, Including Minnedosa, Birtle, Russel, Strathclaire, Shoal Lake, Brandon, Virden, Souris, Hamiota, Rivers, Rapid City, Oak Lake, Hillview, Elkhorn and Griswold, for the Years 1881 to 1952 Inclusive.

Crop Year	Previous Winter Precipitation, November to March	Spring, Summer, and Fall April to October	Year November to October	Crop Season		
				Previous Fall August to October	Growing Season April to July	Previous Fall, August to October Plus April to July
1881		23.99			16.07	
1882	5.21	14.33	19.54	7.92	9.14	17.06
1883	4.23	10.58	14.81	5.19	4.15	9.34
1884	3.28	16.12	19.40	6.43	9.16	15.59
1885	2.49	12.96	15.45	6.96	10.47	17.43
1886	2.97	9.51	12.48	2.49	6.62	9.11
1887	2.62	17.26	19.88	2.89	13.25	16.14
1888	4.44	11.70	16.14	4.01	8.60	12.61
1889	2.73	7.44	10.17	3.10	4.56	7.66
1890	4.36	18.96	23.32	2.88	10.19	13.07
1891	4.11	13.15	17.26	8.77	9.40	18.17
1892	3.27	12.33	15.60	3.75	7.32	11.07
1893	5.54	9.76	15.30	5.01	6.30	11.31
1894	5.09	9.90	14.99	3.46	6.83	10.29
1895	2.41	12.12	14.53	3.07	8.89	11.96
1896	4.18	16.67	20.85	3.23	12.82	16.05
1897	7.99	8.14	16.13	3.85	5.00	8.85
1898	5.12	15.65	20.77	3.14	9.02	12.16
1899	3.74	13.59	17.33	6.63	9.47	16.10
1900	3.02	15.56	18.58	4.12	3.71	7.83
1901	4.17	16.63	20.80	11.85	10.94	22.79
1902	4.63	13.87	18.50	5.69	11.42	17.11
1903	3.85	15.78	19.63	2.45	8.46	10.91
1904	7.42	10.69	18.11	7.32	7.13	14.45
1905	3.53	17.01	20.54	3.56	9.75	13.31
1906	3.00	15.78	18.78	7.26	11.92	19.18
1907	6.12	14.03	20.15	3.86	8.88	12.54
1908	2.79	11.63	14.42	5.15	7.60	12.75
1909	3.89	10.71	14.60	4.03	8.54	12.57
1910	4.88	9.16	14.04	2.17	6.18	8.35
1911	5.32	19.59	24.91	2.98	10.80	13.78
1912	2.20	15.46	17.66	8.79	9.98	18.77
1913	3.42	11.96	15.38	5.48	7.26	12.74
1914	3.28	12.25	15.53	4.70	8.28	12.98
1915	1.41	13.21	14.62	3.97	8.41	12.38
1916	6.78	15.62	22.40	4.80	9.85	14.65
1917	5.18	7.34	12.52	5.77	4.39	10.16
1918	2.70	11.52	14.22	2.95	7.10	10.05
1919	4.03	16.41	20.44	4.42	10.97	15.39
1920	4.42	12.51	16.93	5.44	7.05	12.49
1921	3.93	15.70	19.63	5.46	7.70	13.16
1922	3.58	14.19	17.77	8.00	8.05	16.05
1923	7.60	12.53	20.13	6.14	9.55	15.69
1924	3.00	16.51	19.51	2.94	9.03	11.97
1925	4.72	16.09	20.81	7.48	10.54	18.02
1926	1.98	15.12	17.10	5.55	6.10	11.65
1927	5.58	18.82	24.40	9.02	11.68	20.70
1928	3.83	12.42	16.25	7.14	10.16	17.30
1929	2.47	9.57	12.04	2.26	5.60	7.86
1930	4.69	14.13	18.82	3.97	11.13	15.10
1931	2.43	11.01	13.44	3.00	5.97	8.97
1932	3.75	15.14	18.89	5.04	10.17	15.21
1933	4.10	15.34	19.44	4.97	8.37	13.34
1934	4.13	8.74	12.87	6.97	4.97	11.94
1935	5.49	19.46	24.95	3.77	14.00	17.77
1936	4.91	8.16	13.07	5.46	5.21	10.67
1937	2.99	13.96	16.95	2.95	8.73	11.68
1938	5.64	8.94	14.58	5.23	5.64	10.97
1939	4.79	10.82	15.61	3.30	7.12	10.42
1940	2.13	12.57	14.70	3.70	7.07	10.77
1941	3.96	17.52	21.48	5.50	11.52	17.02
1942	4.92	16.53	21.45	6.00	11.03	17.03
1943	4.85	11.50	16.35	5.50	8.40	13.90
1944	2.32	17.07	19.39	3.10	12.07	15.17
1945	3.75	12.68	16.43	5.00	8.67	13.67
1946	4.29	14.03	18.32	4.01	8.53	12.54
1947	4.21	14.29	18.50	5.50	8.97	14.47
1948	4.50	15.54	20.04	5.32	11.25	16.57
1949	4.92	16.27	21.19	4.29	12.40	16.69
1950	3.29	17.99	21.28	3.87	13.65	17.52
1951	3.22	10.36	13.58	4.34	5.40	9.74
1952	1.52	12.49	14.01	4.96	7.07	12.03
Seasons	71	72	71	71	72	71
Means	4.05	13.70	17.75	4.92	8.79	13.60

(2) TEMPERATURE

The available records for temperature commenced with the summer of 1881. The average mean monthly temperatures calculated as the average of all stations include data from Minnedosa, Birtle, Russell, Dropmore, Brandon, Virden, Souris, Hamiota, Rivers, Rapid City, Oak Lake, Hillview, and Elkhorn for the years 1881 to 1952. These figures are given in Table 4.

The figures in Table 4 show that the mean temperatures during the months of April to October inclusive are above freezing. The mean monthly temperatures during the months of November to March are below freezing, and hence this is the period during which it may be expected that the ground will be frozen.

The average mean yearly temperature figures for the various stations (that have records extending over more than two decades) in the Rossburn-Virden map area of Manitoba indicate that the mean temperatures are highest in the south-eastern portion of the area and tend to decrease slightly toward the north-west. The respective average mean yearly temperature figures for these stations are as follows: Souris (30 years), 36.51 degrees; Hillview (33 years), 33.37 degrees; Hamiota (21 years), 34.46 degrees; Brandon (58 years), 34.09 degrees; Minnedosa (64 years), 33.95 degrees; Birtle (35 years), 33.93 degrees; Russell (51 years), 32.40 degrees. There are no available temperature records for the forested region on the Riding Mountain.

For comparison with the precipitation figures, the mean temperatures for the winter months of November to March; for the open months of April to October, and for the 12 months November to October, etc., are given in Table 5.

The figures for the seasonal periods by years given in Table 5 indicate that the open or growing season temperatures approach very closely to their respective average means and show much less fluctuation then the precipitation figures given in Table 3. The temperatures during the winter season, however, fluctuate considerably.

The meteorological date in Tables 2 and 4 may be summarized by stating that although the average precipitation during the open season is slightly lower than in the southern and eastern portions of Manitoba this is offset by somewhat lower summer temperatures and thus greater precipitation efficiency. However, periods of drought do occur and moisture conservation practices are a necessary part of the farming program.

(3) NATURAL INDICATORS OF CLIMATE

The average climatic conditions and the variations from the average prevailing in the Rossburn-Virden map area of Manitoba have been outlined above through the presentation of precipitation and temperature data as recorded at various meteorological stations throughout the area. However, the mathematical representation of local climatic changes was limited because of lack of sufficient data, particularly from the forested region on the Riding Mountain. These local variations in climate may be further substantiated through observation of the native vegetation and morphological characteristics of the regional soils, which are a reflection of the prevailing climatic conditions.

Within the Lake Souris Basin, the adjoining Oxbow Till Plain, and the south-eastern portion of the Newdale Till Plain, Blackearth soils have developed on the well-drained sites under tall prairie grasses and associated herbs. Native trees and shrubs (poplar, willow, etc.) occur but their presence is restricted to areas in which the soil climate has been effected by local ground water conditions. Toward the north-western reaches of the Newdale Till Plain, the soils exhibit an increasing influence of more humid climatic conditions and aspen becomes increasingly prevalent. On the southern slope of the Riding Mountain the prairie and aspen grove vegetation gives way to mixed deciduous and coniferous forest and the soils exhibit Grey-Black and Grey Wooded profile characteristics. This gradual change from grassland to forest vegetation, accompanied by the transition from Blackearth to Grey Wooded soils, is indicative of an increasing moisture

Table 4: Average Mean Monthly Temperatures in Rossburn-Virden Map Area of Manitoba For the Years 1881 to 1952, Expressed as the Mean of All Stations Available.

Month	No. of Years Recording	Mean Average Temperature in Degrees Fahrenheit	Range of Mean Temperatures: Highest Monthly Average Mean in Degrees Fahrenheit		Range of Mean Temperatures: Lowest Monthly Average Mean in Degrees Fahrenheit	
January	71	-2.8	10.7	(1891)	-19.0	(1950)
February	71	1.2	19.1	(1931)	-17.6	(1936)
March	71	15.5	27.2	(1945)	- 0.7	(1899)
April	71	37.0	43.0	(1952)	26.6	(1920)
May	71	50.6	57.4	(1901)	43.2	(1890)
June	71	59.6	66.0	(1933)	54.4	(1902)
July	72	64.8	72.7	(1936)	60.0	(1884)
August	72	61.9	67.6	(1949)	57.2	(1890)
September	72	51.9	59.4	(1897)	45.7	(1903)
October	72	39.6	46.9	(1947)	29.4	(1925)
November	72	20.7	37.9	(1952)	4.0	(1896)
December	72	5.8	21.0	(1939)	- 3.5	(1917)

Table 5: Seasonal Mean Temperatures in Rossburn-Virden Map Area of Manitoba, Expressed as the Average for all Available Stations, Including Minnedosa, Birtle, Russell, Strathclaire, Shoal Lake, Brandon, Virden, Souris, Hamiota, Rivers, Rapid City, Oak Lake, Hillview, Elkhorn, and Griswold, For the Years 1881 to 1952 Inclusive.

Crop Year	Previous Winter November to March	Spring, Summer And Fall April to October	Year November to October	Crop Season	
				Previous Fall	Growing Season April to July
1881	-	-	-	-	-
1882	7.8	51.3	33.3	46.2	50.0
1883	2.6	49.0	29.7	53.4	50.3
1884	1.6	50.7	30.4	47.4	52.9
1885	.2	48.1	28.8	48.5	51.2
1886	6.5	51.8	33.3	46.6	54.9
1887	.9	50.0	29.8	49.3	53.1
1888	1.2	48.7	28.9	46.9	49.3
1889	12.0	51.9	35.3	47.9	53.8
1890	2.7	50.3	30.6	49.4	52.1
1891	11.4	51.2	34.6	48.4	52.0
1892	7.4	51.7	32.9	50.2	50.2
1893	1.8	50.7	29.9	52.3	50.4
1894	3.0	53.9	32.7	49.6	56.1
1895	7.8	51.9	33.6	50.8	54.9
1896	6.9	50.7	32.6	48.0	53.1
1897	3.3	53.8	32.8	48.2	53.7
1898	6.6	50.9	32.4	53.9	52.2
1899	2.2	49.9	29.9	49.2	50.2
1900	10.4	55.3	36.5	49.3	57.1
1901	7.7	53.9	34.4	53.1	54.7
1902	13.6	51.5	35.7	52.1	51.9
1903	7.0	51.1	32.7	50.9	52.2
1904	4.4	50.9	31.5	49.4	51.5
1905	12.4	50.7	34.7	50.1	50.8
1906	13.1	53.8	36.9	50.6	53.9
1907	10.1	48.5	30.4	53.6	46.7
1908	12.8	52.5	35.9	49.1	53.3
1909	9.4	52.5	34.3	51.5	50.9
1910	11.9	53.7	36.3	53.6	55.2
1911	6.1	52.9	33.5	51.8	54.5
1912	4.9	51.8	32.3	51.1	53.7
1913	7.6	52.4	33.8	49.7	54.4
1914	11.9	54.1	36.7	50.1	54.2
1915	12.1	52.4	35.5	54.8	52.8
1916	5.8	50.9	32.2	51.5	51.9
1917	4.8	50.2	31.4	49.7	51.4
1918	9.6	51.1	33.9	48.9	51.9
1919	11.0	53.4	35.6	50.3	56.7
1920	5.0	53.0	32.9	48.3	50.9
1921	12.6	54.2	36.9	55.5	54.9
1922	8.3	54.1	35.1	53.2	54.4
1923	5.2	52.7	36.8	54.1	53.2
1924	14.2	50.5	35.7	51.9	49.8
1925	6.8	51.7	32.8	52.7	53.9
1926	15.3	51.5	36.4	48.0	53.5
1927	7.8	51.8	33.4	48.7	50.9
1928	8.1	50.9	33.1	52.6	51.3
1929	9.7	51.9	34.5	49.9	51.5
1930	8.4	52.6	34.4	53.2	54.2
1931	17.6	54.6	39.1	51.3	54.8
1932	12.0	53.4	36.1	54.5	55.7
1933	7.9	53.6	34.6	50.3	55.5
1934	10.0	53.3	35.3	51.1	55.1
1935	10.7	51.2	34.1	51.0	51.9
1936	.5	53.0	31.1	49.3	54.4
1937	6.6	54.1	34.3	51.1	54.9
1938	9.7	54.4	35.8	52.8	53.2
1939	7.5	53.3	34.2	56.3	54.6
1940	15.3	54.9	38.4	51.4	53.8
1941	10.6	54.2	36.1	56.6	56.3
1942	15.8	52.4	37.3	51.5	52.7
1943	5.7	53.1	33.4	52.4	52.7
1944	13.7	54.2	37.3	53.6	54.8
1945	14.6	50.2	35.1	53.4	48.9
1946	8.9	52.8	34.5	50.9	54.7
1947	8.8	52.7	34.4	50.0	51.4
1948	7.2	53.5	34.3	54.0	52.3
1949	7.2	54.1	34.4	55.6	54.8
1950	5.6	50.7	31.9	52.7	49.6
1951	5.5	51.7	32.1	52.0	52.4
1952	8.5	55.3	35.5	48.8	56.2
Seasons	71	71	71	71	71
Means	8.2	52.2	33.8	51.1	53.0

efficiency either through higher precipitation or lower temperatures.

F. NATIVE VEGETATION

The area covered by the Rossburn-Virden map sheets lies almost entirely within the Boreal forest region, as delineated by W.E.D. Halliday.* However, the portion of the area lying to the south of the Riding Mountain, and designated by Halliday as belonging to the aspen-oak section, is considered by J.H. Ellis to be an area of woodland invasion of prairie and therefore should be classified with the grassland region.**

On the slopes of the Riding Mountain, approximately above the 1,900 foot contour, the native vegetation consists predominantly of mixed woods. Small, scattered areas of prairie vegetation do occur but these are limited to areas of coarse textured outwash deposits. Halliday included this general area with the mixed-wood section of the Boreal forest region and, as the name implies, the characteristic vegetation is a mixture, in varying proportions, of aspen, balm of Gilead, white spruce, and paper birch. Large areas of well-developed aspen and balm of Gilead associations occur, particularly towards the contact with the aspen-oak section. The lower positions and upper water-catchment areas develop black spruce and tamarack sphagnum bogs. There is also a minor occurrence of white elm, green and 'prairie' ash, Manitoba maple, and bur oak.

In the remainder of the map sheet area the vegetation varies somewhat with the parent material of the soils and the topography, particularly as they influence the local soil climate. On the boulder till and lacustrine plains the vegetation is now of a transitional nature. Although there are indications that originally the prevailing vegetation was tall prairie grasses, woodland invasion during relatively recent times has produced a park-like aspect to the area. Aspen is the dominant forest species and occurs in groves around the depressions or locally humid positions. These aspen groves increase in size towards the contact with the mixed-wood section as the trees encroach farther up the slopes. Well-developed stands of aspen and black poplar also occur in this section on the locally humid sites provided by the northern and eastern exposures of the hills and river channels. This situation of woods on the north and east facing slopes and grassland on the southern and western exposures occurs in the Arrow and Tiger hills, in the sand dune areas, and in the larger river valleys. On locally arid sites, such as on the steep banks of ravines or where the soils are thin and lie over either shale rock or gravel, scattered bur oak is frequently found along with scrubby aspen. In the most humid positions, where non-saline Meadow soils occur, some willow and black poplar have become established.

For more detailed information on the occurrence and distribution of plant species in the Rossburn-Virden map areas reference is here made to the individual soil association descriptions and to the list of common plant species identified in the area by Professor C.W. Lowe and supplied as Appendix I.

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* W. E. D. Halliday, "A Forest Classification for Canada", Forest Series, Bulletin No. 89, Ottawa, 1937.

** J. H. Ellis, "The Soils of Manitoba", Project 14, Economic Survey Board, 1938.

2. SOILS

A. SOIL CLASSIFICATION

Before presenting detailed descriptions of the individual soils that occur in the Rossburn-Virden map sheet areas, the following explanatory notes are presented to develop a common understanding of soils and of the field system classification that has been developed and used by the Manitoba Soil Survey.

(1) THE SOIL PROFILE

A cross section through the surface deposits affected by the soil-forming processes exposes what is known as the "soil profile". In agricultural practice it is often customary to refer to different depth levels in the soil as "surface soil" and subsoil", but because the respective soil horizons which make up the soil profile have definite significance and differ in depth with different soils, it is more fitting to use the specific pedological terms "A" horizon, "B" horizon, and "C" horizon.

The upper or "A" horizon is the horizon of maximum weathering, and of the maximum removal of the products of weathering by downward movement of the water which enters the soil from above. In a grassland soil the "A" or surface horizon also contains the maximum accumulation of organic deposition. The "B" or subsurface horizon (where it exists) lies below the "A" horizon; it is often finer in texture and more compact as a result of the downward movement of clay and other fine (colloidal) materials from the "A" horizon. Underlying the "B" horizon is the "C_1" horizon which may be only slightly altered by the soil-forming processes. This grades into the unaltered geological deposits that lie below the soil profile. The geological deposits on which the soil is developed are known as soil parent material. If organic matter occurs on the surface of the soil in the form of leaf mat or forest litter it is designated as the "A_0" layer. When soils have an accumulation horizon of lime carbonate such an accumulation horizon is designated by the symbol "Ca". Poorly drained soils, in which ground water stands in the soil profile, have a condition designated as "Gley" (i.e.; a layer in which intermittent water logging causes partial oxidation and reduction of iron) that can be recognized by bluish grey, olive grey or mottled colors, and the presence of iron concretions or bog iron.

The various soil horizons that make up the soil profile may differ in thickness, in color, in texture or size of particles, in structure or arrangement of particles into aggregates, in consistence, in porosity, in mechanical intrusions and chemical concretions, and in reaction or alkalinity and acidity. The expression of these characteristics in the respective soil horizons reflects the soil-forming processes.*

(2) FACTORS AFFECTING SOIL TYPE

The factors that control the soil-forming processes and determine the soil type are (1) the climate, or the temperature and moisture within the soil; (2) the vegetation, which in part affects the soil climate during growth and is the primary source of the organic matter; (3) the parent material, or the geological deposits which contribute the soil minerals; (4) the position in which the soil is found in relation to topography; (5) the internal drainage, or the presence or absence of ground water within the soil; (6) the age,

* The main soil horizons may be subdivided for more detailed and accurate descriptions, in which case they may be designated as A_1, A_2, A_3; B_1, B_2, B_3; C_1, etc.

or length of time during which the soil has been under the influence of the soil-forming processes; and (7) in the case of cultivated soils, the modifying effects of culture or the work of man.

The most important factor in soil formation is the soil climate, or the temperature and moisture within the soil. In virgin soils the climate determines the native vegetation which is produced, and the native vegetation in turn determines the type of organic matter that is deposited within or on the soil. Soil climate also determines the activity of micro-organisms, the rate of the production and decomposition of organic matter, the rate and extent of mineral weathering, and the extent to which the products of weathering are accumulated in or are removed from the soil.

Because of the differences in topographical position and drainage, the soil climate may vary considerably within relatively short distances in the same field. For example, the soils occurring on knolls or strongly sloping positions are "locally arid" (or drier and warmer than the normal soils) due to the fact that a large portion of the precipitation may run off. Soils in the depressions which receive the runoff waters in addition to the precipitation are "locally humid" (or wetter and cooler than the regional well-drained soils). The topographical position occupied by the soil, and the external and internal drainage within the soil, thus affect the soil climate, hence the soil climate should not be confused with the atmospheric climate. Soil climate is the chief factor affecting soil formation, and in the final analysis each individual soil is the result of the interaction of soil climate, vegetation (or organic life) and parent material (or mineralogical deposits).

All soils in the normal well-drained position in a given region will have a regional soil climate (except insofar as it may be modified by the kind and texture of the parent material and the vegetative cover); all normal or regional soils with the same regional climate will be subject to the same soil-forming processes and will tend to have similar age or degree of development. On the other hand, variation in soil climate results in soil variation. The differences in soil climate brought about by difference in topographical position, drainage, etc., result in the development of local soils that differ from the regional soils with which they are associated.

It must be observed, therefore, that as the soil climate is modified by topographical position, a number of different soils may be found in association with each other on a given parent material or geological surface deposit. For example, on boulder till in the Blackearth soil zone, the prevailing normal or well-drained soil will be of the Blackearth type, but the soil on the knolls will be a shallow phase Blackearth. In the depressions, either black Meadow soils or leached grey Meadow soils (Meadow Podzols) may be found surrounded by a fringe of Saline and Alkalinized soils, or by degrading Blackearths. Each of these soil types will show different profile characteristics when examined in cross section.

Soil-forming processes similar to those responsible for the development of these respective soil types will be in operation on the other geological surface deposits found in the same region, but the comparable soil types may show certain differences which are due to the texture and mineralogical composition of the parent material on which they are developed, as well as differences in degree of expression. For example, an examination of a Blackearth soil developed on calcareous boulder till, compared with a Blackearth soil developed on sandy textured lacustrine sediments, reveals varietal differences which are due to the material on which each is formed. The varietal differences exhibited in the respective comparable soil types are the result either of physical differences due to texture, or of chemical differences due to the mineralogical composition, lime reserve, etc.

(3) SOIL MAPPING

The foregoing explanatory notes emphasize the fact that soils (as they occur

TABLE 6: KEY TO FIELD CLASSIFICATION OF THE SOILS IN THE ROSSBURN-VIRDEN MAP AREA IN MANITOBA.

A_1 Areas in which the well-drained (or normal) soils are characterized by a relatively deep "A" (or surface) horizon, very dark grey in color, granular in structure, high in organic matter, friable, and generally neutral to only slightly alkaline in reaction; fading gradually into a relatively thin "B" (subsurface) horizon that is greyish brown in color, somewhat more compact than the "A" horizon, tending to break into coarsely columnar clods or irregular aggregates when dry, and grading into a crumbly line carbonate accumulation ($CaCO_3$) horizon at depths which vary with the different materials on which the soils were formed	BLACKEARTH SOIL ZONE

Soil Associations And Phases	Soil Associates or Local Soil Types Occurring in Association (Dominant Soils in Capitals)				
	Well-Drained Members	Excessively Drained Members	Intermediately Drained Members *	Poorly Drained Members**	Halomorphic Members ***
Soils Developed on Glacial Till:					
B_1 Moderately calcareous till --					
OXBOW ASSOCIATION: Oxbow loam to clay loam) Oxbow loam to clay loam (smooth phase))	BLACKEARTH	Thin Blackearth	Blackearth-Meadow Calcic Blackearth-Meadow Degrading Blackearth-Meadow	Calcic Meadow Meadow Podzol	Solonchak Solonetz Solodized-Solonetz Solod
Oxbow loams (modified phase)	BLACKEARTH-LIKE	..	Calcic Blackearth-Meadow	Calcic Meadow Meadow Podzol	Solonchak Solonetz Solodized Solonetz
B_2 Shaly and mixed till and stratified drift --					
ARROW HILLS - LENORE COMBINATION: Lenore loam to clay loam	BLACKEARTH	..	Blackearth-Meadow Calcic Blackearth-Meadow	Meadow Calcic Meadow	Solonchak Solonetz Solodized-Solonetz Solod
Arrow Hills sandy loam	Blackearth	THIN BLACKEARTH	Blackearth-Meadow	Meadow	..
B_3 Thin mantle of shaly till over shale bedrock --					
EASTBANK ASSOCIATION	BLACKEARTH-LIKE	..	Blackearth-Meadow	Meadow	Solonchak Solonetz Solodized-Solonetz Solod
B_4 Thin mantle of lacustrine sediments over till --					
BERESFORD ASSOCIATION	BLACKEARTH	..	Blackearth-Meadow Calcic Blackearth-Meadow	Calcic Meadow Meadow Podzol	Solonchak
Soils Developed on Lacustrine and Outwash Deposits:					
B_5 Fine textured lacustrine deposits --					
HARDING ASSOCIATION: Harding clay to silty clay Harding clay to silty clay (Till substrate phase)	Blackearth-like	..	BLACKEARTH-MEADOW	Meadow Meadow Podzol	Solonchak Solonetz Solodized-Solonetz

B_6 Medium textured lacustrine deposits --					
CARROLL ASSOCIATION:					
Carroll clay loams	BLACKEARTH	..	Blackearth-Meadow Calcic Blackearth-Meadow	Meadow Calcic Meadow	Solonchak Solonetz Solodized-Solonetz
Carroll loams	BLACKEARTH	Thin Blackearth	Blackearth-Meadow Calcic Blackearth-Meadow	Calcic Meadow Meadow Podzol	Solonchak Solonetz Solodized-Solonetz
Carroll clay loams (Till substrate phase).....	BLACKEARTH	..	Calcic Blackearth-Meadow	Calcic Meadow	Solonchak Solonetz Solodized-Solonetz
B_7 Fine sandy textured lacustrine deposits with moist substrata --					
SOURIS ASSOCIATION:					
Souris fine sandy loam.....	Blackearth-like	..	BLACKEARTH-MEADOW	Calcic Meadow	Solonchak
Souris loamy fine sand.....	Blackearth-like	..	BLACKEARTH-MEADOW	Calcic Meadow	..
B_8 Sandy deposits over coarse sandy and gravelly substrata --					
MINIOTA ASSOCIATION:					
Miniota sandy loam) Miniota sandy loam (shaly phase))	BLACKEARTH	..	Blackearth-Meadow	Meadow Meadow Podzol	..
B_9 Gravelly outwash deposits --					
MARRINGHURST ASSOCIATION	BLACKEARTH	Thin Blackearth	Blackearth-Meadow	Meadow	..
Soils Developed on Alluvial Deposits:					
B_{10} Recent flood-plain and alluvial clay deposits --					
PIPESTONE ASSOCIATION	BLACKEARTH-LIKE	..	Blackearth-Meadow	Meadow	Solonchak Solonetz

Cont'd.

* The intermediately drained soils do not carry specific genetic soil names but are designated as intergrades between the associated well-drained and poorly drained members.

** Gleysolic soils.

*** The halomorphic group includes soils whose properties have been determined by the presence of salts. In this group the Solonchak is a saline soil without structure; Solonetz is a soil from which the soluble salts have been leached and is characterized by a prismatic structure; Solodized-Solonetz is a degrading Solonetz soil with white-capped columns and, the Solod is a regrading soil in which a dark colored "A" has formed in the "A_2" of the Solodized-Solonetz.

TABLE 6: CONT'D. KEY TO FIELD CLASSIFICATION OF THE SOILS IN THE ROSSBURN-VIRDEN MAP AREA IN MANITOBA.

A_2	Areas in which the well-drained soils are characterized by a very dark grey "A" horizon and a brown "B" horizon of approximately equal thickness; or where some of the well-drained soils show degrading profile characteristics and some are of the Blackearth type	SLIGHTLY DEGRADING BLACKEARTH SUB-ZONE

Soil Associations And Phases	Soil Associates or Local Soil Types Occurring in Association (Dominant Soils in Capitals)				
	Well-Drained Members	Excessively Drained Members	Intermediately Drained Members	Poorly Drained Members	Halomorphic Members
B_1 Soils developed on highly calcareous glacial till --					
TIGER HILLS - HILTON COMBINATION					
Tiger Hills Association	DEGRADING BLACKEARTH	..	Degrading Blackearth-Meadow	Calcic Meadow Meadow Podzol	Solonchak
Hilton Association	BLACKEARTH	Thin Blackearth	Calcic Blackearth-Meadow	Calcic Meadow	Solonchak Solonetz
B_2 Soils developed on moderately calcareous glacial till --					
NEWDALE ASSOCIATION:					
Newdale (Undulating phase) Newdale (Rolling phase) Newdale (Smooth phase)	BLACKEARTH Degrading Blackearth	Thin Blackearth	Blackearth-Meadow Calcic Blackearth-Meadow Degrading Blackearth-Meadow	Calcic Meadow Peaty Meadow Meadow Podzol	Solonchak Solonetz Solodized-Solonetz
Newdale (Modified phase)	BLACKEARTH-LIKE	..	Calcic Blackearth-Meadow Degrading Blackearth-Meadow	Calcic Meadow Peaty Meadow Meadow Podzol	Solonchak Solonetz Solodized-Solonetz

A_3	Areas in which the well-drained or regional soils were originally of the Blackearth type but have been subsequently modified by woodland invasion. The "A" horizon of the modified soils shows varying stages of transition from black to grey-black or grey (often a grey and black mottling), and is neutral to slightly alkaline in reaction. The "B" horizon tends to be blocky in structure and the aggregates more or less coated with humus that has leached from the "A" horizon. The lime carbonate below the "B" horizon is concretionary and usually well defined, but it occurs at somewhat greater depth than in the corresponding Blackearths	GREY-BLACK TRANSITIONAL ZONE

B_1 Soils developed on moderately calcareous glacial till --					
ERICKSON ASSOCIATION	GREY-BLACK	..	Degrading Blackearth-Meadow Moist Grey Wooded	Peaty Meadow Meadow Calcic Meadow	..
B_2 Soils developed on medium textured lacustrine deposits --					
ONANOLE ASSOCIATION:					
Onanole clay loams	GREY-BLACK	..	Degrading Blackearth-Meadow Moist Grey Wooded	Peaty Meadow Meadow Podzol	..
Onanole fine sandy loams	Grey-Black	..	DEGRADING BLACKEARTH-MEADOW	Peaty Meadow Meadow Podzol	..
B_3 Soils developed on shaly gravel outwash deposits --					
SEECH ASSOCIATION:					
Seech coarse sandy loam	..	BLACKEARTH	Blackearth-Meadow	Peaty Meadow	..
Seech sandy loam (Deep phase)	GREY-BLACK	..	Degrading Blackearth-Meadow	Peaty Meadow	..

A_4	Areas in which the well-drained or regional soils have developed under forest vegetation and are characterized by a grey "A_2" horizon, slightly acid in reaction and platy in structure, and a brown to greyish brown nutty structured "B" horizon, grading into a lime carbonate accumulation horizon					..GREY WOODED ZONE
B_1	Soils developed on moderately calcareous glacial till --					
	WAITVILLE ASSOCIATION:					
	Waitville clay loam	GREY WOODED	..	Moist Grey Wooded	Peaty Meadow	..
	Waitville loam to clay loam (Modified phase)	Grey Wooded	..	MOIST GREY WOODED	Peaty Meadow	..
B_2	Soils developed on medium textured lacustrine deposits --					
	RACKHAM ASSOCIATION:					
	Rackham clay loams	GREY WOODED	..	Moist Grey Wooded	Peaty Meadow	..
	Rackham fine sandy loams	GREY WOODED	..	Moist Grey Wooded	Peaty Meadow Meadow Podzol	..
B_3	Soils developed on shaly gravel outwash deposits --					
	ZAPOROZA ASSOCIATION	Grey Wooded	DEGRADING BLACKEARTH	Humid Grey-Black	Peaty Meadow	..

A_5	Sub-Areas of local soils which occur in the Rossburn-Virden map sheet areas that have been determined primarily either by the character of the parent material or by immaturity. (Variable soils on river terraces, benchlands and eroded slopes; juvenile soils on recent alluvium; solodic soils on shale outcrops; sandy regosolic soils; and organic soils	.. LOCAL SOIL AREAS
B_1	Variable soils on recent alluvial deposits in the Assiniboine and confluent valleys	Assiniboine Complex
B_2	Immature soils with dark colored surface horizons on sandy overwash deposits in the upper Minnedosa Valley	Horod fine sandy loam
B_3	Immature soils with weak profile development on shallow clay deposits in small isolated pockets on the south-west slope of the Riding Mountain	Proven Lake clay
B_4	Solodized clay textured soils on outcrops of dark grey shale in the Assiniboine Valley	Benton clay
B_5	Variable soils on river terraces and benchlands	Benchlands Complex
B_6	Eroded slopes and channels with feeble soil development. (Includes both deep channels cut through boulder till into shale and the relatively shallow ravines with some soil development	Eroded Slopes Complex
B_7	Organic soils of varying depth and type	Peat
B_8	Sandy regosolic soils	Duned sand

in the field) must be considered as a complex intermixture of types and variations which present serious difficulties in the preparation of a soil map. Soil maps may be either of the detailed or of the reconnaissance type. The difference between these two types of maps is in the map scale and the degree of detail shown. The ideal soil map would be a detailed map on a large scale which shows the occurrence and distribution of every soil found on every farm. On such a soil map, each soil type would be shown as a separate unit, but even on a detailed map it is impractical to show all the minor variations that can be observed in the field.

In a reconnaissance soil survey, the area involved and the scale of the map used is such that it is impossible to show each individual soil as a unit. In the reconnaissance soil maps of the Rossburn-Virden area, each unit shown, in most cases, may be considered as a complex of types known as a soil association, having a dominant soil type interspersed with local soil types of minor importance. However, while the soil associations are generally shown as units on the reconnaissance soil map, local associated soils and textural phases are occasionally mapped or designated as separate units where the areas involved are sufficiently large or where such units are of sufficient local importance.

In conducting this type of survey in the Rossburn-Virden area, a traverse was made along each road allowance, thus giving lines of traverse one mile apart and permitting the observation of at least two sides of each quarter section. Foot traverses inside of the sections (which are essential in a detailed soil survey) where rarely made unless some important detail was required which could not be obtained from the ordinary lines of traverse. Along the lines of traverse the soils were examined at from one-quarter to one-half mile intervals, or more frequently if closer inspection was indicated. At each point of inspection the soil profile (or cross section through the soil) was exposed by digging with a spade, so that the soil could be properly examined. The soil was then named and noted on the field map. Whenever a boundary or a change of soil could be detected along the line of traverse it was plotted on the map as observed. If the course of the soil boundaries inside the respective sections could be seen from the lines of traverse they were mapped accordingly. Otherwise the boundaries entering the various sections were joined arbitrarily, similar to the practice followed in contour mapping. Within the confines of of the Riding Mountain National Park the soil survey was limited to traverses along the park roads and trails.

(4) FIELD CLASSIFICATION

In the Manitoba soil survey the associated genetic soil types that are developed on similar materials (or geological deposits) in the same zone are designated as a "soil association" and the individual associated soils (which are recognized by their soil profile characteristics) are referred to as "soil associates".* The soil associations or associates may be subdivided into phases and textural classes if such a subdivision is required. The individual soil types or associates occurring in a given area are thus grouped into soil associations, and the common regional soil characteristics, that are expressed in the typical or well-drained soils of all the various associations (as a result of a common regional climate), provide the criteria for designating the soil zone to which they belong.

Thus, the various soil associations are made up of soil associates with different profile characteristics. These associates can be classed as genetic soil types that have developed under different drainage or moisture conditions (namely; variation in local soil climate). A practical field classification of the soils occurring in the Rossburn and

* The terms association and associate as used in this report are comparable to catenary association and series as defined in the Soil Survey Manual, United States Department of Agriculture (1951).

identification of the prevailing or dominant soils shown as units on the soil maps, and also indicates the soils of minor importance found intermixed with the typical or dominant soils.

B. SOIL DESCRIPTIONS

The following descriptions of the individual soil associations and soil associates have been arranged according to the zone or subzone in which they occur. The dominant soil of each association is not necessarily typical of the zone or subzone under which it is listed, due to local influences of parent material and drainage, but the grouping facilitates continuity of presentation and ease of comparison of soils with similar genetic profile features. The profile characteristics which typify each zonal division are outlined at the beginning of each section and the deviation from these exemplary features is noted in the individual association descriptions. Four distinct soil zones or subzones have been recognized in the Rossburn-Virden map sheet areas. These are: the Blackearth zone; the Slightly Degrading Blackearth subzone; the Grey-Black subzone; and the Grey Wooded Zone. The azonal and intrazonal soils, which do not exhibit any pronounced effect of the regional climate and vegetation and occur indiscriminately in any soil zone, are grouped as Local Soil Areas.

Soils of the Blackearth Zone

The Blackearth soil zone in Western Canada exists as a broad belt of black or very dark grey soils in which the well-drained members have been developed under a luxuriant growth of mixed prairie grasses in a region of sub-humid climate. This zone differs vegetatively from the drier prairie region in the species and density of growth of the grassland cover and in the occurrence of trees on the local humid sites. Trees, which have invaded the grassland area and occur along stream channels and surrounding local depressions, impart a park-like appearance to much of the Blackearth zone and clearly distinguish it from the treeless plains to the west and south of Manitoba which constitute the Dark Brown and Brown soil zones. The typical well-drained Blackearth soil is characterized by a thick black or very dark grey "A" horizon which grades through a dark greyish brown transitional "B" horizon into a lime carbonate accumulation subhorizon which occurs usually at depths ranging from 12 to 18 inches. The surface horizon is high in organic matter content and has a well-developed granular structure. It is neutral to slightly alkaline in reaction. These soils are generally very fertile in their native state and are used largely for grain production.

The Blackearth soil zone occupies the southern and western portions of the Rossburn-Virden map sheet areas and includes the basinal areas of glacial Lake Souris and the Brandon glacial lakes, and the Oxbow Till Plain which lies to the west of these lake basins. It is bounded on the north by the slightly degrading Blackearth soils on the Newdale Till Plain. The soils which occur in the Blackearth zone are the Oxbow, Harding, Carroll, Souris, Miniota, Marringhurst, Beresford, Pipestone and Eastbank associations and the Arrow Hills-Lenore combination.

OXBOW ASSOCIATION:

The Oxbow association consists of loam to clay loam soils developed on light brownish grey, moderately calcareous boulder till. The well-drained member of this association is a Blackearth soil and has developed under tall prairie-grass vegetation. The parent material of the Oxbow soils, which was derived from glacial transported shale, limestone and granitic rock fragments, was variably saline throughout its extent with the soluble

salt content reaching high concentrations in some areas. The effect of these salts and their downward movement in the better drained sites has been an important factor in the genesis of the Oxbow soils.

The soils of the Oxbow association occur on the upland plain to the west of the Assiniboine River and the Lake Souris Basin. In the northern portion of the area the broad valley of the Assiniboine River was used as a natural boundary to separate these soils from the soils of the Newdale association which, although developed on similar parent material, exhibit different genetic profile characteristics due to a slight difference in the soil climate. The Oxbow soils cover approximately 554,880 acres, which represents 16.2 percent of the total acreage within the Rossburn-Virden map areas.

The topography is generally undulating (irregular gently sloping). The slopes are usually short and terminate in shallow undrained depressions or eroded intermittent stream channels (Figure 6). However, in an area adjoining the Lake Souris Basin, to the west and north of Virden, this irregular land surface gives way to a smoother topography which seems to have resulted from the area being affected by shallow waters of glacial Lake Souris. Over the entire area covered by this association soil drainage is subject to much local variation and large, continuous areas of well-drained soils do not occur. In the northern portion of the area some extensive tracts of salinized Meadow soils are encountered.

FIGURE 6

Landscape view of an area of Oxbow loams showing undulating topography, aspen groves and eroded knolls.

The native vegetation on the Oxbow soils varies considerably on the different soil members of the association. The well-drained soils, which occur on the upper portion of the slopes, have developed under tall prairie grasses and associated herbs; while on the knoll positions, where the soils are excessively well drained, dry-land species predominate. In the depressions the vegetation also varies with the nature of the soil. Where the Meadow soils are not strongly salinized, a fringe of poplar and willow invariably occurs around their outer margin. However, in local depressions and in some extensive low areas in the northern portion of the association, where the soils are strongly carbonated, salinized or alkalinized, alkali-tolerant vegetation prevails. Thus the area presents various aspects of vegetational cover which combine to impart a park-like appearance to the general terrain.

Variable surface stoniness occurs throughout the entire area of Oxbow soils. However this stoniness does not constitute a serious problem to cultivation except in areas where severe glacial erosion of glacial till resulted in a concentration of stones and boulders at the surface. This condition is found along many of the stream channels which meander through the area and in a broad belt of Oxbow, modified phase soils adjacent to the Assiniboine Valley.

In addition to the associated members which comprise the normal Oxbow soils, two phases have been separated and will be described as: the smooth phase, and the modified phase.

(i) Oxbow Loam to Clay Loam:

The associated soils in the Oxbow loam to clay loam may be regarded as the representative Oxbow soils. They occupy approximately 437,274 acres, or nearly 79 percent of the total area covered by the Oxbow association. The topography consists of low knolls and ridges separated by shallow depressions which are interspersed in an irregular pattern characteristic of ground moraine. The short slopes generally range from 2 to 5 percent with sharper relief occurring along eroded runways. Surface runoff is excessive on the knolls and poor to absent in the depressions, so that soil drainage may vary considerably in short distances. The well-drained soils which occur on the slopes may be described as follows:

FIGURE 7

Soil profile of Oxbow loams. A Blackearth soil developed on moderately calcareous glacial till. (Measuring stick interval = 6 inches.)

A	Horizon:	Very dark grey loam to clay loam (4 to 8 inches thick); fine granular structure; friable; neutral in reaction.
B	Horizon:	Dark greyish brown clay loam (5 to 10 inches thick); medium sized columns break readily into medium blocky aggregates; hard, firm when moist; neutral to slightly alkaline in reaction. Grades into: -
Cca	Horizon:	Light grey to white calcareous clay loam (6 to 10 inches thick); crumb structure; friable; strongly alkaline in reaction.
C	Horizon:	Light brownish grey, clay loam glacial till; psuedo-crumb structure; friable; alkaline in reaction; generally contains salt pseudomycelium and streaks of concretionary iron.

On the knolls, where runoff of rain water is very rapid, the amount of moisture that enters the soils is much reduced and a drier soil climate exists. For this reason the soils on the knolls are very thin and the "A" and "B" horizons together may be only a few inches in thickness. The "A" horizon of very dark grey to very dark greyish brown loam is generally slightly alkaline in reaction and 3 to 4 inches in thickness. This horizon together with part or all of the "B" horizon is very often lacking in cultivated soils due to removal by wind and water erosion. In virgin sites the "B" horizon exhibits a well-developed columnar structure with the columns breaking into coarse blocky aggregates. This horizon is brown in color, slightly alkaline in reaction and varies from 5 to 8 inches in thickness. It is underlain by a prominent, light grey to white "Ca" horizon, which grades into the light brownish grey, clay loam boulder till.

Toward the base of the slopes, where runoff is slower than from the well-drained and knoll positions, the soils are imperfectly drained. These imperfectly or intermediately drained soils occupy a marginal strip of land surrounding the depressions. The width of this strip depends upon the steepness of the slope. The soils in this intermmediately drained position have thicker profiles than those occurring farther up the slopes. The "A" horizon is from 8 to 12 inches thick, and the "B" horizon, although not as well developed structurally as in the better drained soils, is 10 to 16 or more inches in thickness. The "B" horizon generally consists of a dark greyish brown, medium blocky "B_2" layer and a brown to yellowish brown, granular or crumb structured "B_3" layer. The lime carbonate is quite evenly distributed in the parent material, which is iron stained and contains concretionary salt crystals.

The intermediately drained soils under woods surrounding many of the depressions reflect their environment in their profile characteristics. The "A" horizon is dark grey in color, slightly acid in reaction, and of a loam texture. This slightly leached horizon is underlain by a well-developed heavy clay loam to clay "B_2" horizon, which has a medium to coarse blocky structure and is slightly acid in reaction. This is underlain by a yellowish brown, gleyed layer ("Bg" horizon), that is slightly alkaline in reaction and contains concretionary iron. The parent material is iron stained, strongly alkaline, and has an olive hue when moist.

In the depressional areas the poorly drained soils exhibit a wide range of variability. Meadow, saline Meadow, and degraded Meadow or Meadow Podzol soils are all encountered. The Meadow and saline Meadow soils consist of a 4 to 8 inch, black, clay loam to clay "A" horizon; a prominent, light grey to white, clay loam "C_{ca}" horizon; and pale olive, clay loam boulder till parent material. The profiles are alkaline in reaction and iron stained throughout. In the case of the saline member, gypsum crystals and salt pseudomycelium appear in each horizon. The degraded Meadow or Meadow Podzol soils have leached profiles showing a grey "A_2" horizon and a compacted, columnar "B" horizon. These soils are slightly acid near the surface but become slightly alkaline toward the base of the "B" horizon and strongly alkaline in the parent material. The "C_{ca}" and "C" horizons are iron stained and often contain soluble salts.

(ii) Oxbow Salinized Associates:

In the northern portion of the area covered by the Oxbow association, in the vicinity of Two Creeks, Willen, and Kirkella extensive tracts of land occur in which the dominant soils are the salinized and alkalinized members. These areas have been separate on the soils map and designated as Oxbow salinized associates. Within these areas the local relief is generally less than in the surrounding country and soil drainage is dominantly imperfect to poor. The low positions are occupied by saline Meadow soils, similar to those described above, and salt encrustations on the surface of the soils are common. On the slightly elevated land, where surface runoff and internal drainage is better, the soils are often degraded and exhibit solodized-Solonetz profile characteristics. These profiles have a thin, dark grey "A_1" horizon; a bleached "A_2" layer; and a highly

compacted "B" horizon which consists of medium-sized round-top columnar aggregates. These columns have a grey surface, particularly on the upper portion, but are very dark brown to black inside. They are extremely hard when dry. The "B" horizon is underlain by a well-defined layer of lime carbonate accumulation, and the "C" horizon is strongly alkaline, iron stained and contains soluble salt concretions. Some better drained soils do occur in association with these salinized and alkalinized or solonetzic soils; however they generally have thinner profiles than the representative Oxbow soils and contain soluble salts in their lower horizons.

(iii) Oxbow, Smooth Phase

The Oxbow smooth phase occurs on the eastern margin of the Oxbow soil area in the vicinity of Hargrave and Harmsworth. This is an area that appears to have been affected by waters of glacial Lake Souris. The topography is much smoother with less local relief than is found in the representative Oxbow soil area and many of the depressions contain shallow deposits of lacustrine material over the boulder till. This topographical phase occupies approximately 39,500 acres and comprises about 7 percent of the total area of Oxbow soils.

The area of Oxbow, smooth phase soils constitutes the best agricultural land in the Oxbow association. Due to the smoother topography, the percent of arable land per quarter section is much higher than over most of the Oxbow soil area, and the soils often have deeper profiles as a result of surface deposition of lacustrine material. With the exception of the thicker "A" horizons, which occur particularly in the intermediate and poorly drained positions, the profiles of the various associated soils exhibit the same characteristics as were described under the representative Oxbow soils.

(iv) Oxbow Modified Phase

Soils of the Oxbow modified phase occupy approximately 78,105 acres (14.1 percent of the Oxbow soil area) and occur in narrow bands along eroded stream channels and in scattered areas adjacent to the valley of the Assiniboine River. These soils are developed on boulder till that was eroded by glacial waters to the extent that a layer of stones and gravel of varying thickness was left as a remnant of this erosion. In some areas, where no subsequent deposition occurred, this coarse textured layer remained as a surface mantle to form the parent material of the upper horizons of the soil profiles. Elsewhere, this layer of coarse rock fragments was covered by a variable thickness of finer textured deposits and now appears as a gravel or cobble lens within the soil profiles. Thus the soils of the Oxbow, modified phase exhibit little uniformity in surface texture and parent material and have variable profile characteristics depending upon the thickness of fine textured deposits and the thickness of the coarse textured lens. The surface textures range from coarse sandy loam to clay loam and the "C" horizon may consist of stony boulder till, a mixture of gravel and stony till or only slightly modified till.

The profiles of the soils of the Oxbow, modified phase have been strongly influenced by their variable parent material. The textural changes within the profiles have greatly affected the internal drainage of these soils and restricted the development of zonal profile characteristics. Therefore, they should be considered as intrazonal soils occurring in association with the Oxbow soils.

Agriculture: The representative, well-drained and intermediately drained Oxbow soils are moderately high in fertility. They have developed under tall prairie grasses and, in their native state, have a high organic matter content, moderately high available plant nutrient level, good moisture retention and aeration relationships, and good tilth. However, the percentage of land occupied by these fertile soils varies on individual farms throughout the area of Oxbow soils and is quite low in some portions of the area. The other associated soils in the Oxbow association are much lower in natural fertility and

their widespread occurrence, particularly in some portions of the area, is responsible for the overall relatively low productivity of the Oxbow soils, as compared to some other Blackearth till soils in Manitoba.

The less productive soils in the Oxbow association consist of: the eroded, excessively drained soils on the knoll positions; the degraded Meadow or Meadow Podzol soils; the saline Meadow soils; the degraded saline or solodized-Solonetz soils; and the coarser textured and stony soils of the Oxbow modified phase. Many of these soils are not suited to arable culture and constitute waste land or are used to a limited extent for native hay and pasture. The widespread distribution of these submarginal soils throughout most of the Oxbow soil association renders the land most suited to mixed farming.

The best agricultural land in the Oxbow association occurs within the area of Oxbow smooth phase. Here, the percentage of land occupied by the poorer associates is at a minimum for the area as a whole, and the topography is less conducive to loss of topsoil through erosion. The least productive individual farms are generally located on the saline associate of the representative Oxbow soils and on areas occupied by the Oxbow modified phase.

In most cases, it is costly to improve the productivity of the poorer soils in the Oxbow association. Their widespread occurrence in areas that are often subject to spring flooding renders most soil improvement methods impracticable. Applications of barnyard manure and chemical fertilizers are beneficial to crops on the degraded and slightly saline soils and the inclusion of grass and legume crops in the rotation assist in reducing the erosion and maintaining the fertility of the excessively drained soils on the knolls.

FIGURE 8

View of a prominent esker-like ridge in the Arrow Hills

ARROW HILLS—LENORE COMBINATION:

The Arrow Hills-Lenore combination consists of a group of soils developed from shaly loam till and from coarse shale rubble and gravel. The soils developed on shaly loam till are classified as the Lenore association and the soils on the coarse shale drift, which are found on the crests of the esker-like ridges and some hillocks, as the Arrow Hills association. Of the two associations, the Lenore covers a much greater area than the Arrow Hills.

The region in which this combination of soils are found is marked by a series of distinct ridges and hillocks that range from 20 to more than 100 feet in height above the surrounding terrain (Figure 8). This group of ridges and hills begin about one mile north of the village of Arrow River and extend south by south-eastward to the Assiniboine River valley. Near the village of Arrow River, the terrain consists of a series of prominent hills, many of which are capped with glacial till. Exposures of shale bedrock on some slopes of these hills indicate that at least a number of the higher hills are erosion remnants which have been subsequently covered by glacial drift.

The Lenore and Arrow Hills soils occur intermixed with one another and with small occluded areas of Newdale modified phase and Miniota soils. Near the village of Arrow River, the soils of the Newdale modified phase occur in small local areas mostly on the knolls or low hills. The Miniota soils also are of local occurrence but are more commonly found farther south in the depressions that border the ice-contact stratified drift deposits.

The Lenore and Arrow Hills soils occupy approximately 50,662 acres or 1.48 percent of the total area in the Rossburn-Virden map sheets. The topography, as designated earlier, is irregular gently sloping with hills and ridges of varying dimensions. Soil drainage and runoff are generally good on the till plain to excessive on the elevated positions.

Vegetation varies with the site, the kind of soil, drainage and concentration of salts. In the Lenore association, the vegetation on the well-drained soils consists mainly of blue-grass intermixed with blue couch-grass, June grass, wormwood, sage, snow-berry and silver-berry. In the poorly drained sites, the soils are usually salty and the native plants consist mainly of salt-grass, gum-weed, wild barley, goosefoot and sea blite. Sedges and some reeds are often present in the intermittent slough beds and, where the salt content is low the depressions are ringed with willow and aspen. Trees also are present on the north and east slopes of the hills covered with till or sandy sediments, but are absent on the slopes that have shale rubble or gravel substrate. On these coarse textured sites and on the crests of the hills and ridges, the vegetation is xerophytic consisting dominantly of sage, wormwood, blue-stem, wild flax, spear grass, grama grass, snow-berry and silver-berry.

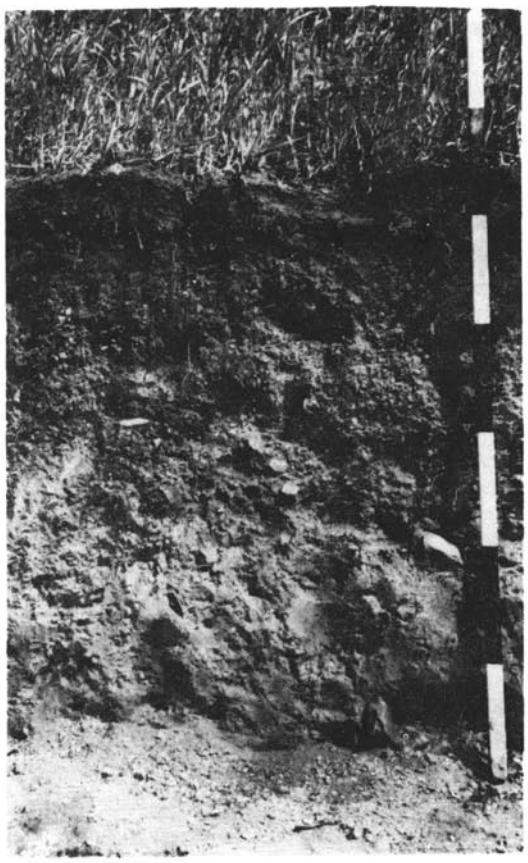

FIGURE 9

Soil profile of Lenore loam. A Blackearth soil developed on shaly loam till.
(Measuring stick interval = 6 inches.)

Lenore Association:

The soils of the Lenore association are developed from shaly till with a high content of lime carbonate and a soluble salt content which is higher than normal for soils formed from till sediments in Manitoba. The till sediments of the Lenore soils differ from the Newdale till primarily in higher shale content. This is reflected by greyer and somewhat darker colors in the parent material. Apart from the features mentioned, the two types of till have many features in common. A generalized description of the representative virgin profile of the well-drained associate is given below.

A Horizon: Very dark grey loam (6 to 9 inches thick) with a fine granular structure that is slightly cemented to friable when dry, moderately porous and neutral in reaction.

B Horizon: Dark greyish brown loam (8 to 13 inches thick) with fine columnar structure which is moderately hard, moderately porous and slightly alkaline in reaction. This horizon grades sharply into: -

Cca Horizon: Light brownish grey to very pale brown loam (7 to 12 inches thick) that is amorphous to weakly fragmental, porous and strongly calcareous. This layer blends gradually with the horizon below.

C Horizon: Light grey to a pale brown loam, high in shale and lime carbonate. It has a pseudo-fragmental to amorphous structure and becomes slightly cemented when dry.

The soils in the more poorly drained positions in general have had some sediments deposited by water and wind over the till and also have been affected by salts in varying degrees. In the imperfectly drained positions, Solonetz and solodized-Solonetz are most common. Some regrading types or incipient Solods occur where the textures are somewhat coarser than the normal heavy clay loams and clays. As a whole the depressional areas are gypsiferous and these salts are particularly evident in drier years along roadcuts and in the native pastures. Thin deposits of muck or peat are found in some sloughs subject to periodic inundation. In these sloughs the profiles are strongly gleyed, iron stained and many soils contain traces of salts below the bleached horizon. Meadow Podzols are absent in the Lenore Association. The only soils that have been influenced by leaching under woods are those found on the northern slopes of hills containing till deposits occurring in the vicinity of the village of Arrow River.

Arrow Hills Association:

The soils of the Arrow Hills association are primarily confined to the elongated ridges and isolated hills found throughout the region in which the Arrow Hills - Lenore combination of soils are located. The Arrow Hills soils contain a thin mantle of sandy sediments on the surface which is underlain by gravel, rounded shale boulders and shale rubble. On the apices of the ridges the sandy surface appears to be partly aeolial in origin whereas on the slopes or the depressions bordering the ridges, the sandy sediments are chiefly the result of water deposition. The dominant member of this association is the somewhat excessively drained associate. A brief description of this dominant soil is given below.

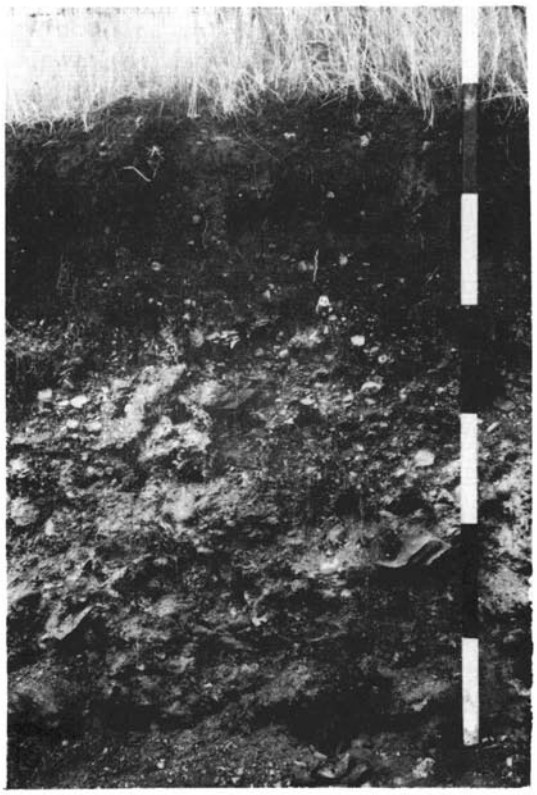

FIGURE 10

Soil profile of Arrow Hills sandy loam. A Black-earth soil developed on a thin mantle of sandy sediments over shaly stratified drift.
(Measuring stick interval = 6 inches.)

A Horizon: Very dark grey sandy loam to loam that is fine granular, friable and slightly alkaline in reaction. The horizon is 5 to 8 inches thick.

B Horizon: Brown to dark greyish brown sandy loam to loam with a weakly developed fine columnar structure. Columns are slightly coated and are moderately friable. Reaction is slightly alkaline but no free-lime carbonate is indicated. The horizon is from 4 to 6 inches thick.

Cca Horizon: Pale brown to light grey gravel and cobbles which are moderately calcareous. Contains more finer material than the substratum. Horizon is 7 to 10 inches thick. Grades gradually into: -

D Horizon: Pale brown to light grey mass of unconsolidated rounded shale boulders, shale rubble and gravel. Contains small amounts of free-lime carbonate.

Soils associated with the somewhat excessively drained member are those on the lower slopes

and depressions bordering the ridges. The sandy stratified sediments become thicker over the shale drift from the crest to the foot of the slope. In places the sandy deposits over the shale are more than three feet in thickness. At the base of the slopes, the drainage is often poor because of runoff and seepage from the ridges, and impedance of percolation by finer sediments in the substratum.

Agriculture: The value of the Lenore soils for production of cereal crops normal to the region ranges from poor in the saline depressional areas to good in the well-drained positions on very gently sloping topography. The imperfectly to poorly drained associates of the Lenore soils have been affected to a greater or lesser extent by salts. Some soils are in a state of salinization while other have degraded. Degradation is most prevalent in the lower lying areas and in consequence these soils are in poor physical condition as well as being low in fertility. In their present state these soils, in general, are suitable only for hay and pasture. Drainage is essential and over-grazing should be avoided to prevent the spread of such plants as wild barley, snow-berry and other salt-tolerant plants. Where flooding is not a problem it is desirable to grow some legumes with the grasses to facilitate internal drainage. Most of the well-drained Lenore soils also contain small amounts of salts in the substrata but the salts do not materially affect crop production in normal years. In dry years some decrease in grain yield is expected due to physiological drought induced by the salts. Those soils without salts and those found on favourable topography are good producing types. Wind and water erosion is becoming increasingly severe in areas with undulating topography. These soils are not strongly aggregated due to many inert particles of weathered shale and in such a condition are easily eroded by the agencies mentioned. To reduce losses by wind and water, it is suggested to establish a cropping rotation which includes some improvement crop rather than following the fallow-grain sequence commonly used in Western Canada.

The Arrow Hills soils are not suitable for arable culture and past attempts of growing grains on some of the ridges and hills offered poor compensation. The high hills and ridges afford limited pasturage while the lower sandy slopes and depressions can be used for both pasturage and hay.

EASTBANK ASSOCIATION:

The Eastbank association consists of soils developed on water-laid sediments of medium texture underlain with undifferentiated coarse shaly drift. The water-laid deposits range in thickness from several inches on the crests of tne ridges and knolls to three or more feet in the depressional areas. The underlying drift deposits decrease in thickness toward the Assiniboine Valley, and at some sites the combined thickness of the surficial glacial sediments over the Cretaceous shale bedrock is less than two feet.

The soils of the Eastbank association are located on the upper terrace of the Assiniboine River valley in Townships 10, 11, and 12 in Range 25 and in Township 10, Range 26. These soils cover an area of approximately 10,470 acres which represents 0.31 percent of the Rossburn-Virden map areas.

The topography of the terrace on which these soils occur is smooth gently sloping. It is marked by several continuous ridges with intervening runways and sloughs. Some dissection of the terrace by steep-banked ravines entering the Assiniboine Valley occurs, but this feature is not as conspicuous on this terrace as it is in regions where the drift sediments over the bedrock are much thicker by comparison. Drainage is good over the greater part of the area due to the moderate relief and the presence of drainage channels. Internal soil drainage also is good because of the coarseness of the substratal sediments and the gradual slope of the terrain toward the Assiniboine Valley. As a result of rapid infiltration and moderate runoff, the native vegetation consists principally of dry-land grasses, herbs and shrubs on the uplands and wet-land vegetation in the more humid sites. On the drier uplands such plants as silver-berry, snow-berry, wormwood, sage, grama grass, and blue couch-grass are common; whereas down the slope to the wet sites

a progression of plants are found that are common to the more humid conditions in the Blackearth zone.

The soils of the Eastbank association are complex in character due to the variable thickness of the finer textured surface mantle over the coarse shale drift. Most of the well-drained areas have less than fifteen inches of the finer sediments, although some local sites with good drainage have greater thicknesses of this material. The representative and dominant associate of the Eastbank association is the well-drained member and its description is given below:

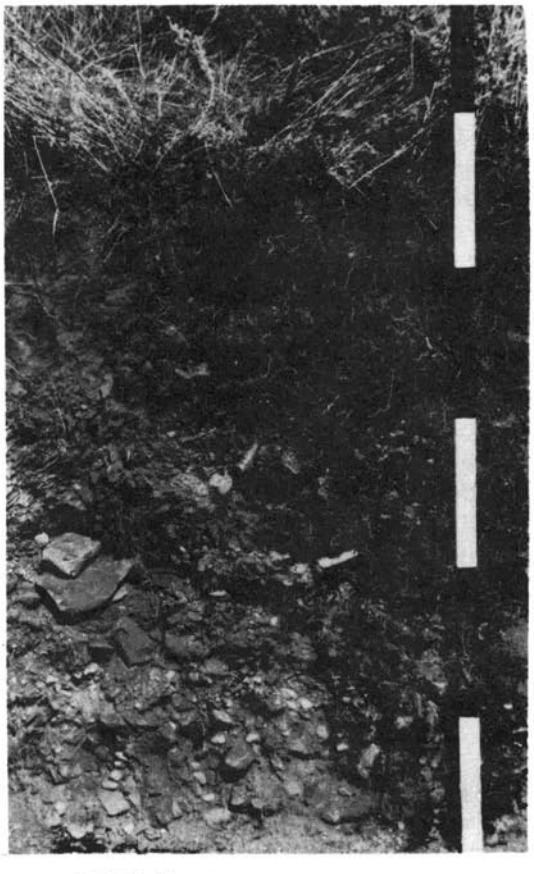

FIGURE 11

Soil profile of the Eastbank clay loam. A Blackearth soil developed on water-laid sediments of medium texture underlain with undifferentiated coarse shaly drift.
(Measuring stick interval = 6 inches.)

A	Horizon:	Dark grey loam (5 to 10 inches thick); fine granular structure; friable and porous; slightly acid in reaction.
B_2	Horizon:	Dark greyish brown loam (4 to 10 inches thick); weakly developed fine prismatic structure, breaks into fine granular aggregates; moderately friable and porous; slightly acid in reaction.
B_{3u} *	Horizon:	Brown gravel with a predominance of shale and containing some fine sediments that are slightly stained with organic matter (5 to 21 inches thick); loose mass of rubble; slightly alkaline in reaction.
D	Horizon:	Grey gravel very high in shale; loose; moderately calcareous.

The profile characteristics of the genetic soil types which occur as the imperfectly and poorly drained members of the Eastbank association bear a marked resemblance to corresponding associates in the Lenore association. They differ principally in the presence of a shale substratum below the solum of the Eastbank soils.

The imperfectly drained soils in this association are chiefly Solonetzic in character. All stages in the degree of development from the Solonetz to the incipient Solods are represented, although the solodized-Solonetz is the most common type. The solodized-Solonetz soils have well-developed "A_2" and "B" horizons with their characteristic structures. The "B" horizon is very tough and has low porosity. A high concentration of soluble salts occurs just below the "B" horizon. The Solonetz soils found in the area differ from the solodized-Solonetz in their lack of a prominent "A_2" horizon and lesser density of the prismatic "B" horizon. The Solonetz soils are higher in reaction and are more friable than the more strongly degraded types. In these soils, the salts are commonly present in the lower part of the "B" horizon as well as in the lower strata. The incipient Solod soil is a regrading type in which a friable and slightly acid "A1" horizon has developed in the upper part of the "A_2" horizon. The "B" horizon is passing through a stage of disintegration and is not as dense as in the solodized-Solonetz soil.

Most of the poorly drained soils of the Eastbank association have a 20 to 36 inch layer of heavy clay loam to clay textured sediments superimposed over the coarse shale drift. Saline soils are the most common type and in many localized areas the salt concentration is sufficient to inhibit the growth of all plants except glasswort, salt-grass, sea blite, gumweed, wild barley and other salt-tolerant species. In some locations where

* Unconforming with above material.

the soils are more permeable and the water table is lower, the salts have been leached to lower levels and other plants normal to wet areas are found. In this type of soil a thin layer of peat and muck is commonly present and a strong gley horizon occurs immediately below the mucky "A_1" horizon.

Agriculture: The Eastbank soils are characterized by a thin surface mantle of medium textured material with good water retention capacity, a droughty substratum of coarse shale gravel, stoniness on the ridges, and salinity in the depressions. Most of the area is under cultivation and in years of normal rainfall fair crops of cereal grains are produced. A large part of the area however is droughty because of the proximity to the surface of the shale rubble which tends to restrict root development. Where the surface mantle is two or more feet thick, the crops are better than the average for the area. At present the stony areas and the poorly drained soils are used as native pasture lands.

Grain farming with wheat as a principal crop cannot be considered a satisfactory system for the Eastbank soils. During seasons of plentiful precipitation, good yields of grain have been obtained, but in drier years poor crops have resulted. Grain farming, without the supplementary measures of using grasses and legumes in the crop rotation, does not maintain organic matter or provide for the retention of the best soil structure.

In recent years forage crops have been grown to a greater extent in parts of the Eastbank soil area. Sweet clover and brome grass are the most important of these crops which assist both in control of wind erosion and in the maintenance of soil fertility. This increased use of forage crops is associated with livestock production. Mixed farming with emphasis on livestock production is recommended for the Eastbank soils.

BERESFORD ASSOCIATION:

The Beresford association consists of clay loam soils developed on a two-storey parent material composed of a thin covering of lacustrine sediments over calcareous boulder till. The lacustrine material and the boulder till are both of a clay loam texture, but are commonly separated by a slight gravel or cobble lens marking the erosional surface of the underlying till. This stratification of the parent material has influenced the profile of the soils developed from it; however, the well-drained member of the association can be classified as a Blackearth soil.

The main area of Beresford soils in the Rossburn-Virden map sheets lies to the south of Alexander in an irregular strip extending south-east to the Tiger Hills. This area of lacustrine-till transition soils is located on a strip of ground and low end moraine deposits within the basin of glacial Lake Souris. They are bordered on the east and west by soils developed on thicker lacustrine deposits which consist of the Carroll, Harding and Souris associations. Other small areas of Beresford soils occur to the north of the Assiniboine River in the vicinity of Forrest. Together the areas of Beresford soils occupy approximately 48,154 acres, which represents 1.4 percent of the total area of the map sheets.

The topography of the Beresford soils is level to very gently sloping with considerable micro-relief in some areas. Surface drainage is generally restricted to runoff into local depressions, although shallow, meandering stream channels provide better surface drainage for some portions of the soil area. The native vegetation consists of mixed prairie grasses on the better drained sites, salt-tolerant grass species in the poorly drained areas, and poplar and willow bluffs surrounding many of the depressional areas. Scattered surface stones occur throughout the soil area, but generally do not constitute a problem to cultivation.

A generalized description of the well-drained member of the Beresford association is given below:

A Horizon: Dark grey clay loam (8 to 12 inches thick); fine granular structure; friable; neutral in reaction. Grades into:

B Horizon: Greyish brown clay loam (5 to 8 inches thick); medium granular structure; friable; neutral to slightly alkaline in reaction. A thin pebble or cobble lens may occur at the base of this horizon.

D_{ca} Horizon: Very pale brown clay loam boulder till (8 to 12 inches thick); weak crumb structure; friable; alkaline in reaction and highly calcareous.

D Horizon: Very pale brown clay loam boulder till; pseudo-crumb structure; friable; calcareous; may contain gypsum crystals and salt pseudomycelium.

The intermediately drained Beresford soils are usually calcic-black soils and are more or less salinized. The profile generally consists of a very dark grey, clay loam "A" horizon which is calcareous and may contain some soluble salts. This is underlain by a light grey, iron-stained horizon of lime carbonate accumulation, which grades into a mottled, pale brown and light yellowish brown, gleyed "Dg" horizon of clay loam boulder till. This subsoil contains clusters of gypsum crystals and blotches of marly material.

The poorly drained associates of the Beresford association include saline Meadow and degraded Meadow soils. The saline Meadow soils have a very dark grey, calcareous and saline "A" horizon over a gleyed subsoil which fades into modified boulder till at various depths. The degraded Meadow or Meadow Podzol soils occur in the wooded depressions. They are leached soils with a strongly platy, acid, dark grey "A_2" horizon and a very dark brown, massive, clay textured "B" horizon. The profile is iron stained throughout and the gleyed subsoil is olive grey modified till.

Agriculture: The better drained soils of the Beresford association are fertile soils suited to grain production. They have a high organic matter content, good moisture retention capacity, and are moderately resistant to wind erosion. The topography is favorable for large rectangular fields suited to power equipment. Recommended fertilizers should be applied for maximum yields.

In areas which contain a large proportion of intermediately and poorly drained saline soils, mixed farming is more suitable and is generally being practised at the present. Improvement in soil drainage is the only method of permanently increasing the fertility of these soils. Manure and chemical fertilizers will help to increase yields on marginal saline land, but without improved drainage utilization of strongly saline areas is restricted to hay and pasture.

HARDING ASSOCIATION:

The Harding association consists of clay textured soils developed on shallow lacustrine clay deposits. These lacustrine deposits are underlain by glacial till at varying depths below the soil profile. Where the glacial till is encountered within 30 inches of the surface, the soils are classified as Harding clay, till substrate phase.

The Harding soils have developed under grassland vegetation and the better drained member of the association exhibits Blackearth profile characteristics. However, the dominant soil associate in this association is the imperfectly drained member and it has been strongly influenced in its development by the processes of salinization and alkalinization. Thus, the Harding soils are dominantly intrazonal.

Almost all the soils in this association in the Rossburn-Virden map sheets occur in two distinct areas. The larger of the two areas lies to the north of the Assiniboine Valley in a broad strip of land extending southward from the town of Harding for a distance of about 10 miles. This area of Harding soils is surrounded by medium textured soils of the Carroll association, and these two soils (both developed on lacustrine sediments) grade into one another with no sharp line of demarcation. The other extensive area of Harding soils lies to the south of the Assiniboine River in a narrow strip extending southeast from Terence. This area is bordered on the west by soils of the Carroll association, and on the east by Beresford soils. These two areas of clay deposits represent the axial portion of local glacial lakes. Together they occupy approximately 38,550 acres, which represents about one percent of the total area of the Rossburn-Virden map sheets.

The topography of the Harding soils is generally flat to very gently sloping. However, within the area lying to the south of Harding, this smooth topography has been

modified by a number of deeply cut drainage channels. These channels cross the area from the west to east and are bounded by long slopes of varying gradient. The presence of these deep channels is of great benefit to the drainage of the surrounding land. Where the Harding soils occur on flat topography, drainage is very slow and the soils that have developed under these conditions are generally salinized or alkalinized. However, in the vicinity of the eroded channels, the soils have developed under better drainage conditions and are more productive.

The dominant, intermediately drained Harding soils show varying degrees of alkalinization. This is reflected in the soil profile by the degree of development of a columnar structure in the "A" horizon. A generalized description of the representative virgin profile of this associate is given below:

A	Horizon:	Dark grey to very dark grey clay (6 to 10 inches thick); medium columnar structure breaks into granular aggregates; firm, hard when dry; neutral to slightly alkaline in reaction. Tongues into: -
Bg	Horizon:	Greyish brown clay (8 to 14 inches thick); granular aggregates; plastic; alkaline, slightly calcareous; slightly iron stained. Grades into:
Cca	Horizon:	Very pale brown clay horizon of calcium carbonate accumulation; indistinct, variable in depth and often inseparable from the "C" horizon.
C	Horizon:	Light brownish grey clay; massive; plastic and sticky; alkaline in reaction and calcareous; iron stained, and contains concretionary salt crystals.

The profiles of the better drained soils, which occur in the areas influenced by the deeply cut drainage channels, reflect their more favorable moisture relationships by a granular structure in the "A" horizon and brighter colors in the "B" and "C" horizons. The "A" horizon is dark grey, granular, friable, and neutral to slightly alkaline in reaction. It is generally 8 to 12 inches in thickness, but numerous tongues of this material extend into the lower horizons for 12 or more inches. The "B" or "A-C" horizon is a transitional layer between the "A" horizon and the subsoil. It consists of 3 to 6 inches of greyish brown clay which is granular, friable, and alkaline in reaction. The "Cca" horizon is indistinct and blends with the light brownish grey, clay textured parent material.

A prominent feature of both the imperfectly and better drained members of this association is the deep tonguing of the "A" horizon into the subsurface and subsoil layers. This phenomena is attributed to infiltration of surface material into cracks which result from alternate wetting and drying or freezing and thawing of these clay textured soils. It is prominently displayed in fresh road cuts where the diagonal slicing of the soil profile reveals a massive network of these dark colored tongues.

The poorly drained members of the Harding association include: Meadow, saline Meadow, and degraded Meadow or Meadow Podzol soils. The Meadow and saline Meadow soils have a 4 to 6 inch, very dark grey clay "A" horizon which is massive, plastic and sticky, alkaline, and contains free-lime carbonate and concretionary iron. This surface layer is underlain by a thick, greyish brown gley horizon which fades into the grey, strongly iron-stained, clay parent material at about 20 inches below the surface. Salt crystals appear in all horizons of the saline Meadow soils.

The degraded Meadow soils occur in the scattered, wooded depressions which dot the landscape in certain portions of the Harding soil area. These soils consist of a thin mixed leaf and sod mat over a leached, platy structured "A_2" horizon which is acid in reaction and slightly iron stained. This leached layer is underlain by a very dark grey, heavy clay, massive "B" horizon which is extremely firm and also acid in reaction. The parent material shows the influence of ground water by a dark olive grey color in the moist condition and the presence of concretionary iron.

The soils of the Harding, till substrate phase exhibit similar profile characteristics as the comparable members of the representative Harding soils. However they are separated from the representative soils of the association on the presence of a "D"

horizon of slightly modified glacial till within 30 inches of the surface. This horizon is generally similar in texture to the surface horizons and therefore has had little effect upon the genesis of the soils. The presence of this till substrate is often indicated by scattered small stones on the surface.

Agriculture: The Harding soils are highly fertile and are well adapted to grain production. They are moderately high in organic matter, and high in available plant nutrients and moisture retention capacity. Their clay texture and good aggregation renders them moderately resistant to erosion. A very high percentage of the land is arable and large fields can be farmed. The percentage of poorly drained and saline soils is low, particularly in the area north of the Assiniboine River where the surface drainage is favorably affected by the stream channels which traverse the area.

The main agricultural problems associated with these soils arise from the slow internal drainage and surface runoff in areas of flat topography. Periodic excessive wet conditions interfere with tillage operations on these heavy clay soils. Soil salinity tends to reduce yields in some areas, and poor soil aeration may retard plant growth.

The practice of returning crop residues to the soil is highly desirable on these soils. Incorporation of straw with the surface soils helps to improve workability and aeration and assists in maintaining the organic matter level. Trash cover reduces wind erosion on fallow fields and helps to control water erosion on the sloping land bordering stream channels. Chemical fertilizers containing nitrogen and phosphorous applied to grain grown on these soils give profitable returns.

CARROLL ASSOCIATION:

The Carroll association consists of fine to medium textured soils developed on lacustrine sediments. These sediments range in texture from very fine sandy loam to silty clay. They are underlain at varying depths by a substrate of glacial till. These lacustrine sediments which formed the parent material of the Carroll soils were calcareous and saline in their original state, and the process of desalinization has had a marked influence on the development of the resultant soils. However, the well-drained member of the association can be classified as a Blackearth soil.

The Carroll soils are located in the basin of glacial Lake Souris and the Brandon glacial lake. They occur both north and south of the Assiniboine River and bear close geographical relationship with the Harding, Beresford and Souris soils. Within the area of the Rossburn-Virden map sheets, they occupy approximately 184,474 acres, which represents about 5.4 percent of the total area.

The topography on which the Carroll soils are encountered varies considerably. Smooth topography generally associated with lacustrine deposits occurs in some areas. However, a large portion of the area of Carroll soils is undulating to rolling. This local relief pattern is due in part to severe geological erosion normal to areas bordering deeply incised drainage channels and in part to the uneven configuration of the underlying glacial till. Soil drainage is generally good in the areas of undulating topography, but large tracts of imperfectly and poorly drained soils occur where the topography is flat. The native vegetation under which these soils were developed was dominantly mixed prairie grasses. Willows and poplar occur locally surrounding some of the depressional areas, and salt-tolerant vegetative species predominate where soil salinity precludes other vegetation.

The Carroll association is divided into three phases on the basis of texture and depth of the lacustrine deposits over till. These phases are shown on the soils map and will be described as Carroll clay loams; Carroll loams; and Carroll till substrate phase.

(i) Carroll Clay Loams:

The Carroll clay loam soils occupy approximately 126,540 acres, or about 69

percent of the total acreage covered by the Carroll association. The topography varies from level to irregular, moderately sloping. Surface runoff is rapid on the sloping land, but slow on the level areas. Internal drainage is good, except where impeded by a finer textured substrate. A generalized description of the well-drained member is given below:

A Horizon: Very dark grey silty clay loam to clay loam (6 to 10 inches thick); blocky structure with fine granular aggregates; friable; neutral to slightly alkaline in reaction. Grades into: -

B Horizon: Brown silty clay loam (6 to 8 inches thick); medium columnar structure breaks into fine granular aggregates; firm; neutral to slightly alkaline in reaction.

C Horizon: Very pale brown silty clay loam; may be stratified with finer and coarser textured layers; fine pseudo-crumb structure; friable; alkaline in reaction and calcareous. Layers of lime carbonate and gypsum accumulation often occur in the upper portion of the "C" horizon.

Associated with these well-drained soils are: intermediately drained, Blackearth-Meadow intergrade soils; Meadow soils; and saline Meadow soils. The intermediately drained soils are generally solonetzic. They resemble the well-drained member in profile characteristics but are slightly thinner, have a stronger columnar structural development in the surface horizons and have a more pronounced lime carbonate accumulation at the base of the solum. The parent material is invariably saline and iron stained. The Meadow and saline Meadow soils which are more wide-spread in areas of level topography than in the undulating areas, have thin "AC" profiles with gleyed subsoils. Soluble salts and concretionary iron are usually present throughout the profile.

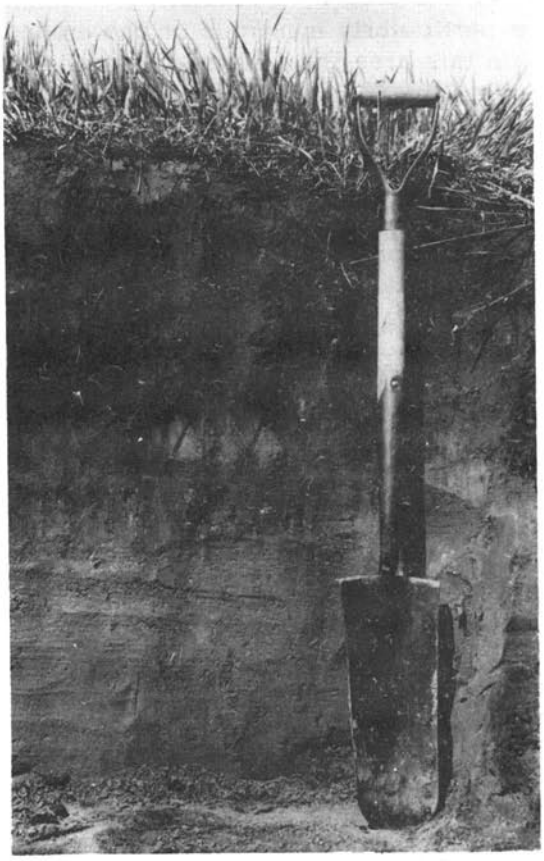

FIGURE 12

Soil profile of Carroll loams. A Blackearth soil developed on very fine sandy loam to silt loam textured lacustrine sediments.

(ii) Carroll Loams:

The Carroll loam soils occupy approximately 29,824 acres, or about 16 percent of the total acreage of the Carroll association. The topography varies from level to gently sloping. Drainage is generally good due to the high permeability of the parent material. Excessively drained soils occur on the knoll positions in areas of undulating topography. A generalized profile description of the well-drained member is given below:

A Horizon: Very dark grey silt loam or very fine sandy loam (12 to 16 inches thick); weakly cloddy, breaks into crumb aggregates; very friable; neutral in reaction. Grades into: -

B Horizon: Brown very fine sandy loam (6 to 10 inches thick); weak, medium columnar structures break into fine granular aggregates; friable; slightly alkaline in reaction.

Cca Horizon: Light brownish grey very fine sandy loam horizon of lime carbonate accumulation. This horizon is ill-defined, being only slightly greyer in color than the underlying subsoil.

C Horizon: Pale brown very fine sandy loam; weak fine pseudo-crumb structure; extremely friable; alkaline in reaction and calcareous.

The excessively drained soils on the knolls have thin profiles. These soils have developed under a drier soil climate, due to the very rapid runoff of rain waters and higher evaporation rate.

As a result of this drier climate the soils resemble Dark Brown - Blackearth transitional soils. The "A" horizon is 8 to 12 inches thick, dark greyish brown in color, medium columnar in structure, and slightly alkaline in reaction. The "B" horizon is only 4 to 6 inches thick and consists of brown, columnar aggregates. It is alkaline in reaction and contains some free-lime carbonate. Below the "B" horizon, a weakly-defined layer of lime carbonate accumulation occurs at the top of the very pale brown "C" horizon. Gypsum crystals are usually present in the subsoil. Under cultivated conditions, the "A" horizon of these profiles on many knolls has been removed by erosion and the knolls appear as light grey patches throughout the cultivated fields.

The intermediately drained and poorly drained associates are of limited occurrence in the Carroll loam soils due to the high permeability of the parent material. Meadow Podzol soils occur in the area south of Kenton where poplar bluffs are fairly prevalent. The poorly drained soils encountered in local depressions are usually finer in texture than the surrounding better drained soils and resemble the hydromorphic associates of the Carroll clay loam soils.

(iii) Carroll Till Substrate Phase:

The soils of the Carroll till substrate phase occupy approximately 28,109 acres, or about 15 percent of the Carroll association. The largest area of these soils occurs north of No. 1 Highway in the Kemnay-Alexander district. Here, the topography is undulating to rolling (irregular, gently to moderately sloping) and the soils closely resemble the Carroll clay loam soils to the south and west. The presence of glacial till within shallow depths from the surface is indicated throughout this area by a scattering of small stones on the surface of the soil. These stones are particularly numerous on the eroded knolls in the cultivated field. At some locations within this area the soils show a definite contact between the lacustrine sediments and the underlying till. Elsewhere no contact is evident and the parent material of the soils which contains stones, closely resembles that of the representative Carroll clay loam soils. This material may have resulted from a reworking by ice of earlier lacustrine deposits. However the soils developed from it resemble the Carroll soils both in profile features and agronomic characteristics and therefore have been classified as a phase of the Carroll association.

FIGURE 13

Incipient gully erosion on Carroll clay loam soils in the Alexander district.

Other areas of Carroll till substrate phase occur as small bands of transitional soils on the outer edges of the Lake Souris Basin. These areas have very gently sloping topography, and the soils are often imperfectly drained due to the change in texture within the soil profile.

Agriculture: The Carroll soils are highly productive, except where their fertility has been drastically lowered by the loss of the "A" horizon through water and wind erosion. Prior to cultivation, these soils represented some of the best potential agricultural land in Western Canada. They developed under a luxuriant growth of mixed prairie grasses, from parent material high in plant nutrients and of ideal texture for workability and moisture-aeration relationships. The resultant soil was a deep Blackearth of excellent fertility.

These soils were brought under cultivation early in the period of settlement of western Manitoba. Since that time the soils have been utilized almost exclusively for the production of cereal grains. This method of utilization has not appreciably affected the fertility of the soils which occur on level topography, but has been disasterous to soils in areas with undulating and rolling topography. Continuous grain-fallow rotations, removal of crop residues, and cultivation by rectangular fields regardless of the slope has resulted in the complete removal of the fertile top soil by water and wind erosion from a large portion of this land (Figure 13).

On areas of level or near level topography, these soils are ideally suited to the production of cereal grains. The use of trash cover to reduce wind erosion is necessary, especially on the Carroll loam soils, and fertilizers containing nitrogen and phosphorus will give profitable returns when applied to grain at the recommended rates. The areas of irregular sloping topography require special practises if soil fertility is to be maintained even at the present greatly lowered level. The steeper slopes should be sown to permanent grass or grass and legume crops. Where cultivation is continued, contour farming with buffer strips of grass in rotation on the slopes will assist in reducing further erosion Figure (14). All crop residues should be used as trash cover and returned to the soil. Heavy manuring of eroded knolls will help to restore organic matter to these depleted soils. Eroded gullies should be filled in and seeded to grass. In short, these soils are

FIGURE 14

View of Carroll clay loam soils showing a stabilized runway, a buffer strip of grass and alfalfa and cultivation on the contour. These are some of the measures adopted to control water erosion on these highly susceptible soils.

not suited to the exclusive production of grain crops and in the future should be utilized for dairying or mixed farming with grain crops being restricted to contour strips in rotation with strips of grasses and legumes.

SOURIS ASSOCIATION:

The Souris association consists of fine sandy textured soils developed on sandy lacustrine deposits in the Lake Souris Basin. These sandy sediments are underlain by finer textured deposits at varying depths below the soil profile. This finer textured substrate prevents free internal drainage so that the Souris soils have been developed under conditions of impeded drainage. Thus, the dominant soil in this association is a Black-earth-Meadow Intergrade.

The Souris soils occur in the basinal area of glacial Lake Souris and the Brandon glacial lake. Within the confines of the Rossburn-Virden map sheets, they occupy approximately 237,491 acres, which represents about 6.9 percent of the total area. The topography is generally level to very gently sloping. Occluded areas of sand dunes occur within the lighter textural phase of this association. Except in these areas of duned sand, soil drainage is impeded and the dominant soils are the intermediately and poorly drained associates. The native vegetation varies with the soil and substrate moisture conditions. Mixed prairie grasses thrive on the imperfectly drained soils, while meadow grasses, sedges and reeds occupy the lower sites. Xerophytic grass species, ground cedar and purple pin-cushion cactus occupy the drier sites in the duned area; while scrub oak and aspen grow on the north and east-facing slopes and in the small depressions. Deciduous trees including species of oak, elm, ash and maple are found on the beach-like ridge east of Oak Lake and provide a pleasant park area for summer campers.

The Souris association is divided into two textural phases. The finer textured soils, which occur mainly in the eastern portion of the area and occupy approximately 71,526 acres, have a surface texture of fine sandy loam. The coarser textural phase occupies approximately 165,965 acres and includes: well-drained and imperfectly drained soils with a surface texture of loamy fine sand; poorly drained soils which may have finer surface textures; and lithosolic duned sand which consists dominantly of the fine sand fraction.

FIGURE 15

View of Souris fine sandy loam showing soil profile exposed along road cut and typical gently sloping topography. Note the use being made of this imperfectly drained soil for the production of hay.

(i) Souris Fine Sandy Loam:

The dominant associate of the Souris fine sandy loam soils is the imperfectly drained member. These soils generally have free-water movement in the surface horizon but impeded drainage in the subsoil. A generalized profile description of this associate is given below:

A Horizon: Dark grey fine sandy loam (8 to 12 inches thick); weak fine crumb structure; extremely friable; alkaline in reaction and contains some free lime carbonate.

AC Horizon: Greyish brown loamy fine sand (5 to 8 inches thick); weak fine crumb structure; extremely friable; alkaline and calcareous. Contains concretionary iron.

C Horizon: Light yellowish brown to light grey fine sand; structureless and loose; alkaline, strongly calcareous and diffusely iron stained.

Meadow soils occupy the poorly drained positions. These soils have a dark greyish brown fine sandy loam "A" horizon which is calcareous and contains concretionary iron. This surface horizon is 6 to 10 inches thick and is underlain by a strongly developed gley horizon which is light grey in color, marly, and iron stained. The parent material consists of very pale brown fine sand and is diffusely iron stained. An unconforming or "D" horizon of finer textured material is sometimes encountered within three feet of the surface. A perched ground water table commonly occurs within profile depth during wet seasons.

(ii) Souris Loamy Fine Sand:

The soils of the Souris loamy fine sand phase consist predominately of four associated members. These are: moderately well-drained soils in areas of micro-dune topography; imperfectly drained soils on smooth topography; poorly drained Meadow soils in flat depressional areas; and excessively drained, lithosolic soils in areas of duned sand. All of these soils occur over extensive areas and none can be said to be the dominant member.

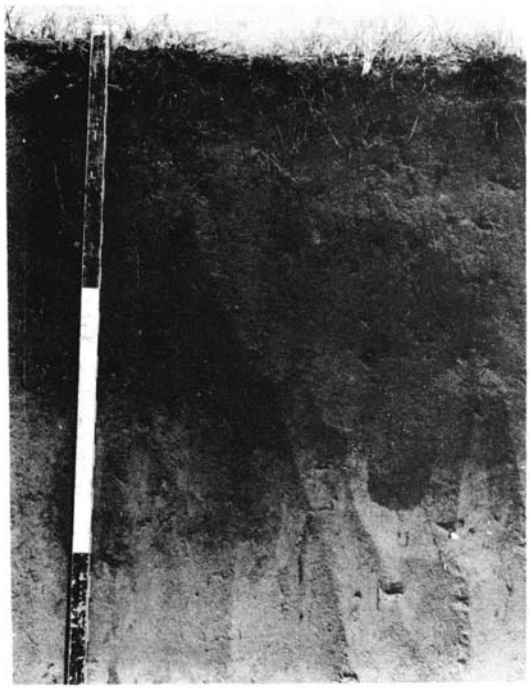

FIGURE 16

Soil profile of Souris loamy fine sand. A Black-earth-like soil developed on sandy textured lacustrine sediments.
(Measuring stick interval = 12 inches.)

The moderately well-drained soils are restricted to areas in which the sandy sediments were slightly duned subsequent to deposition but have been stabilized by vegetation. These soils have been leached to a varying degree due to the rapid percolation of moisture through the surface horizons. They generally have a dark grey "A" horizon seldom exceeding 15 inches in thickness. This surface horizon consists of loamy fine sand, is extremely friable, and neutral to slightly acid in reaction. This horizon may be underlain by a weak, brown colored "B" horizon or may grade directly into a pale brown fine sand "C" horizon that is slightly calcareous and is generally iron stained (Figure 16).

The imperfectly drained soils are similar in profile characteristics to the imperfectly drained member of the Souris fine sandy loam soils. The dark grey loamy fine sand "A" horizon grades through a thick transitional layer of greyish brown fine sand

into the pale brown "C" horizon. Iron staining usually commences in the transitional layer which also is slightly calcareous in some sites. No distinct layer of lime carbonate accumulation is perceptible. The poorly drained soils also resemble the equivalent member of the finer textured phase and often are of similar texture due to greater sedimentation in these depressional areas. The position of the gley horizon in these Meadow soil profiles varies with the average height of the ground-water table.

The skeletal soils which occur on the duned sands have very feeble profile development, which consists mainly of a slight organic matter accumulation in the surface 2 to 6 inches of sandy material. These soils are generally slightly acid for a depth of 4 feet or more. Under woodland vegetation, on the north and east slopes and in the depressions, a slight "B" horizon of iron concentration usually occurs at varying depths (Figure 17.).

FIGURE 17

Area of duned sand associated with the Souris soils. Note change in vegetation on different exposures (photograph taken facing north).

Agriculture: The soils of the Souris association possess features which render them almost unique in their agricultural problems and potentialities. Like all sandy textured soils in the dry farming belt of Western Canada, their utilization must be tempered by their high susceptibility to soil drifting (Figure 18). Also, they have the low moisture retention capacity characteristic of sandy soils and are therefore subject to drought. However, the feature that sets them apart from most other soils of like texture and modifies their potential value is the moist substrate which occurs throughout the area.

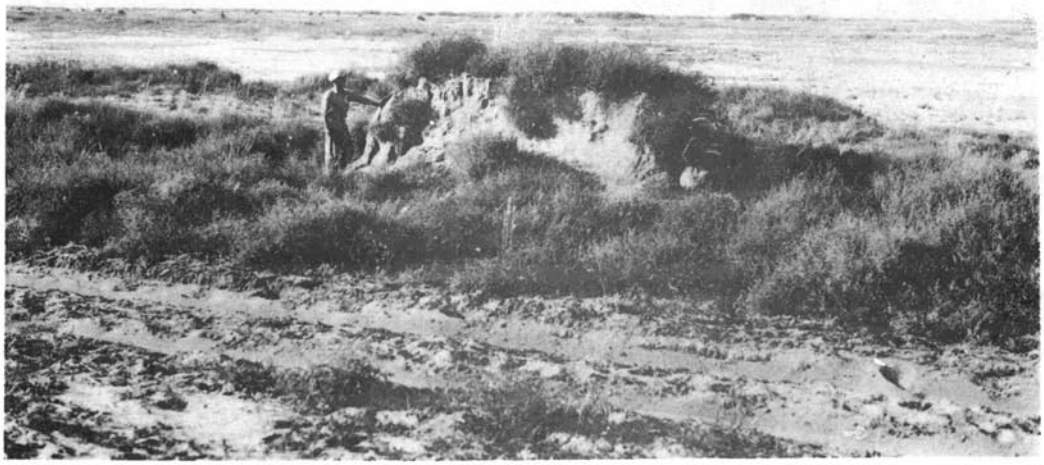

FIGURE 18

View of an area of Souris loamy fine soil showing the effects of severe wind erosion.

In the past this natural sub-irrigation feature of these soils has been largely neglected. Wherever drainage and topography permitted, the soils have been generally utilized by the continuous growing of grain crops alternated with black summerfallow. This

has resulted in severe and irredeemable loss of fertility through the removal by wind erosion of much of the organic matter and finer soil separates from the surface soil. Wherever poor surface drainage or rough, duned topography prohibited cultivation, the soils have been used to a limited extent for livestock grazing (Figure 19). The native vegetation on these soils provide pasturage of poor quality. This pattern of land use has been very wasteful of the potential productivity of the Souris soils.

FIGURE 19

Landscape view of area of poorly drained Souris loamy fine sand soils showing cattle grazing on native vegetation. Trees in background are on area of duned sand.

In recommending methods of improving the utilization of these soils a distinction must be made between the two textural phases of the association and the duned areas. The soils of the Souris fine sandy loam phase can be used for limited grain production in a mixed farming program. Their susceptibility to soil drifting and surface drought must be recognized and counteracted by special management practices. Field shelterbelts do well on this soil and should be utilized for surface protection. The trees tap the underground water supply and thus can survive periods of prolonged surface drought. Additional surface protection can be provided by strip cropping and avoidance of black summerfallow through the use of trash cover and fallow substitutes such as corn. Deep rooted, perennial legume crops should be included in the rotation as they also will tap the substrate moisture and provide forage during dry seasons. Thus, a system of land use is envisioned in which grasses and legumes are grown in rotation with cereal crops and corn on elongated fields perpendicular to the prevailing winds and surrounded by field shelterbelts. It is suggested that through practices such as these the soils of the Souris fine sandy loam phase can be utilized for mixed farming, and it is further emphasized that continuation of the present system of grain growing, alternated with fallow, will eventually ruin these soils for any type of agricultural production.

The wet Meadow and sandy imperfectly drained soils of the Souris loamy fine sand phase are not suited to arable culture. They must be utilized for the production of feed for livestock. For this purpose they have a good potentiality. However the native vegetation, and that which has developed after unsuccessful attempts at cultivation have been abandoned, constitute a low quality feed and should be surplanted with suitable grasses. This can be readily accomplished on the better drained land but the wet meadow areas require special investigation. The possibility of controlled drainage whereby the height of the water table can be regulated deserves consideration. Also, high quality grass species which thrive under wet conditions may provide a partial solution. In a general area that suffers from a moisture deficiency, these wet lands offer interesting possibilities and methods should be sought for their more intensive utilization.

The sand dunes which occur interspersed with the coarser textured Souris soils should always be kept under a vegetative cover. These duned sands will support the growth of adapted trees and commercial forests can be attained through the planting of suitable coniferous trees. This has been demonstrated in other areas of similar character in Manitoba and should be extended to include all areas of sand dunes on which it is feasible.

MINIOTA ASSOCIATION:

The Miniota association consists of sandy loam soils developed on sand and

coarse sand outwash deposits. These deposits frequently become coarser with depth so that a fine gravel or gravel substrate is of common occurrence. The surface texture of the soils is generally sandy loam or loamy sand, but some soils with coarser surface and subsurface textures have been included with the soils of this association due to their intimate geographical relationship. Where the outwash material contains a high percentage of shale fragments, the soils were classified as Miniota shaly phase. The well-drained member of the Miniota association exhibits Blackearth profile characteristics with some modification due to the influence of the coarse textured parent material upon the local soil climate.

The Miniota soils occur in scattered areas around the margin of the Lake Souris Basin at the points of confluence of rivers and streams with the glacial lake basin. The largest areas are located in the vicinity of Miniota, bordering the Assiniboine River, and to the south of Wheatlands, adjacent to the Minnedosa River. Smaller, fan-like areas occur south of Virden. The Miniota, shaly phase soils occur interspersed with areas of Lenore soils in the strip of land between the Arrow Hills and the Assiniboine River. The Miniota soils as a whole occupy approximately 100,710 acres in the Rossburn-Virden map sheets. This represents about 2.9 percent of the total area mapped.

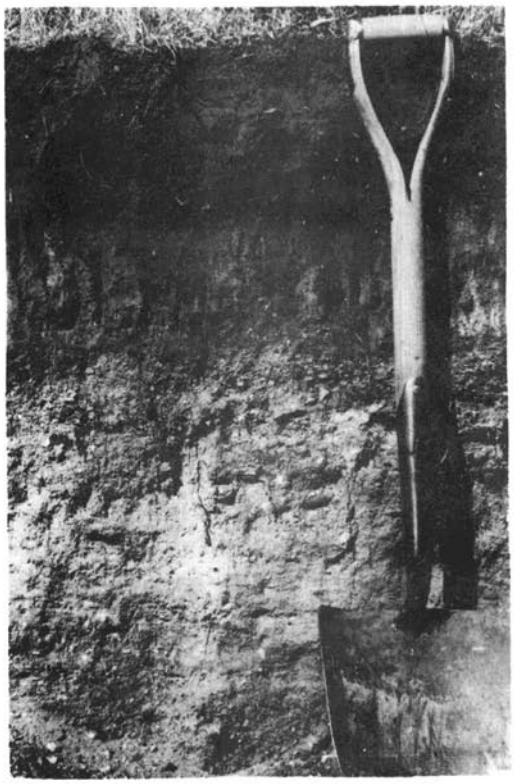

FIGURE 20

Soil profile of Miniota sandy loam. A Blackearth soil developed on sandy outwash deposits over a gravelly substrate.

The topography of the Miniota soils is level to slightly undulating. Beach-like ridges occur in some areas where the deposits were subject to wave action along the shores of the glacial lake. Elsewhere, eroded stream channels have bissected the areas giving added relief to the originally smooth plains. Soil drainage is good over almost the entire area of Miniota soils due to the high permeability of the parent material. Poorly drained soils are restricted to depressional areas in which the sandy outwash deposits are underlain by glacial till at shallow depths. The native vegetation on these sandy soils is dominantly mixed prairie grasses with a preponderance of xerophytic species on the driest sites. Surface stoniness is not a problem on these soils as the upper layers of the outwash deposits are well sorted into the finer sized grains.

(i) Miniota Sandy Loam:

A generalized profile description of the well-drained member of Miniota sandy loam is given below:

A	Horizon:	Very dark grey sandy loam (8 to 12 inches thick); fine crumb aggregates; slightly hard when dry; neutral to slightly alkaline in reaction. Grades into: -
B	Horizon:	Dark greyish brown loamy sand (7 to 14 inches thick); weakly irregular columnar structures break into fine crumb aggregates; hard when dry, very friable when moist; slightly alkaline in reaction. Grades sharply into: -
C_{ca}	Horizon:	Light grey, stratified sand and coarse sand (6 to 10 inches thick); structureless; often weakly cemented with lime carbonate.
C or D	Horizon:	Pale brown to light grey, stratified sand, coarse sand and/ or fine gravel; structureless and loose.

The type of soil profile which occurs in the depressional areas depends upon

the height of the perched layer of ground water, and therefore upon the depth of the sandy deposits over glacial till. Where the till occurs close to the surface, Meadow soils have been developed. These soils have a dark grey, sandy loam "A" horizon with a fine crumb structure, very friable consistence, and neutral to slightly alkaline reaction. This is underlain by a gley horizon of dark yellowish brown, sand and coarse sand. The "C" horizon consists of very pale brown, sand and coarse sand which is strongly iron stained. Where the sandy deposit is thicker, the excessive surface water which collects in these local catchment basins percolates through the soil before its downward movement is arrested by the till substrate. This results in the formation of a Meadow Podzol soil with a distinct "A_2" horizon, dark colored "B" horizon, and iron-stained "C" horizon. This type of profile is usually acid in reaction down to the layer of ground-water accumulation.

(ii) Miniota Shaly Phase:

The soils of the Miniota shaly phase are generally similar to the representative Miniota soils. Where these soils occur, the deposit of shaly gravel is generally thin and is underlain by fine textured shaly till. For this reason there is a higher percentage of imperfectly and poorly drained soils associated with this phase than is normal to the Miniota soils.

Agriculture: The soils of the Miniota association are fair in agricultural value. The problems associated with their utilization are those common to all sandy textured soils in the Blackearth zone. Under native conditions these soils are moderately high in fertility and, except during periods of severe drought, support a good growth of native grasses. However, when brought under continuous cultivation for the production of grain, this fertility is rapidly lowered by the loss of organic matter and the finer soil particles through wind erosion.

During the pioneer period of settlement in Manitoba, these soils were highly valued as the land most suited to the production of wheat. Thus the name Wheatlands was given to a village situated on these sandy soils. The main reason for this pioneer concept was that the varieties of wheat available at that time required a much longer growing period than those raised today and the more rapid maturity obtained on the sandy lands was often the critical factor in crop production. However the productivity of these soils declined rapidly and prolonged drought conditions have caused the periodic abandonment of much of the land. This occurred during the severe drought of the "thirties", but with the return of better moisture conditions and high grain prices the land has again been brought under cultivation and is presently being used almost exclusively for the production of grain crops.

These soils can not withstand exposure to the wind. Several inches of the "A" horizon have been lost from all cultivated fields and the dust storms which occur every spring are evidence of further depletion. If grain production is continued, measures should be adopted which will help to control this severe loss of top soil. These measures include: strip farming, trash cover, field shelterbelts, and green manure crops. However, a stable agricultural program for these soils requires the inclusion of an auxilary livestock enterprise. This would enable the utilization of soil improvement crops grown in rotation with the grain crops, and would help to stabilize farm income.

MARRINGHURST ASSOCIATION:

The Marringhurst association consists of coarse textured soils developed on coarse sandy and gravelly outwash deposits. The surface texture of these soils is generally coarse sandy loam. However, some soils which have a sandy loam surface layer and gravelly subsoil have been included with the association. Although these soils are well within the Blackearth zone, the coarse textured parent material causes a locally arid soil climate which is reflected in the native vegetation and the soil profile characteristics.

Most of the soils of the Marringhurst association occur in scattered areas adjacent to the valley of the Assiniboine River. The largest area is located at the confluence of the Qu'Appelle and Assiniboine rivers in the area known locally as the St. Lazare Plains. Other sizeable areas occur in the vicinities of Shellmouth, the Oak Lake Indian Reserve, and Brandon. These, together with numerous smaller areas along tributary rivers and creeks, occupy a total area of approximately 80,640 acres, which constitutes about 2.4 percent of the Rossburn-Virden map sheets.

The topography of the Marringhurst soils is generally level to gently undulating. However, a peculiar topographical condition is encountered in the area of Marringhurst soils within the broadened valley of the Assiniboine River in the vicinity of the Oak Lake Indian Reserve. Here the topography is very rough, being of the type commonly referred to as knob and kettle topography. This condition is thought to have resulted through the original deposition of the gravel on the surface of a block of stagnant ice. Later when the ice melted the gravel was lowered to the valley bottom in its present uneven configuration.

Almost all of the Marringhurst soils are well drained or excessively drained due to the high porosity of the gravel parent material. Poorly drained soils occur only in local depressions or old stream channels in which the gravel deposits are very thin and are underlain by a finer textured substrate such as glacial till. The native vegetation on these gravelly soils consists of mixed prairie grasses with a predominance of xerophytic species such as: grama grass (Bouteloua gracilis), and spear grass (Stipa comata). Surface stoniness varies with the depth of the coarse sandy mantle and the degree of sorting of the surface layers.

A generalized profile description of the well-drained member of the Marringhurst association is given below:

A	Horizon:	Very dark brown coarse sandy loam (3 to 7 inches thick); irregular coarse prismatic; hard when dry, very friable when moist; neutral in reaction. Grades into: -
B	Horizon:	Brown coarse sand and fine gravel (3 to 7 inches thick); structureless; loose; slightly alkaline in reaction. Grades sharply into: -
C_{ca}	Horizon:	Light grey coarse sand and gravel (6 to 10 inches thick); structureless; loose but weakly cemented with lime carbonate when dry; alkaline and very calcareous.
C	Horizon:	Variegated, stratified coarse sand and gravel with a general yellowish brown color; structureless and loose. Gravel contains limestone, shale, and granitic rock fragments.

The excessively drained soils which occur on the elevated sites have a columnar, dark greyish brown "A" horizon and a relatively thick, dark reddish brown "B" horizon. The poorly drained soils have thin, black, crumb structured "A" horizons over a strongly carbonated and iron-stained subsoil.

Agriculture: The best utilization of the Marringhurst soils is illustrated by the community pastures operated by the P.F.R.A. (Prairie Farm Rehabilitation Branch of the Canada Department of Agriculture). Two such pastures, known as the Archie and the Ellice Community Pastures, are located on Marringhurst soils on the St. Lazare Plains. These pastures were established in 1939 as a part of the program for rehabilitation of abandoned farm land in the drier sections of Western Canada. Portions of the area which had previously been cultivated were seeded with drought-resistant grasses, such as crested wheat grass, and the whole of the pasture area was enclosed and subdivided by a network of strong fences. Stock-watering facilities have been secured by the use of windmills. Grazing privileges are accorded at reasonable fees to stock raisers in the vicinity. These community pastures include a total of 60,640 acres. During the 1952-53 season 2,740 head of cattle and 142 horses were grazing on this land.* The estimated carrying

* Report on Prairie Farm Rehabilitation and Related Activites, 1952-53. Canada Department of Agriculture, Prairie Farm Rehabilitation Branch, Regina, Sask.

capacity of pasture land on these soils is about 20 acres per animal unit. (See Figure 21.)

Some grain farming is still being attempted on certain areas of Marringhurst soils. Fair crops of wheat and flax are occasionally obtained in years of high precipitation and even distribution of rainfall throughout the growing season. However this is a very unstable type of agriculture as cultivation of these soils is hazardous due to their great susceptibility to drought and wind erosion. Cultivation and consequent wind erosion results in very rapid depletion of the organic matter reserve which has been built up in these soils during hundreds of years under virgin grassland. This organic matter is the source of most of the fertility and water holding capacity of these gravelly soils. Without it, they would be of very little agricultural value.

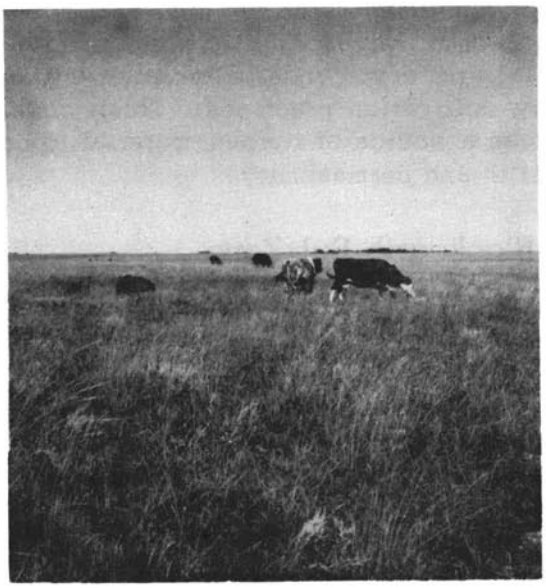

FIGURE 21

Cattle grazing in Archie Community located on Marringhurst soils.

PIPESTONE ASSOCIATION:

The Pipestone association consists of immature clay soils exhibiting various degrees of development toward the Blackearth type. They are developed on clay textured flood-plain deposits of the Pipestone Creek. The lower-lying areas still receive periodic additions of silt and clay alluvial sediments during flood stages of this creek.

The Pipestone soils occur on the outer margin of the Lake Souris Basin in a relatively small area to the west of Oak Lake. They extend south into the South-Western soil map area and north along the broad, shallow channel of the Pipestone Creek for a distance of about 20 miles. In the area covered by the Rossburn-Virden map sheets they occupy approximately 20,608 acres or 0.6 percent of the total area. The topography of these soils is generally flat. As a result of this flat topography and the clay texture of the parent material, drainage is poor over a large portion of the area. The native vegetation consists of grasses and associated herbaceous plants. The grass species present vary with the soil drainage. Mixed prairie grasses predominate on the moderately well-drained soils, while meadow grasses, reeds and sedges occupy the poorly drained sites. Toward the margins of the Pipestone soil area the clay deposits become thin over the underlying sands and the Pipestone clay soils are interspersed with low ridges on which sandy soils of the Souris association are encountered.

The typical, moderately well-drained soils of the Pipestone association have weakly developed profiles in which a black clay "A" horizon tongues into and through an olive grey transitional layer which fades into the dark olive grey subsoil. The "A" horizon has a fine granular structure but is very plastic and sticky. It is alkaline in reaction. Below this surface layer the clay is massive, plastic and sticky, and contains blotches of concretionary lime, iron and gypsum. The dark stained surface horizon is generally 10 to 15 inches thick but tongues of this material protrude to a depth of 25 inches or more.

The poorly drained soils have less profile development and often consist of a mucky, black surface layer of a few inches depth underlain by massive clay with olive grey and black mottling as the dominant feature. Other poorly drained soils show some alkalinization with a weakly columnar "A" horizon over a marly, iron-stained subsoil. Soluble salts often occur in these poorly drained soils.

Agriculture: The better drained Pipestone soils are highly productive and suited to the growth of most regional crops. The chief soil problems arise from their slow drainage. The area is susceptible to spring flooding both from drainage water carried in by the

Pipestone Creek and from local melt water and heavy spring rains. Seeding is often delayed in wet spring seasons and some crop flooding occurs. Improved surface drainage would help remedy this condition and may be effective in bringing larger areas of this soil type under cultivation. At present, a large portion of this soil area is unarable due to excessive moisture. These poorly drained soils are being used as native hay land.

The Pipestone soils are susceptible to soil drifting, especially when the surface soil aggregates become pulverized through slacking down under alternate wetting and drying, freezing and thawing, or through faulty cultivation practices. Trash cover should be utilized to control wind erosion and also as a source of fibrous material to be incorporated later with the surface soil to improve tilth and permeability.

Soils of the Slightly Degrading Blackearth Sub-Zone

Between the grassland soils of the Blackearth zone and the forested soils of the Grey Wooded zone in Western Canada there is generally a narrow strip of transitional soils which comprises the Grey-Black sub-zone. However, in the western part of Manitoba this transition from grassland to forested soils occurs over a broad expanse of gently sloping ground moraine between the Lake Souris Basin and the Riding Mountains. Here the change in climatic conditions and native vegetation is very gradual and a large portion of the transitional area is occupied by soils which show the effect of increasing moisture efficiency but do not exhibit the degree of leaching commonly associated with the soils of the Grey-Black sub-zone. These soils have been designated as Slightly Degrading Blackearth soils. They differ from the normal Blackearth soils mainly in the development of a brown coarse granular to blocky "B" horizon of about equal thickness as the overlying very dark grey "A" horizon. The increased moisture efficiency also is reflected in the native vegetation of this area. The frequency and size of aspen groves increases in a northerly direction as the trees encroach farther up the slopes away from the locally humid depressions. In the early period of settlement the area was known as the "Oat Country" and coarse grains still constitute the major crops under the prevailing system of mixed farming. Except for the local soils in the river valleys and eroded stream channels the soils of this area all belong to the Newdale association.

Somewhat similar conditions as those described above also occur on the elevated land of the Brandon Hills. However the rough topography in this area causes sharp changes in local climate accompanied by corresponding abrupt changes in native vegetation and soils. As a rule the soils on the north and east facing slopes are developed under aspen and oak woods and show a variable amount of degradation, while those on the southern and western slopes are developed under mixed prairie grasses and exhibit Blackearth profile characteristics. Due to this complex pattern of intimately related genetic soil types the soils of this area have been classified as the Tiger Hills-Hilton combination.

TIGER HILLS—HILTON COMBINATION:

The Tiger Hills-Hilton combination consists of thin Blackearth and degrading Black soils developed on high-lime boulder till. These soils occur as a combination on the rough morainic topography of the Brandon and Tiger hills. Their intimate geographical association is due to the local variation in soil climate between the slopes of different exposure and vegetative cover. Generally the north and east-facing slopes, which have a more favorable temperature - percipitation relationship, are wooded and occupied by degrading Black soils of the Tiger Hills association; while the drier southern and western slopes are under grassland vegetation and the soils are the thin Blackearths of the Hilton association.

The parent material of these soils is highly calcareous boulder till derived mainly from limestone and granitoid rocks and is low in shale material. For this reason the soils are low in clay content and are generally of a loam texture. Drainage is good

over most of the area due to the steep local relief. The runoff waters either leave the area by way of deeply eroded ravines or accumulate in local enclosed depressions. Surface stones occur throughout the soil area and are very numerous in some localities. The soils of the Tiger Hills-Hilton combination occupy approximately 14,490 acres in the Rossburn-Virden map sheets (0.4 percent of the total area).

Tiger Hills Association:

The Tiger Hills soils exhibit varying degrees of degradation depending on the topographical position and the period of time in which the soils have been influenced by forest vegetation. The well-drained soils which occur on the slopes under a closed stand of aspen have strongly degraded profiles approaching the Grey Wooded type. The eluvial "A" horizon and illuvial "B" horizon are strongly expressed, but are thin compared with most Grey Wooded soils due to the high-lime content of the parent material. A generalized profile description of this soil is given below:

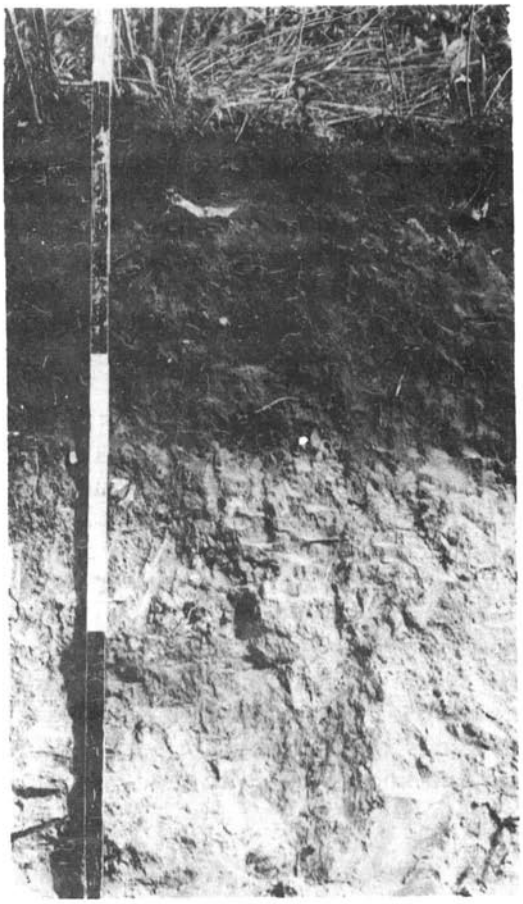

FIGURE 22

Soil profile of Tiger Hills loam. A degrading Blackearth soil developed on highly calcareous glacial till.
(Measuring stick interval = 12 inches.)

A_0	Horizon:	Very dark greyish brown, partially decomposed leaf mat; slightly acid in reaction (1 to 2 inches thick).
A_2	Horizon:	Dark greyish brown fine sandy loam (3 to 6 inches thick); medium platy; friable; slightly acid in reaction. Mottled with organic matter in the upper portion.
A_3	Horizon:	Light yellowish brown loam (2 to 3 inches thick); coarse crumb; friable; acid in reaction.
B_2	Horizon:	Yellowish brown clay loam (5 to 7 inches thick); fine to medium blocky; firm; acid in reaction. Grades sharply into: -
C_{ca}	Horizon:	Very pale brown loam (6 to 10 inches thick); fine crumb structure; very friable; marly.
C	Horizon:	Very pale brown loam boulder till; fine psuedo-crumb structure; very friable; alkaline and very high in lime carbonate content.

Toward the apex of the slopes the tree cover becomes more open and the soil profiles are thinner and less strongly degraded. This is a result of increased runoff and consequent drier soil climate. Meadow, saline Meadow and degraded Meadow soils occur in the depressional areas at the base of the slopes. These soils are common to both the Tiger Hills and Hilton associations. The parent material of these poorly drained soils is generally modified and may consist of stratified drift deposits.

Hilton Association:

The well-drained Hilton soils are thin Blackearth or Rendzina soils and occur under mixed prairie grasses on the drier sites in this area of variable micro-climatic conditions. The depth of the soil profile is related to the topographical position and to the variable soil moisture regime which accompanies the sloping topography. The profiles decrease in thickness toward the top of the slopes as a result of the decrease in soil moisture due to accelerated surface runoff. A generalized profile description of the well-

drained member is given below:

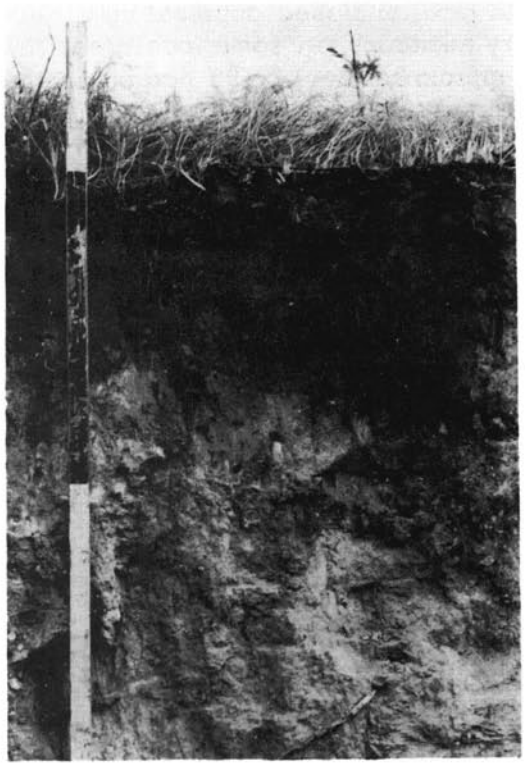

FIGURE 23

Soil profile of Hilton loam. A Blackearth soil developed on highly calcareous glacial till. (Measuring stick interval = 12 inches.)

A	Horizon:	Dark grey loam (6 to 10 inches thick); fine crumb structure; friable when moist, hard when dry; slightly alkaline in reaction and may contain some free lime carbonate.
A-C	Horizon:	Dark greyish brown loam (2 to 4 inches thick); fine crumb; friable; alkaline in reaction, contains free lime carbonate.
Cca	Horizon:	Very pale brown loam (5 to 10 inches thick); fine crumb; friable; alkaline and marly.
C	Horizon:	Very pale brown loam boulder till; fine psuedo-crumb; friable; alkaline and very high in lime carbonate content.

Toward the top of the slopes and on the grass-covered knolls the soil profiles are very thin. These soils are calcareous to the surface and exhibit only weak profile development. They generally consist of a 4 to 6 inch dark greyish brown loam "A" horizon over a layer of lime carbonate accumulation. The depressional areas at the base of the slopes are generally occupied by saline Meadow soils, although Meadow and degraded Meadow soils also occur.

Agriculture: The soils of the Tiger Hills and Hilton associations that occur in the Rossburn-Virden map area are of little agricultural value. They generally occur on slopes of 5 to 10 percent or more and, if cleared of natural vegetation and brought under cultivation, the shallow "A" horizon is rapidly lost through soil erosion. The soils are often very stony. The high-lime content renders crops grown on them susceptible to physiological drought and nutritional deficiencies. Even though the organic matter content of the surface may be quite high, the total reserve is low due to the shallow depth of the profile. Therefore these soils, as they occur in this area, are best utilized in their native state as woodlot and pasture lands. This is the general practice at the present time and should be continued.

NEWDALE ASSOCIATION:

The Newdale association consists of medium textured soils developed on boulder till of mixed materials derived from shale, limestone, and granitic rock sediments. These soils have developed under intermixed aspen grove and grassland vegetation. The influence of woods, together with a higher precipitation-effectivity due to a slightly cooler climate than prevails to the south, have resulted in some degradation in the soils. For this reason the soils of this area have been referred to as "Northern Black Earths".*

The soils of the Newdale association are by far the most extensive types in the Rossburn-Virden map areas. They cover approximately 1,365,708 acres, which constitutes over 39 percent of the total area within the map sheets. The northern boundary of the association coincides roughly with the 1,900 foot contour on the southern slope of the Riding Mountain and the soils extend south-west to the Arrow Hills and southward to the Lake Souris Basin.

* "The Soils of Manitoba", by J. H. Ellis, Project 13, Economic Survey Board, 1938.

The topography is generally undulating (irregular gently sloping) with innumerable undrained depressions varying in size from small "potholes" and sloughs to large meadows and intermittent and shallow lakes (Figure 24). Variations from this typical, ground morainic type of topography occur, notably within a strip of land adjacent to the Assiniboine River Valley between Foxwarren and Cracknell where the relief is characterized by broad, smooth gentle slopes, and in the southeastern portion of the soil area where the terrain is smoother and marked depressions less numerous. As a result of this irregular relief pattern, surface drainage is quite variable and ranges from excessive runoff on the steeper slopes to prolonged inundation of the depressed areas. Internal or soil profile drainage has a corresponding range from good to very poor.

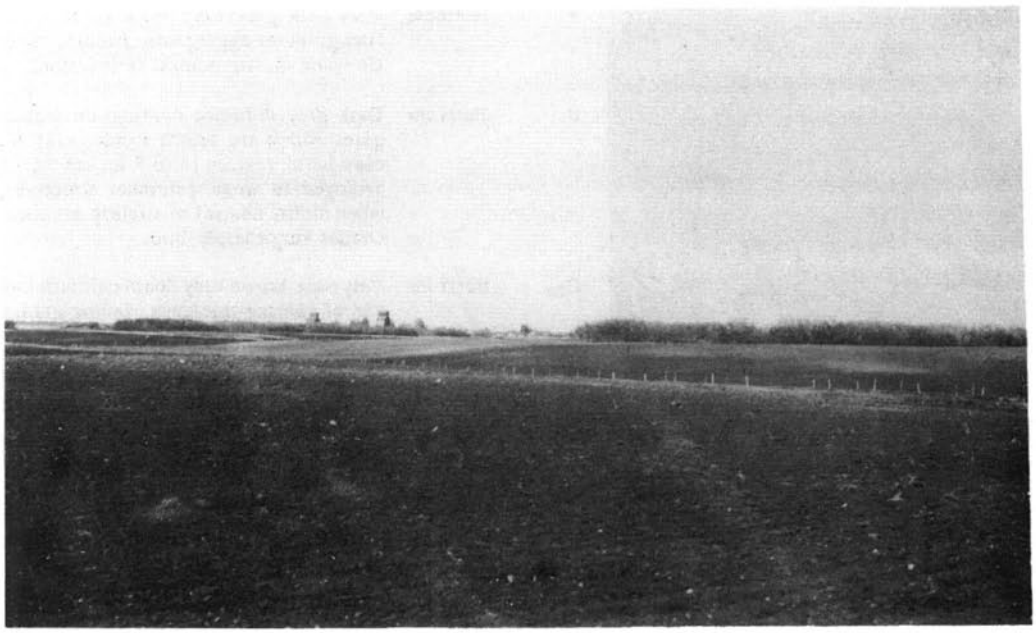

FIGURE 24

Landscape view of Newdale undulating phase showing typical topography and scattered groves of aspen. Note the evidence of erosion on the knolls and slopes.

The majority of the better drained Newdale soils were developed under grassland vegetation. However, the area as a whole lies within what has been designated as the "Park Belt" and islands of aspen occur in ever-increasing size from south to north. In the southern portion of the area, aspen occurs as rings of trees around the sloughs in the depressions. Towards the north the trees have crept farther up the slopes, particularly on the northern exposures, so that only the soils on the higher positions have not been influenced by this woodland invasion.

Although glacial stones are present in all the Newdale soils, they do not constitute a serious problem to cultivation over most of the area. The exception is in areas adjacent to the major river channels where the boulder till was subjected to severe erosion during the post-glacial period. Here, the finer material was washed out of the surface layer, leaving a stony, water-worked till as the parent material from which the soils were subsequently developed.

The Newdale association has been separated into four major divisions or phases on the basis of topography and modification of the parent material. These divisions are shown on the soils map and will be described as: the undulating phase, the broadly rolling phase, the smooth phase, and the modified phase.

(i) Newdale Undulating Phase:

The associated soils in the Newdale undulating phase may be regarded as the representative Newdale soils. They occupy approximately 986,865 acres, or about 72 percent of the total area covered by the Newdale association. The topography varies from roughly undulating to smooth, but is characteristically moderately undulating (irregular, gently sloping) with innumerable undrained depressions. As a consequence of this irregular topography, surface drainage is variable and, due to this variation in drainage and in the amount of water that enters the soil profile, the soils may vary considerably in different parts of the same field. The representative Newdale soils, which are found in the well-drained positions and on the more gentle slopes, may be described as follows:

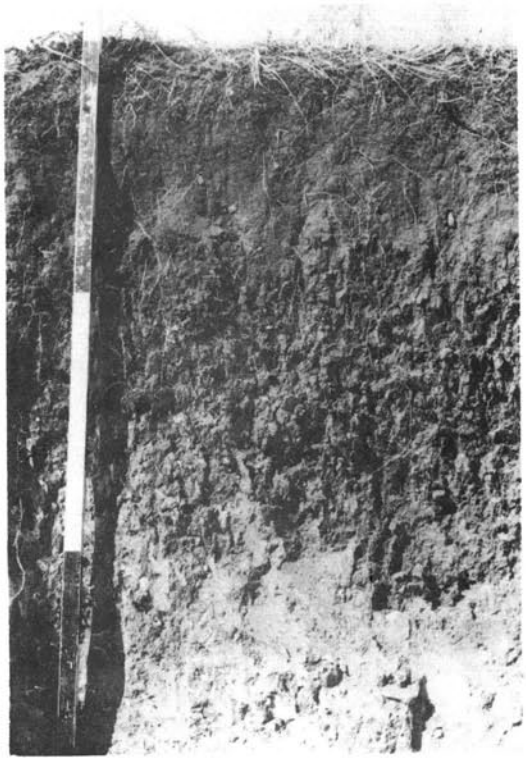

FIGURE 25

Soil profile of the well-drained associate of the Newdale undulating phase. A slightly degrading Blackearth soil developed on moderately calcareous glacial till.
(Measuring stick interval = 12 inches.)

A	Horizon:	Very dark grey clay loam (6 to 10 inches thick); fine granular aggregates; friable, moderately plastic when moist; neutral in reaction.
B	Horizon:	Dark greyish brown coatings on fine blocky aggregates which are brown inside; clay loam to heavy clay loam texture (5 to 8 inches thick); aggregates arranged in weak columnar structures; hard, firm when moist; neutral to slightly alkaline in reaction. Grades very sharply into: -
C_{ca}	Horizon:	Very pale brown clay loam calcium carbonate horizon of varying thickness, fading gradually into: -
C	Horizon:	Light brownish grey glacial till of clay loam texture; amorphous; weakly cemented when dry, plastic when moist; contains powdered iron in root channels and concretionary carbonates. Glacial rock fragments are from limestone, granitic and shale rock materials.

Associated with these well-drained soils are intermediately drained, poorly drained, and degraded soils of variable character. The intermediately drained soils usually occur as narrow bands around the edge of depressions or along the margin of broad shallow draws. They are generally similar in character to the well-drained member described above. However, the "A" horizon is deeper, the "B" horizon less distinct, and the "C" horizon shows the influence of imperfect drainage by being iron stained, mottled with lime carbonate and in some cases containing gypsum crystals and pseudomycelium of other soluble salts.

The soils which occur in the numerous undrained depressions and shallow draws are of four distinct types. These types, which are often associated with one another in the poorly drained sites, are: Meadow soils; degraded Meadow soils; mucky, high-lime soils; and mucky saline soils. The Meadow and degraded Meadow soils are the common members associated with the better drained soils throughout the Newdale undulating phase area. The degraded Meadow, or Meadow Podzol, soils are more common in the northern portion of the area and the saline Meadow soils are the dominant type in the southern portion.

The Meadow soils are variable in thickness and are often developed on modified parent material. The profile generally consists of two or more inches of muck or mucky material on a variable thickness of very dark grey to black clay loam. The black "A" horizon tongues into a highly carbonated and iron stained subsoil which may consist of alluvium, water-worked till, or undifferentiated till. The soil is usually alkaline

throughout, but the reaction of the "A" horizon may be neutral to slightly acid if the soil is slightly degraded.

The Meadow Podzol soils are characterized by a grey, acid "A_2" horizon; a thick, blocky, dark brown "B" horizon; and a carbonated and iron-stained subsoil. The surface horizon imparts a grey color to the soil when exposed by cultivation and extensive areas of these greyish soils are a characteristic of the cultivated fields in the northern portion of the Newdale soils.

The calcareous and saline Meadow soils occur most commonly in association with shallow, intermediately drained calcareous soils in large areas in the central and northern portion of the Newdale soils. These areas are quite distinctive from the Newdale undulating phase and have been separated and designated on the soils map as the calcareous and salinized associates. They are characterized by low relief; numerous sloughs, shallow draws, intermittent and shallow lakes; and a high percentage of intermediate and poorly drained, calcareous and salinized soils. Other soil associates normal to the Newdale undulating phase occur, but their presence is restricted to small isolated areas of better drained land and even they are affected to some extent by calcareous and slightly saline subsoils.

The dominant soil type in these areas of low relief is the intermediately drained, calcareous associate. It occurs in belts adjacent to the poorly drained soils and has been developed under vegetation which consists mainly of dry-land grasses and herbs and alkali-tolerant plants. The deciduous trees that do occur are less vigorous than in other areas and dry-land vegetation such as wolf willow, snow-berry, wormwood and sage, is more prevalent. The representative profile of this associate is described as follows:

A	Horizon:	Very dark grey clay loam (6 to 12 inches thick); fine granular structure; firm, sticky when moist; slightly alkaline and contains some free lime carbonate; occasional salt pseudomycelium also present. Grades into: -
A-C	Horizon:	Light brownish grey clay loam (2 to 4 inches thick); crumb structure; friable; alkaline; contains free lime carbonate and some salt pseudomycelium. Grades sharply into: -
C_{ca}	Horizon:	Light grey to white calcium carbonate horizon (10 to 15 inches thick); clay loam; contains some concretionary iron, gypsum and salt pseudomycelium. Grades into: -
C	Horizon:	Light olive grey clay loam boulder till which is massive, plastic and sticky and contains large blotches of concretionary iron, lime carbonate and gypsum crystals.

The calcareous and salinized Meadow soils occur in the poorly drained positions and are usually non-arable because of inundation during the spring season or the presence of excessive amounts of soluble salts. The profiles are similar to the representative Meadow soils of the Newdale undulating phase, but the "A" horizon is strongly blotched with lime carbonate and contains both salt and limonite concretions.

(ii) Newdale Broadly Rolling Phase:

This topographical phase of the Newdale association occurs in a broad belt adjacent to the Assiniboine River Valley in the vicinity of Foxwarren, Binscarth, Russell and Silverton. It represents an indistinct recessional morainic area in which the relief is characterized by relatively broad, smooth gentle slopes varying in length from one-quarter to three-quarters of a mile and having summits from twenty to one hundred feet higher than the intervening depressional areas. It occupies approximately 82,176 acres, which represents slightly over 6 percent of the total area of Newdale soils.

The soils in this area have been influenced to a varying degree by a general, although somewhat erratic, higher shale content of the boulder-till parent material than is normal to the Newdale soils. In some parts of the area, particularly in the vicinity of Russell, shale bedrock frequently is close to the surface on the crests of the rolls and occasionally is encountered at depths of two to six feet.

The soils of the broadly rolling phase show modifications in profile characteristics and distribution of associates from those of the Newdale, undulating phase. These modifications result from the rolling topography, higher shale content of the parent material, and a slightly more humid climate. The well-drained soils, which occur on the heights of land and over a large portion of the gentle slopes, generally have a deeper "A" horizon and darker colored "B" horizon than the normal Newdale well-drained soils. A generalized profile description of these soils is given below:

A	Horizon:	Very dark grey clay loam (8 to 12 inches thick); finely granular aggregates; friable; neutral in reaction. Grades quite sharply into: -
B	Horizon:	Brown to dark brown clay loam to heavy clay loam (8 to 12 inches thick); fine blocky aggregates arranged in weakly developed columns; firm when moist, hard when dry; neutral to slightly alkaline in reaction. Grades into: -
Cca	Horizon:	Light grey lime carbonate horizon (8 to 12 inches thick); clay loam; finely granular; friable. Grades into: -
C	Horizon:	Light brownish grey, clay loam shaly boulder till; fine pseudo-granular; friable; moderately calcareous; contains blotches of concretionary limonite and flakes of undecomposed shale.

The greater portion of soils in the intermediately drained position have been affected to a varying extent by the influence of woods. These soils occur in the shallow depressions on the slopes and in narrow bands adjacent to the poorly drained areas. They are characterized by a textural "B" horizon with more strongly developed sub-angular blocky or fine blocky structure than the well-drained member and, in some cases, by a thin, greyish "A_2" horizon which is slightly acid in reaction. Intermediately drained soils which show little or no effect of woods also occur and are similar in character to the corresponding associates in the Newdale undulating phase.

The soils in the poorly drained positions are variable and may consist of Meadow, Meadow Podzol, saline Meadow, or mucky Meadow soils. The small depressions which occur toward the base of the slopes, but at a slightly higher elevation than the large basinal areas, are usually occupied by Meadow Podzol soils. Meadow and mucky Meadow soils predominate in the large basinal areas, and saline soils are sometimes found on the edges of sloughs and intermittent lakes. These soils are similar in profile characteristics to the corresponding associates in the Newdale undulating phase.

(iii) Newdale Smooth Phase:

The Newdale smooth phase occurs as a marginal strip at the south-east extremity of the Newdale soil area. The topography is irregular and gently undulating in some portions, but generally it is relatively smooth as compared to the area of the Newdale soils to the north and variations in relief are much less pronounced. This topographical phase occupies approximately 171,495 acres in the Rossburn-Virden map areas and comprises about 12.5 percent of the total area of Newdale soils.

This area is somewhat similar to that denoted as the calcareous and salinized associates within the Newdale undulating phase. The soils in the smooth phase are generally thinner and more calcareous than is normal to the Newdale association and soluble salts commonly occur in the lower horizons of the soil profiles. However in this area, although calcareous and saline soils are common in the shallow depressions, the dominant soils are moderately well drained. These soils although similar in morphological characteristics to the representative well-drained Newdale soils have thinner profiles and less pronounced "B" horizons. This deviation from the representative type is due to the lower relief and possibly in part to a more calcareous parent material. The associated poorly drained soils are mostly saline Meadow soils of similar characteristics to those in other Newdale soil areas.

(iv) Newdale Modified Phase:

Soils of the Newdale modified phase occupy approximately 125,106 acres (9.2 percent of the Newdale soil area) and occur in scattered areas adjacent to the valleys of the Assiniboine, Birdtail and Minnedosa rivers. These areas are characterized by slightly undulating (irregular, very gently sloping) topography and park-like vegetation. The soils are developed on boulder till that was eroded by glacial waters to the extent that a layer of stones or gravel of varying thickness was left as a remnant of this erosion. Where no subsequent deposition occurred, the skeletal material remained as a surface mantle, but where deposition did occur, the coarse fragments are now within the soil profile. Thus the profiles exhibit little uniformity in texture and parent material and no representative description can be given. The surface textures range from sandy loam to clay loam and the subsoil or parent material mav be stony till, a mixture of gravel and stony till, or only slightly modified till. The soils resemble those of the Oxbow modified phase but are separated on the basis of their relationship with the normal zonal soils.

Agriculture: The representative, better-drained Newdale soils are highly fertile and productive. They are characterized by a high organic matter content, moderate supply of plant nutrients, favorable texture and structure, excellent moisture retention and aeration relationship, and very good tilth and workability. Thus, in areas where these better drained associates comprise a large portion of the soils on individual farms, capable farm operators are rewarded with consistent high yields of grain or forage crops and consequent prosperity relative to the times. However, the productivity of these fertile Newdale soils is considerably reduced over a large portion of this area by the occurrence of a high proportion of poorly drained calcareous and salinized, or stony soils. Some of these soils are not suited for grain production and their extent, largely dependent on the local topography, has rendered the area as a whole more suited to mixed farming than to the exclusive production of grain crops.

The practice of mixed farming as a means of utilizing extensive areas of non-arable soils which characterize portions of the Newdale soil area, is further supported by climatic conditions of the area which favor the production of coarse grains. Prior to the development of early-maturing varieties of wheat, this area was known as the oat country and, although the wheat acreage has increased during recent years, oats and barley still occupy a major portion of the sown acreage.

A complementary livestock enterprise for farms on Newdale soils is not only desirable from the standpoint of suitability of the area to feed crops and utilization of waste land, but also is highly desirable as an integral part of a stable farm program. Soil erosion is an ever-increasing problem on this undulating and rolling topography, and a continuous fallow-grain system of cropping would eventually result in a severe reduction of fertility of these originally, highly fertile soils. Six and eight-year crop rotations including two or more years of grasses and legumes grown for hay and pasture, together with contour cultivation, seeding down to permanent grass of steep slopes and natural runways, and the use of trash cover and windbreaks to reduce wind erosion, are necessary practices on all the soils if fertility is to be maintained.

Local soil areas within the Newdale association which present special management problems are those occupied by salinized, degraded, and stony soils. The salinized soils are usually located in poorly drained areas which are often too wet for cultivation. These are best suited for native hay and pasture land. Where adequate drainage can be provided, improvement in land use may be obtained through the growth of saline-tolerant grasses and legumes. The degraded soils under cultivation and seeded to grain are indicated by short crops and reduced yields. These soils are low in organic matter and available plant nutrients and are benefitted by applications of manure and commercial fertilizers and the growth of grasses and legumes. The stony soils are restricted to areas of Newdale modified phase and within these areas surface stoniness is variable. Where

the soils are too stony for cultivation, the land is best suited for native hay and pasture.

Thus it may be seen that the agricultural value of Newdale soils varies from high to very low and the value of any individual parcel of land is largely dependent on the local topography which governs the distribution of the various soil associates. For this reason, the Newdale broadly rolling phase with its characteristic long gentle slopes, together with certain portions of the undulating phase where the intervening sloughs and potholes are at a minimum, constitute the best agricultural land in the Newdale association. These soils are highly fertile and very productive, but the same topographical features which are responsible for the high percentage of well-drained, fertile soils are also those features most conducive to loss of this fertility through soil erosion. Therefore, judicious management of these soils is of paramount importance.

Soils of the Grey-Black Sub-Zone

The Grey-Black soil sub-zone occurs as a transitional strip of land on the south slope of the Riding Mountain between the strongly leached soils of the Grey Wooded zone and the slightly degraded soils of the Newdale association. The width of this sub-zone is determined by the degree of slope and is widest where the topography has been smoothed by post-glacial erosion and sedimentation. The soils in this area are assumed to have developed originally under grassland vegetation, but prior to cultivation they had been under the influence of a closed forest cover for a considerable period of time. The typical well-drained soils are characterized by a thin, greyish-black, mottled "A_2" horizon underlain by a textural, brown to dark brown "B" horizon with well-developed blocky structure. The eluvial "A_2" horizon is slightly acid in reaction and the illuvial "B" horizon is neutral to slightly acid. A distinct horizon of lime carbonate accumulation occurs immediately below the "B" horizon. These soils have not been severely depleted in fertility by leaching and they compare favorably in productivity with the soils of the Blackearth zone. The soils that occur in this sub-zone within the Rossburn-Virden map sheet areas belong to the Erickson and Onanole associations.

ERICKSON ASSOCIATION:

The Erickson association consists of medium textured soils developed on boulder till parent material of similar origin and composition to that of the Newdale and Waitville associations. These soils are located at a higher elevation than the Newdale soils and the process of degradation under woods is more advanced. They occur as a transitional belt between the slightly Degrading Blackearth soils of the Newdale association and the Grey Wooded soils of the Waitville association.

This transitional belt of Grey-Black soils, which traverses the south slope of the Riding Mountain, lies approximately between the 1,900 and 2,000 foot contours and varies in width with the degree of slope. Where the change in elevation is sharp, the transition from Black to Grey Wooded soils is abrupt; but where the slope is more gentle, the increase in degradation of the soils is gradual and a broad transitional zone must be recognized. The soils of the Erickson association occupy the major portion of this transitional zone. They cover approximately 190,054 acres, which represents 5.5 percent of the total area within the Rossburn-Virden map sheets.

The topography of the Erickson soils is irregular, moderately sloping. It is similar in form to that of the Newdale, undulating phase, but the slopes are generally sharper and the undulations are therefore more accentuated. The surface drainage of the Erickson soils is generally good. However, as a result of the moderately undulating topography, undrained depressions and shallow lakes are of common occurrence. The vegetation of the area is dominantly aspen with a thick undergrowth of hazel, dogwood, chokecherry, cranberry, rose, vetch, etc. Black poplar and willows predominate in the poorly drained sites.

Glacial stones are present throughout the Erickson soils; however surface stoniness is not a problem to cultivation, except where it has been accentuated by erosion of the finer materials from knoll positions. Where this has occurred, stones have become sufficiently concentrated on the eroded surface of the soil to present tillage problems.

The dominant member of the Erickson association is the well-drained associate, which occurs on the crests and slopes of the undulations. A generalized description of the representative profile of this associate is given below.

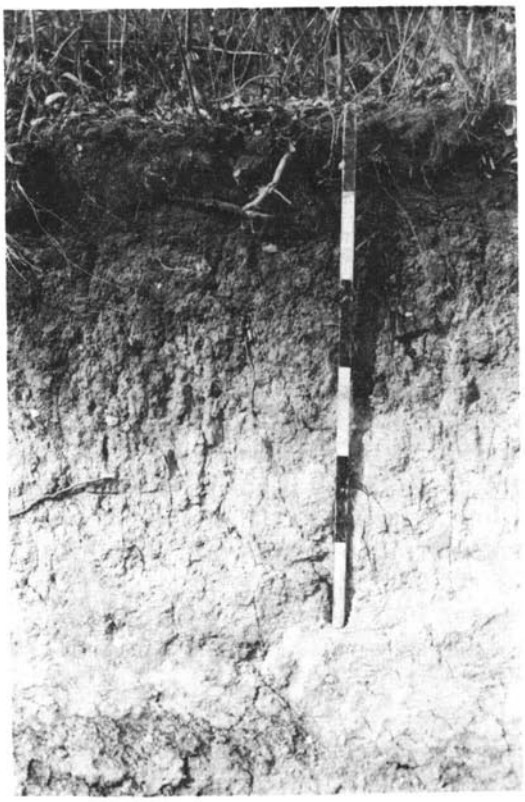

FIGURE 26

Soil profile of Erickson clay loam. Grey-Black soil developed on moderately calcareous glacial till.
(Measuring stick interval = 6 inches.)

A_o	Horizon:	Very dark brown leaf and sod mat (1 to 3 inches thick); partially decomposed; mixed with considerable mineral matter in the lower portion; neutral in reaction.
A	Horizon:	Dark grey clay loam (5 to 8 inches thick); granular; friable; slight greyish blotching may be evident under dry conditions; neutral to slightly acid in reaction.
B_2	Horizon:	Dark greyish-brown heavy clay loam (6 to 10 inches thick); medium-sized blocky aggregates arranged in weakly developed irregular columns; hard when dry, firm when moist; neutral to slightly acid in reaction. Grades into:-
B_3	Horizon:	Greyish-brown clay loam (2 to 4 inches thick); fine granular aggregates; firm; contains some free lime carbonate. Grades sharply into:-
C_{ca}	Horizon:	Very pale brown calcium carbonate horizon (variable in thickness, usually 8 to 12 inches thick); clay loam; pseudo-granular aggregates; weakly cemented; contains pockets of powdered concretionary iron. Fades gradually into:-
C	Horizon:	Light greyish brown, clay loam glacial till; psuedo-fragmental; hard when dry, but plastic when moist; contains concretions of calcium carbonate and powdered iron, and glacial rock fragments from limestone, shale and granitic rocks.

The intermediately drained soils are of minor importance in the Erickson association as their occurrence is restricted to narrow strips surrounding the poorly drained sites. Within these confined limits, the soil profiles vary considerably. Differences in the degree of degradation are exhibited by the character and depth of the "B" horizon. In some places this horizon has a well-developed blocky structure and is 4 to 6 inches thicker than the "A" horizon. Elsewhere the subsurface layer is granular in structure and represents a gradual transition between the "A" horizon and the subsoil. A bleached "A_2" subhorizon is seldom in evidence, except in some local areas where Meadow Podzol soils have been developed. These occur only in slight depressions part way up the slopes where temporary ponding of runoff waters and subsequent percolation of these waters through the soil has resulted in greater degradation.

The soils which occur in the undrained depressions are generally Peaty Meadow, Half Bog or Bog soils. The Peaty Meadow soils predominate. They consist of 3 to 12 inches of fen peat underlain by a shallow mucky "A" horizon which is generally clay in texture. The subsoil is very calcareous and iron stained and usually consists of a variable depth of clay alluvium over glacial till. These soils were not differentiated from the Half Bog and Bog soils when the area was mapped.

Agriculture: The better drained Erickson soils are nearly equal in fertility to

the corresponding members of the Newdale undulating and rolling phases. The organic matter content of the surface soil is slightly lower, due to increased leaching, but the supply of available plant nutrients other than nitrogen is about equal and the soil reaction may be more favorable for the growth of most grain and forage crops. The moisture retention capacity is equal to that of the Newdale soils and the precipitation-effectivity is higher in this area due to a somewhat cooler climate.

The same reasons that were advanced to discourage continous grain cropping of Newdale soils are even more applicable to this area of Erickson soils. The rougher topography accompanied by steeper slopes and accelerated runoff renders these soils highly susceptible to severe water erosion when unprotected by vegetative growth. This if forcibly emphasized by the exposure of greyish-brown subsurface and subsoil material on nearly every cultivated knoll within the area, and the presence of eroded gullies wherever runoff waters are locally concentrated. The end result of continued fallow-grain farming should be very evident to anyone.

Frost hazard is still an important risk in the production of wheat at this elevation and coarse grains are better adapted to the area. Forage crops suited to the climate produce well on these fertile soils and their utilization by means of a complementary livestock enterprise also enables use to be made of the nonarable, poorly drained soils as hay and pasture lands. The rough, irregular topography restricts the use of contour strips of grass as a means of reducing water erosion. Therefore, long-term crop rotations with a strong emphasis on grasses and legumes, together with contour cultivation and seeding down of runways and steep slopes to permanent grass is the recommended method for minimizing erosion and avoiding the rapid lowering of fertility. The use of sweet clover in the rotation as a green manure crop is very beneficial to these soils which tend to be low in available nitrogen. It also offers a method of protecting the soil and replenishing the fibre content when the production of grasses and legumes for hay and pasture is not desired by the farm operator. The use of trash cover as a surface protection and source of organic matter should be a standard practice.

ONANOLE ASSOCIATION:

The Onanole association consists of sandy loam to silty clay loam textured soils developed on lacustrine sediments. These sediments are underlain, at inconstant depths below the soil profile, by a substrate of glacial till. The well-drained members of this association are Degrading Blackearth soils which exhibit variable degrees of modification from the Blackearth type.

These soils are located in the vicinity of Proven Lake, and represent the southern portion of an area of glacio-lacustrine deposits on the south slope of the Riding Mountain. They occupy approximately 10,265 acres, or 0.3 percent of the total area in the Rossburn-Virden map sheets. The topography is generally gently to sharply undulating (irregular, gently to moderately sloping) with a smooth, very gently sloping area occurring as a narrow strip adjacent to the west and south borders of the peat bog surrounding Proven Lake.

The Onanole soils were originally developed under grassland vegetation but came under the influence of woods with the invasion of this area by aspen from the higher land to the north. At present, the vegetative cover on the well-drained, virgin sites consists mainly of aspen with a dense undergrowth of upland shrubs such as: hazel, rose, saskatoon, dogwood, etc. In the lower positions, black poplar and willow occur interspersed with areas of meadow grasses and herbs, reeds, and sedges.

The Onanole association is divided into two textural phases. The finer textured soils, which occur in the southern portion of the area and occupy approximately 7,245 acres, have a surface textural range of very fine sandy loam to silty clay. They have been designated on the soil map and are described below as Onanole clay loams. The sandy textured soils, designated as Onanole fine sandy loams have a range of surface

texture from sandy loam to fine sandy loam and occupy approximately 3,020 acres in the northern portion of the area.

(i) Onanole Clay Loams:

The dominant soil associate of the Onanole clay loams is the well-drained member. It occurs on the knolls and usually extends well down the slopes. These soils are developed on very fine sandy loam to clay loam textured material and the finer textures occur in the lower positions. A generalized description of the representative virgin profile of this member developed on very fine sandy loam parent material is given below:

A_0 Horizon: Dark greyish-brown, partially decomposed leaf mat (1 to 2 1/2 inches thick); neutral to slightly acid in reaction.

A_1 Horizon: Dark grey very fine sandy loam; very friable; crumb structure; neutral. (Very thin and often absent.)

A_2 Horizon: Greyish brown very fine sandy loam (1 to 2 inches thick); crumb structure; friable; neutral in reaction.

B_2 Horizon: Dark greyish brown very fine sandy clay loam (6 to 8 inches thick); coarse granular to fine blocky structure; firm when dry, slightly plastic when moist; neutral to slightly acid. Grades into:-

B_3 Horizon: Greyish brown very fine sandy loam (2 to 4 inches thick); medium granular; firm; slightly alkaline and contains some lime carbonate. Grades into:-

C_{ca} Horizon: Light grey very fine sandy loam, calcium carbonate horizon (8 to 12 inches thick). Fades gradually into:-

C Horizon: Light yellowish brown very fine sandy loam; weak crumb-like aggregates; very friable; very high content of lime carbonate.

Intermediately drained soils occur on the lower portions of the slopes in the areas of sharply undulating topography, and over a large portion of the very gently sloping area adjacent to the peat deposits surrounding Proven Lake. These soils are quite variable in texture and are commonly developed on stratified parent material. However, the textures are generally finer than on the higher positions and are usually in the clay loam class. The degree of profile development is also variable and the soils are often relatively immature.

The poorly drained positions are occupied by Peaty Meadow, Half Bog and Bog soils and the organic layer is usually underlain by silty clay material. Profile development under the peat is generally feeble, except at the outer edges of the depressions where the organic horizon is less than 12 inches thick. The subsurface horizons, where present, are gleyed, highly calcareous, strongly iron stained, and often contain gypsum and other soluble salts.

(ii) Onanole Fine Sandy Loams:

The dominant soil associate in the sandy textured phase of the Onanole soils is the intermediately drained member. The topography is generally smoother than in the main area of finer textured Onanole soils south of Proven Lake, and the underlying substrate of boulder till is usually closer to the surface. Thus, the soils are characterized by lower relief and impeded internal drainage. Well-drained soils are restricted to the higher knoll positions. Where they occur, the profiles are deeper than in the finer textured phase and leaching is more pronounced. However, due to the sandy textured parent material, the soil horizon separations are based largely on color differences and variations in texture; structure and consistence are of less significance.

A generalized description of the representative profile of the intermediately drained member is given below.

A_0 Horizon: Very dark greyish brown leaf and sod mat (1 to 3 inches thick); upper portion is undecomposed but degree of decomposition increases with depth; slightly acid in reaction.

A Horizon: Dark greyish brown sandy loam to fine sandy loam (8 to 12 inches thick); weak crumb structure; extremely friable; neutral to slightly alkaline in reaction. Grades into: -

B Horizon: Pale brown sandy loam to fine sandy loam (6 to 10 inches thick); may have slightly finer texture than "A" horizon; weak fine granular aggregates; friable; slightly iron stained toward base; neutral to slightly alkaline in reaction. Grades into: -

C Horizon: Very pale brown fine sandy loam to sand; structureless; may be weakly cemented with lime carbonate; contains concretionary lime and iron.

The soils in the poorly drained positions are dominantly Peaty Meadow soils and are characterized by 3 to 12 inches of fen peat, underlain by 8 to 12 inches of dark grey, gleyed fine sandy loam over a subsoil highly mottled with iron and lime. A substrate of finer textured material is of common occurrence in these low positions. Where the surface layer of peat exceeds 12 inches in thickness, the soils are classified as Half Bog or Bog soils and generally exhibit little profile development below the organic layer.

Agriculture: The Onanole soils range from medium to low in natural fertility. The finer textured phase is much superior to the sandy phase in respect to organic matter content, available plant nutrient level, and moisture retention capacity. However, the relatively higher fertility of these finer textured soils is accompanied by a greater susceptibility to water erosion, due to the sharply undulating topography on which they occur. Thus, the Onanole soils have a limited adaptability and are not suited to the exclusive production of grain.

Although mixed farming is the dominant practice in this area, the hay for livestock is obtained mainly from the nonarable land in the low positions. Hence, the cultivated soils are utilized under a fallow-grain rotation. This land-use practice has resulted in serious loss of top soil on the finer textured soils and rapid depletion of the low natural fertility on the sandy soils. The recognition that these soils are unsuited for continued grain production is a prerequisite to the establishment of a stable farm program. They are best suited to stock raising, and to the production of forage crops for seed and hay. Grain crops should be limited to the areas of smoother topography and should be restricted to periodic production in long-term rotations with grasses and legumes. Manure and commercial fertilizers containing nitrogen and phosphorus can be expected to give excellent response on these soils and should be applied to increase the production of both forage and grain crops.

Soils of the Grey Wooded Zone

The Grey Wooded soil zone occurs on the upper slopes of the Riding Mountain approximately above the 2,000 foot contour. This upland region is within the mixed wood section of the Boreal forest and the native vegetation consists of a closed stand of aspen, birch, spruce and tamarack. This forest cover reflects the occurrence of a more humid climate here than in the adjoining areas of aspen grove and grassland, and the soils of this region exhibit a corresponding increase in degradation or leaching. The representative well-drained soil is characterized by a 2 to 3 inch leaf mat ("A_0" horizon) underlain by a very thin, crumb structured, dark grey "A_1" horizon; a well-developed, bleached, platy "A_2" horizon; a thick, blocky structured, brown "B" horizon; and a "Ca" horizon of lime carbonate accumulation. The soil is acid in reaction down to the base of the "B_2" horizon and the overall thickness of the soil profile is greater than in the transitional and Blackearth zones with soils containing similar parent materials. These strongly leached soils are much lower in organic matter content and available plant nutrient supply than the grassland soils. They occur mainly on rough topography and are highly susceptible to erosion if stripped of their protective forest cover. The growing season for cultivated crops is shorter here than in less elevated regions and frost hazard is a serious threat in most years. For these reasons the area is not generally suited to grain farming but rather

to mixed farming with limited feed grain and forage crop production on the smoother lands and maintenance of the forest cover on the steeper slopes.

The soils which occur in the Grey Wooded soil zone in the Rossburn-Virden map sheet areas have been mapped as the Waitville, Rackham, Zaporoza, and Seech associations.

WAITVILLE ASSOCIATION:

The Waitville association consists of medium textured soils developed on boulder till. The parent material is essentially the same as that of the Newdale and Erickson soils. The separation of these three associations is based on the degree of weathering or leaching as evidenced by the soil profile characteristics. The Waitville soils are the most strongly leached and the well-drained member of this association exhibits well-developed Grey Wooded profile characteristics.

The soils of the Waitville association occur over a large extent of land on the Riding Mountain. Within the surveyed area of the Rossburn-Virden map sheets, they occupy approximately 90,189 acres or 2.6 percent of the total area. The southern boundary of the association coincides roughly with the 2,000 foot contour and the soils extend northward, intermixed with areas of soils developed on glacial outwash and lacustrine deposits.

The topography is irregular, steeply sloping to hilly and short slopes of 15 to 20 percent or more are common (Figure 27). The numerous undrained depressions, which result from this rough, irregular topography, are occupied by shallow lakes, spruce and tamarack bogs and open swamps. On the slopes and knolls, the native vegetation consists of mixed woods. Aspen predominates, but is intermixed with white birch and spruce and undergrown with hazel, dogwood, rose, cranberry, vetch, etc. Glacial stones occur throughout the soils and are concentrated on the surface in scattered areas where intense erosion occurred during glacial times. These areas have been separated on the soil map and will be described under the heading of Waitville modified phase.

FIGURE 27

Landscape view of an area of Waitville clay loam showing roughly undulating topography and light colored topsoil.

As a result of the steeply sloping topography, most of the soils in the Waitville association are well drained. Intermediately drained soils occur only within very

narrow strips around the edges of undrained depressions, and the depressional areas themselves are mainly occupied by Bog and Half Bog soils. The soils in these undrained depressions have not been differentiated on the soil map because they are chiefly organic soils and are underlain by variable textured lacustrine and outwash sediments or modified glacial till.

The well-drained soils vary considerably in depth of profile and degree of leaching. The variation may be attributed to the irregular sloping topography and the resulting variable moisture regime. The profiles are thicker and less degraded near the base of the slopes than on the crests and the most strongly leached profiles occur in slight depressions on the face of the slopes. Cultivated soils on the crests of the slopes usually have truncated profiles due to the removal of surface material by wind and water erosion. A generalized profile description of the typical well-drained soil which occurs on the average slopes is given below:

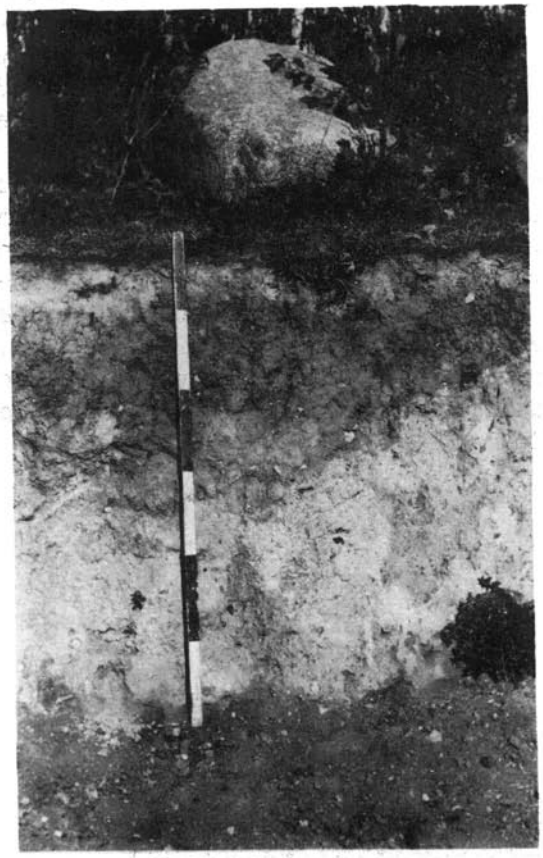

FIGURE 28

Soil profile of Waitville clay loam. A Grey Wooded soil developed on moderately calcareous glacial till.
(Measuring stick interval = 6 inches.)

A_0 Horizon: Reddish brown, partially decomposed leaf mat (1 to 3 inches thick); slightly acid in reaction.

A_1 Horizon: Very dark grey mucky clay loam; finely granular; friable; neutral to slightly acid; very thin or absent.

A_2 Horizon: Pale brown sandy loam to loam (2 to 4 inches thick); weakly developed fine platy to crumb structure; moderately hard; coarse rock fragments are largely decomposed; slightly acid in reaction. Grades sharply into:-

B_1 Horizon: Brown clay loam (2 to 4 inches thick); fine to medium blocky aggregates; very hard when dry, moderately plastic when moist; aggregates have greyish coating near top and organic staining and darker color occurs with depth; slightly acid in reaction. Blends gradually into:-

B_2 Horizon: Dark brown heavy clay loam (4 to 6 inches thick); fine to medium blocky aggregates are coated with colloidal clay and organic matter and lighter in color inside; hard and strongly compacted; slightly acid in reaction. Fades gradually into:-

B_3 Horizon: Brown clay loam (3 to 5 inches thick); slightly stained with organic materials; fragmental structure; firm; contains some free lime carbonate. Grades sharply into:-

C_{ca} Horizon: Light grey, calcium carbonate horizon of variable thickness; clay loam; pseudo-crumb structure; friable when moist, weakly cemented when dry; contains some powdered iron concretions. Fades into:-

C Horizon: Light greyish brown, clay loam glacial till; pseudo-fragmental; hard; strongly calcareous; contains powdered iron concretions and glacial rock fragments.

The intermediately drained soils within the narrow strips adjacent to the undrained depressions are variable in profile characteristics. The variability is chiefly in the thickness and character of the "B" horizon. The "A" horizon generally consists of 12 to 15 inches of dark grey clay loam which is finely granular in structure, friable, and neutral in reaction. However, the "B" horizon varies from a thin transitional layer between the "A" and "C" horizons to a compacted, blocky illuvial horizon of up to 15 inches in thickness. The subsoil is highly calcareous glacial till or slightly modified till and usually contains concretionary iron.

Waitville Modified Phase:

Within small, scattered areas on the south slope of the Riding Mountain the glacial till was subjected to severe erosion by waters from the melting ice sheet. Broad sheets of flowing water removed much of the finer materials from the surface layer of till and left an erosion surface of coarse sediments, gravel and stones. These areas are now characterized by level to gently sloping topography and very stony, sandy loam to sandy clay loam soils. They have been classified as Waitville modified phase and occupy approximately 4,685 acres, or slightly over 5 percent of the total area of Waitville soils in the Rossburn-Virden map areas.

The soils of the Waitville modified phase are dominantly imperfectly drained, due to the level topography and the presence of a fine textured, undifferentiated till substrate. The soil profiles vary because of the variable nature of the water-worked till parent material. The dominant, intermediately drained member is generally characterized by a thin, greyish brown, sandy loam "A" horizon and a "B" horizon which is 8 to 12 inches thick, brown in color, clay loam in texture, blocky in structure, firm in consistence, and slightly acid in reaction. The soils are usually very stony on the surface and lenses of gravel and stones generally occur within the profiles.

Agriculture: The normal, well-drained Waitville soils are medium in natural fertility. Compared to the Erickson and Newdale soils they are lower in organic matter; lower in available plant nutrient supply, particularly nitrogen and phosphorus; slightly lower in moisture retention capacity; and they occur at a higher elevation where frost hazard is a definite problem in the production of grain crops. However, the most important aspect of these soils in relation to their agricultural utilization is the very steep slopes which characterize their topography.

The Waitville soils are highly susceptible to erosion if unprotected by vegetative cover. Many of the steeper slopes which are at present under cultivation should be permanently retired to grass or forest and those which have not been cleared should be left in their native state. On the more gentle slopes where cultivation is practical, the cropping program should be designed to provide some protective cover and to build up the organic matter content of the soils. The growth of grasses and legumes for hay and pasture or seed production is the best method by which these aims may be accomplished. If grain crops must be grown, they should be produced in rotation with grasses and legumes, and crop residues should be utilized as trash cover and a source of organic matter. Cultivation should always be done on the contour. Exposure of bare soils through summer-fallowing should be avoided. This can be accomplished through the use of sweet clover as a green manure crop during the fallow year. All crops will respond to fertilizers containing nitrogen and phosphorus.

The soils of the Waitville modified phase are generally very stony. The difficulties involved in the tillage of these stony soils have, to a large extent, prevented their cultivation. Local areas have been cleared of trees and stones for cropping purposes, but most of the land is being used for grazing or as woodlots. The soils are low in organic matter, nitrogen, and phosphorus and, if cultivated, they are better suited to forage crops than to wheat or coarse grains.

RACKHAM ASSOCIATION:

The Rackham association consists of sandy loam to silty clay loam soils developed on lacustrine sediments of similar origin and composition to those on which the Onanole soils have been developed. These sediments range in texture from sand to silty clay loam and are underlain, at variable depths below the soil profile, by a substrate of glacial till. The soils of this association are more strongly leached than the Onanole soils and the well-drained members exhibit typical Grey Wooded profile characteristics.

The Rackham soils are located on the upper slopes of the Riding Mountain. They occur in areas of irregular shape and size interspersed with the soils on glacial till and outwash deposits to the south and west of Clear Lake. Within the mapped area of the Rossburn-Virden map sheets, they occupy approximately 19,942 acres, which represents about 0.6 percent of the total area. The topography is irregular, steeply sloping to hilly and in this respect, areas of these soils are indistinguishable from the surrounding areas of Waitville soils on glacial till. (See Figure 29). This topographical relationship indicates that the sediments on which these Rackham soils have been developed were deposited in shallow waters temporarily ponded against the ice front. Subsequent erosion caused some modification and removal of these sediments and resulted in the complex soil pattern which presently characterizes the area. The native vegetation on the Rackham soils is also the same as on the Waitville soils; thus, from surface appearance, the only distinguishing feature between these two associations is the absence of stones in the areas of Rackham soils.

FIGURE 29

Landscape view of Rackham clay loams showing roughly undulating topography and grey colored topsoil.

The Rackham association is divided into two textural phases. The finer textured soils, which occupy approximately 14,694 acres, have a surface textural range of very fine sandy loam to silty clay loam and have been designated as the Rackham clay loams. The sandy textured soils, designated as Rackham fine sandy loams, are less extensive and occupy only about 5,248 acres.

(i) Rackham Clay Loams:

The soils of the Rackham clay loam textural phase are dominantly well-drained. Intermediately drained and poorly drained members do occur in the lower positions, but Bog and Half Bog soils occupy most of the depressional areas and therefore the more poorly drained members of the Rackham association are very limited in extent. The well-drained soils are generally developed on very fine sandy loam parent material whereas, the more poorly drained soils on the lower slopes and in the depressions are finer textured. A generalized description of the representative virgin profile of the well-drained associate is given below.

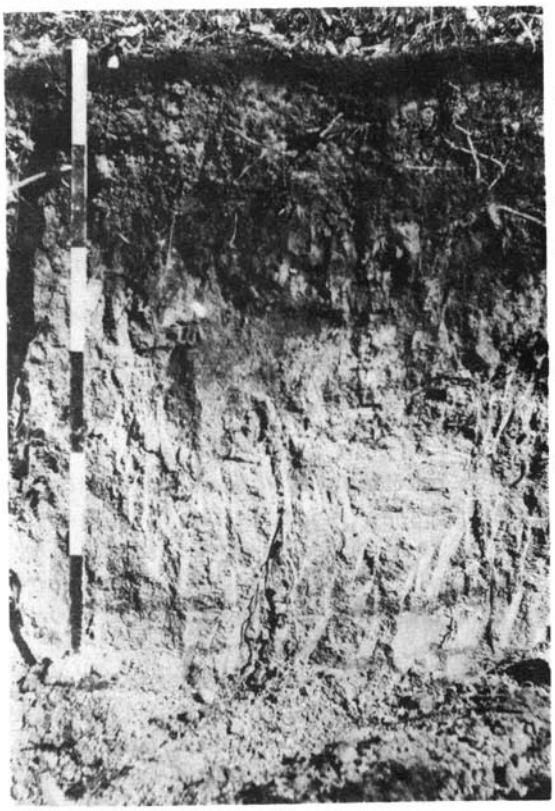

FIGURE 30

Soil profile of Rackham clay loam. A Grey Wooded soil developed on medium textured lacustrine sediments.
(Measuring stick interval = 6 inches.)

A_0 Horizon: Very dark brown leaf litter and partially decomposed leaf mat (2 to 3 inches thick); neutral to slightly acid in reaction.

A_1 Horizon: Generally absent.

A_2 Horizon: Light brownish grey very fine sandy loam (2 to 6 inches thick); weak fine platy structure breaks readily to crumb aggregates; extremely friable; slightly to moderately acid in reaction. Grades sharply into: -

B_1 Horizon: Greyish brown very fine sandy clay loam (4 to 6 inches thick); fine blocky to coarse granular aggregates; firm; slightly acid in reaction. Grades into:-

B_2 Horizon: Very dark greyish brown heavy clay loam (5 to 7 inches thick); blocky aggregates heavily coated with organic matter; firm; slightly acid in reaction. Grades into: -

B_3 Horizon: Light yellowish brown very fine sandy clay loam to silty clay loam; (4 to 6 inches thick); fine granular structure; friable; slightly alkaline in reaction. Fades gradually into: -

C_{ca} Horizon: Light grey; very fine sandy loam to silty clay loam calcium carbonate horizon; indistinct and variable in thickness. Fades into: -

C Horizon: Very pale brown very fine sandy loam to silty clay loam; weak pseudo-crumb structure; very friable; high calcium carbonate content.

In the intermediately drained positions, the soils are generally characterized by a dark grey "A" horizon which is 5 to 12 inches in thickness; a slightly compacted, dark greyish brown "B" horizon, which is 2 to 6 inches thick; and a subsoil which is highly calcareous, iron stained, and varies in texture from very fine sandy loam to silty clay loam. Strongly degraded soils of the Meadow Podzol type also occur but are of minor importance.

The poorly drained members of the Rackham association are restricted to small, shallow depressions and narrow strips around the edges of Bog and Half-Bog soil areas. Where they occur, the profiles generally consist of 3 to 12 inches of partially decomposed fen peat, underlain by a 4 to 8 inch mucky "A" horizon which is dark grey in color, massive, plastic and sticky, slightly alkaline in reaction, and contains some concretionary iron. The subsoil is highly mottled with calcium carbonate and iron. These soils range in texture from fine sandy clay loam to silty clay and are common to both textural phases of the Rackham association.

(ii) Rackham Fine Sandy Loams:

The Rackham fine sandy loam soils are characterized by deep, leached profiles generally developed on fine sand parent material. The low organic matter and the sandy nature of these soils has restricted the development of a strongly compacted "B" horizon. The representative, virgin profile of the well-drained associate may be described as follows:

A_0 Horizon: Very dark brown leaf mat (2 to 3 inches thick); neutral in reaction.

A_1 Horizon: Generally absent.

A_2	Horizon:	Light grey fine sand (6 to 8 inches thick); structureless; loose; slightly acid in reaction. Grades sharply into: -
B_1	Horizon:	Pale brown fine sandy loam (2 to 4 inches thick); weakly granular; firm; slightly acid in reaction. Grades into: -
B_2	Horizon:	Brown fine sandy loam to fine sandy clay loam (5 to 8 inches thick); weakly coarse granular aggregates; slightly plastic when moist, hard when dry; slightly acid in reaction. Fades into: -
B_3	Horizon:	Light yellowish brown fine sand (2 to 4 inches thick); structureless; weakly cemented; slightly alkaline in reaction.
C_{ca}	Horizon:	Very pale brown, weakly defined calcium carbonate horizon; fine sand (4 to 10 inches thick). Fades gradually into: -
C	Horizon:	Light grey fine sand; structureless and loose; moderately calcareous.

The intermediately drained soils are similar in profile characteristics to those of the finer textured phase. Strongly degraded soils sometimes occur in the lower positions. These soils consist of a deep, fine sand "A_2" horizon underlain by a thick, clay loam "B" horizon which is dark greyish brown to olive in color, weakly blocky, firm, and acid in reaction. The subsoil contains concretionary iron and lime carbonate.

Agriculture: The Rackham soils are extremely susceptible to erosion and the loss of fertility through the effects of wind and water erosion is the primary consideration in land use recommendations. The characteristic features of these soils, namely; fine sandy and silty textures, low organic matter content, feeble structure, and steeply sloping to hilly topography combine to render prolonged cultivation very hazardous. These soils should not be farmed under a fallow-grain system of cropping.

The soils of the finer textured phase are moderately high in natural fertility. The available nitrogen and phosphorus supply is medium to low, due to soil development under forest vegetation, but the soils are friable, have a good moisture retention capacity, and they are located in an area of high precipitation-effectivity. Grass and legume crops will produce well on these soils, especially if the deficiencies in natural fertility are offset by the application of manure or appropriate commercial fertilizers. The growth of grass-legume mixtures for hay and pasture or suitable grasses for the production of seed should constitute the major portion of the cropping system on these very erosive soils. Grain crops should be grown in rotation with improvement crops on slopes of the lowest gradient. Coarse grains are better suited to the area than wheat because of the prevailing cooler climate and shorter frost-free period than exists at lower altitudes. Sharp slopes and eroded knolls should be permanently retired to grass or left under forest vegetation.

The soils of the sandy textured phase of the Rackham association are not suited to arable culture. Combined with their susceptibility to water and wind erosion, they also are unsuited to crop production because of low water retention capacity, and low organic matter content and general fertility. These soils should be utilized for hay and controlled grazing, forestry, and the preservation of wild life.

RACKHAM—WAITVILLE TRANSITION:

The Rackham-Waitville transition consists of sandy textured soils developed on a thin mantle of lacustrine sediments over water-worked glacial till. The occurrence of these soils is restricted to a single area of approximately 2,560 acres. This area is located to the east of Bottle Lake in Township 19, Range 19 West of the Principal meridian. The topography is smooth to slightly undulating and the soils are generally imperfectly drained due to slow runoff and impeded internal drainage. Surface stoniness is variable depending on the depth of the sandy mantle over the reworked till. A lens of cobbles invariably occurs at the contact of these materials and stoniness becomes severe in portions

of the area where this contact is close to the surface.

The well-drained soils in this transitional area exhibit Grey Wooded profile characteristics and are similar in profile features to the representative sandy textured Rackham soils. The "B" horizon generally occurs immediately above or within the cobble lens, at the contact of the sandy mantle and the underlying reworked till. Thus, the profiles vary in depth with the variation in thickness of the sandy surface deposit. Over most of the area, this surface deposit is very thin and the soils are intermediately to poorly drained. The representative profile consists of 3 to 6 inches of dark grey, fine sandy loam over a weakly developed, yellowish-brown "B" horizon. The "B" horizon terminates in the cobble lens and the underlying sandy modified till is highly calcareous and contains concretionary iron. (See Figure 31.)

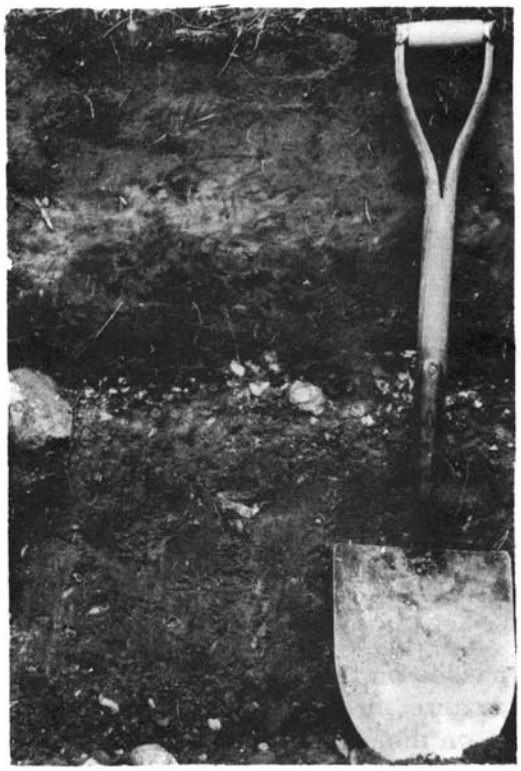

FIGURE 31

Soil profile of Rackham-Waitville transition soils. Grey Wooded soil developed on a thin mantle of sandy textured lacustrine sediments over modified glacial till. Note cobble lens at the base of the "B" horizon which represents the erosion surface of the glacial till strata.

Agriculture: The variable nature of the Rackham-Waitville transitional soils is reflected in their agricultural potentialities. Cultivation is generally restricted to portions of the area in which the sandy mantle is of sufficient thickness to eliminate severe surface stoniness; the very stony soils are used for native pasture. The cultivated soils are low in organic matter content and general fertility. Water erosion is not a problem, due to the smooth topography, but the soils are moderately susceptible to wind erosion. The low water retention capacity of these sandy soils is partially offset by the impeded internal drainage, but poor moisture retention can be a problem in dry seasons.

These soils are best adapted to mixed farming. Manure and commercial fertilizers containing nitrogen and phosphorus should be used to supplement the low nutrient supply of the soils, and the addition of organic matter through the growth of grasses and legumes would assist in maintaining their initial productivity.

SEECH AND ZAPOROZA ASSOCIATIONS:

The Seech and Zaporoza associations consist of coarse textured soils developed on shaly coarse sand and gravel outwash deposits. The coarse textured parent material of these soils has been the dominant soil-forming factor in their development. The high porosity of these deposits has affected the local soil climate and vegetative cover under which the soils have formed and thus has altered the normal regional development of these soils. Although they occur entirely within the Grey Wooded zone, most of the soils exhibit only slight degradation and Grey Wooded profiles occur only at the higher elevations and on the more humid north-facing slopes. The soils that have developed under mixed prairie grasses and aspen vegetation and exhibit Blackearth and Degrading Blackearth profile characteristics are included in the Seech association; whereas those (occurring at higher elevations) that have developed under mixed woods and exhibit Grey Wooded profile characteristics are included in the Zaporoza association.

The Seech and Zaporoza soils, intermixed with areas of Rackham and Waitville soils, occur on the upper slopes of the Riding Mountain. The Seech and Zaporoza soils occupy approximately 28,160 acres or 0.8 percent of the total area in the Rossburn-Virden

map sheets. The topography is irregular, steeply sloping to hilly and the drainage is dominantly excessive. The native vegetation varies with the soil texture, elevation, and topographical position. It is mainly mixed tall prairie grasses and associated herbs, with woods becoming prevalent in the imperfectly drained sites and at the higher elevations (Figure 32). The low positions are occupied by spruce and tamarack bogs or open swamps.

FIGURE 32

View of an area of Seech coarse sandy loam showing the native grass and herbaceous vegetation which occurs on the coarse textured soils within the Grey Wooded zone.

The Seech association is divided into two phases on the basis of depth of profile which, in this case, is a reflection of surface texture, drainage and the degree of degradation under woods. These two phases are shown on the soils map and will be described as the shallow phase and the deep phase.

(i) Seech Shallow Phase:

This is the dominant soil type in the Seech-Zaporoza complex. Soils belonging to this phase occupy approximately 20,505 acres, which represent over 72 percent of the total area mapped as Seech and Zaporoza associations. The dominant member of this phase is well to excessively drained and has developed under tall prairie grasses and associated herbs. A generalized description of the representative virgin profile of this associate is given below.

A_0 Horizon: Very dark brown, partially decomposed sod mat, neutral in reaction (1 inch thick).

A Horizon: Very dark grey coarse sandy loam (3 to 6 inches thick); weak coarse crumb structure; extremely friable; neutral in reaction. Grades into: -

B Horizon: Dark greyish brown coarse sandy loam (6 to 8 inches thick); weak column-like structure with medium granular aggregates; friable; neutral in reaction. Fades into: -

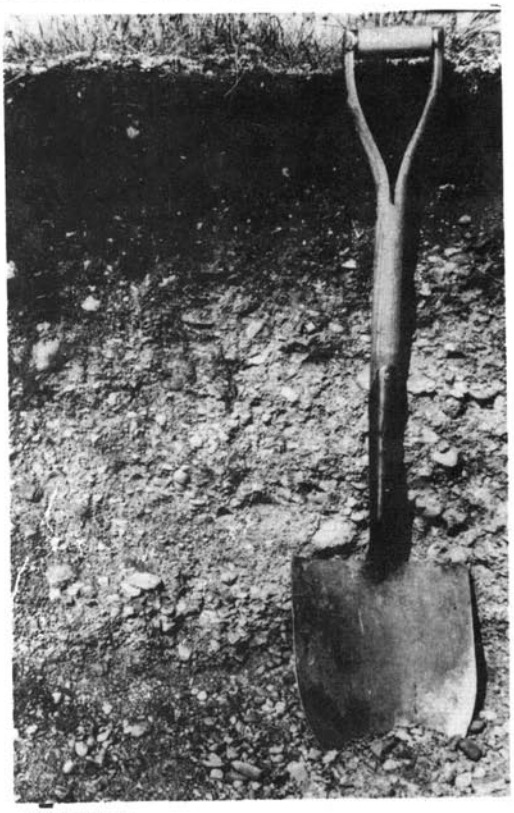

FIGURE 33
Soil profile of Seech coarse sandy loam, shallow phase. Blackearth-like soil developed under grassland vegetation on shaly coarse sand and gravel outwash deposits in the Grey Wooded zone.

Cca Horizon: Light grey calcium carbonate horizon (2 to 4 inches thick); weakly cemented coarse sand, fine gravel and flakes of shale.

C Horizon: Pale brown, somewhat stratified, coarse sand, fine gravel, shale flakes, and cobbles; loose; calcareous.

The well to excessively drained soils generally grade sharply into the organic soils in the poorly drained positions so that the intermediately drained and poorly drained members are of little importance. The soils in the depressional areas are mainly Bog and Half Bog soils and are not differentiated from those which occur in association with other soils of the area.

(ii) Seech Deep Phase:

The soils of the Seech deep phase have developed under aspen grove and grassland vegetation. The invasion of areas of this soil by aspen is due to a more humid soil climate than exists in surrounding areas of the Seech shallow phase soil. The more favorable moisture relationships of this soil are the result of a finer surface texture and smoother topography. Soils of this phase occupy approximately 3,000 acres, or slightly more than 10 percent of the total area of Seech and Zaporoza soils. The dominant member of this phase is the well-drained associate of which a generalized profile description is given below.

A_0 Horizon: Very dark brown sod and leaf mat (1 to 2 inches thick); partially decomposed; neutral in reaction.

A_1 Horizon: Very dark grey sandy loam (4 to 6 inches thick); weak crumb structure; extremely friable; neutral in reaction. Fades into: -

A_2 Horizon: Greyish brown sandy loam (4 to 6 inches thick); mottled; weak crumb structure; very friable; slightly acid in reaction. Grades into: -

B_2 Horizon: Brown coarse sandy loam (8 to 12 inches thick); weak blocky structure breaks readily into crumb aggregates; friable; neutral to slightly acid. Grades into: -

B_3 Horizon: Pale brown sand to coarse sand (2 to 4 inches thick); very weak crumb structure; extremely friable; slightly alkaline; usually contains limestone and granitic cobbles and shale flakes.

C Horizon: Greyish shaly coarse sand; single grain; loose; calcareous.

The intermediately and poorly drained members of this phase are very limited in extent and therefore of little significance. The soils in the undrained depressions are largely organic soils of the Bog and Half Bog types.

(iii) Zaporoza Association:

The soils of the Zaporoza association have been developed on similar parent material to the Seech soils but under the influence of mixed woods vegetation. The greater growth of woods in these areas than in other areas of similar outwash deposits appears to be primarily due to the cooler, more humid climate which occurs at the slightly higher

elevations where the Zaporoza soils are found. Areas of this soil occupy approximately 5,555 acres, or about 18 percent of the total area of the combined Seech and Zaporoza soils in the mapped portion of the Rossburn-Virden map sheets. The topography is steeply sloping to hilly and soil drainage is generally excessive. A generalized description of the dominant, well to excessively drained associate is given below.

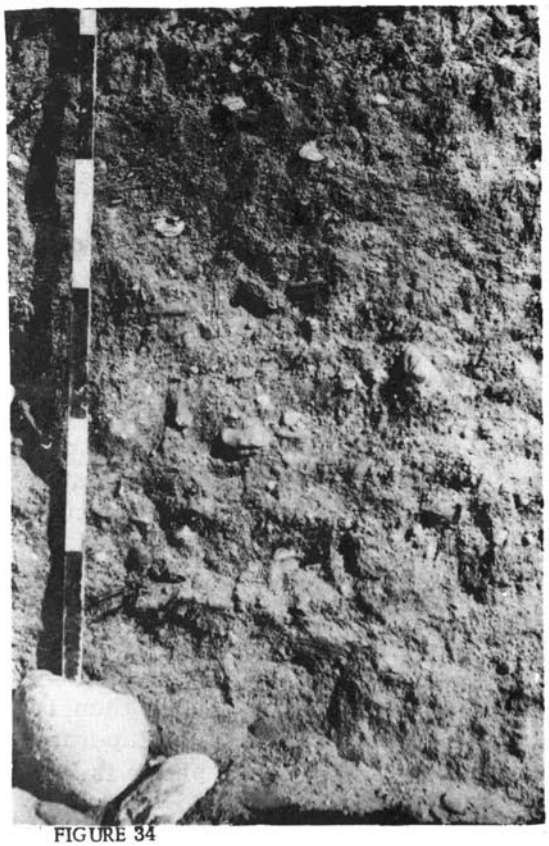

FIGURE 34

Soil profile of Zaporoza coarse sandy loam. A Grey Wooded soil developed on shaly gravel outwash.
(Measuring stick interval = 6 inches.)

A_0	Horizon:	Dark brown leaf mat; partially decomposed; neutral to slightly acid in reaction (1 inch thick).
A_1	Horizon:	Generally absent.
A_2	Horizon:	Light brownish grey loamy coarse sand (3 to 6 inches thick); weak platy structure; extremely friable; slightly acid in reaction. Grades into: -
B_1	Horizon:	Brown coarse sandy loam (3 to 5 inches thick); weak granular aggregates; friable; slightly acid in reaction. Grades into: -
B_2	Horizon:	Yellowish brown coarse sandy loam (4 to 6 inches thick) weak blocky structure; firm; neutral in reaction. Grades into: -
B_3	Horizon:	Light yellowish brown coarse sand and gravel (2 to 5 inches thick); single grain; loose; slightly alkaline in reaction.
C	Horizon:	Light grey coarse sand and gravel and dark grey flakes of shale; single grain; alkaline in reaction. Sand and gravel contain a high percentage of limestone material.

Small areas of intermediately drained soils of the Zaporoza association occur toward the base of the slopes as narrow bands surrounding the organic soils in the depressional areas. These intermediately drained soils are similar in general profile characteristics to the well drained Seech soils. However, these soils were developed under different moisture conditions and contain concretionary iron in the lower horizons.

Agriculture: With the exception of the small areas of Seech sandy loam, deep phase, the soils in these associations are not suited to arable culture for the growth of field crops. They have a very low moisture retention capacity, low organic matter and available plant nutrient supply, and are very susceptible to wind and water erosion if unprotected by native vegetation. These soils should be utilized through controlled grazing or for forestry and the preservation of wild life.

The soils of the Seech sandy loam, deep phase are adaptable to mixed farming with emphasis on the growth of grasses and legumes for hay and pasture. They are also subject to drought, because of low moisture retention capacity, and are low in organic matter and available plant nutrients, but their slightly finer texture and smoother topography render them suitable for limited crop production.

Local Soil Areas

A number of soil types occur in the Rossburn-Virden map sheet areas that do not show zonal soil characteristics but occupy localized areas in one or more of the soil zones and sub-zones. This category includes: the immature soils of the Assiniboine,

Horod, Proven Lake and Benton associations; the miscellaneous soils of the Benchlands and Eroded Slopes complexes; the Organic soils; and the regosolic soils of the duned sand areas.

ASSINIBOINE COMPLEX:

The alluvial materials which form the bottom lands in the river valleys that transverse the Rossburn-Virden map sheets are collectively referred to as the Assiniboine complex. These materials occur in the U-shaped valleys of the Assiniboine, Qu'Appelle, Birdtail and Minnedosa rivers. The texture of these alluvial deposits varies both within the soil profiles and from one site to another, but generally it is within the range of silty clay loam to clay. These materials are of comparatively recent origin, in fact, deposition still occurs during flood stages of the contributing rivers. For this reason, soil profile development has generally not progressed beyond the formation of layers of organic matter accumulation which may lie within the stratified material or at the present surface. Therefore, the Assiniboine complex may be said to consist of azonal, regosolic soils developed from recent alluvial sediments.

The Assiniboine alluvium occupies approximately 101,990 acres in the Rossburn-Virden map sheets, which represents 3 percent of the total area. The topography is flat to very gently sloping and soil drainage is generally imperfect or poor. The native vegetation varies with the drainage. The greater portion of the imperfectly drained soils supported a lush growth of meadow-prairie grasses prior to cultivation; while slightly better drained sites, such as river levees, were occupied by deciduous trees including species of elm, ash, maple, poplar and willow. Most of the areas of poorly drained soils still retain their native vegetative cover of willow, swamp birch, meadow grasses, reeds and sedges. Stones are a rare occurrence on these alluvial soils except where the deposition is thin and overlies stony material.

The most pronounced profile development on these alluvial materials occurs on the moderately well-drained sites under woodland vegetation. Under such conditions a weak, greyish, platy "A_2" layer and a slight textural "B" horizon is sometimes in evidence. However, the stratified nature of the profile often masks the genetic development and layering represents the most prominent feature of the soil profile. The imperfectly drained soils show much variation in degree of profile development, but generally consist of 12 or more inches of dark greyish brown silty clay to clay surface material over stratified greyish brown silty clay loam to silty clay. The subsurface horizon and underlying material usually contain concretionary iron and flecks of lime carbonate. The poorly drained soils are characterized by a surface organic layer which may consist of a few inches of muck or up to two or more feet of fen peat. Below this organic layer the mineral material consists of gleyed, olive grey silty clay to clay.

Agriculture: Cultivation of the Assiniboine alluvium is restricted to the better drained soils in the wider portions of the Assiniboine and Minnedosa river valleys (Figure 35). These soils are very fertile and are highly productive under optimum moisture conditions. The chief problems concerning their cultivation arise from their slow internal drainage, lack of adequate runoff and susceptibility to flooding. Low porosity also is a detriment to these immature soils and cropping practices which add fibrous organic matter are recommended.

The poorly drained soils are being utilized to some extent for native hay and pasture. The quality of this hay and pasturage could be improved in some areas through the seeding of adapted grasses. However many areas are presently too wet for this purpose and are often inaccessible during most of the summer season.

HOROD ASSOCIATION:

The Horod association consists of immature, sandy textured soils developed

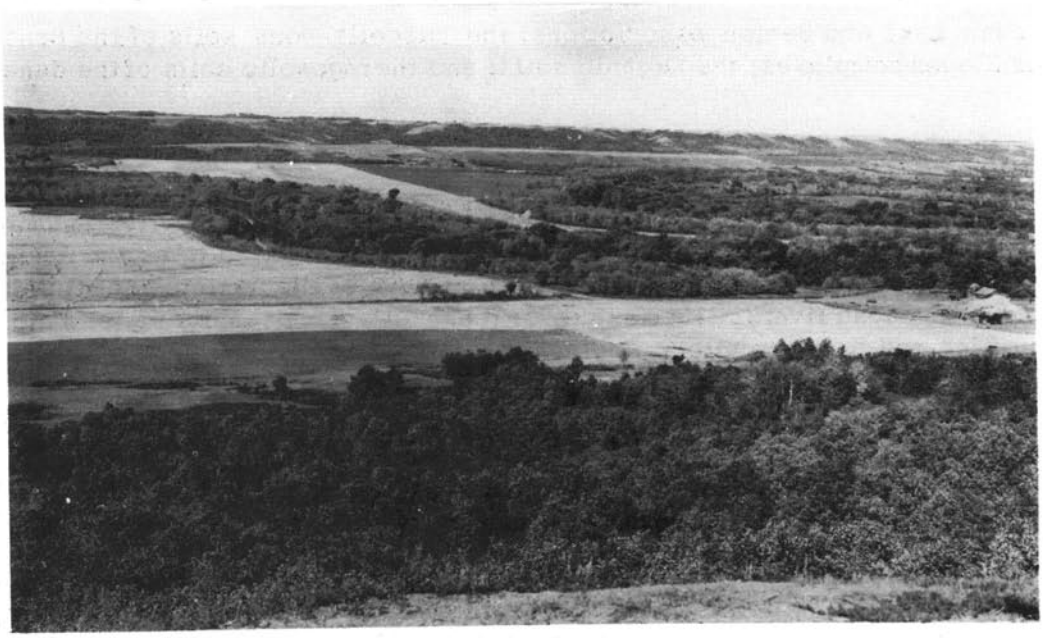

FIGURE 35

View of cultivated land on the alluvial flats in the Assiniboine valley north-east of Virden.

on sandy alluvial deposits occurring in the upper portion of the Minnedosa River Valley. This alluvial material appears to have been deposited by the Minnedosa River and contributary waters which entered the valley through lateral gullies and ravines. The material is well sorted and is dominantly of a medium sand texture. Some gravel substrata occur but these appear to exist only in small pockets or strips. The Horod soils exhibit variable degrees of profile development but are generally characterized by a deep, very dark grey to black "A" horizon, a thin brownish colored "B" horizon, and a light grey sand subsoil.

The soils of the Horod association occupy approximately 2,585 acres, or less than 0.1 percent of the total acreage in the Rossburn-Virden map areas. The topography is smooth and generally very gently sloping toward the Minnedosa River. Drainage is dominantly good and only small scattered areas of intermediately and poorly drained soils occur. The native vegetation under which the soils have been developed consists of tall prairie grasses and associated herbs. Stones are rare. A generalized profile description of the representative well-drained associate is given below:

A_0	Horizon:	Very dark brown sod mat; moderately well decomposed, neutral in reaction (1 to 2 inches thick).
A	Horizon:	Very dark grey sandy loam (8 to 10 inches thick); structureless; very friable; neutral in reaction. Grades into: -
B	Horizon:	Greyish brown sandy loam (4 to 6 inches thick); weak fragmental structure; very friable; alkaline in reaction. Grades into: -
C	Horizon:	Light brownish grey sand; structureless; loose; moderately calcareous.

The poorly drained soils are quite variable, but generally consist of a shallow surface layer of fibrous peat over iron-stained, slightly calcareous mucky sand. In these poorly drained depressional areas, the ground-water table is generally within three feet of the surface.

Agriculture: The well-drained Horod soils are moderately productive and are suited to the growth of all regional field crops. However, they are quite low in organic matter content and have little or no structure and are therefore very susceptible to wind

erosion. Measures to control soil drifting must be adopted if this soil is to remain productive. The use of trash cover, cover crops and windbreaks are highly desirable. Crop rotations including grasses and legumes are beneficial to the maintenance of the fertility of these soils and fertilizers containing nitrogen and phosphorus should give response on all crops under favorable climatic conditions.

PROVEN LAKE ASSOCIATION:

The Proven Lake association consists of immature, fine textured soils developed on thin deposits of clay and silty clay textured lacustrine sediments that are underlain either by coarser textured sediments or by resorted till. These deposits occur in small isolated pockets on the southwest slope of the Riding Mountain, usually surrounding small lakes or in former lake sites. Drainage in these areas is generally imperfect to poor and the soils exhibit variable degrees of profile development.

The soils of the Proven Lake association occupy approximately 5,043 acres, which represents only 0.15 percent of the total acreage in the Rossburn-Virden map areas. The topography is smooth, very gently sloping to level and the areas are generally subject to flooding by runoff water from the surrounding higher land. The native vegetation consists of black poplar, willows, meadow grasses and herbs, with some aspen on the better drained sites. Stones are generally not present.

On the very gently sloping sites, surface drainage is adequate but internal drainage is very slow. The soils in these positions have some profile development and a generalized description of the representative profile is given below:

A	Horizon:	Very dark grey clay (4 to 12 inches thick); medium to coarse granular; moderately plastic when moist, hard when dry; slightly alkaline. Tongues into: -
C	Horizon:	Grey clay; fine pseudo-fragmental structure, very plastic and very sticky; moderately calcareous; slightly iron stained.
D	Horizon:	Light grey to light brownish grey, calcareous, medium textured lacustrine sediments or fine textured resorted till (may or may not be present within 30 inches).

The poorly drained soils have only slight profile development and are characterized by the presence of a surface layer of peat or muck of variable thickness. The weakly formed "A" horizon consists of dark grey clay which is massive, very plastic and very sticky, moderately calcareous and contains concretionary iron. The subsoil is olive grey in color and is highly mottled with concretionary lime carbonate and iron.

Agriculture: Drainage is the main problem associated with the agricultural utilization of Proven Lake soils. Areas of intermediately drained soils which are not subject to spring flooding are highly productive and suited to the production of a variety of regional crops. The organic matter content is moderately low and tillage costs are high due to the clay texture. Additions of crop residues and the growth of deep-rotted legume crops where drainage is adequate are beneficial to the tilth of these soils. All crops should respond favorably to fertilizers containing nitrogen and phosphorus.

Areas of poorly drained Proven Lake soils are generally too wet during the spring season to allow the seeding of crops. Unless artificial drainage of these areas can be obtained, their use is necessarily restricted to that of native hay and pasture. Improvement of surface drainage is usually not feasible due to the nature of the surrounding terrain and the lack of natural drainage channels.

BENTON ASSOCIATION:

The soils of the Benton association consist of heavy clay soils developed on deposits of Cretaceous shales of the Riding Mountain Formation. These soils occur on

the slopes of the Assiniboine Valley on low hillocks or slacked masses of shale outcrop. Their occurrence is restricted to local areas by the mantle of glacial till and alluvial deposits which covers the shale bedrock throughout most of this glacial valley. The total area of Benton soils is approximately 4,122 acres, which represents only 0.1 percent of the total mapped area in the Rossburn-Virden map sheets.

The topography of these soils is gently to steeply sloping. Soil drainage consists mainly of runoff as internal drainage is extremely slow below the thin "A" horizon. The native vegetation consists of a sparse growth of xerophytic and alkali-tolerant grasses and herbaceous plants. The dominant plant species are: grama grass (Bouteloua gracilis); western couch grass (Agropyron Smithii); alkali grass (Distichlis sp.); perennial gumweed (Grindelia perennis); sage (Artemisia sp.); and wormwood (Artemisia sp.). Some cactus species also occur in scattered locations.

The soils developed on these shale deposits are degraded soils in various stages of development ranging from Solonetz to Solod types. The prevailing soil profile

FIGURE 36

Exposure of the round-topped, columnar structures of the "B" horizon of an incipient Solod in the Benton association. (Measuring stick interval = 1 inch.)

has a greyish brown clay "A" horizon of a few inches in thickness, underlain by a thick "B" horizon of dark brown clay with irregular columnar structure and acid reaction. The tops of these tough, waxy columns tend to be rounded and are sometimes coated with light grey material (Figure 36). The "B" horizon grades into an amorphous dark grey clay, neutral to slightly acid in reaction and containing numerous large gypsum crystals and streaks of concretionary iron. The substratum of weathered shale, containing gypsum crystals, iron compounds, and streaks of bentonite, is usually encountered within shallow depths below the "B" horizon. Over a large portion of the soil area the thin "A" horizon has been removed by wind and water erosion and "burn-out" or "blow-out" areas are of common occurrence.

Agriculture: The Benton soils are very heavy and intractable, low in fertility, susceptible to excessive runoff and to soil erosion, and usually strongly acid in reaction. Hence they are of little agricultural value. At present they are being utilized in conjunction with the eroded valley slopes as a source of sparse pasturage for small herds of cattle.

BENCHLANDS COMPLEX:

The Benchlands complex consists of all the soils occurring on the valley terraces of the Assiniboine, Birdtail and Minnedosa rivers. These soils are generally developed on a thin surface mantle of medium to fine textured alluvial and outwash deposits

over a substratum which may consist of cobbles, gravel, shaly gravel, sand, or modified boulder till. The surface texture varies from loam to heavy clay loam and the surface mantle of these finer sediments is usually 10 to 18 inches thick.

These soils were developed largely under mixed prairie grasses, although some woodland invasion has occurred in areas which have deep surface mantles and finer textured substrata. The soils are dominantly of the Blackearth type with some modifications due to the textural stratification of the parent material.

The soils of the Benchlands complex occupy approximately 25,907 acres in the Rossburn-Virden map sheets, which represents about 0.8 percent of the total map area. The topography is smooth, very gently sloping, and drainage is good to excessive due to the coarse textured subsoils. Surface stoniness is generally slight, but becomes severe in areas where the surface mantle is thin or absent and the underlying material is stony, eroded boulder till.

No representative profile descriptions can be given for the soils in this complex as the profile characteristics vary with the texture and thickness of the surface mantle and the nature of the underlying material. As a rule, the "A" horizon is restricted to the finer textured surface layer and is very dark grey, granular, friable, and neutral in reaction. The underlying material is alkaline and calcareous.

Agriculture: The agricultural value of the Benchlands soils is variable due to the variability of the soils themselves. Where the surface mantle is a foot or more in thickness and of a clay loam or finer texture, the soils can be utilized for grain production. Even on these select sites however the soils are often susceptible to drought, due to the gravelly substrata, and should be utilized in a mixed farming enterprise. The coarser textured soils and those with very thin surface mantles are not suited to arable culture and should to be used as hay and pasture lands. The very stony areas are further restricted in their agricultural use and provide only limited pasturage for sheep or cattle.

ERODED SLOPES:

This local soil category includes all the land occupied by the eroded slopes of river valleys, ravines and other water courses. It is a land-form class rather than a unit of soil classification because mature soils do not exist on these steep slopes and the soil material that is present varies from one site to another. This material generally consists of stony, modified boulder till, except in the deep valleys of the larger rivers which have been cut into the shale bedrock.

The native vegetation on these eroded slopes is strongly influenced by the variable micro-climatic conditions which prevail on the different exposures. Except in the elevated region of the Riding Mountain where all the valley slopes are heavily wooded, the woods are generally restricted to the slopes with northern and eastern exposures, while the south and west-facing slopes are covered by grassland vegetation. The woods dominantly consist of aspen and oak with some birch, ash, elm, etc., on the lower portions. The grassland species include a dominance of xerophytic types as well as herbaceous plants common to drier areas such as: anemones, asters, goldenrod, sage, wormwood and yarrow.

The total area occupied by Eroded Slopes in the Rossburn-Virden map sheets is approximately 134,630 acres, which represents almost 4 percent of the total map area.

Agriculture: The primary agricultural value of the wooded valley slopes stems from their ability to conserve moisture and aid in preventing floods rather than from direct use as farm lands. For this reason it is very important to preserve the tree cover and the underlying mat of leaf litter and decaying organic matter. This involves protection against fire, destructive grazing by livestock, and excessive removal of trees for domestic or commercial purposes.

Grazing should also be limited on the steep, grass-covered slopes of these river valleys and ravines. Overgrazing of these slopes can result in severe erosion and the formation of deep gullies which may cut back into the adjoining uplands and destroy good agricultural land.

ORGANIC SOILS:

The organic soils which occur in the Rossburn-Virden map sheets are undifferentiated and include Half Bog and Bog soils composed of fen, woody or mixed peats. These organic soils occur in small scattered areas throughout the Grey-Black and Grey Wooded soil zones. The majority of these areas are covered by stands of black spruce and tamarack, although some open marshes occur, particularly around the margins of shallow lakes. The thickness of the peat deposits ranges from 12 inches to four or more feet. The underlying mineral material generally consists of modified boulder till with a shallow mantle of lacustrine sediments in some areas. The peat deposits are neutral to slightly alkaline in reaction and usually contain lime-charged ground water in the lower depths. The total area of these organic soils in the Rossburn-Virden map sheets is approximately 42,342 acres (1.2 percent of the total area).

Agriculture: The organic soils in this area are of little agricultural value. The areas of open marsh are used to a limited extent for hay and pasture, but the hay is of poor quality and the areas are often inaccessible during wet seasons. The wooded bogs are of little commercial value for forestry due to the poor quality of trees and the small isolated areas in which they occur. Some use is derived from these trees for local domestic purposes.

DUNE SANDS:

The areas of duned sand which occur interspersed with soils of the Marringhurst association on the Rossburn map sheet have been separated from this association and mapped as local soils. These dune sands are similar in soil characteristics and vegetative features to the dune sands associated with the soils of the Souris association on the Virden map sheet. For this reason the description of these soils presented under the Souris association need not be repeated here. The sand dunes mapped as local soils on the Rossburn map sheet occupy approximately 19,533 acres.

Agriculture: These areas of dune sands lie largely within the boundaries of the Archie and Ellice Community Pastures and provide limited grazing for the enclosed livestock. Some shelter is also provided by the aspen groves which cover the northern and eastern exposures of these dunes, as they represent the only treed areas in the enclosed pasture lands.

C. LAND CLASSIFICATION

(1) ESTIMATED SUITABILITY OF SOILS FOR AGRICULTURAL USE:

The estimated suitability of the soils of the Rossburn-Virden area for various purposes is shown in Table 7. The ratings contained in this table are based on general observations and on a study of the characteristics expressed in the individual soil profiles within the mapping units. They are not based on crop yield data (which are not available) but represent the considered opinion of the soil surveyors, as indicated by the characteristics of the respective soils and by other natural phenomena.

TABLE 7: ESTIMATED SUITABILITY OF THE SOILS IN THE ROSSBURN-VIRDEN AREA FOR VARIOUS PURPOSES.

Symbols: E = excellent; E-G = excellent to good; G-E = good to excellent; G = good; G-F = good to fair; F-G = fair to good; F = fair; F-P = fair to poor; P-F = poor to fair; P = poor; VP = very poor; V = variable; X = not naturally favourable, but could be utilized if suitable corrective measures were adopted; +- = more or less suitable; -- = not suitable, or of relatively low value.

Note: The following estimates are given as a guide to the average suitability of each soil association or phase for land use in average seasons. In seasons of above average precipitation, many of the soils will give better returns than are indicated, but in periods of severe drought, even the better soils may give less satisfactory returns. It should also be observed that the respective average estimates must be modified on local farms to conform with local variations. Further, the estimates given are not absolute values. They are the opinions of the soil surveyors based on the characteristics of the soil and on general observations.

Soil Designation	CULTIVATED LAND								UNBROKEN LAND			Forestry and Field Windbreaks
	Grain Crops		Intertilled Crops			Cultivated Hay and Pasture Crops		Gardens and Fruits	Native Hay	Grazing	Wild Life	
	Wheat	Coarse Grains	Fodder Corn	Seed Corn	Roots & Potatoes	Grasses	Legumes					
Arrow Hills Association	P	P-F	P-F	P	F-P	F	P	P-F	F	F	+-	--
Assiniboine Complex	(V)G-F	(V)G-F	(V)G-F	P	(V) G	G	G	G	G	G	+-	++
Benchlands Complex	P-F	F-P	F-P	P	F-P	F-G	F	F-P	F	F	+-	+-
Benton Association	VP	VP	VP	VP	VP	P-F	P-F	VP	P	F-P	+-	--
Beresford Association	G	G	F-G	F	F-G	F-G	F-G	F	F	F-G	--	++
Carroll Association:												
Clay loams	G-E	G	G	G-F	G	G	G	G	-	-	--	++
Till substrate phase	G	G-F	G	G-F	G	G	G	G	-	-	--	+-
Loams	G-F	F-G	G	G-F	F-G	G-F	G	G-F	F	F-G	--	+-
Eastbank Association	F	F-P	P-F	P	F-P	F	P-F	F-P	F	F	+-	--
Erickson Association	G	G-E	--	--	G	G	G-E	G-F	F	F-G	++	++
Eroded Slopes	--	--	--	--	--	--	--	--	P	F-P	++	+-
Harding Association	G-E	G-E	G-F	F	G-F	G	G	G	-	-	--	+-
Horod Association	F	G-F	--	--	G-F	G-F	G-F	G-F	F-G	E-G	--	+-
Lenore Association	(V)F	(V)F	--	--	F	F-G	F-G	F	F	F	+-	--
Marringhurst Association	P	VP	P-F	P	P	P-F	P	P	F-P	F	--	--
Miniota Association:												
Sandy loam	F-P	P-F	F-P	P	F	F	F-G	F	F-P	F	--	--
Shaly phase	P-F	P	P-F	P	F	F	F	F	F	F	--	--
Newdale Association:												
Undulating phase	G-E	E-G	--	--	G	G	G-F	G	F-G	G-F	+-	++
Calcareous and salinized associate	(V)F	(V)F-G	--	--	F	F-G	F-G	F	F-G	G-F	+-	+-
Rolling phase	G-E	E-G	--	--	G	G	G-F	G	F-G	G-F	+-	++
Modified phase	(V)F	(V)F	--	--	F-G	F	F-P	(V) F	F-G	G-F	+-	+-
Smooth phase	G	G	--	--	G-F	G-F	G-F	G-F	F-G	G-F	+-	+-
Onanole Association:												
Clay loams	F-G	G	--	--	G-F	G	G	G-F	F	F-G	+-	++
Fine sandy loams	F-P	F-P	--	--	F-P	F	F	F-P	F-P	F	+-	++
Oxbow Association:												
Loam to clay loam	G-F	G-F	F	--	F	F	F-G	F	F	F-G	+-	+-
Saline ~~phase~~ associate	P-F	P-F	P	--	P	F	F	P	F	F-G	+-	--
Smooth phase	G	G	F-G	--	F-G	F-G	G-F	F-G	F	F-G	+-	+-
Modified phase	(V)F-F	(V)F-F	--	--	P-F	F	F-P	(V)P-F	F	F-G	+-	+-
Organic Soils	--	--	--	--	--	--	--	--	(V)F	(V)F	+-	+-
Pipestone	G-E	G	G	--	F-G	G	G	F-G	G	G	--	+-
Proven Lake	F	F-G	--	--	F-P	G	G	F-P	F	F	+-	--
Rackham Association:												
Clay loams	F	F-G	--	--	F-G	G	G	G-F	F	F-G	++	++
Fine sandy loams	P	P-F	--	--	P-F	F	F	F-P	F-P	F	++	++
Sand Dunes	--	--	--	--	--	--	--	--	--	F-P	++	+-
Seech Association:												
Coarse sandy loam	VP	P	--	--	P	P-F	P-F	P	P-F	F	+-	--
Deep phase	P	F-P	--	--	P-F	F	F	P	F	F	+-	+-
Souris Association:												
Fine sandy loam	P-F	F-P	G	G-F	F	G-F	G	F	F	F-G	+-	++
Loamy fine sand	P	P	(V)P-F	--	(X)	G-F	G	(X)	F	F-G	+-	++
Tiger Hills-Hilton Combination	F-P	F-P	F	--	F	F-G	F-G	F	F-P	F	++	+-
Wattville Association:												
Clay loam	F	F	--	--	F	F-G	F-G	F	P-F	F-P	++	++
Modified phase	F-P	F	--	--	F-P	F-G	F	F-P	P-F	F-P	++	+-
Zaporoza Association	--	--	--	--	--	F	F-P	P	F-P	F	++	+-

(2) LAND-USE CAPABILITY CLASSES:

The soils which occur in the Rossburn-Virden map sheet areas can be grouped into land-use capability classes on the basis of observed characteristics such as soil depth, texture, slope, erosion, stoniness, salinity, drainage and fertility. Brief definitions of the eight recognized land-use capability classes, together with a list of the soils that may be placed in each class, are given under the following headings:

(a) Land Suited To Arable Culture:

CLASS I -- Land of very good productivity. Highly productive soils on land that is level to very gently sloping. Some local areas may need clearing, provision for water control, and fertility maintenance. However, good farming methods are essential to keep soil in good condition and to control weeds, diseases and insect pests. No soils of the Rossburn-Virden area are listed in this land-use capability class.

CLASS II -- Land of good productivity. Good soils on land that is level to gently sloping. Some areas in certain soil associations may be slightly stony, some may require moderate drainage, and some areas may be subject to wind and water erosion or may require improvement in workability. The following soils may be listed in this category:-

Newdale undulating phase;
Newdale rolling phase;
Harding association;
Erickson association;
Carroll clay loams;
Assiniboine complex;
Pipestone association;
Carroll till substrate phase;
Newdale smooth phase;
Beresford association;
Oxbow smooth phase.

CLASS III -- Land of moderate productivity. Soils in this land class are limited in productivity due to one or more of a number of factors such as: susceptibility to wind and water erosion, limited fertility, soil drought (due to sandy texture or to physiological drought resulting from excess lime carbonate), salinity, stoniness, poor drainage, etc. These limitations may be of the same kind as those noted in Class II land, but the limiting factors are effective to a greater degree. The following soils may be listed in this category:-

Onanole clay loams;
Carroll loams;
Horod association;
Oxbow loam to clay loam;
Rackham clay loam;
Newdale calcareous and salinized associate;
Newdale modified phase;
Waitville clay loam;
Proven Lake association;
Lenore association;
Miniota sandy loam.

(b) Land Suited To Limited Arable Culture:

CLASS IV -- Land of limited productivity. Soils in this class are best suited for hay, pasture, or forestry, but may include local areas of somewhat better soils that can be used for crop production to a limited extent. Limitations of this class are, low

fertility, unfavorable topography, stoniness, or arrested drainage. The following soils may be listed in this category:-

Tiger Hills-Hilton combination;
Waitville modified phase;
Onanole fine sandy loam;
Eastbank association;
Benchlands complex;
Miniota shaly phase;
Oxbow modified phase;
Rackham fine sandy loam;
Oxbow saline phase;
Seech deep phase.

(c) Land Not Generally Suited To Arable Culture:

CLASS V -- Land suitable chiefly for grazing, hay or forestry. The soils in this class are generally on level to gently sloping topography and are not particularly subject to erosion, but they are not suited for general crop production because they are either stony, salinized, calcareous, infertile, gravelly, coarse textured, or poorly drained. The following soils may be listed in this category:-

Souris loamy fine sand;
Arrow Hills association;
Marringhurst association;
Seech coarse sandy loam.

CLASS VI -- Land suitable for hay, grazing or tree production with limitations. These limitations arise from the soils being infertile, and either very poorly drained and inaccessible during part of the summer season or very droughty due to coarse texture and steeply sloping topography. The following soils may be listed in this category:-

Zaporoza association;
Organic Soils;
Dune Sands.

CLASS VII -- Land suited for grazing or forestry with major limitations. The land in this class requires extreme care to prevent erosion. Destructive burning, or overgrazing. Such land may be steep, rough, hilly and highly susceptible to erosion. Generally this class is most suited for forestry. The following soils may be listed in this category:-

Benton association;
Eroded Slopes.

CLASS VIII -- Land suited only for wild life and recreation. This land may be extremely rough, rocky, or water-logged. No soils in the Rossburn-Virden area are listed in this land-use capability class.

3. ANALYTICAL AND EXPERIMENTAL DATA

The soil problems in the Rossburn-Virden map sheet areas are concerned mainly with the control of wind and water erosion, combating of drought, and to a lesser extent, with the low fertility level of soils developed on sandy textured sediments and of those formed under the prolonged influence of woods. On the coarse textured soils, the major problems are combating of drought, control of soil drifting and the building up of organic matter; while on finer textured soils occurring on undulating topography, the control of both wind and water erosion are of primary importance. To provide information of practical importance with respect to the soils of this area, certain physical and chemical determinations were considered necessary. These are presented under the headings of (1) surface soils and (2) soil profiles.

.SURFACE SOILS

From the various soils mapped, a large number of surface samples were collected. The water retention capacities, as indicated by the moisture equivalent values of these samples, were determined to provide a check on the textural names given to the soils in the field. Representative samples were then selected from each group of samples and subjected to mechanical analysis and to a number of chemical determinations of agronomic interest. The laboratory analyses of these samples included mechanical analysis (to ascertain texture); moisture equivalent (for water retention capacity); total nitrogen, and readily available phosphate and potash (an indication of fertility); and pH values (to indicate the reaction). In most cases, samples from corresponding virgin and cultivated sites were secured, but in other cases undisturbed samples were not obtained.

(a) Mechanical Analysis and Water Retention Capacity:

The mechanical analysis data of comparable samples are shown in Table 8; the results of the determinations of moisture capacity and indications of fertility of the representative soils are shown combined in Table 9. In the method of mechanical analysis used, the soils were first treated to bring the organic matter, etc., into solution before the sand, silt and clay were separated. The organic matter brought into solution in this procedure is included in the "solution loss" figures in Table 8, but as the solution in some cases may include mineral matter, the "solution loss" figures cannot be considered as an accurate measure of humified organic matter. However, where the "solution loss" is low, the organic matter also is low.

The water retention capacity of the soils was obtained by determination of moisture equivalent values* and calculation of the available water above the hygroscopic and wilting coefficients retained against the pull of gravity per six-inch depth of each comparable set of soil samples. The water retention capacity figures thus obtained are closely related to the amount of clay and organic matter present. In connection with the indicated water retention capacity of the various soils it should be noted that as the organic matter normally decreases with depth, the water retention capacity also correspondingly decreases with depth, if the texture of the soil remains constant.

In Table 9 the calculated water retention capacity in inches per six-inch depth above the hygroscopic coefficient and the wilting point is given. Although the water between the hygroscopic coefficient and the wilting point also is considered as "available

* For practical purposes the "moisture equivalent" values represent the amount of water in percent of dry soils when the wet soil is subjected to a definite centrifugal force. The retention capacity of soils for water thus obtained can be used to calculate the number of inches of water available to plants that the soils will retain under free drainage.

TABLE 8: MECHANICAL ANALYSIS OF REPRESENTATIVE SURFACE SOIL SAMPLES ROSSBURN-VIRDEN AREA.

No. of Samples	Dominant Soil Type	Condition:- Virgin or Cultivated	Percentage of Mineral Soil Separates												
				SAND				SILT							
			Fine Gravel 2.0 to 1.0 mm	Coarse Sand 1.0 to 0.5 mm	Medium Sand 0.5 to 0.25 mm	Fine Sand .25 to .1 mm	Very Fine Sand .1 to .05 mm	Coarse Silt .05 to .005 mm	Fine Silt .005 to .002 mm	Clay Less Than .002 mm	Total Coarse Sand 2.0 to .25 mm	Total Fine Sand .25 to .05 mm	Total Silt .05 to .002 mm	Clay Less Than .002 mm	Organic Matter, Etc., as Solution Loss
2	Newdale clay loam (Undulating phase)	Virgin	1.47	3.26	6.63	11.06	7.38	30.52	9.30	21.03	11.36	18.44	39.82	21.03	9.34
3	Newdale clay loam (Undulating phase)	Cultivated	2.05	3.17	5.57	7.96	7.62	36.01	11.49	19.12	10.79	15.58	47.50	19.12	7.01
1	Newdale clay loam (Rolling phase)	Cultivated	.77	.98	1.77	8.14	9.43	30.68	7.88	27.98	3.52	17.57	38.56	27.98	12.37
2	Newdale clay loam (Smooth phase)	Virgin	1.58	2.15	5.09	9.94	6.68	36.99	9.27	21.71	8.82	16.62	46.26	21.71	6.59
1	Newdale (Stony phase)	Cultivated	2.58	5.30	9.05	12.34	8.34	29.65	6.43	19.49	16.93	20.68	36.08	19.49	6.82
4	Marringhurst sandy loam	Virgin	3.28	14.39	26.99	20.13	4.71	10.25	4.16	12.18	44.66	24.84	14.41	12.18	3.91
8	Miniota sandy loam	Virgin	4.28	14.02	21.89	13.33	3.60	18.80	5.21	14.05	40.19	16.93	24.01	14.05	4.82
4	Miniota sandy loam	Cultivated	6.15	14.91	25.27	11.66	4.62	16.85	3.61	12.48	46.33	16.28	20.46	12.48	4.45
2	Oxbow loam to clay loam	Virgin	2.05	3.48	6.36	10.83	8.24	36.85	7.41	20.25	11.89	19.07	44.26	20.25	4.53
1	Lenore clay loam	Virgin	1.74	2.55	4.64	9.49	13.11	29.71	7.12	25.14	8.93	22.60	36.83	25.14	6.52
1	Beresford clay loam	Virgin	1.52	1.81	3.21	6.70	11.35	34.42	7.30	28.99	6.54	18.05	41.72	28.99	4.68
1	Harding clay to silty clay	Virgin	-	0.07	0.20	1.86	7.75	41.00	11.74	34.80	0.27	9.61	52.74	34.80	2.57
1	Carroll fine sandy loam	Virgin	-	0.08	0.53	26.22	33.42	20.21	2.25	15.31	0.61	59.64	22.46	15.31	1.98
5	Carroll clay loams	Virgin	0.03	0.11	1.16	17.38	17.39	30.48	5.84	20.52	1.30	34.77	36.32	20.52	7.09
6	Souris sandy loams	Virgin	0.39	2.17	14.23	38.37	13.42	12.34	1.72	12.87	16.79	51.79	14.06	12.87	4.49
1	Eastbank clay loam	Virgin	1.99	5.00	11.51	9.12	3.91	27.91	8.87	26.40	18.50	13.03	36.78	26.40	5.29
3	Erickson clay loam	Virgin	1.34	3.50	6.72	10.36	6.97	25.93	10.46	26.25	11.56	17.33	36.39	26.25	8.47
7	Erickson clay loam	Cultivated	1.97	4.95	8.81	11.09	7.34	25.42	9.33	23.79	15.73	18.43	34.75	23.79	7.30
1	Onanole fine sandy loam	Cultivated	2.85	5.33	15.30	33.02	10.47	10.83	4.29	11.44	23.48	43.49	15.12	11.44	6.47
3	Waitville clay loam	Virgin	1.93	4.18	6.58	9.44	6.38	24.87	10.54	29.39	12.69	15.82	35.41	29.39	6.69
6	Waitville clay loam	Cultivated	1.61	3.23	6.77	11.49	9.39	25.29	9.23	26.22	11.61	20.88	34.52	26.22	6.77
2	Rackham silty clay loam	Cultivated	-	0.35	0.81	0.87	1.40	45.43	12.71	28.82	1.16	2.27	58.14	28.82	9.61
1	Rackham fine sandy loam	Cultivated	2.01	5.56	23.77	38.15	6.77	11.51	2.83	7.87	31.34	44.92	14.34	7.87	1.53
1	Zaporoza coarse sandy loam	Cultivated	7.36	35.89	23.72	4.78	1.85	8.74	1.83	11.78	66.97	6.63	10.57	11.78	4.05
1	Horod sandy loam	Cultivated	2.17	11.86	27.97	23.21	4.26	13.49	3.70	7.97	42.00	27.47	17.19	7.97	5.37
1	Assiniboine loams	Cultivated	-	0.50	2.68	30.52	17.54	14.98	2.05	18.47	3.18	48.06	17.03	18.47	13.26

Table 9: Moisture Retention Capacity and Indications of Fertility Shown By Surface Soil Samples Rossburn-Virden Area.

Dominant Soil Type	Condition:- V-Virgin C-Cultivated	Moisture Retention Capacity				Indications of Fertility				
		No. of Samples	Moisture Equivalent (1)	Calculated Water Retention Capacity In Inches Per Six-Inch Depth Above The		No. of Samples	Percent Total Nitrogen (2)	So-Called "Readily Available"		Reaction pH (4)
				Hygroscopic Coefficient	Wilting Point			Phosphate (3)	Potash (4)	
Marringhurst sandy loam	V	12	14.81	.89	.67	8	.264	L	L-M	7.10
Marringhurst sandy loam	C	5	13.85	.83	.61	2	.188	VL	VL	7.10
Miniota sandy loam	V	22	22.54	1.35	.99	18	.301	L-M	M-L	6.85
Miniota sandy loam	C	24	17.23	1.03	.76	16	.273	L	L	6.95
Souris loamy sand	V	4	9.95	.60	.44	4	.230	L-M	M	7.35
Souris loamy sand	C	3	7.22	.43	.32	2	.144	L-M	L-M	7.10
Souris sandy loam	V	5	18.32	1.10	.80	7	.335	M-L	M-H	7.20
Souris sandy loam	C	5	13.68	.82	.60	4	.229	L-M	M-H	7.50
Carroll loams	V	4	22.70	1.36	.95	1	.343	M-L	VH	7.00
Carroll loams	C	5	18.94	1.14	.83	2	.297	ML	M-H	6.80
Carroll clay loams.....	V	13	33.19	1.70	1.24	12	.416	M-L	VH	7.15
Carroll clay loams.....	C	13	29.10	1.49	1.09	5	.346	L-M	M-H	7.10
Harding clay	V	3	42.32	2.13	1.58	1	.379	L	VH	7.20
Harding clay	C	3	38.87	1.98	1.45	1	.222	VL	H	7.10
Beresford clay loam	V	3	38.87	1.98	1.45	-	-	-	-	-
Beresford clay loam	C	3	32.39	1.65	1.21	-	-	-	-	-
Eastbank clay loam	V	2	38.72	1.97	1.44	1	.315	VL	H	6.65
Eastbank clay loam	C	2	33.86	1.73	1.31	2	.279	VL	H	6.75
Lenore clay loam	V	2	36.91	1.88	1.38	1	.429	L-M	H	7.15
Lenore clay loam	C	2	33.33	1.70	1.26	2	.336	L-M	H	7.15
Tiger Hills clay loam	V	1	30.55	1.56	1.14	-	-	-	-	-
Tiger Hills clay loam	C	1	23.77	1.21	.89	-	-	-	-	-
Oxbow clay loam	V	14	29.77	1.52	1.11	6	.479	L	H	7.10
Oxbow clay loam	C	12	25.71	1.31	.96	7	.354	L	H	7.40
Newdale clay loam(undulating).. (phase)	V	35	33.27	1.70	1.24	12	.547	L-M	H	7.10
Newdale clay loam " " " ..	C	41	30.06	1.54	1.12	12	.424	L-M	H	7.15
Newdale clay loam(rolling phase)	V	5	34.07	1.74	1.27	5	.555	L-M	H	7.20
Newdale clay loam(rolling phase)	C	7	30.33	1.55	1.13	5	.416	L-M	H	7.15
Newdale clay loam(smooth phase)	V	5	36.88	1.88	1.38	3	.475	L-M	H	7.00
Newdale clay loam(smooth phase)	C	5	31.61	1.61	1.18	3	.370	L-M	H	7.10
Newdale clay loam(modified phase)	V	1	32.86	1.68	1.22	-	-	-	-	-
Newdale clay loam(modified phase)	C	2	28.04	1.43	1.05	-	-	-	-	-
Erickson clay loam	V	15	35.06	1.79	1.31	15	.487	L-M	H	6.85
Erickson clay loam	C	17	30.20	1.54	1.13	15	.384	L-M	M-H	6.85
Waitville clay loam	V	13	32.56	1.66	1.21	13	.347	L	H	6.85
Waitville clay loam	C	13	26.67	1.36	1.00	13	.221	L	M-H	6.85
Rackham silty clay loam	V	5	36.06	1.84	1.34	5	.430	L-M	H	6.75
Rackham silty clay loam	C	4	33.05	1.69	1.23	4	.373	L	M-H	6.75
Rackham fine sandy loam	V	1	11.74	.71	.51	1	.097	L	M	6.70
Rackham fine sandy loam	C	1	11.44	.69	.50	1	.097	L	M	6.60
Zaporoza coarse sandy loam	V	1	18.79	1.12	.82	1	.277	L-M	M-H	6.70
Zaporoza coarse sandy loam	C	1	15.98	.96	.52	1	.148	L	M	6.90
Seech sandy loam (deep phase)..	V	1	19.88	1.19	.87	1	.318	M	M	7.00
Seech sandy loam (deep phase)..	C	1	17.17	1.03	.75	1	.270	M	M	6.95
Onanole fine sandy loam	V	1	27.94	1.65	1.22	1	.373	M	H	6.90
Onanole fine sandy loam	C	1	18.37	1.09	.80	1	.306	ML	M	7.00
Proven Lake light sandy loam ..	C	1	15.58	.93	.68	1	.235	ML	M	7.00
Horod sandy loams.....	V	1	20.31	1.22	.89	1	.360	L	M	6.80
Horod sandy loams	C	1	19.18	1.15	.84	1	.323	L	M	6.80

(1) Moisture equivalent by Briggs and McLane Method. (2) Total nitrogen by A.O.A.C. Gunning Method.

(3) Readily "available phosphate" by Merkle Method. (4) Readily "available potash" by Merkle Method.

	Phosphorus (p.p.m.)	Potassium (p.p.m.)
Extra high (EH)	---	250+
Very high (VH)	100+	200 - 250
High (H)	50 - 100	150 - 200
Medium High (MH)	25 - 50	100 - 150
Medium (M)	12 - 25	75 - 100
Low (L)	5 - 12	0 - 75
Very Low (VL)	0 - 5	---

(5) pH by glass electrode.

water", it is used only by the more drought-resisting plants to a small extent and under certain conditions. For general crops, the wilting point (approximately 54 percent of the moisture equivalent) is the lowest limit to which most plants will continue to utilize sufficient water without becoming permanently wilted.

The figures in Table 9 indicate that the finer textured soils ranging from clay loam to clay can retain 1 to 1 1/2 inches of water above the wilting point per 6 inch depth of surface soil. The coarse textured soils in the sandy loam group normally retain less than 1 inch of available water in the 6 inch depth, except in soils with higher organic matter content. Variations in organic matter content as well as relative quantities of clay in the soils within a textural group alters the retention capacity to a marked degree. The influence of organic matter on the water holding capacity of a soil is noted by the water retention data of virgin and cultivated samples obtained from the same soils.

From a textural standpoint, the problem soils in this area are (a) the Carroll and the Rackham which are silty and subject to water erosion; (b) the Souris, the Seech and the Onanole are sandy textured and susceptible to wind erosion; and (c) the Marringhurst, and the Miniota are coarse textured droughty soils.

(b) Fertility:

The soils in the Rossburn-Virden area as a whole have a good supply of nitrogen and available potash but are low in available phosphate. The following points on natural fertility are worthy of note.

Nitrogen: The total nitrogen content in cultivated soils is much lower than in the virgin soils. This is exemplified in Table 10 through the grouping of representative soils according to genetic soil type and texture.

The figures in Table 10 show that there has been considerable loss of nitrogen in the cultivated soils as compared with the virgin soils. Depletion of nitrogen in finer textured soils is attributable mainly to continuous grain cropping, whereas on sandy soils considerable loss of nitrogen is sustained by removal of organic matter through wind erosion. No definite trend of nitrogen content by zones is indicated in the data although the percentage of nitrogen in sandy textured soils is lower in the Grey Wooded zone than it is in similar materials in the Blackearth zone.

Phosphate: The relative ratings for available phosphate shown in Table 9 indicate that low to moderately low values are common for all soils in the various zones. The sandy textured soils, which also are relatively low in nitrogen, tend to be low in available phosphate.

Potash: The indications are that all the soils in the Rossburn-Virden area except those of the Marringhurst association have a good supply of available potash. High values of potash in the boulder till soils as shown in Table 9 are further substantiated by the good supply of exchangeable potassium occurring in the exchange complex of the Newdale, Erickson and Waitville soils (Table 15).

(c) Field Experiments:

Additional evidence in connection with fertility of soils in the Rossburn-Virden area is provided by the results of fertilizer trials conducted by the Soils Department of The University of Manitoba and the Manitoba Department of Agriculture during the years 1950 to 1953 inclusive on a number of farms within the area. These trails were not conducted on all soil types, hence no comparison is made between results secured on different soils.

Table 10: Average Total Nitrogen in Well-drained Virgin and Cultivated Soils Arranged by Soil Zone and Texture

Soil Zone and Texture	Average Percent Total Nitrogen In		Nitrogen Loss In Percent
	Virgin Soil	Cultivated Soil	
BLACK EARTH SOIL ZONE:			
Lenore, Oxbow and Newdale soils on till	.474	.369	23.2
Marringhurst, Miniota and Souris soils on moderately coarse textured sediments	.303	.218	28.1
Carroll and Eastbank soils on medium textured sediments	.358	.307	18.0
Harding soils on fine textured sediments	.379	.222	43.5
GREY-BLACK TRANSITION:			
Erickson soils on till	.487	.384	21.1
Onanole, Proven Lake and Horod soils on moderately coarse textured sediments	.366	.288	21.3
GREY WOODED SOIL ZONE:			
Waitville soils on till	.347	.221	36.3
Zaporoza and Rackham soils on moderately coarse textured sediments	.187	.117	37.5
Rackham on medium textured sediments	.430	.373	13.3

In these trials, ammonium phosphate fertilizer (11-48-0) was drilled in with wheat after fallow and with barley after fallow and stubble at rates of 20, 40 and 60 pounds per acre; and the ammonium phosphate fertilizer (16-20-0) was applied with the seed in similar rotations at the rate of 48 and 96 pounds per acre. The effect of the fertilizers obtained in the three years from the respective treatments is given in Table 11.

TABLE II: Effect of Ammonium Phosphate Fertilizer on Yields of Wheat and Barley in the Rossburn-Virden Area

(1950 to 1953 Inclusive)

Crop	Land Preparation	Yield of Check Plots (bus./acre)	Increase in Yield From Application of				
			11-48-0 (lbs./acre)			16-20-0 (lbs./acre)	
			20	40	60	48	96
Wheat	Fallow	25.0	3.3	7.5	9.1	6.0	9.7
Barley	Fallow	38.5	8.4	12.0	13.5	9.3	14.0
Barley	Stubble	24.5	7.0	9.3	10.7	10.0	17.2

In these trials the greatest increase in yield was obtained from the use of ammonium phosphate fertilizers applied at the high level. During the period in which these experiments were conducted, it is indicated that the 16-20-0 fertilizer (with a higher percentage of nitrogen than the 11-48-0) gave greater increases than the latter when applied at rates containing equal units of phosphate. This marked response of wheat and barley to these fertilizers implies that nitrogen as well as phosphate fertilization is required if optimum yields are to be obtained.

(d) Soil Reaction:

The data on soil reaction indicate that all of the well-drained soils range fairly close to the neutral point (neutral point - pH 7.0). Some of the soils are slightly acid but not sufficiently so to require the application of lime. Large amounts of lime were present in the sediments when they were deposited and as a whole the soils have more than adequate amounts of lime within reach of the plant roots. In poorly drained and in some intermediately drained soils of the grassland region, lime content near, and in places at, the surface is higher than desirable for optimum plant growth. In such areas the pH is high, especially where other salts also are present. In the forested region, on the other hand, the surface soils tend to be more acid in reaction because of more intensive leaching. Although some acidity occurs in the upper horizons of these soils, it seldom extends more than two feet from the surface, where limy material is normally encountered.

Table 12: Physical and Chemical Data of Representative Virgin Profile Samples
Rossburn-Virden Map Area

Zone	Dominant Soil Type	Soil Horizon	Depth in Inches	Moisture Equivalent	Percent Carbon	Percent Nitrogen	C:N Ratio	Percent Inorganic CO_2	pH
BLACKEARTH	Marringhurst Sandy Loam	A	0-4	31.90	6.80	.535	12.71	-	6.92
		B	4-10	20.83	1.99	.202	9.85	.08	6.63
		C_1	10-16	8.41	1.15	.104	-	8.01	7.45
		C_{ca}	16-21	10.05	.64	.064	-	8.32	7.52
		C_2	21-27	4.84	.26	.022	-	8.52	7.67
			27-36	9.05	.06	.021	-	8.01	7.62
	Miniota Sandy Loam	A_{11}	0-3	28.76	4.84	.444	10.91	-	7.43
		A_{12}	3-12	20.01	3.36	.320	10.50	-	7.35
		B	12-21	15.35	1.03	.122	8.44	.76	7.33
		C_1	21-31	10.13	.42	.067	6.27	8.89	7.64
		C_2	31-38	7.00	.09	.037	2.43	9.35	7.74
			38-45	3.26	.04	.019	2.11	10.12	8.02
	Souris Sandy Loam	A	0-20	10.39	1.75	.178	9.83	-	7.59
		B	20-26	7.49	.60	.074	8.11	-	7.58
		BC	26-32	7.05	.44	.064	6.88	.14	7.54
		C_1	32-44	9.53	.50	.061	-	4.27	7.73
		C_2	44-48	6.09	.19	.040	-	3.82	7.71
			48-54	4.59	.15	.016	-	4.38	7.72
	Carroll Clay Loam	A	0-5	37.61	5.81	.578	10.05	.58	7.48
		C_1	5-13	32.29	1.55	.183	8.47	13.29	7.79
		C_{ca}	13-19	31.64	1.03	.088	11.70	20.19	8.08
			19-25	29.79	.16	.070	10.86	16.56	8.06
		C_2	25-30	28.76	.50	.056	8.93	13.57	8.05
			30-36	27.76	.42	.047	8.94	11.97	7.72
	Harding Silty Clay	A	0-10	38.10	4.10	.424	9.67	.56	7.51
		C_1	10-20	34.45	.67	.187	3.58	7.92	7.58
		C_{ca}	20-28	34.43	.35	.096	3.65	10.81	7.56
			28-34	30.65	.63	.084	7.50	10.44	7.61
		C_2	34-40	22.44	.31	.049	6.33	7.92	7.72
			40-42	21.77	.31	.040	-	9.95	7.93
	Beresford Clay Loam	A	0-8	27.01	4.47	.398	11.23	-	7.30
		B	8-14	21.14	1.83	.172	10.64	.42	7.59
		C_1	14-19	19.24	.88	.100	8.80	10.62	7.64
		C_{ca}	19-24	23.17	.72	.076	9.47	14.79	7.65
			24-30	24.97	.52	.052	10.00	15.87	7.91
		C_2	30-36	22.24	.26	.038	6.84	10.95	8.05
			36-42	21.46	.13	.030	4.33	9.93	8.03
	Lenore Clay Loam	A	0-7	35.11	5.98	.451	13.26	-	6.70
		B	7-15	25.77	2.48	.213	11.64	-	6.58
		BC	15-19	27.52	1.30	.135	9.63	.08	6.69
		C_1	19-24	25.75	.68	.076	8.95	10.58	7.41
		C_{ca}	24-30	26.47	.64	.065	-	14.05	7.59
		C_2	30-36	25.56	.24	.056	-	11.67	7.42
			36-42	30.76	-	.044	-	10.61	7.53
	Oxbow Clay Loam	$A-A_0$	0-2	37.09	7.60	.673	11.29	-	6.83
		A	2-7	26.43	4.13	.370	11.16	-	6.90
		B	7-14	22.58	1.62	.181	8.95	.07	7.07
		BC	14-17	19.73	.88	.110	8.00	6.84	7.56
		C_{ca}	17-23	21.44	.63	.086	7.32	11.24	7.94
			23-30	21.29	.36	.054	6.67	11.31	8.24
		C_2	30-36	20.49	.26	.046	5.65	10.15	8.29
			36-42	20.02	.23	.038	6.05	9.12	8.12

Table 12 Cont'd: Physical and Chemical Data of Representative Virgin Profile Samples
Rossburn-Virden Map Area

Zone	Dominant Soil Type	Soil Horizon	Depth in Inches	Moisture Equivalent	Percent Carbon	Percent Nitrogen	C:N Ratio	Percent Inorganic CO_2	pH
	Newdale	A	0-9	32.94	5.74	.53	11.03	.17	7.30
	Clay Loam	B	9-17	24.70	1.62	.18	9.00	.01	7.40
	Undulating	C_{ca}	17-26	24.70	.32	.06	5.33	9.91	8.00
	phase	C	26-48	22.20	.10	.05	2.00	7.95	8.10
	Newdale	A-Ao	0-1.5	50.54	12.12	1.008	12.02	-	7.55
	Clay Loam	A_{11}	1.5-6	35.27	6.57	.571	11.51	-	7.25
	Rolling phase	A_{12}	6-10	29.41	4.08	.383	10.65	-	7.15
		B	10-15	26.27	1.18	.136	8.68	-	7.35
		BC	15-21	24.91	.83	.102	8.14	3.75	8.25
		C_1	21-27	22.83	.52	.067	7.26	6.21	8.45
		C_2	27-33	24.26	.38	.037	-	7.85	8.70
			33-36	23.20	.39	.032	-	7.65	8.65
	Newdale	A-Ao	0-2	41.79	8.39	.935	8.97	-	7.19
	Clay Loam	A	2-7	30.65	5.03	.449	11.20	.12	7.02
	Smooth phase	B	7-13	25.71	1.03	.148	6.96	3.23	7.30
		C	13-21	25.22	.53	.117	4.53	12.16	7.61
			21-32	24.33	.55	.065	-	12.60	7.90
GREY-BLACK TRANSITION	Seech	A	0-5	28.12*	5.80	.477	12.16	-	7.25
	Sandy Loam	B	5-12	14.07	1.13	.116	9.74	-	7.40
		BC	12-18	18.12	1.22	.130	9.38	7.39	7.55
		C_1	18-30	6.43	1.16	.025	-	11.91	8.50
		C_2	30-36	3.95	.04	.014	-	13.95	8.20
	Horod	A-Ao	0-2	29.75	6.88	.624	11.03	-	7.70
	Sandy Loam	A	2-12	13.63	2.52	.235	10.72	-	7.45
		B	12-16	9.00	1.09	.102	10.69	.89	7.10
		C_1	16-24	9.50	.63	.062	10.16	6.42	8.15
		C_{ca}	24-32	10.14	.22	.034	6.47	8.75	8.20
		C_2	32-40	9.67	.16	.017	-	7.83	7.75
			40-46	9.05	.16	.017	-	7.74	7.75
			46-54	6.64	.13	.008	-	7.06	7.45
	Erickson	A	0-6	36.97	7.08	.61	11.60	.01	7.20
	Clay Loam	B_2	6-14	28.05	1.34	.16	8.37	.23	6.90
		B_3	14-18	25.98	1.00	.15	6.67	4.46	7.30
		C_{ca}	18-24	25.31	.59	.07	8.42	8.17	7.50
		C	24-48	29.97	.22	.06	3.66	6.60	7.70
GREY WOODED	Zaporoza	A_o	0-1	39.82	10.81	.729	14.83	-	7.50
	Coarse Sandy	A_2	1-5	13.24	1.21	.102	11.86	-	7.20
	Loam	B_1	5-9	13.79	.34	.050	6.80	-	7.45
		B_2	9-17	17.26	.46	.031	-	.77	7.70
		C_1	17-24	6.77	.40	.034	-	8.53	8.05
		C_2	24-30	6.21	.01	.017	-	11.17	8.30
	Rackham	A_o	0-1.5	108.39	29.80	1.223	24.37	-	7.55
	Silty Clay	A_2	1.5-8	26.09	1.84	.161	11.43	.11	7.25
	Loam	B_2	8-18	27.79	.63	.070	9.00	1.04	7.60
		C_1	18-24	25.39	.64	.060	-	10.83	8.05
		C_2	24-32	30.28	.60	.046	-	13.93	8.25
			32-42	30.38	.39	.032	-	14.10	8.25
	Waitville	A_o	0-2	108.72	30.20	1.76	17.15	.46	6.20
	Clay Loam	A_2	2-7	12.93	.57	.08	7.12	-	6.10
		B_1	7-11	22.83	.63	.09	7.00	.01	6.00
		B_2	11-15	24.78	.61	.09	6.78	.25	6.40
		B_3	15-21	20.86	.45	.07	6.42	4.75	7.30
		C_{ca}	21-32	22.65	.39	.06	6.50	13.37	7.70
		C	32-48	23.34	.41	.05	8.20	10.82	7.70

REPRESENTATIVE PROFILES

Typical virgin soil profiles were selected and subjected to a number of analytical determinations to obtain data supplementary to the field observations in respect to the regional soil-forming processes. Analytical determinations on the profiles in the Rossburn-Virden area have been limited in number except on the Newdale, Erickson and Waitville soils which have been analyzed in greater detail.*

Analyses of the various soil profiles shown in Table 12 indicate some differences in moisture equivalent, organic and inorganic carbon, nitrogen and carbon-nitrogen ratios, due to the influence of the texture and regional climate, but do not show great variation in soil reaction. This lack of reaction differential indicates high base saturation as well as some uniformity in chemical composition of the different soils originally developed under the process of calcification.

Additional information on the Newdale, Erickson and Waitville soils is presented in Tables 13, 14, 15, and 16 to show some characteristics of soils developed on similar parent material but under the influence of different environmental conditions. It is pointed out that these soil profiles not only are representative of those soils developed on moderately calcareous till in Manitoba but also are closely related in lithology of coarse sediments, mineral composition of sands, mineralogical composition of clay fractions and in chemical composition to other soils developed on moderately calcareous sediments under similar environmental conditions. This feature is emphasized because studies on other soils of similar carbonate content in Manitoba have shown close similarities in the characteristics mentioned.

Table 13

Table 13: Mechanical Analysis of Three Regional Soils.
(In percent of oven-dry weight)

Soil Profile (Well-drained Associate)	Horizon	Fine Gravel 2.0-1.0 mm	Coarse Sand 1.0-0.5 mm	Medium Sand 0.5-0.25 mm	Fine Sand 0.25-0.1 mm	Very Fine Sand 0.1-0.05 mm	Silt 0.05-0.002mm	Clay 0.002 mm
Newdale	A	1.61	2.25	3.64	8.40	20.99	41.01	22.10
	B	1.54	2.69	5.28	9.13	18.03	37.64	25.69
	C_{ca}	3.74	4.26	5.89	11.38	13.10	35.70	25.93
	C	3.16	5.41	8.13	13.89	12.46	36.19	20.76
Erickson	A	1.84	2.78	5.76	10.21	8.46	43.20	27.75
	B_2	1.80	3.39	5.66	10.35	8.71	36.51	33.58
	B_3	2.04	3.22	6.16	10.13	9.45	40.26	28.74
	C_{ca}	2.59	3.99	6.52	10.39	11.16	38.53	26.82
	C	2.35	4.07	6.98	10.44	12.13	39.98	24.05
Waitville	A_2	3.09	6.90	13.09	24.91	15.72	29.64	6.65
	B_1	3.33	4.76	8.12	13.32	11.80	29.34	29.33
	B_2	3.91	5.01	11.26	12.38	7.42	28.41	31.61
	B_3	3.85	5.80	10.28	14.21	11.53	29.57	24.76
	C_{ca}	4.86	7.24	8.89	13.94	11.07	34.63	19.37
	C	4.08	6.05	8.85	14.72	10.88	36.00	19.42

From the mechanical analysis data given in Table 13 it may be noted that profiles of Newdale, Erickson and Waitville soils show progressively greater differences in clay content between the "A" and "B" horizons. This textural differential between the "A" and "B" horizons of these regional soils is characteristic of other soils developed under similar environmental conditions.

* "Pedological Processes of Some Manitoba Soils", W.A. Ehrlich. Ph. D. Thesis, University of Minnesota, 1954.

Table 14: Mineralogical Composition[1] of Clay Fractions of Two Regional Soils.

Soil Profile (Well-drained Associate	Horizon	Clay[2] Fraction	Montmorillonite	Hydromica	Vermiculite	Muscovite	Illite	Feldspars	Calcite	Quartz	Kaolinite Group	Chlorites	Sepiolite	Talc	Mixed layers of Montmorillonite and Illite	Others
Newdale	A	C	3	1		-	4	3	2	3	2	-	-	-	2	Hematite, Spinel
		M	3	1		<1	5	2	2	<1	1	-	-	1	2	Boehmite, Goethite
		F	6	1		-	4	2	-	-	-	-	-	-	4	Gibbsite
	B	C	2	1		-	4	3	1	4	2	-	-	-	2	Boehmite, Hematite
		M	4	1		1	7	2	<1	<1	1	-	-	-	1	Goethite, Lepidocrosite, Gibbsite
		F	5	1		-	3	1	1	-	-	-	-	-	3	
	C	C	2	1		-	5	2	1	2	1	-	-	1	2	Bayerite, Goethite
		M	2	<1		1	2	1	1	-	-	-	-	-	4	Spinel, Hematite
		F	3	3		1	1	2	1	-	-	-	-	1	4	
Waitville	A_2	C	1	-	-	2	3	1	-	6	1	-	-	-	-	Bayerite, Boehmite
		M	5	1	-	1	2	2	1	1	-	-	-	strong lines	-	Goethite, Diaspore
		F	6	2	1	1	1	2	-	<1	-	1	-	-	-	Hematite
	B_2	C	2	-	-	2	3	2	<1	3	1	1	-	weak lines	-	Bayerite, Boehmite
		M	8	1	-	<1	2	1	1	1	1	1	-	-	1	Diaspore, Hematite
		F	7	1	-	-	2	1	-	-	-	-	3	-	1	
	C	C	1	1	2	-	2	2	1	5	2	1	-	-	-	Goethite, Bayerite
		M	6	3	-	1	1	3	-	1	2	-	-	-	2	
		F	10	1	-	<1	-	1	1	-	-	-	2	-	1	

[1] Results are in the scale of 1-20; 1 = 1-5%: 2 = 6-10%; etc.

[2] Coarse = 2.0 - 0.2 u; Medium = 0.2 - 0.1 u; Fine = <0.1 u.

The mineralogical analyses of the clay fractions* in the Newdale and Waitville profiles (Table 14), as well as in others which are not given, show that montmorillonite and illite predominate. Other minerals of some magnitude in the soils are the hydromicas, feldspars and quartz. Only small quantities of kaolinite were noted. The equal abundance of the clay minerals in all horizons of the various profiles examined indicates that they are not post-glacial weathering products. It is thought that the mineralogical composition of the Newdale and Waitville soils is representative of the composition of other soils in Manitoba.

Table 15: Exchangeable Cations (Milli Equivalents) And Base Saturation Of Three Regional Soils.

Soil Profile (Well-drained Associate)	Horizon	Depth Inches	Calcium	Magnesium	Potassium	Sodium	Hydrogen	Total	Base Saturation (Percent)
Newdale	A	0-9	26.68	7.67	2.37	.05	.44	37.21	98.81
	B	9-17	18.05	7.40	1.25	-	.05	26.75	99.81
Erickson	A	0-6	39.25	5.87	1.75	-	.31	47.18	99.34
	B_2	6-14	26.38	5.48	1.41	.01	.05	33.33	99.85
	B_3	14-18	26.37	4.99	.98	.03	-	32.37	100.00
Waitville	A_2	0-5	4.57	.90	.43	-	.98	6.88	85.76
	B_1	5-9	13.74	5.99	1.80	.05	1.31	22.89	94.28
	B_2	9-13	14.38	6.99	2.05	.08	.55	24.05	97.71
	B_3	13-19	17.06	5.37	1.57	.18	-	24.18	100.00

Exchangeable cations and base saturation in the Newdale, Erickson and Waitville soils are shown in Table 15. In this table the data shows the variation normally expected in moderately calcareous soils subject to the various environmental conditions. The base saturation in these soils is high due to replacement of bases, principally cal-

Table 16: Chemical Analysis of Three Regional Soils.

Soil Profile (Well drained Associate)	Horizon	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	P_2O_5	MnO	Total
Newdale	A	76.38	11.34	3.50	.64	2.44	1.63	1.82	1.02	.25	.24	99.26
	B	74.80	12.61	3.75	.58	1.85	1.64	1.71	1.18	.13	.27	98.52
	C_{ca}	65.87	10.94	2.69	.46	12.13	3.97	1.40	.86	.13	.21	98.66
	C	68.33	11.09	3.25	.47	9.52	4.15	1.40	.86	.15	.17	99.39
Erickson	A	74.10	13.20	3.75	.62	2.67	1.56	1.86	.87	.30	.30	99.23
	B_2	73.72	14.34	3.99	.54	1.98	1.83	1.93	.89	.11	.27	99.60
	B_3	68.97	12.96	4.32	.55	6.67	2.62	1.61	.78	.19	.19	98.86
	C_{ca}	66.40	10.98	3.58	.56	10.85	3.29	1.45	.74	.16	.19	98.20
	C	69.00	10.79	3.75	1.08	8.01	3.22	1.40	.74	.22	.24	98.45
Waitville	A_2	82.51	8.65	1.87	.42	1.57	.70	1.47	1.36	.11	.30	98.96
	B_1	75.80	12.73	4.64	.60	1.22	1.72	1.82	1.11	.05	.30	99.99
	B_2	73.87	12.62	5.62	.50	2.03	1.61	1.72	1.09	.08	.19	99.33
	B_3	72.13	10.01	5.79	.36	4.48	3.30	1.47	1.00	.26	.21	99.01
	C_{ca}	61.36	8.53	2.85	.42	18.99	3.57	1.15	1.11	.07	.17	98.22
	C	65.31	10.18	3.10	.40	13.27	3.68	1.26	1.03	.04	.27	98.54

* Analyzed by H. M. Rice, Associate Chemist, Science Service, Ottawa.

cium, by decomposition of vegetative residues and by weathering. In the case of the Waitville soil however, it is noted that the total exchangeable cations are considerably lower in the "A" horizon than in the surface horizons of the other soils. This contrast is obviously due to variations in clay and organic matter content of the respective soils.

From these data it is readily seen why the Waitville soil is not as fertile as the Newdale and Erickson soils. It is lower in clay and organic matter content and consequently lower in supply of available nutrients for plant growth.

The chemical analysis of three soils given in Table 16 showing the relative proportions of various components also is an indication of the composition of other soils that have developed on moderately calcareous material and under similar enviornmental conditions in the Rossburn-Virden areas. This conclusion is supported by analysis of soils developed on glacial till occurring in other areas in Manitoba. Examination of the data presented in the table reveals two points of significance: (1) the soils contain an abundance of essential elements which are required by plants and (2) the post-glacial weathering of non-calcareous rocks and minerals (except shale) was comparatively slight.

4. AGRICULTURE AND LAND USE

The pioneer agricultural settlement of the area comprising the Rossburn-Virden map sheets began in 1877 with the establishment of the "Nova Scotia Settlement" near the confluence of the Minnedosa and Assiniboine rivers. Prior to this date the activity of the white man in this area had been restricted to the operation of a few scattered trading posts along the Assiniboine and Souris rivers. Notable among these early outposts were Brandon House and Assiniboine House (established by the Hudson Bay Company and North West Company respectively in 1793), Montagne a la Bosse Fort near the present site of Virden (1794), and Fort Ellice near the junction of the Qu'Appelle and Assiniboine rivers (1831). Once the sod on these fertile soils had been broken and the news of their productivity reached Eastern Canada and Europe the settlement rush was on. Within very few years most of the land south of the heavily wooded slopes of the Riding Mountain was occupied by homesteaders. Some of the important factors which contributed to this settlement boom were: the passage of the "Homestead Act" of 1872; the building of a railway between Emerson and Winnipeg in 1879; the movement of steamboats on the Assiniboine River between Winnipeg and Fort Ellice in the years 1879 to 1882; the rapid development of Brandon which was incorporated as a city in 1882; the fast and efficient land survey which necessarily preceded the settlement; and the rapid spread of railways both from Eastern Canada and within the settlement area.

The early settlers who spread throughout the prairie and aspen grove regions of Western Manitoba were almost entirely of Anglo-Saxon origin. Many came from Eastern Canada and the United States, while others immigrated from the British Isles. These people occupied all the lands which could be most readily broken and cultivated so that by 1896, the year of the first influx of Eastern European immigrants, only the wooded slopes of the Riding Mountain remained available for settlement. Thus an early segregation of ethnic groups resulted and, although somewhat modified in later years, is still evident within the area.

The economic and social life of this area has kept pace with the rapid growth and development of the whole of the settle portion of Western Canada, so that after 75 years of settlement little remains of the pioneer environment. The area is organized under a well-managed system of municipal government. Cities, towns and villages are well distributed so that marketing facilities, schools, churches and social centers are within easy access to all. The rail and shipping facilities are adequate for the present system of land use and almost all of the area is supplied with hydro-electric and telephone services. Highways and market roads are well distributed and rapid progress is presently being made in the improvement of these transportation arteries through the building of better grades and more all-weather surfaces.

AREA AND PRESENT USE OF FARM LAND

The use that is presently being made of the land in the Rossburn-Virden map sheet areas of Manitoba is seen by reference to the official figures contained in the Dominion Census and the Provincial Crop Reports. The acreage held as farm lands in the municipalities of this area, according to the Dominion Census data for the years 1941 and 1951, is given in Table 17.

The figures in Table 17 show that with a few exceptions the land in the respective municipalities is nearly all held as farms. The exceptions include: Sifton municipality in which large tracts of land are occupied by Oak Lake and surrounding marsh lands, and by sand dunes; Cornwallis municipality which includes extensive areas of sand dunes and gravely soils, and the military camp at Shilo; Ellice municipality in which a large portion of the land is being used for community pastures; and Boulton municipality

which includes a portion of Riding Mountain National Park. However, the figures given for farm land in percent of total acreage for each municipality are not precise. As is explained in the Census Report, the area of occupied farms reported for each municipality represents the area of land operated by farmers whose headquarters are in the municipality, and large areas of timber land or other nonagricultural land held by a farm operator, but operated apart from the farm business, were excluded. In effect, almost all of the land in the Rossburn-Virden areas outside of those exceptions mentioned above is presently held as farm land.

The figures in Table 17 also show that whereas there was generally a slight increase in the acreage held as farms between 1941 and 1951 the number of individual farms in many municipalities decreased slightly. This indicates the trend in recent years

Table 17: Number of Farms and Area of Farm Lands by Municipalities in Rossburn-Virden Map Area. Census of Canada 1941 and 1951.

Municipalities	Number of Farms		Acreage Held as Farms		Farm Land in Percent of Total Acreage	
	1941	1951	1941	1951	1941	1951
Pipestone**	451	467	233,643	251,903	84.51	91.11
Sifton	263	264	164,550	172,028	79.35	82.96
Glenwood	296	254	132,513	131,784	96.78	96.25
Oakland	299	269	134,380	137,534	98.42	-
Cornwallis	289	235	105,798	104,653	80.15	79.28
Whitehead	271	243	127,355	128,984	92.93	94.12
Elton	352	352	136,070	137,999	98.43	99.83
Daly	260	231	118,532	125,548	87.55	92.73
Woodworth**	405	415	184,470	189,217	89.07	91.36
Wallace	531	539	241,368	248,487	87.08	89.65
Archie	249	229	113,571	130,998	82.15	94.76
Miniota**	384	344	173,010	177,134	86.64	88.71
Hamiota	319	315	136,490	138,314	99.19	-
Blanshard	302	282	137,621	134,374	99.68	97.33
Saskatchewan	317	321	130,691	135,640	98.65	-
Harrison**	355	302	108,104	114,832	78.20	83.07
Strathclair**	332	332	125,524	129,351	90.80	93.57
Shoal Lake	288	284	140,168	134,506	-	97.30
Birtle	450	441	193,700	196,016	95.14	96.28
Ellice*	159	149	124,486	124,156	52.58	52.45
Russell**	258	263	118,090	119,998	96.84	98.49
Silver Creek**	332	316	125,357	128,840	83.74	86.07
Rossburn**	554	485	152,820	154,902	91.49	92.73
Shellmouth	328	300	117,627	126,452	82.23	88.40
Boulton***	340	311	85,997	88,120	64.28	65.86
Park L.G.D.	446	335	106,819	104,639	86.14	84.39
Totals	8,830	8,278	3,668,754	3,766,408		
Means					87.28	88.55

* Includes area in Indian Reserve and Community Pasture.

** Includes area in Indian Reserve.

*** Includes area in Forest Reserve.

toward larger land holding which has resulted partly from the rapid advancement in farm mechanization and partly from the absorption of farm help by the expanding industries and other cultural developments in Manitoba.

The condition of the farm land listed in Table 17 is shown in Table 18. The data given show that there is considerable variation in the percentage of improved land in different portions of the map areas. In general, the proportion of land under cultivation decreases from south to north and is lowest in the wooded zone on the south slope of the Riding Mountain. Exceptions to this are encountered in Sifton municipality, which includes a large percentage of sand dunes and low marsh lands, and Ellice municipality in which the extensive areas of gravelly soils are used for grazing. The unimproved land (which is compiled in the Census Report as woodland and other) may be composed of ravines; stony, gravelly or coarse textured soils; sand dunes; saline soils; wet depressions and unbroken bush land. The unbroken land is used chiefly as pasture and woodlots, and native hay is obtained from the poorly drained areas.

Table 18: Condition of Farm Land by Municipalities in theRossburn-Virden Map Areas of Manitoba. Census of Canada 1951.

Municipalities	Improved Land (In Percent)	Woodland (In Percent)	Native Pasture, Marsh and Wasteland (In Percent)
Pipestone	60.01	0.63	39.36
Sifton	37.08	11.97	50.95
Glenwood	75.28	4.19	20.53
Oakland	70.74	5.93	23.33
Cornwallis	62.83	6.84	30.33
Whitehead	73.98	4.07	21.95
Elton	78.15	3.09	18.76
Daly	65.36	7.26	27.38
Woodworth	62.90	7.36	29.74
Wallace	51.51	7.52	40.97
Archie	45.81	1.95	52.24
Miniota	56.60	14.44	28.96
Hamiota	67.85	8.94	23.21
Blanshard	63.92	8.43	27.65
Saskatchewan	59.03	6.16	34.81
Harrison	56.67	7.19	36.14
Strathclair	60.38	6.13	33.49
Shoal Lake	52.21	7.63	40.16
Birtle	51.23	12.49	36.28
Ellice	37.71	9.41	52.88
Russell	48.16	11.73	40.11
Silver Creek	55.39	10.02	34.59
Rossburn	47.07	13.94	38.99
Shellmouth	48.62	11.05	40.33
Boulton	51.58	10.60	37.82
Park L.G.D.	42.09	8.48	49.43
Average for Area	57.01	7.98	35.01

SIZE OF FARMS

The size of farm which is most common over the entire area appears to be the three-quarter section unit. However, farms vary in average size in different portions of the map areas, being largest on the gravelly and sandy soils of Ellice and Sifton municipalities and smallest on the wooded soils in Rossburn and Boulton municipalities and in the Local Government District of Park. The average number of acres per farm in each of the municipalities within the map areas has been calculated from the Dominion Census figures for 1951 as follows:

Pipestone	539 acres	Blanshard	477 acres
Sifton	652 acres	Saskatchewan	423 acres
Glenwood	519 acres	Harrison	380 acres
Oakland	511 acres	Strathclair	390 acres
Cornwallis	445 acres	Shoal Lake	474 acres
Whitehead	531 acres	Birtle	444 acres
Elton	392 acres	Ellice	833 acres
Daly	543 acres	Russell	456 acres
Woodworth	456 acres	Silver Creek	408 acres
Wallace	461 acres	Rossburn	319 acres
Archie	572 acres	Shellmouth	422 acres
Miniota	515 acres	Boulton	283 acres
Hamiota	439 acres	Park L.G.D	312 acres

TYPE OF AGRICULTURE FOLLOWED

The type of agriculture followed on the farms in the Rossburn-Virden map sheet areas is indicated by the crop acreages and by the various classes of livestock kept. Due

Table 19: Utilization of Land on Farms, Rossburn-Virden Map Areas of Manitoba. Data for Each Municipality Expressed as Acres Per Section of Farm Land (640 Acres). Census of Canada 1951.

	ARABLE LAND						NONARABLE LAND*	
Municipality	Fallow	Grain Crops	Other Crops	Cultivated Hay & Pasture	Potatoes	Farmsteads, Garden, Etc. By Difference	Woodland	Native Pasture, Marsh and Wasteland
Pipestone	115.76	244.64	1.06	14.81	0.11	7.66	4.08	251.87
Sifton	58.15	131.55	0.93	40.05	0.16	6.48	76.60	326.10
Glenwood	126.29	302.05	0.42	39.60	0.18	13.26	26.83	131.37
Oakland	133.69	288.69	2.51	17.59	0.17	10.08	37.93	149.32
Cornwallis	98.91	231.57	4.75	55.01	2.14	9.73	43.79	194.10
Whitehead	140.95	281.32	1.11	38.32	0.15	11.60	26.06	140.47
Elton	156.50	305.38	2.28	22.38	0.32	13.28	19.79	120.08
Daly	138.54	244.44	1.40	17.94	0.17	15.80	46.47	175.24
Woodworth	126.18	246.94	1.53	16.96	0.20	10.75	47.09	190.35
Wallace	100.30	195.38	2.13	19.21	0.19	12.40	48.14	262.21
Archie	94.55	157.95	10.28	23.16	0.19	7.05	12.51	334.31
Miniota	128.34	210.01	3.16	11.04	0.17	9.53	92.39	185.37
Hamiota	147.53	259.32	4.97	10.96	0.20	11.25	57.19	148.56
Blanshard	127.61	258.22	1.75	10.05	0.12	11.33	53.97	176.95
Saskatchewan	122.55	233.84	0.26	8.64	0.17	12.33	39.43	222.77
Harrison	113.77	214.66	0.17	22.12	0.22	11.77	46.00	231.28
Strathclair	119.53	245.87	0.09	11.72	0.23	9.02	39.20	214.34
Shoal Lake	110.68	207.06	0.34	8.09	0.23	7.22	48.85	257.02
Birtle	101.00	194.85	3.65	18.39	0.16	9.82	79.94	232.17
Ellice	61.59	132.28	0.43	41.34	0.15	5.59	60.19	338.45
Russell	84.99	195.58	1.40	15.97	0.15	10.10	75.08	256.71
Silver Creek	95.79	236.49	0.49	10.41	0.38	10.91	64.15	221.38
Rossburn	107.32	173.35	0.42	9.23	0.44	10.51	89.20	249.53
Shellmouth	96.92	190.32	0.66	13.97	0.22	9.06	70.74	258.10
Boulton	87.87	216.69	0.31	11.71	0.33	13.23	67.90	242.05
Park L.G.D.	84.58	154.91	0.26	15.18	0.32	14.09	54.28	316.37
Average for Area	110.77	221.28	1.82	20.15	0.29	10.53	51.07	224.09

* As classified in Census of Canada Report.

to the vicissitudes of climate and economic conditions there is some annual variation in the crop acreage, however, although the respective figures vary slightly from year to year, the agricultural data for the individual municipalities for 1951 reflect very well the type of agriculture followed.

(a) Crop Acreages:

The total crop acreage figures by district units are not as easily interpreted as figures by farm units. To simplify the official crop acreage data, the total figures for the

Table 20: Average Annual Yields of Cereals (in Bushels Per Acre) in Manitoba Crop Reporting Districts Nos. 7(Virden) and 10(Russell) 1921-1953 (33 Years)

Year	Wheat	Oats	Barley	Fall Rye	Spring Rye	Flax
1921	13.2	23.5	18.9	18.3	15.0	8.7
1922	23.4	46.8	34.8	24.3	16.6	13.0
1923	15.1	38.9	27.2	16.3	13.1	10.5
1924	15.0	38.3	28.9	19.5	15.6	8.7
1925	17.7	38.4	27.1	21.0	14.5	9.8
1926	22.5	32.8	26.8	21.5	16.2	9.8
1927	17.5	19.5	26.2	21.8	15.3	10.0
1928	21.3	37.2	29.5	21.6	19.2	10.0
1929	14.6	18.9	15.0	17.8	12.7	6.8
1930	18.6	35.4	26.4	20.2	18.0	8.8
1931	11.0	14.3	12.2	10.8	9.7	4.3
1932	19.2	31.5	23.2	16.2	14.2	5.2
1933	15.4	24.0	17.0	14.1	10.8	6.8
1934	14.5	14.2	10.0	9.2	8.0	5.1
1935	6.8	20.7	19.6	16.2	16.9	9.4
1936	12.4	12.4	11.0	10.4	9.9	4.7
1937	11.8	17.1	13.7	12.0	10.3	5.5
1938	18.5	27.7	21.4	17.9	15.5	7.7
1939	19.9	20.3	16.5	11.2	12.6	6.7
1940	14.4	18.0	14.8	11.1	10.8	7.0
1941	20.7	32.2	25.9	16.2	15.6	8.2
1942	28.2	50.8	37.9	19.2	21.0	10.5
1943	27.5	42.0	33.6	18.9	11.0	10.2
1944	27.5	42.4	31.7	15.0	16.0	11.5
1945	21.9	36.6	32.2	15.5	11.5	12.0
1946	24.8	40.3	30.0	18.5	17.2	10.5
1947	21.1	33.7	24.8	19.0	13.0	10.9
1948	26.3	42.7	31.4	18.8	14.3	10.2
1949	22.8	38.2	31.5	17.8	15.5	9.4
1950	22.1	42.0	30.5	18.7	16.2	8.5
1951	23.4	37.6	31.1	17.3	18.2	7.5
1952	26.5	41.6	34.2	18.6	16.8	9.5
1953	27.8	41.4	30.5	21.0	16.5	10.2
Average For 33 Years	19.5	31.9	25.0	17.1	14.5	8.7

crops and land use in the respective municipalities have been calculated as the average acres per section of land. By thus expressing the crop figures as acres per section, the general use made of the arable land in this area can be visualized more readily.

The average acreage of the various crops per section given in Table 19 shows that throughout the entire area of the Rossburn-Virden map sheets the arable land is used primarily for the production of grain and as fallow preparatory for grain production. The grain crops constitute 91 percent of the crops sown on the farm fields. Wheat is the dominant grain crop for the area as a whole, constituting 36 percent of the seeded acreage as opposed to 30 percent for barley, 26 percent for oats, and 8 percent for other cereals and flax. However, the proportional acreage of wheat to coarse grains decreases from south to north and barley becomes the major crop in the northern portion of the map area. Thus, in the Grey - Black and Grey Wooded zones (as represented by the municipalities of Harrison, Boulton, Rossburn, and Park L.G.D.) the grain crops consist of approximately 26 percent wheat, 48 percent barley, 24 percent oats, and 2 percent other cereals and flax. The ratio of acreage in grain crops to that in summerfallow is approximately the same throughout the area. This ratio is generally about 2 to 1 and indicates that a general cropping sequence of one year fallow, followed by two crops of grain, is the common practice. The small acreage of cultivated grasses and legumes, and other crops, emphasizes the fact that crops other than cereals are grown only as small acreages on a large number of farms or larger acreages on a limited number of farms. The acreage of potatoes indicates that this crop is grown chiefly for domestic consumption.

Data are not available which would show the annual yields of the dominant crops by municipalities or by census districts, but the mean yields of cereal crops and flax from 1921 to 1953 for Provincial Crop Reporting Districts No's. 7 and 10* are submitted in Table 20 as evidence of the average annual yields which have been obtained during this period throughout the entire map area.

During the 33 years for which the data are available the average yields of wheat and other grain crops show wide fluctuations. These fluctuations are due to the effect of drought, soil drifting, wheat rust, plant diseases, insect pests, etc. The reducing effect of these hazards is particularly noticeable during the period of 1929 to 1937. Since that time, more favorable climatic conditions and improvement in the disease resistance of the crops, have resulted in more consistent yields above the long-term average. Unfortunately, no figures are readily available for a comparison of crop yields on the individual soil types.

(b) Numbers Of Livestock:

An appreciable amount of livestock is found on the majority of farms. This is substantiated if the numbers of horses, cattle, sheep, swine and poultry listed for the respective municipalities are expressed as the average numbers per section of land (Table 21).

GENERAL OBSERVATIONS

The general type of farming in the Rossburn-Virden map areas consists of grain production on the arable land with a minor supplementary livestock enterprise. Wheat production is generally less prominent than in the drier climatic zones to the west and south and large acreages of coarse grains are grown both for domestic livestock consumption and commercial sale. Cultivated hay and pasture crops are of minor importance throughout the area, as local nonarable lands generally supply a major portion of this type of livestock feed. Special crops which have recently found adaptation in other parts of

* Virden Crop Reporting District (No. 7) and Russell Crop Reporting District (No. 10) include all the municipalities in the Rossburn-Virden map sheet areas, with the exception of Elton, Cornwallis, and Oakland.

Manitoba have not developed in this area due primarily to the lack of local markets and processing facilities. Some restrictions on crop adaptation result from the shorter growing season, especially in the northern portion of the area. The production of corn for fodder or seed is limited to the Blackearth zone, and many horticultural crops which can be grown in south-central and south-eastern Manitoba are not adapted to the cooler climate of this area.

The City of Brandon with its population of over 20,000 people has somewhat affected the agriculture of the surrounding district. This effect is most prominent on the alluvial soils of the Assiniboine Valley which in this vicinity are being used exclusively for the production of market garden crops. The local market for dairy products also has caused some added diversification of farming in the surrounding district and a portion of the coarse textured Marringhurst soils in this area are being utilized for dairy farming.

The type of farming being conducted in the Rossburn-Virden map areas, which has been described in the preceding sections, has developed as a result of regional crop adaptation, economic conditions and practical experience. However very little emphasis

Table 21: Average Number of Horses, Cattle, Sheep, Swine and Poultry by Municipalities in Rossburn-Virden Map Areas of Manitoba, Expressed as Average Numbers Per Section of Land (640 Acres). Census of Canada 1951.

Municipality	Horses	CATTLE		Sheep	Swine	POULTRY	
		Milk Cows	Other Cattle			Hens and Chickens	Other Poultry
Pipestone	4.3	6.3	16.7	2.0	6.0	28.8	51.5
Sifton	4.2	7.5	22.6	2.3	4.9	26.8	52.2
Glenwood	3.4	6.9	13.8	3.3	11.5	40.9	83.9
Oakland	4.0	5.4	15.4	0.7	6.4	40.6	84.8
Cornwallis	4.8	14.0	18.7	4.5	16.0	69.7	151.8
Whitehead	3.7	6.2	14.6	1.5	6.9	45.3	102.5
Elton	3.4	9.0	14.9	0.3	10.7	77.6	175.2
Daly	4.0	5.2	14.6	1.6	9.7	50.3	104.2
Woodworth	5.0	6.2	18.7	1.1	20.5	50.0	116.3
Wallace	6.0	7.5	21.7	1.6	17.2	50.8	109.9
Archie	5.3	10.6	24.2	1.3	14.1	41.2	86.6
Miniota	4.3	6.7	14.4	2.0	7.8	42.7	90.6
Hamiota	3.9	6.3	15.9	0.4	8.8	66.6	139.8
Blanshard	3.5	7.0	13.5	0.2	11.6	58.2	116.5
Saskatchewan	3.8	6.0	12.6	0.5	7.2	51.7	88.3
Harrison	5.4	10.3	9.0	1.4	6.5	48.8	114.4
Strathclair	4.6	6.9	10.6	0.8	7.9	51.0	118.2
Shoal Lake	4.6	8.5	14.9	0.0	7.3	53.6	117.6
Birtle	5.5	7.6	16.5	1.2	7.8	41.3	87.2
Ellice	2.7	3.9	10.8	0.2	3.6	19.1	39.7
Russell	6.0	8.1	17.6	1.7	6.1	41.7	90.2
Silver Creek	5.4	8.3	14.5	0.6	5.8	38.1	93.0
Rossburn	8.1	17.2	14.5	1.2	7.0	55.5	148.6
Shellmouth	5.7	9.2	16.1	2.0	6.3	34.8	79.5
Boulton	9.0	13.3	13.5	1.9	9.5	49.9	126.8
Park L.G.D.	8.3	13.5	11.9	0.9	8.8	52.5	131.2
Average for Area	5.0	8.4	15.5	1.4	9.1	47.2	103.9

has been placed on the maintenance of soil fertility. The general cropping system of one year bare fallow, followed by two or more crops of grain has, through its effect on soil structure, organic matter content, and the lack of a protective surface covering, predisposed many of the soils to severe loss of fertility through removal of a part or all of the surface horizons by water and wind erosion. This depletion of fertility through erosion has markedly lowered the productivity of the highly susceptible soils, such as those of the Carroll, Souris, Miniota, Rackham, and Onanole associations, and is presently affecting the more resistant soils, such as those of the Newdale, Erickson and Oxbow associations.

Due to the severe restrictions that are imposed on the land use of this area by the existing conditions of local and regional markets, the soil conservation practices which can be economically employed at the present time are limited to those adapted to the present general type of farming.

However much can be done to alleviate this severe hazard of soil erosion within the present cropping practices. Reference is here made to the discussions of agriculture under the individual soil descriptions in this report and to previous publications on the control of soil erosion in Manitoba.*

* "The Land for Thine Inheritance", by J. H. Ellis, Soils Department, The University of Manitoba, Published by the Department of Agriculture, Province of Manitoba, 1947.

"Our Mother Earth", Manitoba Department of Agriculture, 1941.

"Keep Manitoba Soils Productive", Manitoba Department of Agriculture, Publication No. 265, 1953

APPENDIX I.

COMMON PLANT SPECIES AND THEIR DISTRIBUTION, ROSSBURN-VIRDEN MAP SHEETS

Common Name	Botanical Name	DISTRIBUTION							
		Riding Mountain Area							
		Grey-Black Soils Area (1)	Grey Wooded Soils Area (2)	Lacustrine and Till Plains (3)	Gravelly and Sandy Outwash Areas (4)	River Flats Terraces and Eroded Slopes (5)	Arrow Hills Area (6)	Tiger Hills Area (7)	Duned Sand Areas (8)
TREES:									
American Elm	Ulmus americana					x			
Ash, Green	Fraxinus campestris					x		x	
Ash, Lance-leaved	Fraxinus lanceolata			x		x		x	
Bur Oak	Quercus macrocarpa	x	x	x	x	x	x	x	x
Manitoba Maple	Negundo interius	x	x	x	x	x			
Paper Birch	Betula papyrifera	x	x	x		x			
Poplar, Aspen	Populus tremuloides	x	x	x	x	x	x	x	x
Poplar, Balm of Gilead	Populus candicans	x	x	x	x	x			
Spruce, Black, Bog S	Picea Mariana	x	x						
Spruce, White	Picea glauca	x	x						x
Tamarack, American Larch	Larix laricina	x	x						
SHRUBS AND SUB-SHRUBS:									
Black Currant	Ribes americana	x	x	x	x	x		x	
Buffalo Berry, Low	Shepherdia canadensis							x	
Buffalo Berry, Thorny	Shepherdia argentea					x			
Cherry, Choke	Prunus nana	x	x	x	x	x		x	
Cherry, Pin	Prunus pennsylvanica	x	x	x		x		x	
Dogwood, Red Oiser	Svida stolonifera	x	x	x	x	x		x	
Glandular Birch	Betula glandulifera		x						
Gooseberry	Grossularia oxyacanthoides	x	x	x	x	x		x	
Ground, Cedar	Sabina horizontalis			x		x			x
Hawthorn	Crataegus succulenta	x	x	x	x	x		x	
Hazel, American	Corylus americana	x	x	x	x	x		x	
Hazel, Beaked	Corylus rostrata	x	x	x	x	x		x	
High-bush Cranberry	Viburnum trilobum	x	x	x	x	x			
Nanny-berry	Viburnum lentago					x		x	
Narrow-leaved Meadowsweet	Spiraea alba		x	x	x	x			
Raspberry	Rubus stringosus	x	x	x		x		x	
Rose, Prairie	Rosa alcea	x	x	x	x	x	x	x	x
Rose, Wood	Rosa acicularis	x	x	x		x		x	
Saskatoon	Amelanchier alnifolia	x	x	x	x	x		x	
Silverberry	Elaeagnus commutata	x	x	x	x	x	x	x	x
Snowberry	Symphoricarpos occidentalis	x	x	x	x	x	x	x	
Willow, Autumn	Salix serissima					x			
Willow, Bebbs	Salix Bebbiana	x	x	x	x	x		x	x
Willow, Bog	Salix pedicellaris			x				x	
Willow, Basket	Salix petiolaris					x			
Willow, Sand-bar	Salix interior			x		x		x	
Willow, Shining	Salix lucida			x	x	x		x	
VINES:									
Climbing Honeysuckle	Lonicera glaucescens			x		x		x	
Hop	Humulus Lupulus		x			x			
Morning Glory	Convolvulus sepium			x		x			
Smilax, Carrion Flower	Nemexia lasioneuron			x				x	

APPENDIX I. (Contd.)

COMMON PLANT SPECIES AND THEIR DISTRIBUTION, ROSSBURN-VIRDEN MAP SHEETS

		DISTRIBUTION							
		Riding Mountain Area							
Common Name	Botanical Name	Grey-Black Soils Area (1)	Grey Wooded Soils Area (2)	Lacustrine and Till Plains (3)	Gravelly and Sandy Outwash Areas (4)	River Flats Terraces and Eroded Slopes (5)	Arrow Hills Area (6)	Tiger Hills Area (7)	Duned Sand Areas (8)
HERBACEOUS -- NOT GRASS-LIKE									
Alum-root	Heurchera hispida		x	x	x	x			x
Anemone, Crocus; Prairie Anemone	Pulsatilla ludoviciana			x		x	x		x
Anemone, Long-fruited	Anemone cylindrica	x		x		x		x	
Anemone, Red-flowered	Anemone hudsoniana	x	x	x		x			
Anemone, White Wood	Anemone canadensis	x		x	x	x		x	
Artichoke, Jerusalem	Helianthus tuberosus			x				x	
Aster, Golden Prairie	Chrysopsis villosa			x		x		x	
Aster, Hispid Golden	Chrysopsis hispida			x			x		x
Aster, Heart-leaved	Aster cordifolius							x	
Aster, Many-flowered	Aster ericoides		x	x	x	x			
Aster, Smooth Blue	Aster laevis	x	x	x	x	x	x	x	
Aster, Tall White	Aster paniculatus			x		x			
Aster, White Prairie	Aster commutatus			x		x	x	x	
Avens, Large-leaved	Geum macrophyllum	x	x	x	x	x		x	
Avens, Three-flowered	Sieversia triflora			x	x	x		x	
Avens, Yellow	Geum strictum			x	x			x	
Baneberry, White	Actea albe	x	x						
Bearberry	Arctostaphylos Uva-ursi		x			x		x	x
Bedstraw, Northern	Galium boreale	x	x	x		x	x	x	x
Bedstraw, Sweet-scented	Galium triflorum	x	x	x					
Bell-flower, Blue-bells	Campanula petiolaris			x		x		x	x
Bergamont	Monarda menthaefolia			x		x	x	x	
Black-eyed Susan	Rudbeckia hirta	x	x	x	x	x		x	
Blazing-star, Dotted-leaved	Liatris punctata	x		x	x	x	x	x	
Blazing-star, Meadow	Liatris ligulistylis							x	
Broomweed	Gutierrezea Sarothrae			x		x		x	
Buttercup, Pursh's	Ranunculus Purshii			x		x			
Buttercup, Sea-side	Halerpestes Cymbalaria								x
Cactus, Purple Pin-cushion	Neomamillaria vivipara			x			x		x
Chamaerhodos	Chamaerhodos Nuttallii			x			x		
Chickweed, Long-stalked	Stellaria longipes		x					x	
Chickweed, Meadow	Cerastium arvense			x		x	x	x	x
Cinquefoil, Beautiful	Potentilla pulcherrima					x	x		
Cinquefoil, Plains	Potentilla bipinnatifida			x		x	x	x	x
Cinquefoil, Rough	Potentilla monspeliensis			x		x		x	
Cinquefoil, White	Potentilla arguta			x		x			
Clover, Owl's	Orthocarpus luteus			x		x		x	
Clover, Purple Prairie	Petalostemon purpureus			x		x	x	x	
Clover, White Sweet	Melilotus alba			x					
Colt's-foot, Arrow-leaved	Petasites sagittatus		x		x				
Comandra, Pale	Comandra pallida			x				x	
Dewberry	Rubus pubescens	x	x	x	x	x		x	
Dogbane, Spreading	Apocynum androsaemifolium	x	x	x					
Dragonhead	Moldavica parviflora			x					

APPENDIX I. (Contd.)

COMMON PLANT SPECIES AND THEIR DISTRIBUTION, ROSSBURN-VIRDEN MAP SHEETS

Common Name	Botanical Name	DISTRIBUTION							
		Riding Mountain Area							
		Grey-Black Soils Area (1)	Grey Wooded Soils Area (2)	Lacustrine and Till Plains (3)	Gravelly and Sandy Outwash Areas (4)	River Flats Terraces and Eroded Slopes (5)	Arrow Hills Area (6)	Tiger Hills Area (7)	Duned Sand Areas (8)
Ragwort, Cut-leaved	Senecio eremophilus			x					
Ragwort, Golden	Senecio aureus						x	x	
Ragweed, Giant	Ambrosia trifida			x					
Rockcress	Arabis sp. ?		x						
Rosemary, Wild	Andromeda polifolia		x						
Rough Ox-eye	Heliopsis scabra							x	
Sage, Long-leaved	Artemisia longifolia					x			
Sage, Pasture	Artemisia frigida			x	x	x	x	x	x
Sage, Prairie	Artemisia gnaphalodes	x	x	x	x	x	x	x	x
Samphire	Salicornia rubra			x		x		x	
Sanicle	Sanicula marylandica	x	x	x	x	x		x	
Sarsaparilla, Smooth	Aralia nudicaulis	x	x	x	x	x		x	
Scarlet Gaura	Gaura coccinea				x	x			
Sea Blite, Western	Suaeda depressa			x					
Silver-leaf Psoralea	Psoralidium argophyllum			x			x	x	
Silver-weed	Argentina Anserina			x				x	
Skeleton Weed	Lygodesmia juncea			x		x		x	
Spider Flower	Peritoma serrulata			x					
Stinging Nettle, Common	Urtica procera	x			x	x			
Stinging Nettle Great	Urtica dioica			x		x			
Strawberry, Prairie	Fragaria virginiana	x	x	x	x	x		x	
Strawberry, Wood	Fragaria americana		x	x	x	x			
Sunflower, Indian Potato	Helianthus subtuberosus			x					
Sunflower, Maximillian's	Helianthus Maximilliani			x				x	
Sunflower, Rhombic-leaved	Helianthus subrhomboideus			x	x			x	x
Swamp Persicaria	Persicaria coccinea			x		x			
Sweet Pea, Pale	Lathyrus ochroleucus			x	x			x	
Sweet Pea, Veiny	Lathyrus venosus	x	x	x	x	x		x	
Thistle, Wavy	Cirsium undulatum	x		x	x	x		x	
Vetch, American	Vicia americana	x	x	x	x	x		x	
Violet, Canada	Viola canadensis	x	x	x	x	x		x	
Violet, Early Blue	Viola adunca			x					
Violet	Viola sp. ?	x	x			x			
Wallflower, Western	Cheirina aspera			x					
Western Androsace	Androsace occidentalis			x		x			
White Lettuce	Nabalus albus	x	x	x				x	
Wormwood, Linear-leaved	Artemisia dracunculoides			x	x	x			
Wormwood, Smooth	Artemisia glauca			x	x	x		x	
Wormwood, Tall	Artemisia caudata					x			
Yarrow, Common	Achillea Millefolium	x	x	x	x	x	x	x	
FERNS AND FERN ALLIES:									
Horsetail, Scouring Rush	Equisetum affine			x	x				
Little Club-moss	Selaginella densa			x	x		x		
Winter-green, Liver-leaf	Pyrola asarifolia	x							
Winter-green, Shin-leaf	Pyrola elliptica	x							

APPENDIX I. (Contd.)

COMMON PLANT SPECIES AND THEIR DISTRIBUTION, ROSSBURN-VIRDEN MAP SHEETS

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		Grey-Black Soils Area (1)	Grey Wooded Soils Area (2)	Lacustrine and Till Plains (3)	Gravelly and Sandy Outwash Areas (4)	River Flats Terraces and Eroded Slopes (5)	Arrow Hills Area (6)	Tiger Hills Area (7)	Duned Sand Areas (8)
Evening Primrose, Nuttall's White	Anogra Nuttallii							x	
False Dandelion, Smooth	Agoseris glauca			x					
False Gromwell	Onosmodium occidentale			x		x			
False Gromwell, Rough	Onosmodium hispidissimum							x	
False Lily-of-the-Valley	Maianthemum canadense			x				x	
False Soloman's Seal	Polygonatum commutatum			x				x	
Fireweed	Chamaenerion spicatum	x	x	x	x	x			
Flax, Small-flowered Yellow	Cathartolinum sulcatum			x				x	
Flax, Prairie Blue	Linum Lewisii			x		x		x	x
Fleabane, Philadelphia	Erigeron philadelphicus			x	x				
Fleabane, Rough	Erigeron aspen	x							
Fringed Loosestrife	Steironema ciliatum			x		x			
Gaillardia, (Blanket Flower)	Gaillardia aristata			x		x	x	x	
Gentian, Spurred	Halena diflexa			x					
Giant Hyssop	Agastache anaethiodora	x	x	x	x	x			
Goldenrod, Canadian	Solidago canadensis	x	x	x	x	x		x	
Goldenrod, Low	Solidago missouriensis	x	x	x	x			x	
Goldenrod, Stiff	Solidago rigida			x	x				
Goldenrod, Velvety	Solidago mollis			x		x	x		
Goosefoot, Oak-leaved	Chenopodium glaucum			x					
Gumweed, Perennial	Grindelia perennis			x		x		x	
Hedysarum, Northern	Hedysarum boreale			x					
Indian Bread-root	Pediomelum esculentum			x	x	x	x	x	
Indian Paint-brush	Castileja rhexifolia			x					
Ironweed, Spiny	Sideranthus spinulosus					x	x		x
Lady's Thumb	Persicaria maculosa			x		x			
Licorice, Wild	Glycyrrhiza lepidota			x				x	x
Locoweed, Showy	Oxytrophis splendens			x			x	x	
Marsh Hedge Nettle	Stachys scopulorum		x	x	x	x			
Marsh Speedwell	Veronica scutellata					x			
Meadow-rue, Early	Thalictrum dioicum	x	x		x	x		x	
Meadow-rue, Tall	Thalictrum dasycarpum	x		x		x		x	
Milkvetch, Canadian	Astragalus canadensis			x		x		x	
Milkvetch, Flexile	Pisophaca flexilis			x	x	x		x	
Milkweed, Dwarf	Ascelepias ovalifolia			x					
Mint, Wild	Mentha Glabrior			x		x		x	
Morning Glory, Americana	Convolvulus americanus					x			
Moss Phlox	Phlox Hoodii			x		x	x		x
Parsnip, Cow	Heracleum lanatum	x	x			x			
Parsnip, Golden Meadow	Zizia aurea		x			x			
Parsnip, Heart-leaved Golden	Zizia cordata	x		x				x	
Parsnip, Water	Sium cicutaefolium	x		x	x				
Poison Ivy	Toxicodendron radicans					x			
Puccoon, Hoary-leaved	Lithospermum canescens							x	x
Pussy-toes, Small; Cat's Paws	Antennaria microphylla			x		x	x	x	
Pussy-toes, Prairie	Antennaria campestris			x				x	

APPENDIX I. (Contd.)

COMMON PLANT SPECIES AND THEIR DISTRIBUTION, ROSSBURN-VIRDEN MAP SHEETS

Common Name	Botanical Name	Riding Mountain Area: Grey-Black Soils Area (1)	Riding Mountain Area: Grey Wooded Soils Area (2)	Lacustrine and Till Plains (3)	Gravelly and Sandy Outwash Areas (4)	River Flats Terraces and Eroded Slopes (5)	Arrow Hills Area (6)	Tiger Hills Area (7)	Duned Sand Areas (8)
GRASSES AND GRASS-LIKE PLANTS:									
Alkali Grass, Common	Distichlis stricta			x		x		x	
Alkali Grass	Distichlis spicata			x					
Blue-eyed Grass	Sisyrinchium angustifolium			x				x	
Blue Grass, Fowl	Poa palustris			x					
Blue Grass, Kentucky	Poa pratensis	x	x	x				x	
Blue Grass	Poa sp. ?		x	x					
Blue joint	Calamagrostis canadensis	x		x				x	
Blue-stem, Big	Andropogon furcatus			x		x	x	x	x
Blue-stem, Little	Andropogon scoparius			x		x		x	
Brome, Fringed	Bromus ciliatus	x	x	x	x	x		x	
Brome, Short-awned	Bromus breviaristatus					x			
Brome, Nodding	Bromus anomalus	x	x		x	x			
Brome, Smooth-awnless	Bromus inermis	x	x	x	x	x			
Bulrush, Great	Scirpus validus	x	x	x					
Cat-tail	Typha latifolia			x					
Cord Grass, Prairie	Spartina pectinata			x					
Dropseed, Prairie	Sporobolus heterolepis			x		x		x	
Dropseed, Sand	Sporobolus cryptandrous			x					
False Oat-grass	Schizachne purpurascens			x					
Fescue, Red	Festuca rubra					x	x		
Fescue, Sheep's	Festuca ovina			x				x	x
Grama Grass	Bouteloua gracilis			x	x	x	x	x	x
June Grass	Koleria cristata			x	x	x	x	x	
Marsh Arrow-grass	Troglochin palustris			x				x	
Muhlenbergia, Marsh	Muhlenbergia racemosa	x	x	x	x	x		x	
Muhlenbergia, Prairie	Muhlenbergia cuspidata			x		x			
Onion, Nodding	Allium cernuum			x		x		x	
Red Lily	Lilium philadelphicum		x	x					
Red Top	Agrostis alba			x					
Reed Grass, Long-leaved	Calamovilfa longifolia			x	x	x	x	x	x
Reed Grass, Tall	Phragmites communis			x				x	
Rush, Baltic	Juncus ater			x				x	
Rush, Spike	Eleocharis palustris			x		x			
Slough Grass, Beckmann's	Beckmannia syzigachne			x		x			
Sedge, Woolly	Carex lanuginosa			x					
Sedge	Carex sp. ?			x		x			
Spear Grass, Common	Stipa comata		x	x	x	x	x	x	x
Spear Grass, Green	Stipa viridula		x	x	x	x		x	
Tall Manna Grass	Glyceria grandis			x					
Water Plantain	Alisma sp. ?			x					
Western Couch	Agropyron Smithii	x	x	x		x			
Wheat Grass, Awned	Agropyron subsecundum			x		x	x	x	
Wheat Grass, Slender	Agropyron pauciflorum	x		x	x	x	x		
White-grained Mountain Rice	Oryzopsis asperifolia			x				x	
Wild Barley	Hordeum jubatum	x		x		x		x	
Wild Rye, Macoun's	Elymus Macounii	x	x	x		x			
Wild Rye, Nodding	Elymus canadensis			x		x		x	x
Wild Rye, Virginia	Elymus virginicus			x		x		x	
Witch Grass	Panicum capillare			x					

APPENDIX II

EXPERIMENTAL AND ILLUSTRATION STATIONS

Experimental and Illustration Stations that are located in the Rossburn-Virden area are listed below.

(1) Brandon -- Dominion Experimental Farm
W1/2 of Section 34 and portions of Sections 22 and 27 in Township 10, Range 19W.

(2) Hargrave -- District Experimental Substation
Portions of Sections 15 and 16 in Township 11, Range 27W.

(3) Silverton -- Illustration Station
Portions of Sections 16, 22, 9 and 8 in Township 21, Range 27W.

AGRICULTURAL EXTENSION SERVICE PROJECTS

Particulars of the activities of District Agricultural Representatives, Agricultural Societies, Agricultural Education, Co-operative Marketing Organizations, etc., may be obtained from the Provincial Department of Agriculture, Winnipeg, Manitoba.