SOILS REPORT No. 11 1960

Report of DETAILED SOIL SURVEY of PASQUIA MAP AREA in NORTHERN MANITOBA

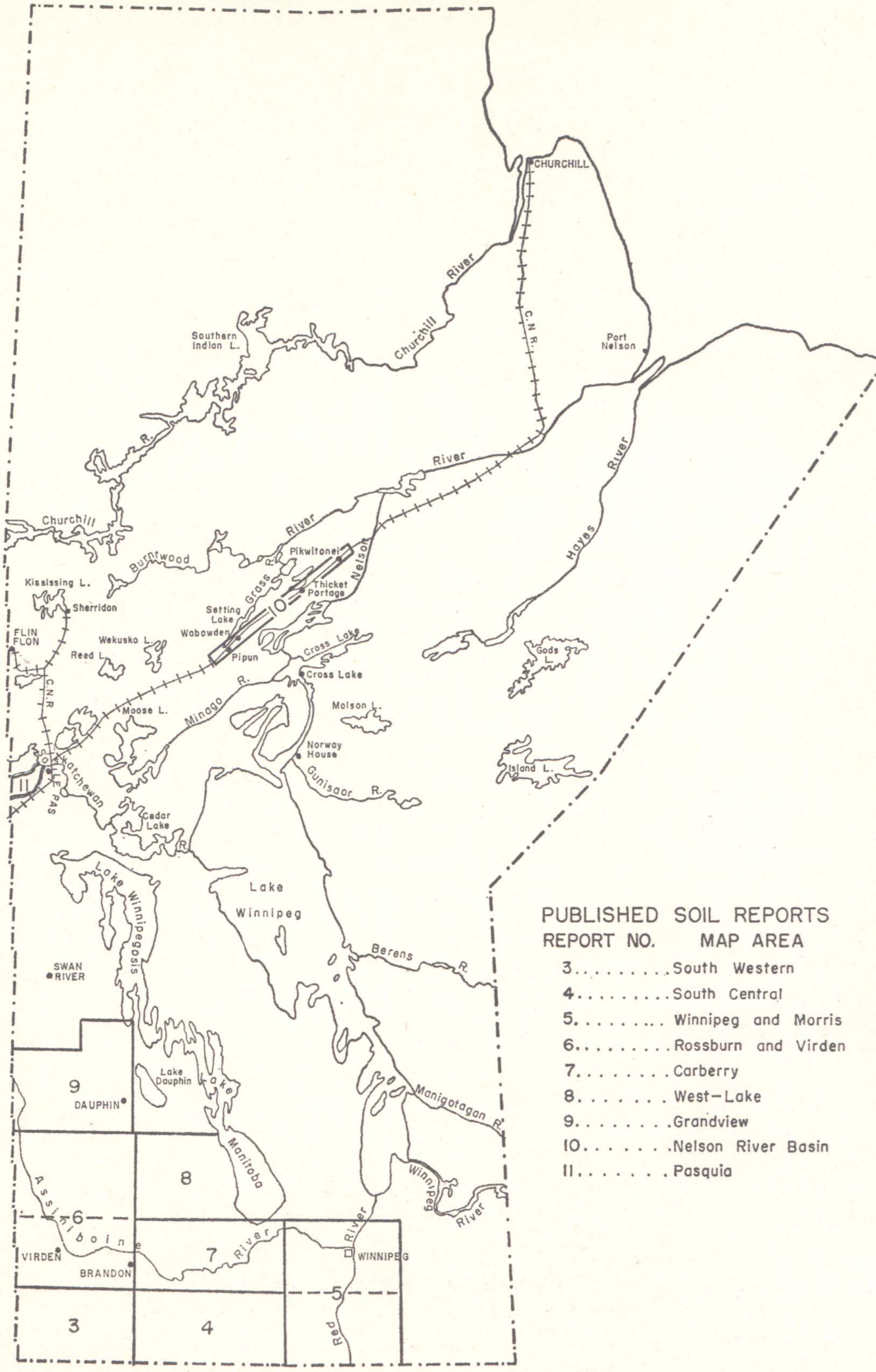
By

W. A. EHRLICH, L. E. PRATT
F. P. LECLAIRE AND J. A. BARR

MANITOBA SOIL SURVEY

CANADA DEPARTMENT *of* AGRICULTURE,
MANITOBA DEPARTMENT *of* AGRICULTURE AND CONSERVATION,
LANDS BRANCH, MANITOBA DEPARTMENT *of* MINES AND NATURAL RESOURCES,
DEPARTMENT *of* SOIL SCIENCE, THE UNIVERSITY *of* MANITOBA

Report published by the Manitoba Department of Agriculture and Conservation.
Map published by Canada Department of Agriculture.



CHURCHILL
Churchill River
C.N.R.
Port Nelson
Southern Indian L.
R.
Churchill
Burntwood
River
Nelson River
Pikwitonei
Grass R.
Thicket Portage
Setting Lake
Wabowden
Pipun
10
Kississing L.
Sherridon
FLIN FLON
Wekusko L.
Reed L.
Hayes River
Gods L.
Cross Lake
Cross Lake
Minago R.
Moose L.
Molson L.
Norway House
Gunisaor R.
Island L.
Saskatchewan
THE PAS
11
Cedar Lake
R.
Lake Winnipeg
Lake Winnipegosis
SWAN RIVER
Berens R.
Manigotagan R.
Winnipeg River
9
DAUPHIN
Lake Dauphin
Lake Manitoba
8
Assiniboine River
6
7
VIRDEN
BRANDON
WINNIPEG
5
Red River
3
4
PUBLISHED SOIL REPORTS
REPORT NO. MAP AREA
3.........South Western
4.........South Central
5........ Winnipeg and Morris
6.........Rossburn and Virden
7.........Carberry
8.......West-Lake
9.........Grandview
10.......Nelson River Basin
11.......Pasquia
Scale: 80 Miles = 1 Inch

FIGURE 1

SOILS REPORT No. 11 1960

Report of

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PASQUIA MAP AREA

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Preface

THE DETAILED SOIL SURVEY of the Pasquia Map Area is the eleventh of a series of reports devoted to the description of the soils of Manitoba as determined through the work of the Manitoba Soil Survey. This report covers the area of The Pasquia Land Settlement Project in the vicinity of Le Pas in Northern Manitoba. A previous reconnaissance soil survey, conducted in 1946 and 1949, had provided the soils information that stimulated intensive investigations into the reclamation possibilities of this area. The reclamation project that resulted from these investigations has since changed much of the Pasquia map area from inaccessible marsh and swamp to potentially productive farm land. This necessitated a resurvey of the soils on a more detailed basis to provide the information on the location and extent of individual soil types that is required for fair assessment of these Crown Lands and for planning future land-use. Such a survey was conducted during the summer of 1958 and the findings of that survey are contained in this report and on the accompanying soil map.

Acknowledgments

THE SOIL SURVEY of the Pasquia area was conducted as a joint project by the Canada Department of Agriculture, the Manitoba Department of Agriculture and Conservation, the Lands Branch of the Manitoba Department of Mines and Natural Resources and the Department of Soil Science, The University of Manitoba.

Acknowledgment is made to Dr. A. Leahey, Canada Department of Agriculture and Dr. R. A. Hedlin, Department of Soil Science, The University of Manitoba, for their critical review of the report.

The work on this project included the following personnel: W. A. Ehrlich, L. E. Pratt, J. A. Barr, F. P. Leclaire, R. E. Smith, G. Emmond, J. Manns, H. Smallwood and G. Shaw. Mrs. Helen E. Gallagher assisted in the recording of field and laboratory data and in the preparation of the report.

The final drafting and printing of the map was undertaken and financed by the Canada Department of Agriculture and the printing of the report by the Manitoba Department of Agriculture and Conservation.

Summary

THE SOIL SURVEY of the Pasquia Map Area covers about 223 square miles in a part of the upper Saskatchewan River Delta that extends westward from Le Pas moraine between the Carrot and Pasquia rivers to the Saskatchewan border. This area lies on the northwestern edge of a broad trough known as the Manitoba Lowlands that was covered at one time by glacial Lake Agassiz. Within the map area, the delta has an average fall of 0.5 feet per mile along the central axis—the fall being eastward from 860 feet above sea level along the Saskatchewan border to 850 feet at the base of Le Pas moraine. Local relief within the area is provided by drumlin-like hillocks of glacial till and by the numerous meandering channels with accompanying levees.

The climate is sub-humid with most of the precipitation falling as rain in the summer months. The average yearly precipitation at Le Pas from 1910 to 1958 was 16.79 inches. Mean monthly temperatures are 3 to 5 degrees lower than at Winnipeg, with a mean annual temperature at Le Pas of 31.6°F as compared with 35.4°F at Winnipeg. The average frost-free period (above 32°F) at Le Pas over the last 48 years was 110 days, although it has ranged from 65 days in 1928 to 139 days in 1937. The vegetation is dominantly sedges and reeds in the uncultivated portion of the flood plain and mixed forest on the levees and hillocks of till.

The soils in the surveyed area consist mainly of Peaty Calcareous Gleysols and Gleyed Mor Regosols developing on alluvial deposits and Grey Wooded soils developing on glacial till and gravelly deposits. The soils on the alluvial plain are very poorly to imperfectly drained—the former being dominant, and on the glacial till and gravelly areas the soils are poorly to well drained with the latter being dominant. The swamp areas on both the alluvial plain and the uplands consist of shallow and deep peats. Most of the swamps mapped are on the flood plain where the shallow peat soils cover a slightly greater area than the deep peat soils.

The total mapped area of 142,677 acres has an arable acreage of about 95,000 acres. Another 10,000 acres of shallow peat soils will be added to this total in the near future. Over half of the arable soils are clays of which about 28,000 acres at one time were intermittently laked. With the exception of about 2,100 acres of moderately to strongly saline soils, the arable acreage is considered as potentially fair to good agricultural soils. The best lands are those on the levees, mapped as the Carrot and Nels series. Slow drainage, water-logging and salinity will always be a problem in some areas. Fertilizers containing nitrogen and phosphate applied to grain give good responses, particularly on the saline soils. Weeds are a problem and it is expected that wind erosion will be serious on the bare fields with sandy textures. A mixed farming program is advocated for a better balanced and assured source of income. Native hay for feed is abundant in this region.

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PART I

GENERAL DESCRIPTION OF AREA

A. HISTORICAL

Early Explorations and Land-Use

The area now known as the Pasquia Land Settlement Project lies within the Saskatchewan River Delta and was first known to the explorers and fur traders of the Hudson's Bay Company as a part of their vast domain of Rupert's Land. During the era of the Hudson's Bay Company rule from 1670 to 1870 the only interest in this land was that of the fur trade. The early explorers, such as Henry Kelsey (1690-91), Anthony Hendry (1754) and Samuel Hearne (1774), who first viewed the Pasquia area were primarily concerned with tracing routes of travel, locating trading posts and generally fostering the fur trade. In so doing they mapped the courses of the Saskatchewan, Carrot and Pasquia rivers and noted the swampiness of the intervening land. During this interval of time the records indicate that some grain and garden crops were grown around the forts and church missions.

After 1870, when the area of Rupert's Land was transferred to the Dominion of Canada, other interests began to develop in this northern region. In his report on the exploratory survey of the Saskatchewan River in 1884, Dr. Otto Klotz referred to the lakes and marshes between Cedar Lake and the Sipanok Channel and to the occurrence of major floods (see Table 1 for later flood data) in the area west of Le Pas. Further reference to these floods is found in the reports of J. B. Tyrrell (1890) and D. B. Dowling (1900) who conducted geological surveys in the area. Interest in land settlement in the Pasquia area began around the turn of the century and a series of river lots were laid out north and south of the Carrot River. Completion of the railway to Le Pas in 1908 added impetus to this interest in agricultural development and the government began to study the reclamation possibilities of this large area of swampy land.

The Pasquia Land Settlement Project

The first study of reclamation for land settlement in the Pasquia area was made in 1910 by W. Ogilvie, a Dominion Land Surveyor. He collected soil samples that were analysed for texture, color, organic content, consistence and reaction at the Dominion Experimental Farm at Ottawa. In his report Ogilvie commented favourably on the suitability of the land for hay, livestock and crop production. He referred to the excellent quality of potatoes and good yields of farm produce along the Carrot

NOTE: The information contained in the historical section of this report was obtained from, "The Pasquia Land Settlement project. Interim Report No. 1." by J. H. Ellis, Manitoba Department of Mines and Natural Resources, December, 1956.

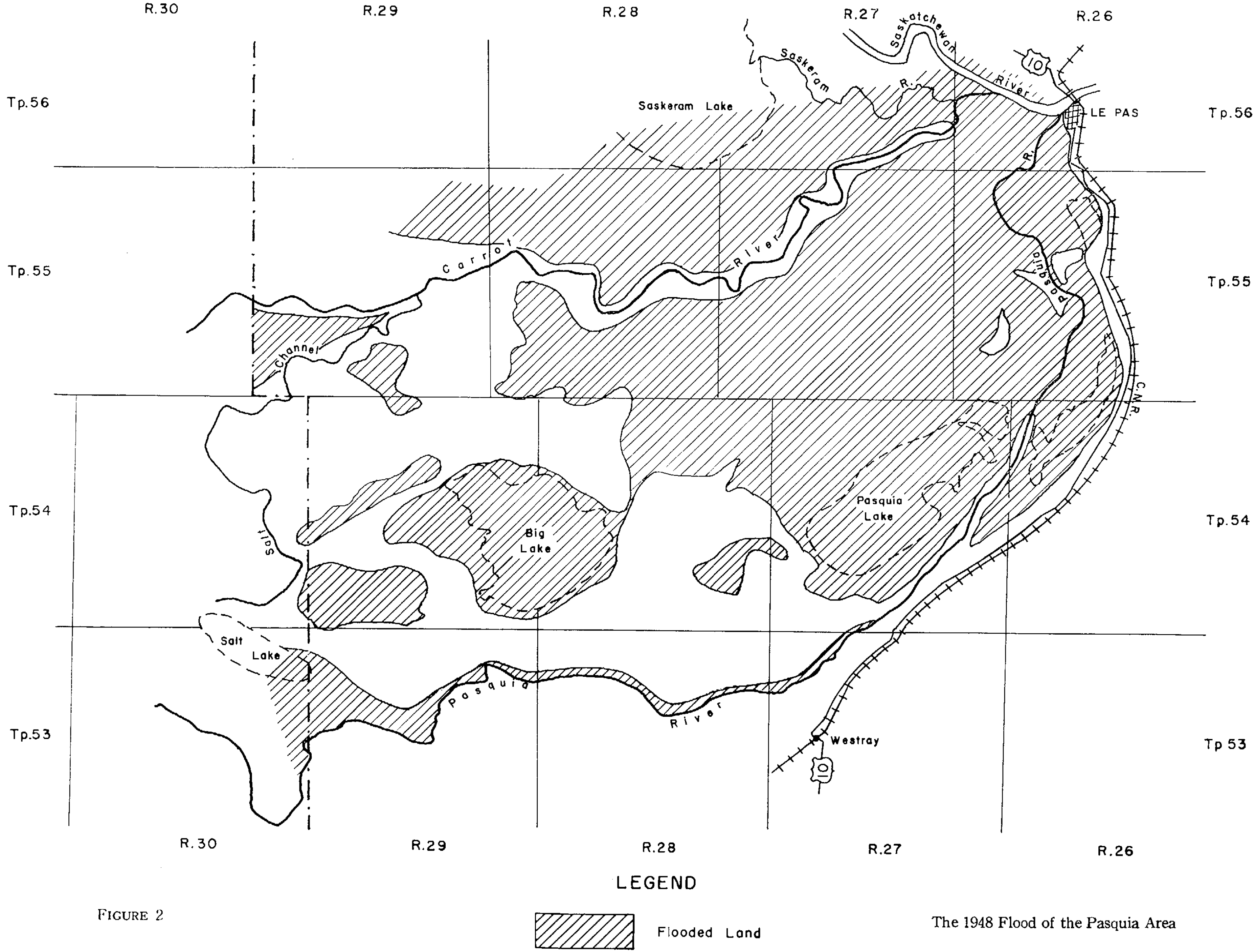


FIGURE 2

The 1948 Flood of the Pasquia Area

TABLE I

Highest Gauge Readings of Saskatchewan River at Le Pas (1913-1958)

Year	Month	Gauge Reading (feet)	Year	Month	Gauge Reading (feet)	Year	Month	Gauge Reading (feet)
1913	July	854.6	1929	June-July	853.2	1944	April	853.2
1914	July	853.6	1930	April	851.3	1945	July	852.4
1915	**August**	**858.8**	1931	April	850.9	1946	April	853.9
1916	**July**	**859.4**	1932	June-July	854.9	1947	May	857.3
1917	July	858.4	1933	May	854.6	**1948**	**June**	**859.3**
1918	April	854.0	1934	April-May	856.1	1949	April	850.6
1919	April	851.7	1935	April	852.5	1950	May	854.5
1920	June	857.4	1936	May	856.1	1951	July	855.4
1921	May	856.1	1937	April	851.9	1952	April	857.2
1922	April-July	852.6	1938	April	852.2	1953	July	857.7
1923	**July**	**857.6**	1939	April	853.1	1954	July	857.3
1924	May	852.8	1940	April-May	852.9	1955	June	855.9
1925	April	855.5	1941	April	851.8	1956	May	857.4
1926	April	853.3	1942	July-Aug.	854.2	1957	May	855.8
1927	July	856.6	1943	April	857.0	1958	April	853.0
1928	July	857.2						

Dates of floods in the Pasquia area between 1913 and 1958 and the respective water gauge readings of the Saskatchewan River at Le Pas are in heavy type.

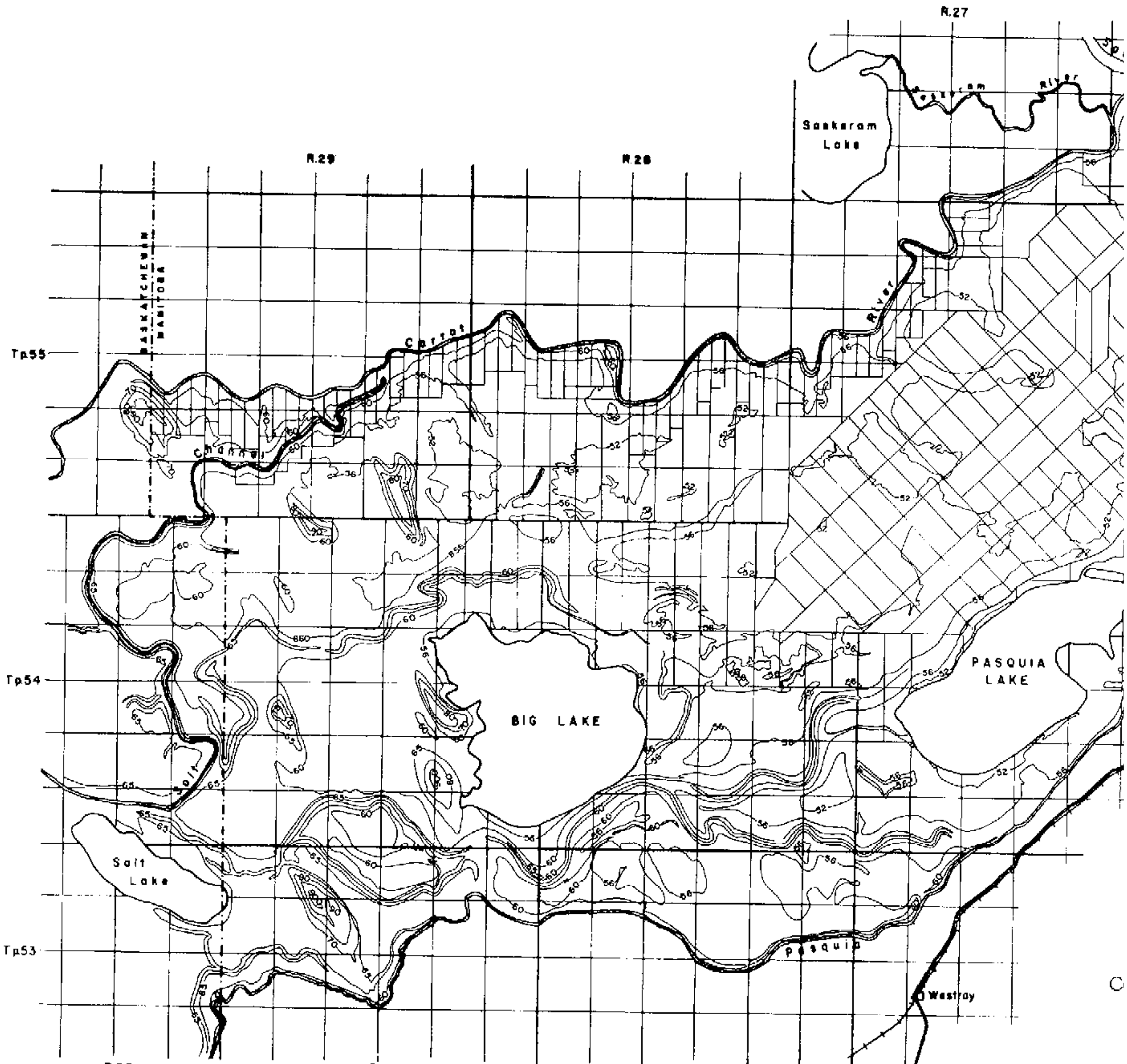
River as proof of a favourable climate. He concluded that, "the soil along the Carrot River is of the finest quality" and that drainage of the low land would lead to favourable development of the area.

During the next few years, several other investigations on reclamation were conducted and eventually led to the conclusions in G. F. Horsey's report of 1923 that the area "has great potential agricultural possibilities but the advisability of its construction is largely dependent in the needs of more farm land in the west, for which, at the present time there is little need," and that "there are no serious engineering difficulties and the area could no doubt be converted into suitable land for mixed farming."

On the basis of Horsey's report, no further consideration was given to the reclamation or disposal of land in the Pasquia area by the Dominion Government. In 1930 the Crown Lands of Manitoba were transferred to Provincial control and the Pasquia area came under the administration of the Provincial Government.

During the dry years of the 1930's the major portion of the marshy areas between the Carrot and Pasquia rivers were dried out. This resulted in an enlargement of the lowland area used for hay and pasture by the settlers on the Carrot River levee, and eventually some of the land was cultivated for grain production. The efforts of these people to obtain land sales and the need for new lands for Post-War Rehabilitation influenced the Provincial Government to re-examine the reclamation of this area. A reconnaissance soil survey conducted in 1946 revealed that the soils were dominantly immature, poorly drained, peaty soils subject to periodic floods. Some of the area was considered unsuitable for agriculture because of high salinity, and a small portion was found unsuitable because of stoniness. A large block of soils were considered suitable for farming if surface drainage could be provided and if the area could be protected from floods.

Following the soil survey, intensive investigations of the reclamation possibilities were undertaken, first by the Lands Branch of the Manitoba Government and later by engineers of the Prairie Farm Rehabilitation Branch of the Federal Government. These investigations resulted in the Canada-Manitoba Agreement of 1953 authorizing the construction of dykes,



R.27
Saskeram Lake
Saskeram River
R.29
R.28
SASKATCHEWAN
MANITOBA
Tp55
Carrot River
Channel
Tp54
BIG LAKE
PASQUIA LAKE
Salt
Salt Lake
Tp53
Pasquia
Westray
R.30
R.29
R.28

canals and other engineering works required for the reclamation of the area. These engineering works, which have been largely completed, include: the diversion of the Pasquia River into the Carrot River; dyking along the diversion ditch and along the south side of the Carrot River; the construction of drainage canals and roads within the project area; and the installation of two pumping stations.

B. LOCATION AND EXTENT

The Pasquia map area is located west of Le Pas ridge and is bordered on the north by the Carrot River, on the south by the Pasquia River and on the west by the Saskatchewan border. This area includes Township 54 in Ranges 28 and 29, and portions of: Township 53 in Ranges 27, 28 and 29; Township 54 in Ranges 26, 27 and 30; Township 55 in Ranges 26, 27, 28 and 29 and Township 56 in Ranges 26 and 27 all west of the Principal Meridian. The area covered by the soil survey is 142,677 acres.

C. POPULATION AND MARKETS

The Pasquia map area extends south-west from the town of Le Pas to the Saskatchewan border. Le Pas, with a population of 4,288 in 1958, is the only town in the vicinity. The present farm population of about 150 is expected to triple when full settlement has occurred in the Pasquia Land Settlement Project. There is an Indian population of about 350 in neighboring Indian Reserves.

Le Pas is the marketing center for the settlement area. It is linked to Southern Manitoba by Highway No. 10, by the Canadian National Railways and by air service with land and water based planes. It is the principal gateway and distributing center for Northern Manitoba. Highway No. 10 extends north to Flin Flon and roads under construction or planned will soon link it with Snow Lake, Wabowden, Thompson and eventually Churchill. Railway lines fan out from Le Pas to Flin Flon, Lynn Lake, Thompson and Churchill. An air field near Atikameg Lake and a sea plane base at Grace Lake handle a large share of the air traffic of Northern Manitoba.

D. RELIEF AND DRAINAGE

The Pasquia Area is part of the upper Saskatchewan River Delta that extends westward from Le Pas into the Province of Saskatchewan. This area lies on the northwestern edge of a broad trough known as the Manitoba Lowland region. About 5,000 to 8,000 years ago this lowland region was covered by glacial Lake Agassiz of which lakes Winnipeg, Winnipegosis, Manitoba, Moose, Cedar and other smaller lakes in the trough are the remnants.

From a relief standpoint the upper Saskatchewan Delta appears as a depressed area that is terminated abruptly on the east and south by morainic deposits that rise 40 to 70 feet above the delta. Elevations of the flood plain in the Pasquia area range from 850 feet at its eastern edge to 860 feet above sea level at the Saskatchewan boundary. The fall eastward along the central axis averages about .5 feet per mile. Local relief is provided by the levees built up by the Carrot and Pasquia rivers and by levees of the intermittent meandering streams that occur throughout the area. Along the Carrot and Pasquia rivers the levees range from 4 to 10 feet in height and are from 200 to 800 yards wide; the meandering levees within the flood plain are 2 to 6 feet in height and are from 100 to 400 yards wide.

The most striking local relief within the surveyed portion is provided by the drumlin-like hillocks of till which range in height from 7 to 65 feet above the surrounding plain. These hillocks, which occur mainly in Range 29, have an elongated form in a north-west and south-east direction.

The natural drainage of the nearly level plain is slow. Prior to the construction of drainage canals, portions of the flood plain were covered with water for a part of the year. Most of the depressional areas were enclosed by levees and surface water removal was by downward percolation, lateral seepage and by

FIGURE 4
Drainage canal in Pasquia Area characteristic of many in the project.

evaporation. In some parts of the area, particularly in the north-eastern portion, the presence of surface water was continuous except during prolonged dry periods.

Stream channels, of which Nel's Creek is the most prominent, meander throughout the area. Generally they do not facilitate surface drainage due to the damning effect of the built up levees. These channels were developed by the flood waters of the Saskatchewan River moving eastward over the delta and not by natural waters within the area. Since the construction of ditches, surface drainage has been greatly accelerated. The diversion of the Pasquia River via Salt Channel to the Carrot River, the dyking along the Carrot River and the control dams and pumping stations are protecting the area from flooding from sources other than local precipitation. When no drainage to the river is possible during periods of high rainfall the excess waters will be diverted to Pasquia Lake and Big Lake. At a later time, when the level of the Saskatchewan River drops, the lake waters can be lowered by gravity drainage.

All lakes except the Pasquia may be considered as intermittent. When filled, all lakes cover nearly 15,000 acres or approximately 10 percent of the surveyed area. These lakes are considered as reservoirs for local waters and at present no plans for their reclamation for agricultural purposes are contemplated. Also present plans do not include complete drainage of the Deep Peat area located in the western section of the reclamation project.

E. GEOLOGY AND SOIL PARENT MATERIALS

A surface mantle of unconsolidated rock materials covers the bedrock formations throughout the Pasquia area. These unconsolidated materials are composed of rock fragments derived from bedrock formations through glacial and post-glacial agencies of ice, water and wind. In recent geological times continental ice sheets completely covered Manitoba and in the process of ice advance from the north and east they picked up and transported huge quantities of materials from the formations over which they passed. When the ice sheets melted the rock materials were deposited as glacial drift in various forms. These drift deposits, along with the recent alluvium, constitute the parent materials of the soils in the region.

(*i*) *Geology of Underlying rocks*

The kind of bedrock formations underlying the thick unconsolidated materials in the Pasquia Project area can only be assumed on the basis of exposures or outcrops in adjacent areas. Exposures of dolomitic limestone of Silurian rocks (see Table 2) have been shown by Stearn* as occurring in Township 57 along the Flin Flon Highway and from Mile 4.8 to Atikameg Lake siding along the Hudson Bay Railway. Contact of the Silurian dolostone with Devonian limestone is shown by Baillie† to occur near Whithorn just south-west of Westray. At Turnberry, an assumed boundary between the Devonian limestone and Lower Cretaceous or

*Stearn, C. W., Stratigraphy and Palaeontology of the Interlake Group and Stonewall Formation of Southern Manitoba. Geological Survey, Memoir 281. Dept. of Mines and Technical Surveys, Ottawa, 1956.

†Baillie, A. D., Silurian geology of the Interlake area of Manitoba. Manitoba Dept. of Mines and Natural Resources. Publication 50-1. 1951.

TABLE 2

Devonian and Silurian Rock Formations in the Manitoba Lowlands*

Era	Time-Rock Units		Rock Units			Lithology
	System	Series	Group	Formation	Units or Member	
Paleozoic	Devonian			Elmpoint		yellowish grey mottled limestone.
	erosional unconformity ?					
	Devonian or Silurian			Ashern		brick red argillaceous dolostone.
	erosional unconformity ?					
	Silurian	Niagaran	Interlake		E	yellowish orange massive fossiliferous and finely crystalline dolostone.
					D	fossiliferous fragmental finely crystalline, and stromatolitic dolostone; biostromal reefs.
					C	yellowish grey calcitic dolostone, fossiliferous with sandy and silty zones.
		Alexandrian			B	greyish yellow crystalline fossiliferous bedded dolostone.
				Stonewall	A	grey normal bedded dolostone underlain by arenaceous and silty shale and dolostone.
	Ordivician			Stony Mountain	Birse	greyish yellow bedded dolostone.

*A. D. Baillie. Silurian geology of the Interlake area in Manitoba. Department of Mines and Natural Resources, Mines Branch, Province of Manitoba. Publication 50-1, 1951.

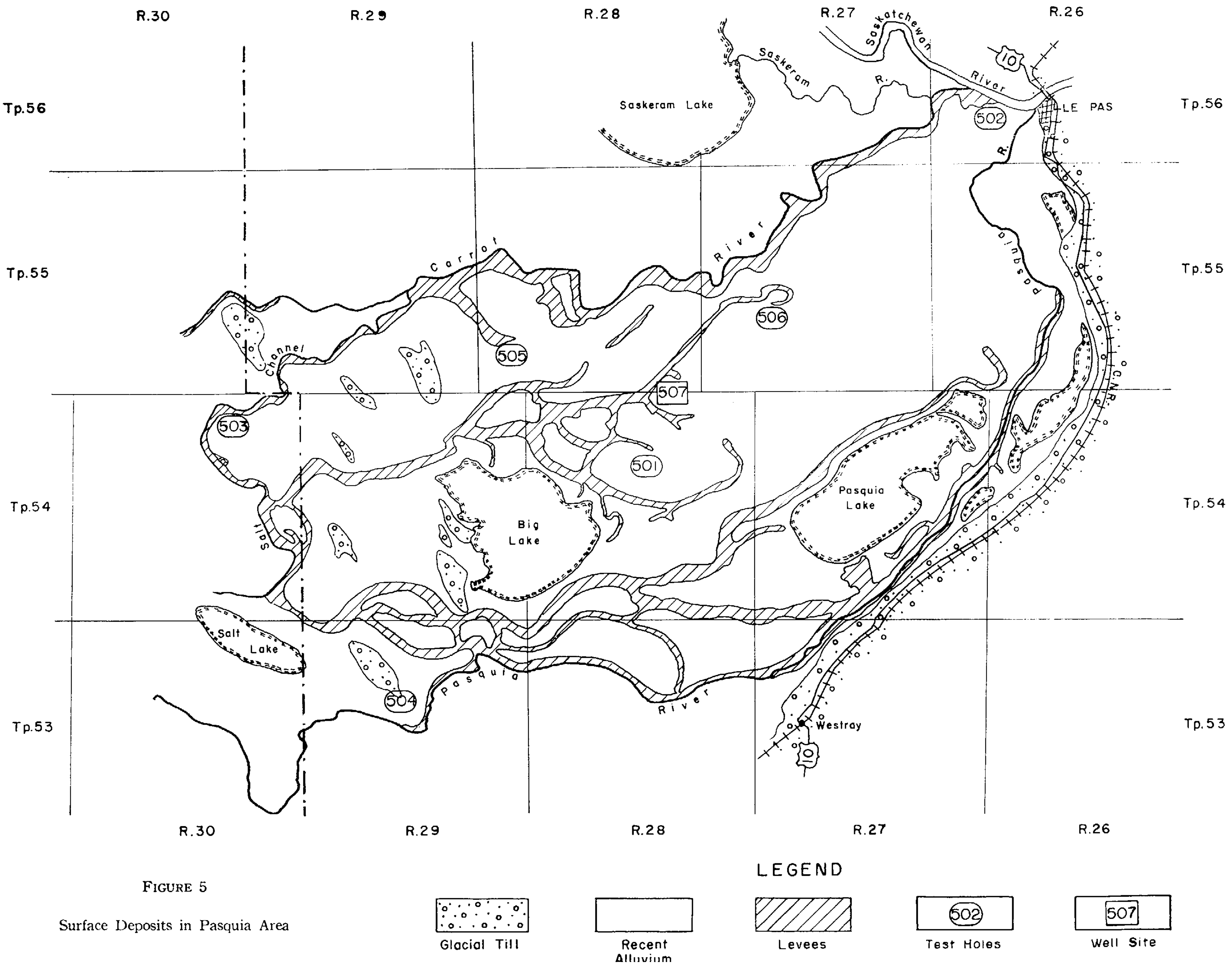


FIGURE 5

Surface Deposits in Pasquia Area

earlier formations is shown by McInnes[△]. This boundary is shown to strike north-west to the Pasquia Hills where it is overlain with Cretaceous shales of the Western Upland region.

These exposures indicate that the underlying bedrock consist of dolomitic limestone of Silurian age and possibly some Devonian limestone along the western edge of the Pasquia area.

(ii) Surface Deposits

The distribution of the surface mineral deposits occurring in the Pasquia Project area is shown in Figure 5. Thickness of these deposits and other unconsolidated materials as shown by seven well borings in the area is presented in Figure 6.

The main surface deposits consist of glacial till, recent alluvium (including levees) and peat. Surface outcrops of glacial till in the Pasquia area are of minor occurrence; in places it is covered with water-laid sediments of alluvium and lacustrine silts and clays that are upward to 150 feet or more thick. The till is underlain with outwash materials of sand, gravel and with rock rubble which, in turn, is in contact with limestone bedrock. Surface glacial till occurs as drumlin-like hillocks in the western portion of the Pasquia area and as a morainic ridge along the eastern and southern fringe of the surveyed area. It is strongly calcareous, generally very stony and contains small pockets of coarse gravel. Gravelly deposits are most common along the frontal margin of the moraine and around the lower portions of the till hillocks.

Surface deposits of recent alluvium dominate the Pasquia area. According to the well borings (see Figure 5) these deposits are up to 60 feet thick. These alluvial sediments are generally underlain with lacustrine silts and clays up to 85 feet thick. Textures of the alluvium range from sand to clay; the textures of the soils on the levees are somewhat coarser than those in the depressional sites that have been periodically flooded.

Most of the recent alluvium and the levees were, and some still are, covered with variable thicknesses of peat, particularly in the western portion of the Pasquia area, where an organic cover of three or more feet is common. In the eastern and southern sections much of the peat has been destroyed by fires.

A feature of interest indicated by the cross-section of unconsolidated deposits is the concave nature of the limestone bedrock. It is quite likely the site of a preglacial river channel of great depth and width. From the well borings the channel appears to have run in an east-west direction.

F. CLIMATE

The climatic data supplied in Tables 3, 4 and 5 are from the information recorded at the Meteorological Station at Le Pas which is located on a timbered ridge immediately east of the Pasquia area.

The climate at Le Pas is designated by Köppen as Dfb.* This type of climate has summer temperatures that are higher, winter temperatures that are lower and an annual range that is much greater than the world average for that latitude. This area is sub-humid and has a definite summer maximum of precipitation.

(i) Precipitation

Precipitation data are given in Table 3. Approximately 75 percent of the precipitation falls as rain during the seven month period of April to October and the remainder falls mostly as snow in the interval of November to March. July is the wettest month with an average precipitation of 2.50 inches. However, rainfall during this month has ranged from a high of 5.51 inches in 1942 to a low of .57 inches in 1937. February is the driest month with an average of .62 inches. The highest February precipitation of 2.17 inches was recorded for 1921 and the lowest of .06 inches was recorded for 1913. The mean yearly precipitation at

[△]McInnes, W., Explored Routes, Churchill and Nelson rivers. Map 58A, 1914.

*W. Köppen and Geiger. "Handbuch der Klimatologie' Bond I, Teil C, Gebüder Borntraeger, Berlin, 1936.

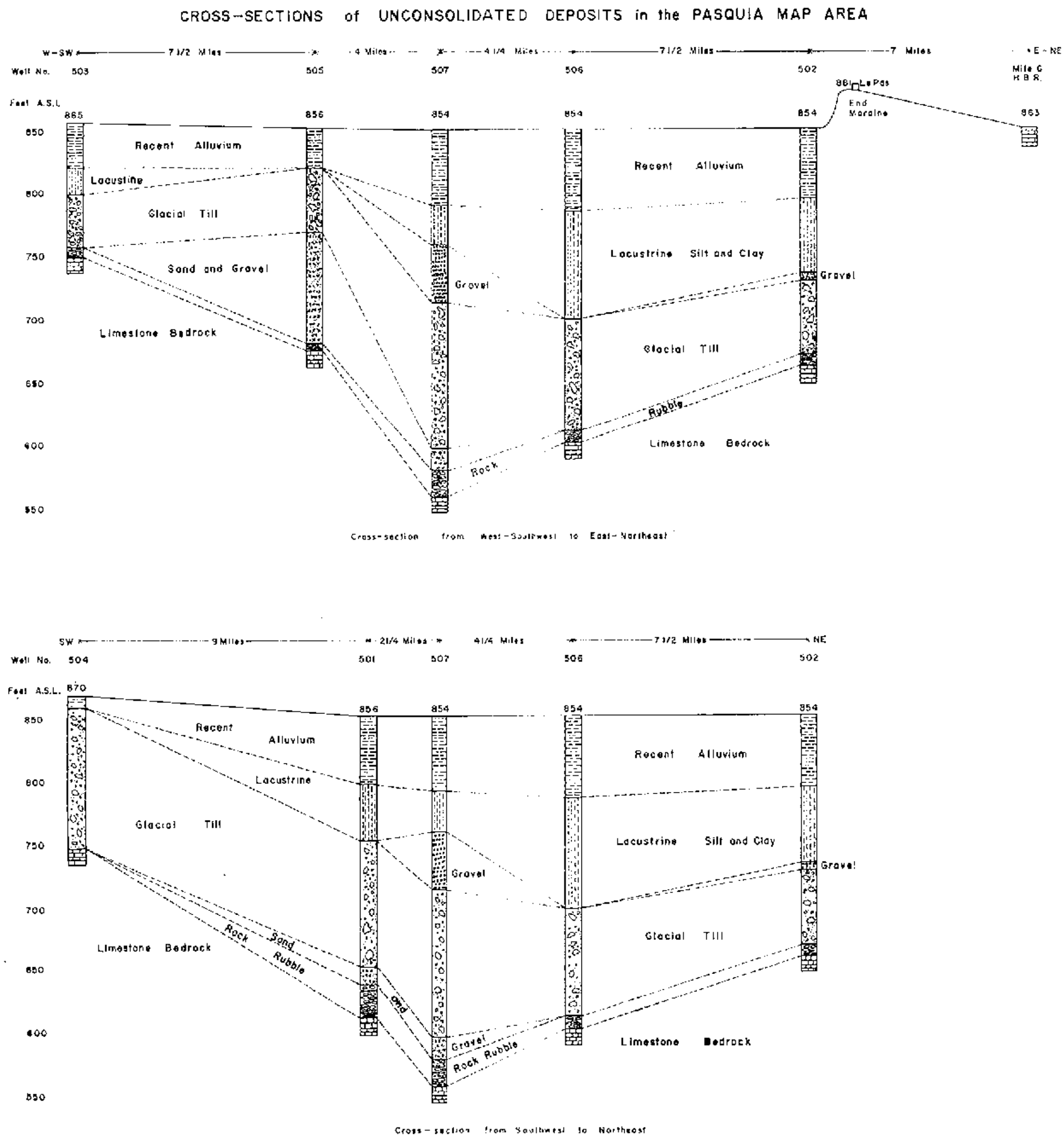

CROSS-SECTIONS of UNCONSOLIDATED DEPOSITS in the PASQUIA MAP AREA
W-SW
7 1/2 Miles
4 Miles
4 1/4 Miles
7 1/2 Miles
7 Miles
E-NE
Well No.
503
505
507
506
502
Mile 6 H.B.R.
Feet A.S.L.
865
856
854
854
854
881 Le Pas
End Moraine
863
850
800
750
700
650
600
550
Recent Alluvium
Lacustrine
Glacial Till
Sand and Gravel
Limestone Bedrock
Gravel
Rock
Recent Alluvium
Lacustrine Silt and Clay
Gravel
Glacial Till
Rubble
Limestone Bedrock
Cross-section from West-Southwest to East-Northeast
SW
9 Miles
2 1/4 Miles
4 1/4 Miles
7 1/2 Miles
NE
Well No.
504
501
507
506
502
Feet A.S.L.
870
856
854
854
854
850
800
750
700
650
600
550
Recent
Alluvium
Lacustrine
Glacial Till
Gravel
Limestone Bedrock
Rock
Sand
Rubble
Sand
Gravel
Rock Rubble
Recent Alluvium
Lacustrine Silt and Clay
Gravel
Glacial Till
Limestone Bedrock
Cross-section from Southwest to Northeast

FIGURE 6

TABLE 3

Precipitation Data for Le Pas, Manitoba - 1910 to 1958 inclusive

Month	Number of Years Recording	Mean Monthly Precipitation in Inches	Monthly Precipitation Ranges in Different Years	
			Highest Monthly Precipitation in Inches	Lowest Monthly Precipitation in Inches
January	47	.75	2.71 (1947)	.02 (1912 & 1927)
February	48	.62	2.17 (1921)	.07 (1915 & 1919)
March	47	.79	2.02 (1936)	.06 (1913)
April	46	.96	2.64 (1911)	Trace (1952)
May	47	1.51	5.40 (1916)	.02 (1924)
June	48	2.29	5.18 (1939)	.21 (1921)
July	48	2.50	5.51 (1942)	.57 (1937)
August	47	2.33	4.47 (1947)	.51 (1915)
September	48	1.95	5.09 (1931)	.28 (1915)
October	48	1.14	2.35 (1917)	.04 (1923)
November	48	1.11	2.72 (1933)	.05 (1928)
December	48	.84	3.15 (1936)	.13 (1913)
		Yearly Mean 16.79 Inches	Highest 12 Months November to October 26.9 Inches (1942-43)	Lowest 12 Months November to October 8.79 Inches (1914-1915)

TABLE 4

Temperature Data for Le Pas, Manitoba - 1910 to 1958 inclusive

Month	Number of Years Recording	Mean Monthly Temperatures in Degrees Fahrenheit	Range of Temperatures	
			Highest Monthly Mean in Degrees Fahrenheit	Lowest Monthly Mean in Degrees Fahrenheit
January	48	−6.8	6.0 (1931)	−26.5 (1950)
February	48	−1.1	16.0 (1931)	−18.4 (1936)
March	48	12.1	22.5 (1946)	0 (1923)
April	47	35.6	44.0 (1915)	20 (1923)
May	47	48.1	56.0 (1919)	41.0 (1918, 1924 and 1945)
June	48	58.3	69.0 (1921)	52.0 (1924)
July	47	64.6	69.5 (1914)	58.0 (1912)
August	47	61.3	65.9 (1956)	56.0 (1923 and 1924)
September	48	50.4	58.2 (1938 and 1940)	44.0 (1926)
October	49	37.8	44.9 (1947)	27.0 (1919)
November	49	17.8	30.0 (1917)	5.9 (1935)
December	49	1.2	14.3 (1939)	−18.0 (1933)
		Annual Mean Temperature 31.6	Highest Annual Mean Temperature 35.8 (1931)	Lowest Annual Mean Temperature 27.8 (1950)

TABLE 5

Some Climatic Factors at Le Pas, Manitoba - 1916 to 1956 inclusive

Mean date of last frost in spring (<33°F)	May 26
Range of last frosts in spring (<33°F)	May 7 (1919) to June 12 (1942)
Mean date of first frost in fall (<33°)	September 15
Range of first frost in fall (<33°)	August 8 (1926) to October 11 (1948)
Average duration of frost free period	110 days
Shortest frost free period	65 days (1924)
Longest frost free period	139 days (1937)
Mean annual duration of sunshine	2,079 hours
Mean duration of sunshine from May to August inclusive	1,045 hours
Shortest duration of sunshine from May to August inclusive	896 hours (1939)
Longest duration of sunshine from May to August inclusive	1,189 hours (1955)

Le Pas is 16.79 inches. During the 44 years in which complete records have been kept there has been one year in which the precipitation was less than 10 inches, 12 years in which it was between 10 and 15 inches, 24 years in which it was between 15 and 20 inches and 7 years in which it was over 20 inches.

(ii) Temperature

Temperature data for Le Pas are presented in Table 4. The mean annual temperature based on 48 year records is 31.6°F. July is the warmest month with an average temperature of 64.6°F. Its mean temperatures however have ranged from a high of 69.5° recorded in 1914 to a low of 58.0° in 1912. January is the coldest month with an average temperature of -6.8°F. For this month the highest mean temperature on record is 6.0°F for 1931 and the lowest is -26.5° recorded for 1950.

(iii) Other climatic factors

One of the important climatic factors from the standpoint of crop production at this latitude (53°49″N) is the frost-free period. This period is usually expressed as the number of days between the date of the last killing frost in the spring and the first killing frost in the fall. The temperature of 29.5°F is generally considered as the temperature at which the regional field crops suffer appreciable frost injury. However in the Pasquia area it is expected that the minimum temperatures will be lower in the peaty depressional areas of the delta than those observed on the higher well-drained site of the weather station at Le Pas. Consequently a more satisfactory estimate of the frost-free period for the Pasquia area is considered to be the period in which the temperature remained above 32°F at the Le Pas weather station.

In Table 5 some climatic data are presented on frost and sunshine periods for the interval between 1916 and 1956. The data in this table show that the average duration of the frost-free period is 110 days, but it has ranged from a low of 65 days in 1924 to a high of 139 days in 1937. In 1923, 1924 and 1926 light frosts in early summer were recorded but were probably local in extent and in harmful effects. In general the frost-free period is sufficiently long for the production of grain, forage and vegetable crops. From the data available this region appears to have a longer frost-free period than the prominent agricultural areas of Swan River, Roblin, Russell and several other more southerly points.

The number of hours of sunshine at Le Pas during the months of May, June, July and August is slightly less than at Winnipeg or Morden, notwithstanding the lower summer precipitation and longer days. September, the harvest month, on the average has 20 hours less sunshine than Winnipeg.

G. VEGETATION

The Pasquia area, as indicated by Rowe* in his forest classification for Canada, is part of the Manitoba Lowlands Section of the Boreal Forest Region. However in the Pasquia area there are open spaces of poorly drained flood plains covered with peat and only the meandering levees and till areas have trees characteristic of the Boreal Forest.

In the flood plain area intermittent wet soil conditions over the years have prevented the establishment of the regional climax vegetation. Most of the open spaces were non-forested except for clumps of willow, swamp birch and scattered poplar on the somewhat better drained sites and some stunted black spruce and tamarack on bog areas in the western portion of the Pasquia area. Peat deposits on the surface and within the soil section are common. These deposits have formed mainly from hydrophytic plants consisting of rushes, sedges, reed-grasses and meadow grasses. In drier seasons, weeds such as sow thistle, Canada thistle, horsetail, dock, etc. invaded the open spaces, particularly those that had been burned over. Other weeds, such as pigweed, goosefoot and wild barley as well as some sea-blite and samphire, are common in the saline areas.

On the levees and till areas, the vegetative cover consisted of climax forest. The levees, in earlier years, supported a fine stand of mixed woods consisting of a crown cover of balsam poplar, aspen, elm, box-elder, green ash, white birch, spruce and balsam fir. Logging operations and fires however have drastically reduced the number of coniferous trees; these have been replaced almost entirely by broad-leaved species. On the till hillocks and on the morainic ridge to the east of the project area, the Boreal Forest vegetation is less vigorous than on the levees. Here, the strongly calcareous till and gravelly soils support a growth consisting chiefly of balsam poplar, aspen, white spruce, jack pine and balsam fir. In wet sites black spruce and tamarack are predominant.

*J. S. Rowe, "Forest Regions of Canada". Canada Department of Northern Affairs and National Resources, Forestry Branch, Bull. 123, Ottawa, 1959.

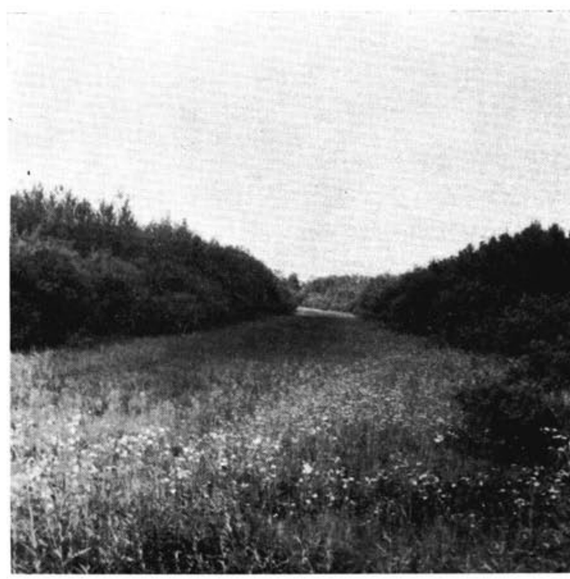


FIGURE 7

Nels Creek showing aspen, balsam poplar and willows on the levees.

PART II

SOILS

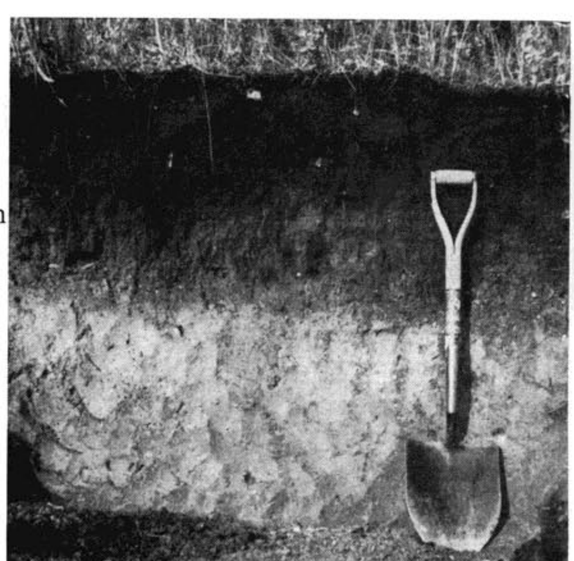
The soils that have developed under the influence of the soil-forming factors of parent material, relief, drainage, climate and vegetation referred to in Part I exhibit physical characteristics which reflect their environment. Through observation of these characteristics it is possible to classify soils in accordance with their genesis or the processes involved in their formation. Such a classification scheme permits the grouping of soils into natural units. The recognition of these units is dependent on the study of the soil profile.

A. SOIL PROFILE

The soil profile is a vertical section of the soil through all its horizons (or layers) and extending into the parent material. The soil horizons differ from one another in one or more of the following features: color, texture, structure, consistence, reaction, concretions, intrusions, and chemical and biological composition. The master horizons are designated by the letter symbols of L, F and H for organic horizons and A, B and C for mineral horizons. For soil descriptions these master horizons are subdivided into sub-horizons, in which case they may be designated by lower case letter suffixes and/or Arabic numeral suffixes as Ahl, Ah2, Ael, Ae2, etc. Where the soil is developed from two or more different materials the division is indicated by Roman numeral prefixes. These horizon and sub-horizon designations are defined in Table 6 and some examples are provided in Figure 8.

FIGURE 8

Examples of the use of horizon nomenclature.



Black soil profile showing subdivision into soil horizons.

Grey Wooded soil profile showing subdivision into soil horizons.

TABLE 6

Definitions of Soil Horizons

ORGANIC HORIZONS:

L *Horizon* (Litter)—An organic layer characterized by the accumulation of organic matter in which the original structures are definable.

F *Horizon* (Fermentation)—An organic layer characterized by the accumulation of partly decomposed organic matter. The original structures are discernible with difficulty.

H *Horizon* (Humus)—An organic layer characterized by an accumulation of decomposed organic matter in which the original structures are indefinable.

MASTER MINERAL HORIZONS

A *Horizon* (Surface)—A mineral horizon or horizons formed at or near the surface in the zone of maximum removal of materials in solution and suspension and/or maximum in situ accumulation of organic matter. It includes: (1) horizons in which organic matter has accumulated as a result of biological activity (Ah); (2) horizons that have been eluviated of clay, iron, aluminum, and/or organic matter (Ae); (3) horizons dominated by 1 and 2 above but transitional to underlying B or C horizons (AB or A and B); (4) horizons markedly disturbed by cultivation and/or pasture (Aa).

B *Horizon* (Sub-surface)—A mineral horizon or horizons characterized by one or more of the following; (1) an alluvial enrichment (exclusive of dolomite or salts more soluble in water) of silicate clay, iron, aluminum, or organic matter (Bt, Bf, Bh, Bfh); (2) a concentration of weathering products believed to have been formed in situ (Bt, Bf); (3) the removal of dolomite and salts more soluble in water (Bm); (4) an oxidation of sesquioxides that results in darker, stronger, or redder colors than overlying and/or underlying horizons in the same sequum (Bmf); (5) a prismatic or columnar structure characterized by the presence of exchangeable sodium (Bn).

C *Horizon* (Parent Material)—A mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (1) the process of gleying, and (2) the accumulation of carbonate and salts more soluble in water (Ck, Cs, Cg and C).

LOWER CASE SUFFIXES:

*a —A layer disturbed by man's activities; i.e., by cultivation and/or pasturing (*anthropic*).

*c —A *cemented* (irreversible) pedogenic layer.

*cc—*Cemented* (irreversible) pedogenic *concretions*.

e A horizon characterized by the removal of clay, iron, aluminium or humus. Usually lighter in color than the layer below (*eluviated*).

*f —A horizon enriched with hydrated iron (*fe*).

g —A *gleyed* layer.

h —A horizon enriched with *humus*.

j —A horizon whose characteristics are weakly expressed (*juvenile*).

k —A horizon enriched with carbonate (*kalk*).

m—A horizon characterized by the loss of water soluble materials only. Usually slightly altered by hydroylsis and/or oxidation (*mellowed*).

*n —A horizon containing over 15% exchangeable sodium or more exchangeable sodium plus magnesium than calcium plus hydrogen (*natrium*).

p —A relic (not currently dynamic) layer, to be used as a prefix (*paleosol*).

*q —A *quasi* cemented pedogenic layer—a partially reversible cementation such as in fragipans.

*r —An inherited consolidated layer (*rock*).

s —A horizon enriched with *salt* including gypsum.

t —A horizon enriched with silicate clay (*ton*).

*w—A *water* saturated layer; the apparent water table.

*z —A permanently frozen layer (*zero*).

*Not used in this report.

B. SOIL CLASSIFICATION

The soils in the surveyed section of the Pasquia Map Area were classified into seven soil series. Further separations were made of some series into types and phases. Three complexes were mapped; two on alluvium with a complex pattern of drainage and textural conditions and the other on a complex of till and gravelly sediments.

C. SOIL MAPPING

Mapping of soils in the Pasquia area was of a detailed nature and involved frequent examinations of textures and tests for salinity. All pertinent information was plotted on mosaics of aerial photographs with a scale of slightly less than four inches per mile. A soils map on the scale of one mile to the inch was prepared from the information obtained.

D. CLASSIFICATION AND DESCRIPTION OF SOILS

A key to the series, types, phases and complexes of soils is given in Table 7. In the soil descriptions that follow, information is presented on the profile features that characterize each of the soil series and the respective phases.

TABLE 7

Soils of the Pasquia Area

Soil	Soil Sub-Group	Texture	Natural Drainage
LE PAS SERIES	Peaty Calcareous Gleysol		
Le Pas modal phase		Silty clay and clay	Very poor
Le Pas moderately saline phase		Silty clay and clay	Very poor
Le Pas strongly saline phase		Silty clay and clay	Very poor
Le Pas sand substrate phase		Clay/fine sand	Very poor
Le Pas drained phase		Silty clay and clay	Poor
Le Pas drained, sand substrate phase		Clay/fine sand	Poor
BIG LAKE SERIES	Peaty Calcareous Gleysol		
Big Lake modal phase		Sandy clay loam and silty clay loam	Very poor
Big Lake drained phase		Sandy clay loam to silty clay loam	Poor
PASQUIA SERIES	Peaty Calcareous Gleysol		
Pasquia modal phase		Fine sand to silt loam	Very poor
Pasquia drained phase		Fine sand to silt loam	Poor
Pasquia drained saline phase		Fine sand to silt loam	Poor
CARROT SERIES	Gleyed Mull Regosol	Fine sandy loam to loam	Imperfect
NELS SERIES	Gleyed Mor Regosol		
Nels loam		Loam and clay loam	Imperfect to poor
Nels fine sandy loam		Fine sand to fine sandy loam	Imperfect to poor
NELS LOAM—LE PAS COMPLEX	Gleyed Mor Regosol Peaty Calcareous Gleysol	Clay loam to clay/clay	Imperfect to very poor
NELS FINE SANDY LOAM—LE PAS COMPLEX	Gleyed Mor Regosol Peaty Calcareous Gleysol	Fine sandy loam to clay/clay	Imperfect to very poor
WESTRAY COMPLEX	Orthic Grey Wooded (mainly)	Loam to gravel	Well to very poorly drained
SHALLOW PEAT	Organic (12-36 inches of peat)		Very poor
DEEP PEAT	Organic (more than 36 inches of peat)		Very poor
LAKES		....	....
TOTAL		....	....

Soils Developed on Recent Alluvium

The largest and most important arable acreage in the Pasquia area consists of recent alluvium or flood plain deposits. On these deposits the soils are immature types with soil drainage from very poor to imperfect and textures from fine sand to clay. As horizon differentiation is weak or absent separations on a series level are made on the basis of drainage and texture. Soils with altered drainage and with certain ranges of salinity are classed as phases of series. Three series, namely Le Pas, Big Lake and Pasquia, which are the poorly to very poorly drained, are classified as Peaty Calcareous Gleysols and the Nels and Carrot series, which have better drainage, as Gleyed Mor Regosols and Gleyed Mull Regosols respectively.

Le Pas Series (53,107 acres)

Le Pas series consists of a group of immature soils developing on moderately calcareous, fine-textured alluvial deposits. These soils, classified as Peaty Calcareous Gleysols, have no significant horizon development and are poorly drained. An organic surface deposit upwards to 12 inches thick is or has been present.

This series occupies the largest portion of the surveyed area. In relation to the other soils developed on recent alluvium, this series in general occurs in the deeper recesses of the flood plain that have been subject to intermittent laking. Native vegetation is primarily reeds and sedges; weeds of various kinds, especially sow thistles, dandelions, wild barley and horsetail, are polluting the areas once cultivated and those areas in which the peat has been partially or completely destroyed by fires. Drainage is variable but the range of variation has been greatly reduced as well as improved by a network of drains and pumping facilities. Permeability is slow in all phases except those with sand-substrates.

In this series of soils, six phases were mapped. These are briefly described in the following sections:

(1) *Le Pas modal *phase* (27,938 acres)

This soil phase is the most extensive of the units mapped in the Pasquia area. The largest block occurs in the north-eastern portion of the area which, in the days prior to the construction

*Modal means the central concept of the series and applies to a phase in each of Le Pas, Big Lake and Pasquia series.

Figure 9

Sow thistle and wild barley on soils of Le Pas drained phase that were once cultivated.

Figure 10

Dense growth of goosefoot on the soils of Le Pas modal phase.

FIGURE 11

Soil profile of Le Pas modal phase. A Peaty Calcareous Gleysol soil developing on fine textured alluvium. Dark layers are muck deposits.
(measuring stick interval =6 inches)

of drains and dykes, was an intermittent lake. Smaller areas occur west and south of this block, around the margins of Big and Pasquia lakes and as depressional areas among the other phases and series.

These soils are presently covered with a luxuriant growth of reeds and sedges but peat accumulation seldom exceeds 12 inches in thickness. In some soils the lack of organic accumulation on the surface is the result of frequent flooding and sedimentation. These processes have retarded continuous organic matter production by covering the peat or muck with mineral sediments during the periods of inundation. As a result of these floods the profiles are stratified with bands of peat or muck as well as banding the clay matrix with thin layers of silty and sandy sediments. Gleying and iron staining are characteristic of these soils. Reaction is variable throughout the profile ranging from slightly acid to moderately alkaline. In general lower reactions are encountered in the layers containing an abundance of organic substances. In these layers the lime carbonate is correspondingly low. Some salts occur throughout this phase but not in concentrations that are injurious to the crops that are grown. In the numerous tests for salts conducted on the soils in this phase the conductivity measurements did not exceed 3.5 mmhos/cm; the average measurement being less than 2.0 mmhos/cm. At present salinity is not considered a problem for future crop production, however salts may become more evident in local areas where drainage has been improved.

(2) *Le Pas moderately saline phase* (6,805 acres)

This soil phase occurs as small isolated areas south and east of Big Lake. The areas of this

TABLE 8

Analyses on Soils of Le Pas Modal Phase

	Profile 1 (E.Cen. 32-54-28)						Profile 2 (S.W.Cor. 8-56-26)			
Horizon	L-H	Cg	Cg	Cg	Cg	Cg	Cg	pL-H	Cg	Cg
Depth (inches)	6-0	0-6	6-18	18-30	30-34	34-42	0-3	3-12	12-24	24-36
Moisture Equivalent	132.7	37.4	35.9	40.8	61.2	22.4	45.1	117.8	52.2	69.8
Organic Carbon (%)	32.11	0.79	0.97	0.69	9.79	0.93	4.83	20.90	4.72	5.45
Total Nitrogen (%)	2.49	0.12	0.10	0.08	0.65	0.07	0.45	1.52	0.33	0.80
C/N Ratio	12.9	6.6	9.7	8.6	15.1	13.3	10.7	13.7	14.3	6.8
Carbonates (as $CaCO_3$ in %)	1.3	9.0	11.1	10.0	0.7	13.5	7.9	0.6	0.6	0.2
pH Values	6.9	8.0	8.0	7.9	6.5	8.1	7.9	7.5	7.8	7.1
Conductivity (mmhos/cm.)	....	0.84	1.02	1.02	....	2.02	2.14	0.71	0.66	0.52

TABLE 9

Analyses on Soils of Le Pas Moderately Saline Phase

	Profile 1 (W.Cen. 2-54-28)		Profile 2 (E.Cen. 28-53-28)		Profile 3 (S.W.¼ 3-54-28)	
Horizon	Cg	Csg	Csg	Csg	Csg	Cg
Depth (inches)	0–6	6–18	0–6	6–18	0–6	6–18
Moisture Equivalent	45.6	36.8	73.8	44.8	43.1	35.9
Organic Carbon (%)	1.86	0.58	15.86	2.60	3.38	0.63
Total Nitrogen (%)	0.28	0.10	1.43	0.23	0.34	0.09
C/N Ratio	6.6	5.8	11.1	11.4	9.9	7.0
Carbonates (as $CaCO_3$ in %)	3.0	6.5	12.1	10.5	7.4	13.2
pH Values	8.0	8.0	7.8	8.0	7.9	8.1
Conductivity (mmhos/cm.)	2.30	5.05	8.83	9.64	6.79	2.79
Water Soluble Salts						
Calcium (%)	0.003	0.027	....	....	....	....
Magnesium (%)	0.003	0.009	....	....	....	....
Potassium (%)	0.002	0.002	....	....	....	....
Sodium (%)	0.010	0.053	....	....	....	....
Sulphates (%)	0.001	0.037	....	....	....	....
Chlorides (%)	0.014	0.120	....	....	....	....
Bicarbonates (%)	0.038	0.024	....	....	....	....
Carbonates (%)	....	....	....	....	....	....

phase and the strongly saline phase occur along the general overflow water course of Salt Lake—the probable source of salts in these sites. The soils are similar to those of the modal phase in all characteristics except the degree of salinity. Salinity in this phase varies within the range indicated by conductivities of 4 to 10 mmhos/cm., or total salt concentrations of 0.3 to 0.9 percent. Salts are dominantly sodium chlorides followed by smaller quantities of calcium and magnesium chlorides and sulphates. No sodium carbonate in the soil material is indicated by tests or by soil reactions which range from mildly to moderately alkaline. On these soils the vegetative cover is affected by salts in various degrees; trees and shrubs are absent except in a few sites and salt tolerant plants, particularly wild barley, are quite common in previously cultivated or burned-over areas.

(3) *Le Pas strongly saline phase* (1,361 acres)

Four small areas south-east of Big Lake in Township 53 Range 28 are designated as strongly saline. These are periodically wet areas with numerous sites completely devoid of vegetation due to high salt concentration. Salts are extremely variable in quantity; the highest concentration determined exceeded six percent. In general, salt concentration decreases with depth. Chloride salts are dominant and in places the concentration is sufficiently high to impart a wetness to the surface soil. Small quantities of nitrates, perhaps 50 parts per million, have been indicated by tests in several areas.

In addition to the high salt concentration in this phase, the soils have the characteristic of having considerable quantities of muck that appear to be co-precipitated with mineral sediments. This condition is quite prominent in strongly salinized sites with no vegetative cover. Here, upward to 30 percent organic matter, mostly muck, is present in the upper 12 inches of soil and upwards to 15 percent in the succeeding three feet of soil material. In less saline sites, the mineral soils contain considerable raw organic materials derived from the annual growth of sedges and reeds. The soil reaction is high but it seldom exceeds a pH of 8.5.

TABLE 10

Analyses on Soils of Le Pas Strongly Saline Phase

	Profile 1 (W.Cen. 26-53-28)		Profile 2 (S.E. 34-53-28)		Profile 3 (N.W.¼ 26-53-28)	
Horizon	Csg	Csg	Csg	Csg	Csg	Csg
Depth (inches)	0–6	6–18	0–6	6–18	0–6	6–18
Moisture Equivalent	88.5	50.6	83.5	54.2	87.6	54.9
Organic Carbon (%)	15.39	4.39	15.35	6.35	16.82	6.51
Total Nitrogen (%)	1.21	0.41	1.37	0.56	1.38	0.53
C/N Ratio	12.7	10.7	11.2	11.3	12.2	12.3
Carbonates (as $CaCO_3$ in %)	9.2	3.0	8.9	6.6	4.7	3.7
pH Values	7.8	8.0	7.6	7.8	7.9	7.9
Conductivity (mmhos/cm.)	17.67	6.24	33.13	7.91	7.07	9.64
Water Soluble Salts						
Calcium (%)	0.142	0.001	0.407	0.063	....	....
Magnesium (%)	0.078	0.001	0.324	0.033	....	....
Potassium (%)	0.012	0.002	0.024	0.008	....	....
Sodium (%)	0.239	0.039	0.766	0.151	....	....
Sulphates (%)	0.173	0.026	0.448	0.085	....	....
Chlorides (%)	0.713	0.050	2.450	0.338	....	....
Bicarbonates (%)	0.018	0.012	0.054	0.038	....	....
Carbonates (%)	....	....	....	....	....	....

TABLE 11

Analyses on Soils of Le Pas Drained Phase

	Profile 1 (N.W.¼ 18-55-28)				Profile 2 N.E.¼ 34-55-27)			
Horizon	Cg	Cg	Cg	Cg	Cg	Cg	Cg	Cg
Depth (inches)	0–6	6–18	18–30	30 +	0–6	6–18	18–30	30 +
Moisture Equivalent	82.2	46.3	40.5	37.2	40.4	35.0	32.1	34.8
Organic Carbon (%)	12.88	2.63	1.97	1.04	4.54	2.39	0.48	0.63
Total Nitrogen (%)	1.27	0.21	0.18	0.12	0.45	0.15	0.09	0.05
C/N Ratio	10.1	12.5	10.9	8.7	10.1	15.9	...	12.6
Carbonates (as $CaCO_3$ in %)	3.6	5.5	10.0	11.3	9.3	9.7	15.1	10.4
pH Values	7.9	8.0	8.1	8.2	8.1	8.2	8.2	8.2
Conductivity (mmhos/cm.)	1.96	1.71	1.68	1.34	1.66	0.65	0.39	0.37

(4) *Le Pas sand substrate phase* (794 acres)

The soils of this phase occur in small wet depressional areas bordering and within the sandy fan to the north and east of Big Lake. These soils have 8 to 24 inches of clay abruptly terminated by a fine sand substrate. The soils are moderately calcareous throughout and generally are slightly saline. Some organic matter in the form of peat and/or muck is present on the surface and in bands within the soil section. The reaction varies from mildly alkaline in the layers containing organic matter to moderately alkaline in the mineral layers. Gleying and iron mottling are pronounced. The salinity indicated in various areas is not considered a serious deterrent to crop growth.

(5) *Le Pas drained phase* (14,932 acres)

Soils of this phase occur generally as long strips bordering some of the more prominent levees, notably those of the Carrot River and Nels Creek. These soils have silty clay to clay textures and are moderately calcareous throughout the soil section. No salinity of consequence has been noted; the conductivities of the soils tested were less than 2.0 mmhos/cm.

Surface drainage is moderately good because of the gentle fall of the terrain toward the deeper recesses of the delta. Internal drainage however, is restricted by the retentive nature of the fine textured sediments. The high water table, originally the main problem, is being lowered by the numerous surface drains constructed in the delta area.

Prior to cultivation and fires, these soils had a layer of peat usually less than 12 inches in thickness. Horizon development in general is negligible and the dark colored surface layer in cultivated fields is due to mechanical mixing of the peat and muck with the underlying mineral sediments.

(6) *Le Pas drained, sand substrate phase* (1,277 acres)

This phase is the better drained equivalent of Le Pas sand substrate phase. The soils occur in small micro-depressional areas within the sandy fan north and east of Big Lake. Some sedimentation of clays occurred in these minor depressions within the sandy area. Some peat and/or muck up to 12 inches thick is or was present on these soils. Considerable peat has been destroyed by fires and some has been incorporated with the mineral soil by cultivation. Where mixing by cultivation has occurred, the surface soils have a dark color much like the grassland soils in the southern part of Manitoba.

The soils in this phase, like the others in Le Pas series, are moderately calcareous and moderately alkaline throughout the mineral soil section. Salinity is significant only in a few spots in some fields. Organic matter is variable in quantity, but bands of raw organic materials within the profiles are of common occurrence.

Agriculture:

The various phases in Le Pas series all have fine surface textures, moderately alkaline reactions and moderate amounts of lime carbonate, but they differ considerably in natural fertility (see Tables 8 to 11). All phases have a plentiful supply of organic matter, however most of it is only partially humified and provides only small amounts of mineral nutrients to growing plants.

Figure 12

Baled native hay (sedges) on Le Pas modal phase.

Figure 13

Breaking of land with characteristic growth of sedges and reeds.

Figure 14

Figure 14a

Fertilized (headed) and unfertilized barley on soils of Le Pas drained phase (10-55-28).

Decomposition of organic matter is slow, particularly within the profiles of waterlogged soils. High amounts of total phosphate are present but this element is relatively unavailable to plants. This low availability of plant nutrients has been indicated by the high response to nitrogen and phosphate application obtained in fertilizer trials conducted on these soils. The crop response to fertilizers varies considerably from one phase to another.

The soil with the highest agricultural potential in Le Pas series is the drained phase. This phase has moderately good surface drainage, moderate permeability and no appreciable quantities of water soluble salts. Waterlogged condition of the soil is a serious problem in wet springs and in periods of high rainfall. In most years this soil produces good crops of grain and forage. Good response of grain crops to nitrogen and phosphate fertilizers has been noted in the trials conducted in recent years. In these trials the most outstanding response was obtained on grain crops grown on stubbleland*. Here, upward to 18 bushels increase per acre of wheat was obtained. On summerfallow the increases in yield due to fertilizer were less marked.

Figure 15

Test plots of flax and wheat on soils of Le Pas drained phase.

Two soils, Le Pas drained, sand substrate phase and Le Pas sand substrate phase, are

*Ellis, J. H., Co-operative field demonstrations in the Pasquia Area. Manitoba Department of Agriculture and Conservation and Lands Branch, Manitoba Department of Mines and Natural Resources, 1960.

rated next in productivity. Their importance is limited by the small total acreage of each phase and the small size of individual soil areas. The drained phase is the better of the two soils because of improved surface runoff. However both soils are subject to a highly fluctuating water table. These soils are particularly well suited to the production of forage crops. Salinity is not a significant factor.

The Le Pas modal phase is the wettest soil in Le Pas series. A considerable portion of the area occupied by this phase was an intermittent lake bed prior to the installation of drains and drainage will continue to be a problem in this portion. If adequate drainage is provided this soil could be as productive as Le Pas drained phase. Under the present conditions some portions are suitable only for forage crops that are relatively tolerant to wetness. Some salinity is indicated in various places.

The moderately saline phase has a low rating for the production of grain crops. With adequate drainage however, the salinity in the surface soils will be reduced and various crops may be successfully grown. Salinity is variable but seldom occurs in concentrations sufficient to inhibit all native plant growth. Forage crops, particularly legumes, can be successfully grown if adequate surface drainage is provided.

The strongly saline phase has very limited agricultural value at the present time. The degree of salinity is variable but over most of the area the salt concentrations are sufficiently high to strongly affect plant growth, and in small patches of land extremely high salinity has inhibited all plant growth. In some portions of the area the salt concentrations are lower and legumes may be grown if surface drainage is adequate. With better drainage some decrease in salt content can be expected.

Big Lake Series (14,459 acres)

The Big Lake series consists of a group of immature soils with very fine sandy loam to silty clay loam textures and moderate amounts of lime carbonate. Bands of organic matter and layers of fine sand to clay textured sediments are common in the soils of this series. This layering effect is well illustrated in Figure 16. All the Big Lake soils were covered with a thin layer of peat before fires and cultivation destroyed or reduced this material over most of the area. These soils are classed as Peaty Calcareous Gleysols.

TABLE 12

Analyses on Soils of Big Lake Modal Phase

	Profile 1 (Cen.West side 25-54-28)				Profile 2 (N.W.Cor. 31-55-26)		Profile 3 (S.W.Cor. 6-55-28)	
Horizon	Cg	Cg	Cg	Cg	Cg	Cg	Csg	Cg
Depth (inches)	0–6	6–18	18–30	30–42	0–6	6–18	0–6	6–18
Moisture Equivalent	38.1	33.7	37.7	35.1	25.9	18.6	76.2	40.1
Organic Carbon (%)	2.52	0.90	1.28	1.11	1.24	0.71	12.01	1.64
Total Nitrogen (%)	0.28	0.10	0.18	0.16	0.13	0.06	1.05	0.20
C/N Ratio	9.0	9.0	7.1	6.9	9.5	11.8	7.6	8.2
Carbonates (as $CaCO_3$ in %)	10.2	12.7	5.9	6.0	13.7	13.1	2.6	9.0
pH Values	8.1	8.1	8.1	8.0	8.1	8.2	7.8	8.2
Conductivity (mmhos/cm.)	0.98	1.63	1.34	0.90	1.66	0.54	6.46	2.56

TABLE 13

Analyses on Soils of Big Lake Drained Phase

	Profile 1 (Cen.West side N.W.¼ 11-55-28)				Profile 2 (S.W. 16-55-28)			
Horizon	Cg	Cg	Cg	Cg	Cg	Cg	Cg	Cg
Depth (inches)	0–10	10–18	18–30	30 +	0–6	6–18	18–30	30–42
Moisture Equivalent	57.8	32.2	24.9	20.3	38.3	32.9	36.2	33.7
Organic Carbon (%)	7.13	1.67	1.05	0.87	2.29	1.13	0.84	0.86
Total Nitrogen (%)	0.50	0.14	0.06	0.07	0.31	0.12	0.11	0.08
C/N Ratio	14.2	11.9	17.5	12.4	7.4	9.4	7.6	10.7
Carbonates (as $CaCO_3$ in %)	...	8.9	12.6	12.7	6.5	11.8	11.6	10.3
pH Values	7.1	8.1	8.2	8.2	8.3	8.3	8.2	8.0
Conductivity (mmhos/cm.)	3.25	2.47	2.12	1.83	0.57	0.44	1.05	2.16
Water Soluble Salts								
Calcium (%)	0.072	0.072	0.045	0.042	0.014	...	0.014	...
Magnesium (%)	0.026	0.015	0.007	0.005	0.001	...	0.002	...
Potassium (%)	0.005	0.003	0.003	0.002	0.002	...	0.002	...
Sodium (%)	0.027	0.010	0.007	0.006	0.003	...	0.007	...
Sulphates (%)	0.241	0.164	0.076	0.062	0.006	...	0.026	...
Chlorides (%)	0.127	0.012	0.009	0.009	0.008	...	0.003	...
Bicarbonates (%)	0.028	0.024	0.022	0.022	0.041	...	0.026	...
Carbonates (%)	...	...	...	...	...	...	...	...

The soils of this series are located north of Nels Creek in scattered areas of various dimensions. Native vegetation is mainly reeds and sedges with some clumps of willows on the higher sites. Permeability is moderate but internal drainage is poor due to the presence of a high water table. Improvement in drainage is anticipated through the effects of the recently constructed drainage ditches.

Two phases of the Big Lake series, Big Lake modal phase and Big Lake drained phase, were mapped and are separately described in the following section.

(1) *Big Lake modal phase* (8,916 acres)

This phase occurs in scattered depressional areas that have been subject to intermittent laking. The naturally poor surface drainage has been improved through the installation of ditches. However, drainage will continue to be a problem in wet seasons because of slow surface runoff, moderately slow permeability and periodic high water tables.

These soils are medium to moderately fine textured, with the finer textures being predominant in the lowest areas. Organic materials in the forms of ooze, muck and peat commonly occur on the surface and in bands within the profiles. Iron mottling and gleying are pronounced. Tests for water soluble salts revealed negligible quantities.

(2) *Big Lake drained phase* (5,543 acres)

The drained phase of Big Lake series occurs on slightly higher ground and is somewhat coarser in texture than the modal phase. A thin layer of peat on the surface is present only in virgin sites missed by fires. Thin bands of organic matter also are present in the profile but the number of layers is generally less than in the modal phase.

Surface runoff is moderately good due to the slightly elevated position of these soils in relation to the adjacent soils. In spite of this favourable relief, a high water table in the spring and often in the summer or fall imparts

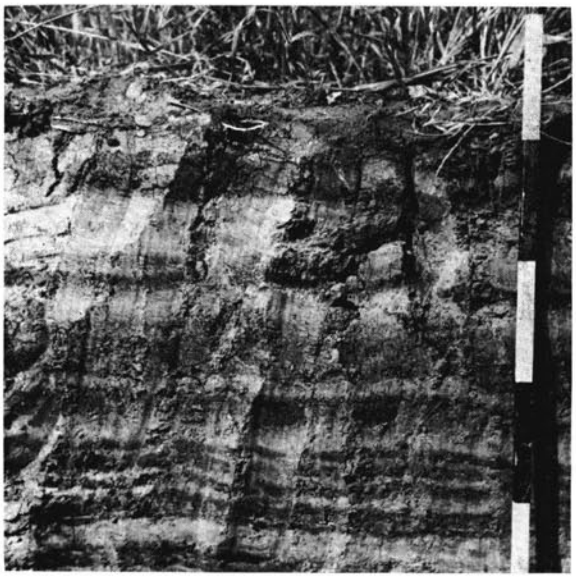


FIGURE 16

Soil profile of Big Lake drained phase. A Peaty Calcareous Gleysol soil developing on a dominance of medium textured alluvial deposits. Peat has been destroyed by fires. (Measuring stick interval = 6 inches).

a soil drainage problem. Changes in the level of the water table are more rapid in this medium textured material than in the clays.

The native vegetation consisted of sedges and reeds with clumps of willows and a few scrubby aspen on the highest sites. At present, weeds such as sow thistle, Canada thistle and horsetail are abundant on both cultivated and virgin lands. These weeds, as well as quack grass, are widespread and under the poor drainage conditions are difficult to eradicate by cultural means.

The soils of this phase are strongly stratified with light colored bands of sandy material alternating with dark colored bands of clayey sediments; the latter bands are usually much thinner. These soils are moderately calcareous, moderately alkaline and contain small quantities of soluble salts—usually below concentrations indicated by electrical conductivities of 4 mmhos/cm.

Agriculture:

The Big Lake drained phase is rated as one of the best soils in the Pasquia map area. The soil is a friable type, easily worked and has relatively good surface drainage. Total phosphate content is high and total nitrogen and organic matter content is high except in areas where the surface peat has been completely destroyed by fires. On the burned-over soils, green manure crops will help restore lost organic matter. It is expected that crops grown on this soil will respond to nitrogen and phosphate fertilizers, particularly when applied to crops grown on stubble land. The problems are slow drainage and weeds.

The modal phase, unlike the drained phase, has very little land under cultivation. In much of this phase, poor drainage will be a continuing problem in some years even with the present distribution of drainage ditches. It is expected that the drains will lower the water table, especially for the summer and fall seasons, and thus facilitate the use of these soils for crop growth. Most of this phase is suitable only for hay crops due to the flooding hazard in the spring and in periods of high rainfall. In these soils the organic matter is in plentiful supply but it is largely undecomposed and under the present wet conditions is humifying very slowly. Both nitrogen and phosphate, in the organic and mineral forms, are in good total supply but their availability to plants is low. Cultivation will accelerate the decomposition of organic matter and minerals and increase the supply of these available nutrients. It is expected that applications of fertilizers containing nitrogen and phosphate will increase crop yields on these soils.

PASQUIA SERIES (5,700 acres)

The Pasquia series consists of a group of moderately calcareous soils with moderately coarse textures. These soils, like the other alluvial types, have or had a thin layer of peat on the surface and have bands of peat within the profile. This series is classed as a Peaty Calcareous Gleysol. Native vegetation consists primarily of sedges and reeds; willows and some aspen occur on the higher sites. Weeds such as sow thistle, Canada thistle, horsetail, quack grass and wild barley are now abundant.

In this series, Pasquia modal phase, Pasquia drained phase and Pasquia drained, saline phase were mapped and are separately described.

(1) *Pasquia modal phase* (1,024 acres)

This phase occurs in four widely scattered areas in depressions previously subjected to periodic laking. These soils have a peaty or mucky surface layer underlain generally with a thin clayey layer not exceeding 8 inches, which in turn is underlain by a strongly gleyed, iron stained and moderately calcareous sandy substratum. Thin bands of peat or muck as well as thin layers of silty and clayey sediments occur within the profile. Salinity at present is negligible but improved surface drainage may result in some upward movement of salts from the substrata.

(2) *Pasquia drained phase* (2,247 acres)

The drained phase, in comparison with the modal phase, has better surface drainage, a thinner layer of clay on the surface of the soil and less banding of finer textured sediments

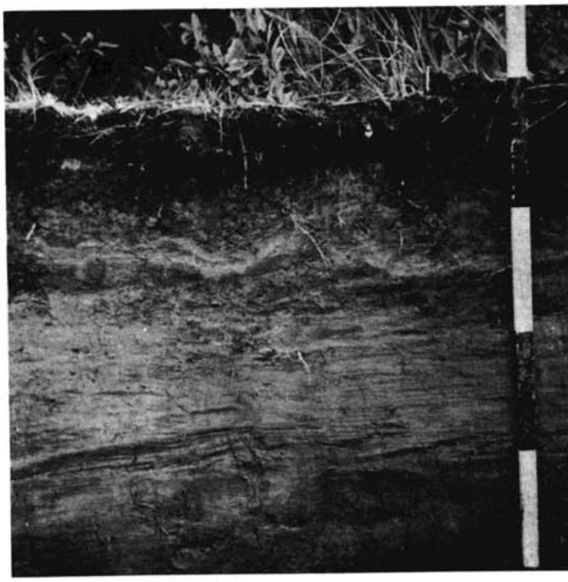


FIGURE 17

Soil profile of Pasquia drained phase. A Peaty Calcareous Gleysol consisting of 4 inches of clay underlain with stratified fine sand alluvium.

TABLE 14

Analyses on Soils of the Pasquia Series

	Pasquia Drained Phase (S.W.¼ 27-54-28)				Pasquia Saline Phase (N.E.Cor. 24-54-28)			
Horizon	Cg	Cg	Cg	Cg	Cg	Cg	Csg	Csg
Depth (inches)	0–6	6–18	18–30	30–42	0–2	2–18	18–30	30–42
Moisture Equivalent	33.5	10.5	18.9	6.9	40.4	19.3	22.6	15.7
Organic Carbon (%)	2.42	1.06	1.19	0.48	3.34	0.66	2.76	1.55
Total Nitrogen (%)	0.25	0.05	0.05	0.03	0.22	0.04	0.13	0.09
C/N Ratio	9.7	21.2	23.8	16.0	15.1	16.5	21.2	17.2
Carbonates (as $CaCO_3$ in %)	7.6	10.5	11.4	9.3	5.8	14.0	9.9	11.0
pH Values	8.2	8.3	8.3	8.3	7.9	8.2	8.1	8.1
Conductivity (mmhos/cm.)	2.14	0.95	0.68	0.66	3.53	3.42	4.42	5.30
Water Soluble Salts								
Calcium (%)	...	...	...	...	0.056	0.013	0.036	0.030
Magnesium (%)	...	...	...	...	0.012	0.003	0.006	0.005
Potassium (%)	...	...	...	...	0.003	0.002	0.008	0.003
Sodium (%)	...	...	...	...	0.045	0.031	0.050	0.037
Sulphates (%)	...	...	...	...	0.096	0.052	0.069	0.052
Chlorides (%)	...	...	...	...	0.062	0.044	0.073	0.072
Bicarbonates (%)	...	...	...	...	0.026	0.020	0.024	0.019
Carbonates (%)	...	...	...	...	...	...	...	...

within the profile. In a few places, the surface layer of clay is absent. A thin layer of muck or peat was present on the surface prior to burning and cultivation. These soils are moderately calcareous and the predominant textural fraction consists of fine sand. Iron mottling is pronounced throughout the soil profiles. Salinity tests revealed that the water soluble salt concentrations are low except in a few local areas.

(3) *Pasquia drained, saline phase* (2,429 acres)

The saline phase is similar to the drained phase in the physical and chemical features except for a general higher degree of salinity. Salinity in this phase ranges from a low of less than 2 mmhos/cm. conductivity to a high of over 20 mmhos/cm. In a few small areas, the salinity is sufficiently high to inhibit all plant growth. The salts, which are primarily chlorides, can only be detected by soil tests or by the presence of indicator plants such as goosefoot, wild barley, salt grass, gum weed, sea blite and glasswort.

Salinity in these sandy soils is variable from one season to another. This variation is due to rapid changes in the ground water level. When the water table is low, the salt concentration in the sandy surface layers is quickly lowered through the leaching effect of percolating rain water. If the water table is kept at a low level, in a few years time soil salinity would not be a serious problem in crop production.

FIGURE 18

Salinity in a wheat field of Pasquia drained, saline phase indicated by bare spots.

Agriculture:

The soils of the Pasquia series have moderate to low natural fertility. This variation in fertility is due to differences in local drainage, salinity, and thickness of the surface clay deposit. The soils are all moderately alkaline in reaction and moderately calcareous.

The modal phase, which is the most poorly drained phase in the Pasquia series, has the best supply of organic matter. This soil has the disadvantage of occurring in depressional areas subject to periodic flooding. Even with the anticipated improved drainage, this phase will be suitable mainly for forage crops tolerant to wet conditions.

The drained phase of the Pasquia series is fair for grain crops and fairly good for the production of forage crops. Some salinity is present but significantly high salt concentrations were noted only at a few locations. The organic matter content is low in areas that have been burned over and hence provision for green manure crops will soon be necessary. Wind erosion is a problem and will become more serious especially on exposed cultivated fields where there is little or no clay mantle on the surface. Use of fertilizers is recommended for maximum crop yields.

The saline phase is similar to the drained phase except for degree of salinity. Salinity is widespread and in a number of places is sufficiently high to entirely inhibit the growth of grain and forage crops. Response of grain crops to nitrogen and phosphate fertilizers has been very high on a trial site on this soil. On some of the trials, increases in yields of fertilized wheat over the check exceeded 20 bushels an acre on summerfallow and 37 bushels per acre on stubble land. This response of wheat to

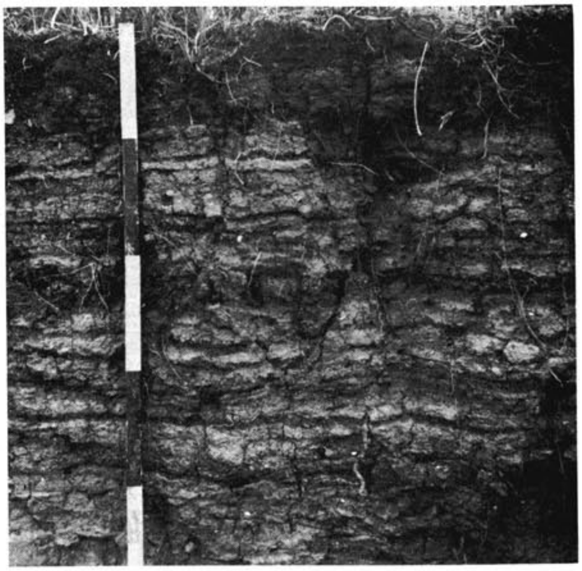


FIGURE 19

A soil profile of Carrot series. A Gleyed Mull Regosol developing on medium textured levee deposits. (Measuring stick interval = 6 inches).

FIGURE 20

Vegetables grown on Carrot River levee.

fertilizers on the Pasquia saline phase was much greater than on the drained phase of Le Pas series. Total yields however were lower.

CARROT SERIES (2,539 acres)

The Carrot series is a group of immature soils with imperfect drainage developing on the levee deposits of the Carrot River. These soils, classified as Gleyed Mull Regosols, are distinguished from the Nels series primarily by the presence of a weak A horizon. This weak horizon development is the result of the slightly higher elevation providing a favourable environment for tree growth and decomposition of organic matter. On these soils, the present crown cover in the virgin areas consists mainly of balsam poplar, aspen, elm, box-elder, green ash and white birch. Both spruce and balsam fir, originally present, have been drastically reduced by logging operations and fires.

The levee on the south side of the Carrot River is narrow over much of its length, although widths of 1,200 yards are reached at some points. When cultivated, the surface soil is quite dark in color. Organic matter content is high on the surface and in thin bands throughout the soil section (see Figure 18). Silt loam is the dominant texture but stratification with layers of different textures ranging from fine sand to clay is characteristic. These soils have moderate amounts of lime carbonate and are moderately alkaline. Iron mottling within six inches of the surface is characteristic.

Agriculture:

This soil is highly fertile and is considered the best type in the Pasquia area. Lime carbonate in the surface is high, however no marked symptoms of chlorosis have been noted in the grain and vegetable crops. The crops respond to nitrogen and phosphate fertilizers, although to a lesser degree than on the other soil types in the area. Excellent yields of vegetables and grain have been obtained in recent years. The main problem at present is weeds. Some wind erosion occurs on bare fields, but this problem can be easily controlled by cultural means. At present, about 85 percent of this land is privately owned.

NELS SERIES (20,677 acres)

The Nels series is a group of imperfectly drained, immature soils found on all significant

TABLE 15

Analyses on Soils of the Carrot Series

	Profile 1 (N.W.¼ 10-55-29)					Profile 2 (N.E.Cor. 9-56-26)			
Horizon	Ah	ACg	Cg	Cg	Cg	Ahj	Cg	Cg	Cg
Depth (inches)	0–2	2–4	4–12	12–24	24–36	0–6	6–18	18–30	30–42
Moisture Equivalent	60.5	32.1	26.0	31.7	19.8	39.8	35.7	34.3	32.1
Organic Carbon (%)	7.40	2.99	1.33	0.96	0.70	5.36	1.67	1.44	1.29
Total Nitrogen (%)	0.69	0.26	0.14	0.06	0.07	0.94	0.17	0.14	0.10
C/N Ratio	10.7	11.5	9.5	16.0	10.0	...	9.8	10.3	12.9
Carbonates (as $CaCO_3$ in %)	9.9	2.2	10.5	13.6	13.3	8.3	9.0	9.1	11.2
pH Values	8.3	8.2	8.2	8.2	8.3	8.1	8.0	8.1	8.1
Conductivity (mmhos/cm.)	0.76	0.54	0.41	0.40	0.39	0.70	1.34	0.54	0.44

levees in the Pasquia area except those of the Carrot River. These soils have no horizon development except a thin layer of organic material on the surface and are classed as Gleyed Mor Regosols.

The Nels series, occurring on low levees up to 1,000 yards wide throughout the delta area, occupies the second largest acreage of the soils in the Pasquia area. These soils have a ridge-like relief with elevations of 2 to 6 feet above the alluvial plain. The channels between the levees range from 3 to 12 feet below the crest of the levees.

Native vegetation originally was balsam poplar, aspen, willows, Manitoba maple and some black spruce. At present this forest cover prevails only on the more prominent levees of the southern and western portions of the area that have not been cultivated or seriously affected by fires.

The soils of the Nels series have been divided into two types that are described as: (1) Nels loam and (2) Nels fine sandy loam.

(1) *Nels loam* (819 acres)

The areas of Nels loam occur on low levees mostly near the mouth of the Pasquia River at the Town of Le Pas. These soils are dominantly loam in texture but contain layers ranging from very fine sandy loam to clay loam. They are moderately alkaline in reaction, moderately calcareous, imperfectly drained and have no significant amounts of water soluble salts. Horizon development is absent except for some organic accumulation on the surface and, in a few sites, a slight darkening of the mineral soil below the organic horizons. Stratification by bands of organic matter and layers of coarse, medium and fine textured sediments is characteristic. Mottling and gleying are present at depths exceeding 12 inches. Permeability is moderate to moderately slow depending on the banding by fine textured material.

(2) *Nels fine sandy loam* (19,858 acres)

Nels fine sandy loam soils cover about 14 percent of the surveyed portion of the Pasquia map area. Most of the soils are imperfectly drained although there are some occluded areas of moderately well drained soils along Nels Creek and poorly drained soils along some of the ill-defined, low levees at other points. The soils are dominantly fine sandy loam, however the range of fine sand to clay loam is encountered. The most prominent levees, like those along Nels Creek, tend to have coarser textures.

Horizon development is very weak to absent. On the prominent levees the soils show a darkening on the surface indicating incipient soil formation. Water soluble salts are low to absent. Both liminess and reaction are fairly

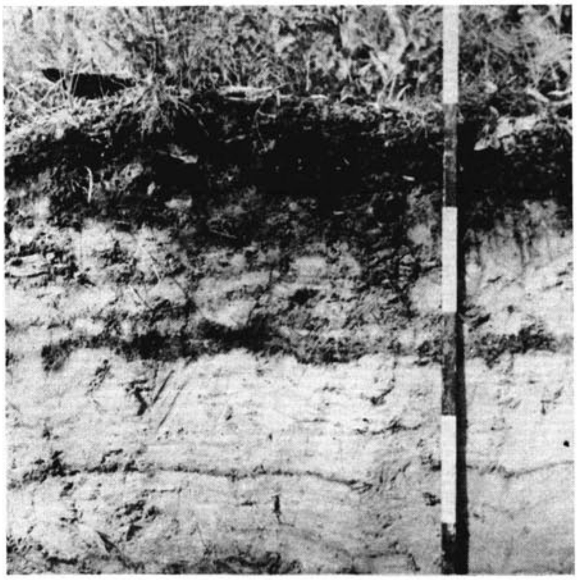


FIGURE 21

Soil profile of Nels fine sandy loam. A Gleyed Mor Regosol soil developing on medium textured levee deposits. (Measuring stick interval = 6 inches).

uniform throughout the soil section, except in the areas of slightly better drained soils where some downward movement of lime has occurred. The occluded areas of more poorly drained virgin soils have a characteristic organic layer up to 12 inches thick consisting of a mixture of grass, grass-like, leaf and woody materials. Iron mottling is high throughout the profile but other gley features are weak to absent.

Agriculture:

The soils of the Nels series are moderately-high in natural fertility. The most favourable feature of these soils, like those of the Carrot series, is their higher elevation and consequent better surface drainage.

The Nels loam is a better soil than the Nels fine sandy loam. It is of medium texture, has a favourable water retention capacity, a good supply of organic matter and good surface drainage. In some years a high water table may reduce the yields of grain. It is expected that nitrogen and phosphate fertilizers applied to crops will give good returns.

The Nels fine sandy loam is lower in natural fertility and in productivity than the Nels loam. Organic matter is low in places and the low water retention capacity of the coarser soils can result in low yields. The plowing down of green manure crops is required, especially along some of the high levees bordering Nels Creek. The use of fertilizers also is recommended. Forage crops, particularly legumes, are well suited to this soil. The favourable relief provides ideal sites for farm buildings, gardens and for crops that are highly susceptible to surface flooding.

NELS LOAM - LE PAS COMPLEX (2,065 acres)

This is a complex of soils that includes the imperfectly drained, medium to moderately

TABLE 16

Analyses on Soils of Nels Fine Sandy Loam

	Profile 1 (S.E.¼ 3-54-28)					Profile 2 (Cen.W.Side NE¼ 18-55-27)			
Horizon	L-H	Cg	Cg	Cg	Cg	Cg	Cg	Cg	Cg
Depth (inches)	3–0	0–6	6–18	18–30	30–42	0–6	6–18	18–30	30–42
Moisture Equivalent	154.1	32.8	26.0	28.2	26.1	46.5	42.1	29.0	13.3
Organic Carbon (%)	39.43	5.50	1.94	1.09	0.98	5.33	5.13	1.01	0.67
Total Nitrogen (%)	2.07	0.41	0.20	0.13	0.11	0.44	0.44	0.10	0.19
C/N Ratio	19.0	13.4	9.7	8.4	8.9	12.1	11.7	10.1	...
Carbonates (as $CaCO_3$ in %)	1.9	0.3	5.8	12.6	14.0	10.5	7.4	14.9	12.6
pH Values	7.6	6.9	8.1	8.3	8.3	7.8	8.1	8.3	8.4
Conductivity (mmhos/cm.)	0.45	...	0.44	0.59	1.33	0.52	1.03	1.84	0.64

fine textured soils of Nels loam (Gleyed Mor Regosol) and the poorly drained clay textured soils of Le Pas series (Peaty Calcareous Gleysol). The Nels soils are dominant in most areas mapped as this complex. They occur on low levees bordering a channel or a series of close and parallel channels. The coarser deposits are four or more feet thick over the clay and this represents the height of the levees above the surrounding plain.

The native vegetation was partly aspen, balsam poplar and willows, but at present willows, sedges, grasses and others are prominent over much of this complex.

The virgin soils have no horizon development. Those that are cultivated have a dark plow layer due to the incorporation of organic matter by tillage implements. Bands of clay of variable thicknesses are of common occurrence in the Nels soils and they tend to restrict the permeability of these soils. Internal drainage is restricted also by the ground water table which tends to be higher in these areas than in the areas mapped as Nels series. Total organic matter content is high. Le Pas soils included in this complex are those of the modal phase and occur in the depressed positions. These soils are clay textured, moderately calcareous and may be slightly saline. An organic horizon on the surface and bands of organic material within the soil section are characteristic.

Agriculture:

The natural fertility of the levee deposits is moderately high but the unfavourable features of channel-ridge topography, clay depressions and the danger of a high water table tend to reduce the value of this land. In places, the terrain is so uneven that the land cannot be worked by implements without considerable difficulty. Land levelling would not be harmful to the productivity of the soil but the cost may be prohibitive. Under the present circumstances the roughest land is most suitable for forage crops and pasture. A high water table in the levee deposits and surface waters in the channels and clay depressions have been seasonal hazards, however considerable improvement in drainage is expected from the effects of the recent drainage system.

NELS FINE SANDY LOAM—LE PAS COMPLEX (419 acres)

Two areas of this complex occur near the Pasquia River in the eastern portion of the surveyed area. This complex is less severely channelled and therefore not as rough in topography as the Nels loam—Le Pas complex. The levee deposits are generally fine sandy loam on the surface but vary from fine sand to silty clay in the substrata. The clay textured soils in the depressions belong to Le Pas modal phase. In these depressions the drainage is poor and surface flooding is a common occurrence. Some improvement in general drainage conditions is expected from the surface drains in the Pasquia area.

Agriculture:

The levee deposits are moderately fertile but have problems related to their sandy texture. They are moderately low in organic matter, subject to wind erosion and have a low water holding capacity. Good use from an agricultural standpoint can be made of the various soils in this complex. Grain crops can be grown on the better drained, medium to moderately fine textured soils and hay crops on the sandy soils and in the depressions.

WESTRAY COMPLEX (5,111 acres)

The Westray complex consists of a broad group of soils developed on high-lime till and gravel deposits on the hillocks in the Pasquia area and on the moraine east and south of the flood plain. The well to imperfectly drained soils are Grey Wooded and those in or bordering the depressions are Meadow, Gleysol and Organic soils.

The relief in the area ranges mainly from irregular very gently to moderately sloping. Some sharp slopes, up to 45 degrees, are encountered on the western or frontal margin of the moraine. The vegetation is mixed-

TABLE 17

Analyses of a soil profile in the Westray Complex

Horizon	L-H	Ae	Bt	BC	C
Depth (inches)	1–0	0–1½	1½–4	4–10	10 +
Moisture Equivalent	107.3	22.4	28.7	26.5	19.7
Organic Carbon (%)	33.09	1.97	1.03	0.93	0.35
Total Nitrogen (%)	1.20	0.12	0.10	0.11	0.04
C/N Ratio	...	16.4	10.3	8.4	8.7
Carbonates (as $CaCO_3$ in %)	...	...	...	19.4	54.7
pH Values	7.3	7.0	7.4	8.0	8.5
Conductivity (mmhos/cm.)	...	0.41	0.30	0.34	0.39

consisting chiefly of white spruce, jack pine, balsam fir, aspen and balsam poplar on the imperfectly or better drained soils and black spruce, tamarack and willows in the depressions. Drainage is dominantly good, particularly in the undulating areas.

The most prominent soil is the Orthic Grey Wooded type developed on strongly calcareous, medium textured till. This soil has a thin solum, seldom exceeding 12 inches in thickness. Stoniness is generally so severe that the land is nonarable. A profile description of the Orthic Grey Wooded soil developed on strongly calcareous till is given below:

L-H—1 to 2 inches; very dark brown leaf mat; neutral in reaction.

Ae —1 to 2 inches; very pale brown sandy loam; fine platy; friable when moist, slightly hard when dry; neutral to slightly acid in reaction.

Bt —2 to 4 inches; greyish brown clay loam; small blocky; firm when moist, hard when dry; neutral.

BC —3 to 7 inches; light brownish grey clay loam; medium granular; firm when moist, hard when dry; mildly alkaline.

C —Pale brown strongly calcareous till; loam in texture; pseudo-granular; friable when moist, slightly hard when dry; moderately alkaline.

Associated soils on till are Gleyed Grey Wooded, Meadow and Peaty Calcareous Gleysol. Soils developed on gravelly deposits are of similar genetic types to those on till. Development of Grey Wooded soil characteristics however is generally weaker because of coarse textures.

Agriculture:

These soils have low natural fertility due to low organic matter content and high lime content. The till soils are generally too stony to cultivate and the gravelly soils are too low in water retention capacity, as well as too low in organic matter and available plant nutrients, to be considered as agricultural soils.

FIGURE 22

Soil profile of an Orthic Grey Wooded type in the Westray Complex developed on strongly calcareous till.

(Measuring stick interval = 6 inches)

FIGURE 23

Shallow peat profile underlain with silty clay. (Measuring stick interval = 6 inches).

SHALLOW PEAT (13,743 acres)

The soils designated as Shallow Peat consist of organic deposits of 12 to 36 inches in thickness. On the alluvial plain the peat deposits lie over alluvium with no horizon development. On the till area a thin A horizon is generally present under the organic deposit. About 85 percent of these peat soils occur in the flood plain.

The Shallow Peat soils, formerly known as Half Bogs, are very poorly drained and are saturated with water during most of the growing season. Vegetation on the flood plain is mostly sedges and reeds with some tamarack, black spruce and willows; on the till areas the cover is mainly tamarack and black spruce. The peats are of the fen variety on the flood plain and mixed woody and fen variety on the till areas. Humification of the peats increases with depth. Generally the peats are slightly acid—the mixed or woody types are more acid than the fen variety.

Agriculture:

The Shallow Peat soils have low natural fertility. Agriculturally they are best suited for hay or pasture land. On the flood plain, the peat can be destroyed by burning and the land cropped to forage and grain if drainage is provided. If possible, some peat should be incorporated with the underlying mineral soil. On the till areas, the peat should not be destroyed because of the nonarable nature of the underlying material.

DEEP PEAT (10,193 acres)

The areas designated as Deep Peat have more than 36 inches of surface organic deposits. These deposits lie over mineral materials, mostly alluvium, in which no horizon development is distinguishable.

TABLE 18

Analyses of Shallow Peat Profiles

	Profile 1 (N.E.Cor. 10-54-28)			Profile 2 (Cen.S.E.¼ 15-54-28)	
Horizon	L–H	Cg	Cg	L–H	Cg
Depth (inches)	18–0	0–12	12–24	16–0	0–14
Moisture Equivalent	201.2	46.1	36.5	152.5	39.0
Organic Carbon (%)	40.07	3.49	1.23	32.13	2.10
Total Nitrogen (%)	2.86	0.28	0.10	2.29	0.16
C/N Ratio	14.0	12.4	12.3	14.0	13.1
Carbonates (as $CaCO_3$ in %)	0.5	3.6	6.9	0.5	8.8
pH Values	6.7	7.9	8.1	6.4	8.1
Conductivity (mmhos/cm.)	...	3.73	2.91	...	2.41

The Deep Peat areas, formerly known as Bogs, occur west and south of Big Lake in large, open tracts. These peats, which are up to 5 or more feet thick, have formed almost entirely from sedges and reeds. Tamarack and black spruce are found only at a few places.

These organic deposits show an increased humification with depth. Reaction of these materials is slightly to moderately acid.

Agriculture:

These soils, in their present state, are best suited for wild life. It is expected that with drainage and destruction of the peat layer the underlying alluvium could be farmed. Under present economic conditions the reclamation or farming of these bog areas is not practical. Even if the peat was destroyed, flooding would continue to be a hazard due to the depressional positions which these soils occupy.

E. ESTIMATED SUITABILITY OF SOILS FOR AGRICULTURAL USE

The estimated suitability of the soils of the Pasquia Area for various purposes is shown in Table 19. The ratings contained in the table are based on general observations and on a study of the characteristics expressed in the individual soils. They are not based on crop yield data but represent the considered opinion of the soil surveyors.

These land-use estimates represent the average suitability of each map unit in normal seasons. In seasons of above average precipitation many of the soils may be too wet, whereas some soils may benefit. Conversely, a year of low rainfall could be beneficial to the low, wet areas and unsatisfactory for the better drained soils. Each estimate of potential crop growth must be modified on each farm to conform with local variations in drainage, salinity and applied cultural treatments.

TABLE 19

Estimated Suitability of Soils for Agricultural Use

RATING 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 suitable if corrective measures were adopted; ++ = well adapted; − + = more or less suitable; − − = not suitable or of relatively low value.

Soil Designation	CULTIVATED LAND			UNBROKEN LAND			Forestry	Field Windbreaks
	Grain Crops	Cultivated Hay and Pasture Crops	Gardens and Fruits	Native Hay	Grazing	Wild Life		
Le Pas modal phase	F-G(X)	F-G(X)	F(X)	G-F	G-F	+−	−−	X
Le Pas moderately saline phase	F-P(V)	F	P-F	F-G	F-G	+−	−−	−−
Le Pas strongly saline phase	P	P-F	P	F	F	+−	−−	−−
Le Pas sand substrate phase	F-G(X)	F-G(X)	F-G(X)	G-F	G-F	+−	−−	X
Le Pas drained phase	G	G-E	G-F	G	G	+−	+−	++
Le Pas drained, sand substrate phase	G-F	G	G-F	G	G	+−	+−	++
Big Lake modal phase	G-F(X)	G-F(X)	F-G(X)	G-F	G-F	+−	−−	X
Big Lake drained phase	G	G-E	G	G	G	+−	+−	++
Pasquia modal phase	F(X)	F-G(X)	F-G(X)	F-G	F-G	+−	−−	X
Pasquia drained phase	F	G-F	F-G	F-G	F-G	+−	−−	++
Pasquia drained, saline phase	F-P(V)	F-G	F	F	F	+−	−−	−−
Carrot series	G	G-E	G-E	G	G	++	++	++
Nels loam	G	G-E	G	G	G	++	++	++
Nels fine sandy loam	G-F	G	G	G-F	G-F	++	++	++
Nels loam-Le Pas complex	G-F(V)	G-F	G(V)	G	G	+−	+−	++
Nels fine sandy loam-Le Pas complex	G-F(V)	G-F	G-F(V)	G-F	G	+−	+−	++
Westray complex	P	P	F-P	P	P	++	+−	+−
Shallow Peat	F(X)	F-G(X)	P	G-F	G-F	+−	−−	−−
Deep Peat	−−	+−	−−	+−	+−	+−	−−	−−