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PREFACE

The Saskatchewan Soil Survey is conducted by the Department of Soils, University of Saskatchewan, with the cooperation of the Dominion and Provincial Departments of Agriculture. The first field work of the Soil Survey was undertaken in the summer of 1921, and the first Soil Survey report was issued in November, 1923. The latter report (Report No. 1) covered two municipalities included in the present area, namely, R.M.s Nos. 132 and 162.

This publication, Soil Survey Report No. 11, differs in several notable respects from reports and maps issued to date. In the first place the work has been carried out in greater detail than in former surveys. In the second, the maps are uncolored, and are of a larger scale than any reports formerly published. It is possible, therefore, to indicate considerably greater detail of information regarding the soil of any particular parcel of land than was practicable in the broader scale of mapping formerly used.

This report, with accompanying maps, deals with an area which has suffered extensive damage through wind erosion. In some localities water erosion has appeared to further such destruction. The problem of drought and soil drifting is exaggerated on light soils and on hilly lands, and much of the area consists of such land types. The farmers and other residents have, therefore, faced acute difficulties in the past series of dry years. Land abandonment has been of common occurrence, and this along with soil deterioration necessarily results in added difficulties in maintaining the services of the Community.

The present soil survey was undertaken with a view to ascertaining the extent of damage from soil drifting, and to present a sufficiently accurate map of the soils, so that any action taken towards rehabilitation and reclamation might proceed from a sound basis of factual information about the land itself.

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SOIL SURVEY

of MORTLACH, CHAPLIN, AND LAKE JOHNSTONE AREA

including

Rural Municipalities Nos. 132, 133, 134, 162, 163, and 164

by

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INTRODUCTION

THIS publication consists of soil maps and a written report. The report should be used in conjunction with the maps. A much fuller description of soils and other physical features are incorporated in the former than can be shown on the maps, and the reader will gain a better understanding of the map features if the report is fully utilized.

The Maps—There are six maps to cover the area included in this publication, one for each Rural Municipality. The maps are complete with legends, and locations on the maps are readily indicated by referring to sections, townships and ranges. The original scale of the maps was one inch equal to one mile, but this was slightly reduced in printing. The users of the map should study the legend carefully. Some features may readily be discovered by a general inspection of the map. Such features are railways, towns, streams, and lakes. However, land features, such as soil type, topography, amount of erosion and stoniness require reference to the legend in order that the map symbols may be properly interpreted. It is impossible to avoid the use of symbols as a short-hand system of recording such data on the map, since otherwise the map would become cluttered with printed explanations. With a little practice the user will find that there is no difficulty in translating the symbols found in any part of the map.

The symbols used in representing soils are in two parts. The first represents the series to which the soil belongs, and the second indicates the surface texture as Hr L for Haverhill loam, R HvC for Regina heavy clay, and Ht FSL for Hatton fine sandy loam. Additional letters are used to indicate the degree of erosion which has occurred as Ht FSL-d2 for Hatton fine sandy loam which has suffered severe drifting, and

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Acknowledgment is due to Messrs. J. S. Clayton, C. A. Rowles, and A. P. Tzogoeff, for assistance in carrying out field and laboratory work in connection with this survey.

Hr L-E for Haverhill loam on which there has been slight water erosion. Other symbols and letter combinations indicate such features as dunes, wind eroded pits, alkali and stoniness.

There are seven topographical separations indicated on the map, ranging from flat and depressional to hilly. In addition a symbol to indicate "blowouts" or "burnouts" is included. The latter is more strictly a condition of microrelief since the pits are relatively shallow, and only discernible on fairly close inspection of the land surface.

Topographical separations are made on the basis of slope of the land, and the frequency of slopes in the distance of one half mile. The slope is given in per cent, a 5% slope being equivalent to a five-foot difference in elevation per hundred feet horizontal distance. Low frequency generally indicates long, smooth slopes, with only two or three complete rolls in a mile. High frequency indicates choppy topography, usually of the knob and kettle type common to morainic areas, with eight or ten complete rolls in the mile.

For a detailed description of topographical separations see Appendix (page 48).

The field work on which these soil maps are based was mainly carried out in the summer of 1937. Some revision and checking was carried on in 1938, and in intervening seasons until printing of the maps in 1940.

The Report—The report is divided into sections dealing with various topics as listed in the table of contents. A number of sketch maps are included to aid the reader in picturing such physical features as physiography, surface geological deposits from which the soils are derived, a generalized grouping of the soils, and the present use of the land.

A main section of the report is devoted to discussing the soils of the area, their classification and characteristics. Some analytical data is included in this section. Of particular interest is the data giving comparison between virgin and cultivated land.

DESCRIPTION OF THE AREA

LOCATION AND EXTENT

The area covered by this soil survey is situated on the third principal meridian, and its eastern boundary lies about eight miles west of the City of Moose Jaw. The following townships and ranges are included in the surveyed area: Townships 13 to 18—Ranges 28 to 30—West of the 2nd Meridian; and Townships 13 to 18—Ranges 1 to 6—West of the 3rd Meridian.

The area comprises a block of six rural municipalities, namely: Hillsborough No. 132, Rodgers No. 133, Shamrock No. 134, Caron No. 162, Wheatlands No. 163, and Chaplin No. 164. The total area is about 1,748 square miles or roughly 1,118,000 acres. Of this approximately 126,000 acres are occupied by lakes Chaplin and Johnstone.

RELIEF

The main physical features consist of the Regina Plain lowland in the north east, the valleys of the Wood River and Lakes Chaplin-Johnstone drainage basins in the western and southern portions of the area, and the rough, hilly, morainic upland which includes most of the remaining land.

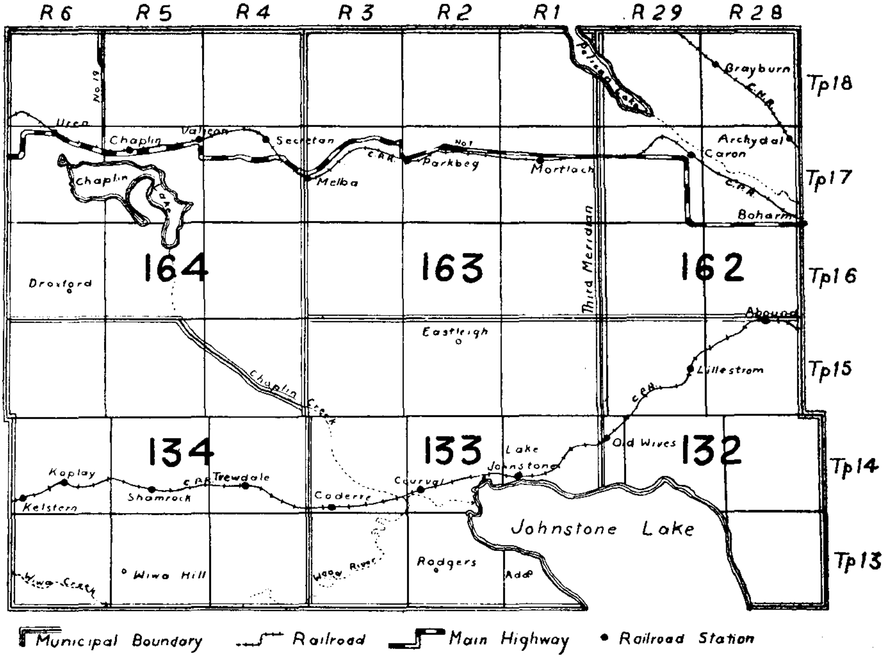


Fig. 1—Sketch Map Showing Area Covered in Detailed Reconnaissance Soil-Survey

This upland includes the abrupt escarpment rising above the Regina Plain, which forms part of that well-known physiographic feature—the Missouri Coteau. From the practical point of view, the rough rolling upland lying west of the escarpment may also be regarded as part of the Coteau.

The basin of Lakes Chaplin and Johnstone (formerly known as Old Wives Lake), cuts through this morainic upland, while the valleys of the Wood River and its tributary, Wiwa Creek, occupy a narrow belt along the west and south borders of the area.

These main physical features are characterized by differences in elevation and topography. The Regina Plain is smooth and nearly level below the 1900′ contour, and varies from undulating to gently rolling up to about 2200′, which marks approximately the base of the Coteau. The lowest elevation in the area (1800′) occurs on Thunder Creek. The Coteau has a pronounced knob and kettle topography, associated with terminal or recessional moraines. In elevation it has a general range of 2200′ to over 2500′. The highest elevation in the area (2800′) occurs to the north-east of Lake Johnstone in the north-east quarter of section 23, township 14, range 28.

In the basin of Old Wives Lake and the valley of Wood River the surface varies from nearly level to gently rolling. In elevation these areas range from below 2000′ to about 2300′. The higher elevation compared with the Regina Plain is due to the location west of the Coteau, since the Coteau marks the rise between the second and third prairie steppes.

DRAINAGE

The Coteau divides the drainage of the area into two main systems. The north-eastern slope of the Coteau and the Regina Plain to the east are drained by Thunder Creek. This is an intermittent stream which flows in a south-easterly direction. Its waters ultimately reach the Qu'-Appelle River, and so form part of the exterior drainage system of the province. The only important tributary of Thunder Creek is Sandy Creek, which rises in the Coteau south of Mortlach. This stream is fed by springs and provides a number of water holes which are permanent sources of water. There are no other streams issuing from the Coteau which are very active at the present time. The second main drainage system may be called the Wood River basin. It occupies the westerly portion of the area, and consists of the Wood River and two tributaries, Wiwa Creek and Chaplin Creek. The latter occupies an alluvial flat between Lake Chaplin and Lake Johnstone, which is part of an ancient drainage channel extending south-eastward into the United States.

At the present time the waters of the Wood River basin form an interior drainage system, emptying into Lake Johnstone. The Wood River itself rises in the Wood Mountains, near the Montana border, and may be classed as a permanent stream, although it may become dry in periods of extreme drought.

Run-off water in the Coteau area mainly collects in the undrained depressions or sloughs.

Lakes Chaplin and Johnstone are remnants of much larger glacial lakes. They have gradually decreased by evaporation and have now become little more than great alkali flats. It is doubtful if they will remain as permanent lakes. Some of the larger sloughs, or small lakes,

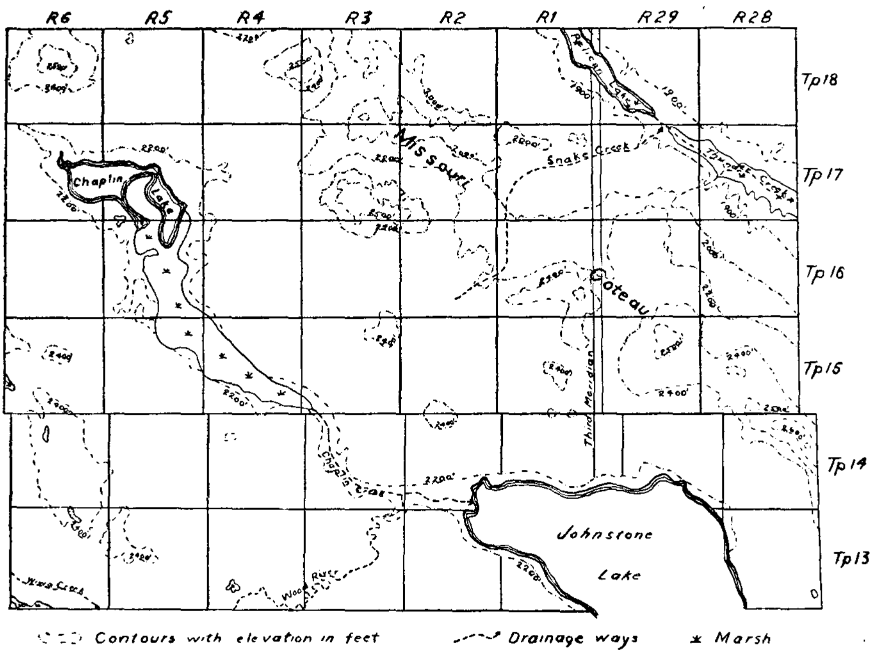


Fig. 2—Physiography and Drainage

are semi-permanent bodies of water, retaining water in wet years, but in times of severe drought gradually drying up until another wet period occurs. At the time of making the survey, very few of the smaller lakes contained water. Pelican Lake, which is dry at the present time, is the largest of these lakes.

The broader features of relief and drainage are indicated on the sketch map (Fig. 2).

SURFACE GEOLOGY

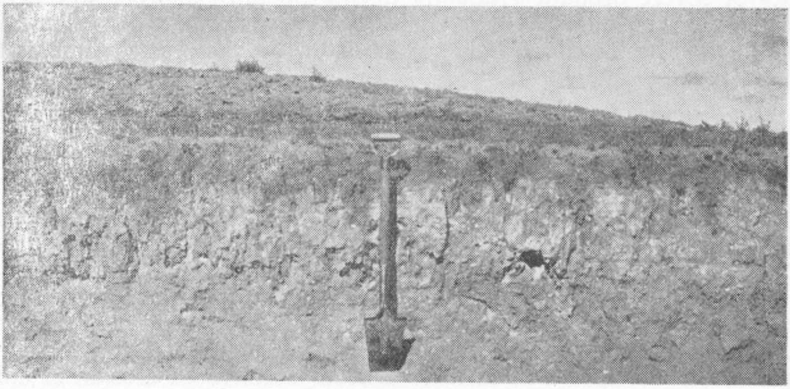
The surface geological deposits may be regarded as part of the raw material out of which the soil is formed. The nature of the surface deposits determines to a large degree the texture, drought resistance and ultimate fertility of the soil. The surface deposits of the surveyed area are chiefly of glacial and post-glacial origin. They consist of morainic and ground moraine deposits, glacial outwash, lake sands, silts and clays, dune sands, and recent alluvium. Due to accelerated erosion of cultivated land, there are also deposits of recent wind-blown material in the form of hummocks, small dunes and blow-pits.

An eroded area in townships 16 rge. 1 and 15 and 16 rge. 2 is marked by deep coulees which lead from the Coteau escarpment down to the lowland south of Mortlach. The erosion evidently occurred toward the close of the glacial period since there is insufficient run-off water at the present time to account for the development of such deep channels. The coulees are mapped as eroded land, the steep slopes and varying nature of the exposed deposits making it impossible to assign soil series names to such areas. Some areas of medium to moderately heavy deposits believed to have been laid down as a result of this erosion are represented by the soils of the Echo series. These soils are generally regarded as solonetz ("burn-out") types developed on glacial till modified by pre-glacial shales.

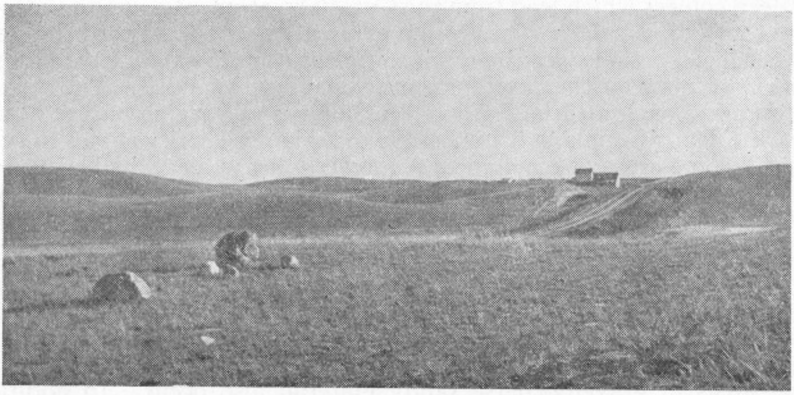
The various kinds of geological deposits are widely scattered throughout the area, but in a broad way they are responsible for the main physiographic and drainage features. The Coteau consists chiefly of morainic deposits of boulder clay. Glacial stones and boulders are common, and local areas of gravelly-coarse sandy material also occur. In addition there are a number of areas of almost stone-free clays scattered throughout this morainic upland. These are classified as glacial lacustrine clays and the soils are mapped as the Sceptre series. However, some of these clay areas lie adjacent to the eroded coulees referred to above, and may be related to preglacial deposits. It may be mentioned here that much of the higher portion of the Coteau is underlain by the Ravenscrag formation, and the lower portions by the Eastend formation. The lowland areas are underlain by Bearpaw shales. It is possible that some of the soils on the Coteau are derived from pre-glacial material since several outcrops of bedrock are known to occur in this area. The morainic covering of the Coteau is the parent material of the Haverhill and Weyburn soils of rolling to hilly topography.

The most extensive areas of ground moraine deposits occur in the north-east lowland, along the base of the Coteau, and in the south and south-west, bordering the valleys of the Wood River and Wiwa Creek. These ground moraine deposits are smoother and generally less stony than the morainic deposits of the Coteau. They are the parent materials of the Haverhill and Weyburn soils of undulating to very gently rolling topography.

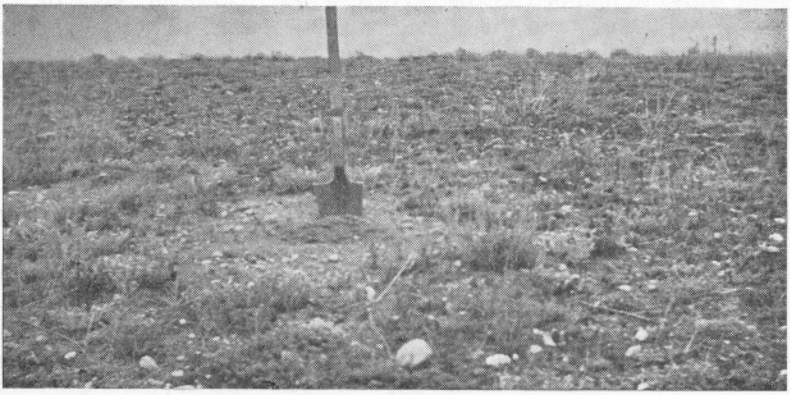
PLATE I



Profile of Haverhill loam, gently rolling phase. This soil is relatively shallow and loss of surface soil by erosion results in the exposure of the infertile gray colored limy subsoil.



Rough, stony land, such as the above, is suitable for use as pasture.



This gravelly soil has little drought resistance. Attempts to cultivate such land inevitably lead to disappointment, and finally abandonment. As pasture land it has some value, although the carrying capacity is rather low.

The glacial outwash deposits are found in two main areas: namely north of the Coteau, in the north-western portion of Wheatlands municipality, and along the Old Wives Lake basin. In the latter case the outwash occurs between the morainic upland and the lake flat. The outwash deposits may include some stream deposits of more recent age. Such deposits result in coarse sandy and gravelly soils, and range in topography from undulating to moderately rolling. They are mapped as Hatton sandy loams, coarse sandy loams and gravelly sandy loams. A few areas of more stony soil are mapped as Haverhill gravelly light loam.

The larger areas of lacustrine deposits occur in the Regina Plains lowland and along the Wood River-Old Wives Lake drainage basins. As mentioned above, small areas of clay, presumably of lacustrine origin, occur throughout the Coteau.

In the Regina Plains lowland, the lacustrine deposits consist chiefly of heavy clays and sands. The former occupy the bed of glacial Lake Regina and underlie the well-known Regina soil series. The sands are of lacustrine, lake shore and possibly deltaic origin, but for practical reasons are grouped together. The soils found on them are mapped in the Hatton series as very fine and fine sandy loams and sands. Some of the fine sands were reworked by wind subsequent to deposition by water. These form the present dune sand areas, and for convenience are also included in the Hatton soils, although they exhibit very little profile development.

The lacustrine deposits of the Old Wives-Wood River basins consist of clays, silts, and sands. Around Chaplin Lake the deposits are chiefly sandy and are mapped in the Hatton series. Along Wiwa Creek, in the

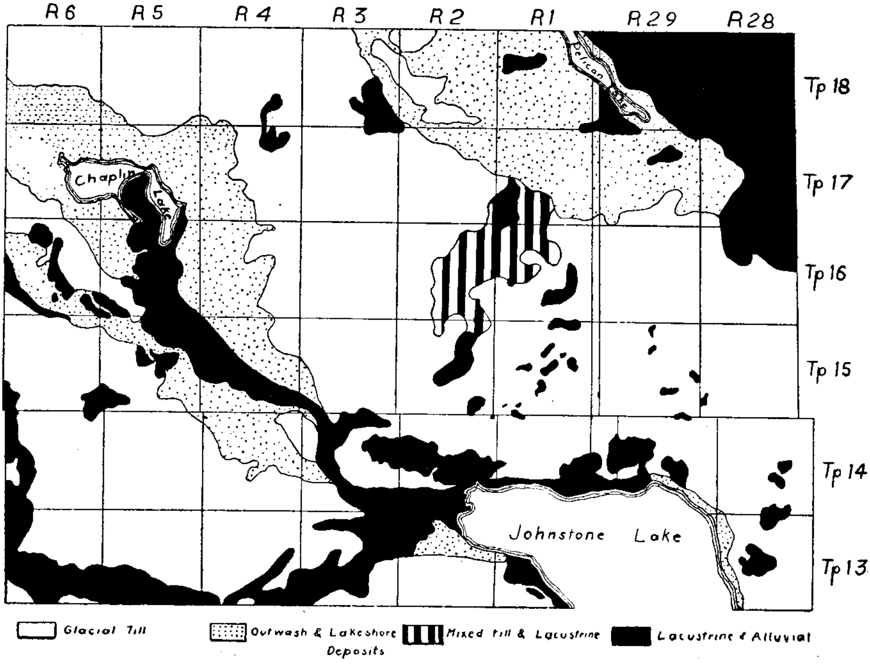


Fig. 3—Geological Nature of Surface Deposits

south-west corner of the area, the deposits are of mixed silty and sandy origin. The silty deposits form the parent materials of the Fox Valley series. Along the Wood River and around Lake Johnstone, lacustrine clays are more common, although some sands and silts also occur. The clays are mapped in the Sceptre series.

Recent geological deposits are represented by the flood plains of the streams, the dry basin of the Old Wives Lake between Lakes Chaplin and Johnstone, and the numerous smaller lakes and sloughs. These deposits are of varying nature but heavy textured types predominate. On the soil map they are mapped either as alluvium or as saline soil (alkali)—the latter where soluble salts are present in sufficient amounts to affect the agricultural value of the land. Owing to the recent origin and variable nature of the deposits, soil profile characters are generally but feebly expressed, and hence the soils are not placed in recognized soil series.

In general the lacustrine and recent deposits are stone free and of nearly level to undulating topography.

The general location and size of the main areas of surface deposits are shown on the sketch map (Fig. 3).

CLIMATE

The relation of climate to the soils of Saskatchewan is discussed in Saskatchewan Soil Survey Report No. 10. Meteorological records are incomplete for the area covered by the present survey. No data are available from the central, south-western and south-eastern portions of the area.

From data available and more particularly from soil and vegetational conditions, the area may be considered as representing the eastern and more humid portion of the brown soil zone. The Regina Plain in the extreme north-eastern corner has been placed in the dark brown zone.

For the area as a whole the climate may be classed as a semi-arid type belonging to the north temperate continental climatic zone, of which Saskatchewan is a part. Such a climate is characterized by relatively low annual precipitation, relatively high summer and low winter temperatures, a short growing season, and wide fluctuations in both temperature and precipitation over short periods.

The local climate of the area is affected by the presence of the lowland plain and the Coteau upland. Although actual data are not available, it is apparent that the eastern portion of the Coteau, chiefly Hillsborough and Caron municipalities, has a somewhat higher moisture efficiency than the area further west. This is indicated by the presence of dark brown soils among the brown zonal types and a heavier stand of grass. Occasional clumps of small poplar and willow also occur in the more sheltered locations.

Meteorological records from Caron and Chaplin, in the northern portion of the area, are given in Table I. As a comparison, data for Swift Current, Regina and Indian Head are also included. These latter stations represent locations in the brown, dark brown, and black soil zones respectively. It will be noted that precipitation varies but slightly between the five stations, with the exception of Indian Head. It is evident that precipitation alone does not determine the climate of a soil region. Temperature is also important. Thus, while Regina has a lower average precipitation than Swift Current, the latter has a relatively higher average temperature. As a result, losses of soil moisture through evaporation and transpiration are greater at Swift Current than at Regina. This difference is reflected in the darker surface and higher content of organic matter and nitrogen of the Regina soils as compared to the soils of the brown soil zone.

From the above standpoint we may state that the surveyed area has a lower moisture efficiency than the dark brown and black soil zones, but a higher efficiency than the main area of brown soils to the west. These conditions are illustrated by the soil-climate indexes included in Table 1. The indexes are based upon certain mathematical relationships between precipitation, temperature, and evaporation. The higher index figures indicate higher moisture efficiencies and hence more favorable soil-moisture conditions.

TABLE 1—Climatic Data for Selected Stations

Station	Average Annual Temperature °F	Average Annual Precipitation, Inches	Soil-Climatic Index*
Caron	34.6	14.79	37.4
Chaplin	35.3	15.16	38.9
Swift Current	38.1	15.18	30.3
Regina	33.2	14.15	44.6
Indian Head	34.2	17.91	50.7

VEGETATION

A detailed study of the native vegetation is beyond the scope of the soil survey. Furthermore, the effects of prolonged drought made it difficult to identify many species of plants. A systematic study of the vegetation of the area has recently been undertaken from the Swift Current Experimental Station.

The dominant type of native vegetation is that of the semi-arid plains grasses with associated herbs and shrubs. These may be roughly subdivided into three main vegetational associations. They consist of: first, the semi-arid range grass association located mainly on areas of medium to heavy textured well drained upland soils; second, the grass and shrub association found usually on areas of light textured soil; and, third, the salt grass association found on areas of poorly drained, saline and low-lying soils.

The range grass association occurs mainly on the rolling phases of the Haverhill series and other well drained medium to heavy soils. Spear grass, June grass, and blue grama grass are the dominant species. These grasses make up much of the relatively sparse range vegetation of the south and south-west of the Province. The feeding value of such grasses is high.

A number of shrubs and herbaceous plants, such as sage brush and mountain sage, are often associated with the grasses. Cacti are found occasionally in very dry places as on the top or eroded sides of knolls. Clumps of buck-brush are often seen in ravines and protected places, while on some of the higher elevations small aspens and willows may be found in sheltered locations. Where sloughs or depressions occur, salt grass and blue joint may be found along with sedges and reeds. Willows are sometimes found on the margins of sloughs.

The grass and shrub association, found mainly on sandy textured

*Soil climatic index prepared by W. Millsap, based upon relation between temperature, precipitation and evaporation.

soils, *i.e.*, fine sandy loams to gravelly loams of good surface drainage, includes sand grass, spear grass and various others. The stands are generally of a patchy nature rather than uniformly covering the ground. Many shrubs occur, such as wild rose, wolf willow, and buckbrush. In a number of areas, these sandy soils are characterized by a fairly high water table and this enables small trees and shrubs to grow comparatively well. Dwarf aspens and willows frequently occur, and volunteer stands of sweet clover are occasionally found. On the gravelly soils the native vegetation may be quite sparse. Where areas of sandy soils have been eroded badly or blown into dunes, native vegetation eventually re-establishes itself. Russian thistle tends to hold the drifted material, and grasses and shrubs appear within a few years. While the drifting is active there is, of course, little or no vegetation present. The grazing value of these sandy areas cannot be thought of as high, but in favorable years the quantity of grass on them may be considerable and may afford large acreages of pasture and hay land.

The salt grass association, as the name suggests, is found on areas of poorly drained, saline, and low-lying soils. An extensive area of these soils is found around Lake Chaplin and along Chaplin Creek. On the less strongly saline soils, blue joint and salt grass occur. Where the salinity is marked, only the salt grass will be found. Wild Barley is often found along the edges of poorly drained or very saline areas. Where heavy textured saline soils occur, Greasewood may be the dominant or only vegetation.

In general, the native vegetation of the area is such as to provide good grazing facilities over a large portion of the uncultivated land, if adequate water supplies are available and proper grazing management is observed.

AGRICULTURE

A brief discussion of the agricultural development of the area in relation to the natural factors of relief, surface geology and climate is introduced at this point.

In general, the agriculture of the area is typical of the brown-dark brown soil zones. The arable lands are largely devoted to wheat production. Mixed farming is practised on the lighter soils where grain production alone is made hazardous by drought and soil drifting. The rougher areas of the Coteau, the coarse textured outwash material and the more saline portions of the recent alluvial deposits are used as grazing land.

Moderate to very severe damage from wind erosion has affected the agricultural value of the lacustrine soils, particularly those of a sandy or silty nature. Wind erosion on the clay soils has also been serious, although its effects on the soil are for the moment less harmful than on the lighter types.

Water erosion is affecting the agricultural value of some soil types, notably the moderately undulating clays, and the rolling glacial clay loams and loams.

Drought has affected all soils in recent years, but the lighter textured types and those of steeper topographies have suffered most.

Local factors of relief and surface geology influence agriculture more than do local variations in climate. In general the soils derived from the heavier textured deposits are of the greatest value agriculturally, and the productivity of the soil decreases as the texture lightens. On the other hand, with similar textures, productivity and the percentage of arable land decreases as the topography becomes rougher.

MUNICIPAL DEVELOPMENT

The more important urban centres are Mortlach, Chaplin, Caron, Coderre and Shamrock. There are a number of smaller railway shipping points in addition to these which serve as marketing centres.

The main line of the Canadian Pacific Railway runs through the northern portions of Caron, Wheatlands, and Chaplin municipalities. A branch line of the C.P.R. also traverses the municipalities of Hillsborough, Rodgers and Shamrock, in the southern section of the area. A branch line of the Canadian National Railway crosses the north-eastern part of Caron municipality. These three railway lines converge at the City of Moose Jaw which is the nearest large marketing and business centre.

Provincial Highway No. 1 runs through the area and roughly parallels the C.P.R. main line. Highway No. 19 enters the area north of Chaplin and connects at that point with No. 1. Many local roads are also available as connections between rural districts and marketing points. The quality and number of local roads vary with the degree of agricultural development. The poorer agricultural lands, such as alkali areas, sand dunes, and the rougher portions of the Coteau have fewer roads than the better agricultural districts.

The area is relatively well supplied with churches and schools. Rural telephone service is fairly commonly available. Some schools have been closed, generally because of lack of pupils, owing to thinning of the population, and there has been some disintegration of other social services, especially in the poorer districts.

SOILS

SOIL CLASSIFICATION

The soils of the area were classified according to the system in use at the time the survey was made. This system is described in Saskatchewan Soil Survey Report No. 10 (1936). Hence the information available in that report is used freely in the following discussion.

The classification of soils is based upon the study of the color, texture, structure, chemical nature and other characteristics of the soil profile. The profile consists of the natural succession of layers or horizons, extending from the surface of the soil into the underlying material which has been only slightly modified by the soil-forming processes. In Saskatchewan the depth of the profile is usually between three and six feet, but may range from two to over ten feet. Upon making a vertical cut or excavation in the soil, the natural horizons or layers of the profile are exposed. These are usually designated as the A, B, and C horizons, beginning from the surface.

The A horizon generally coincides with what is known as the surface soil. It usually contains most of the soil organic matter and important soil organisms. The downward percolation of water tends to remove from this horizon some of the fine clay particles and material such as lime ($CaC0_3$) and other more or less soluble substances.

The B horizon, situated immediately below the A, receives much of the material leached from above. As a result the B horizon is usually heavier in texture, and often contains larger quantities of lime and other substances than the A horizon.

The C horizon occurs in the lower depths of the profile, and is little affected by the soil forming factors such as climate and vegetation which are active in the A and B horizons. The C horizon is composed of the geological deposits or parent materials from which the true soil has been developed.

The various profile features are the result of the combined effects of the major soil forming factors: climate, vegetation, parent material, relief, drainage and maturity.

Variations in the effect of these factors give rise to variations in soil profile features. These differences are used to classify soils into groups. In the present system these groups are known as soil zones, soil series, soil types, and soil phases. These are discussed below.

SOIL ZONES

The soil zones include large belts of soils separated on profile features that reflect broad differences in climate and native vegetation. The zonal soils are named after the prevailing colors of the surface horizons. These colors are associated with variations in the organic matter content of the soils, and this in turn is directly influenced by the climatic-vegetational factors. The following succession of zonal soils is encountered in passing from the south-west to the north-east sections of the province: Brown, Dark Brown, Black, Transition Black-Gray, and Gray (Wooded) Soils. The darker colors indicate a higher content of soil organic matter and more favorable moisture conditions. The area covered by this survey represents soils adjacent to the boundary of the brown and dark brown soils. Hence the brown soils shown on the map are more favorably situated with respect to climatic factors than are the brown soils as a whole.

SOIL SERIES

The term soil series is used to designate a group of soils whose profiles are alike in general character and appearance and which have similar parent materials (or common geological origin). In each soil zone the various series are distinguished by differences both of profile character and parent materials. However, soils of similar geological origin may occur in several zones and in such cases the respective soils are placed in separate series. The variations in climate and vegetation existing between zones give rise to dissimilar profiles even when the parent materials are similar. It follows, therefore, that the profile characteristics by which series are differentiated are the result of the combined influences of climate, vegetation and parent materials.

The dominant soil profile, *i.e.*, that profile which occurs most frequently is taken as the basis of the series separation. Other soils of more local occurrence, whose profiles differ somewhat from the dominant type are frequently found in close association with the latter. These associated soils are usually developed under local conditions of topography, drainage or other soil-forming factors which are not typical of the series as a whole. In a more detailed survey the associated local soils could be shown on the map and classified separately. However, in the series descriptions the dominant soil profile is discussed at some length, and the associated profiles are described in sufficient detail to show how they differ from the typical soil.

SOIL TYPE

While the profiles forming a soil series are alike in geological origin and general profile characteristics, they frequently vary in texture. These textural variations are the result of differences in the clay, silt and sand contents of the profiles, chiefly in the surface or A horizons. (See Table 9 for definitions of textural classes).

Such textural variations within the series are known as soil types, and they are indicated on the map by a combination of letters that represent the series name and the textural class. The main reason for separating soil types lies in the importance of soil texture from the standpoint of agriculture. No single factor concerning the soil is more important than that of texture.

SOIL PHASES

Soil phases represent variations within the soil type. These variations do not greatly affect the profile characteristics, but they have an important influence upon the agricultural use of the soil. The soil phases mapped in this survey are indicated as topographic, stony, gravelly, poorly drained, and eroded (both wind and water eroded soils).

The topographic phases consist of variations in surface relief ranging from level to hilly. Table 12 indicates the various topographic classes and the limits in per cent slope and frequency by which they are defined.

The stony phases represent morainic areas that contain so many glacial boulders and stones that cultivation is usually impossible. At the best such phases represent lands on which costs of clearing are high and good tillage is difficult.

Gravelly phases consist of soil types with frequent gravel subsoils, representing land with low drought resistance.

Poorly drained phases usually represent the lowest arable land, and consist of soils with wet imperfectly drained subsoils that frequently possess a moderate to high content of "alkali" salts.

Wind and water erosion phases are grouped in appropriate classes and these classes are described in Tables 10 and 11.

SOIL SERIES AND TYPES

BROWN SOILS

Sceptre Series.—This series consists of very heavy textured soils derived from post-glacial lacustrine (lake) deposits.

The topography is typically gently to moderately undulating, with a few areas mapped as gently rolling, or mixed undulating to rolling. These soils are generally well drained. Where sloughs or poorly drained areas do occur the soluble salt content is not usually excessive.

Stones are rarely encountered, and offer no obstacle to cultivation. However, where this series borders glacial soils, stones are more frequent.

The surface layer is brown or grayish-brown in color. The structure is granular to small cloddy, the latter readily breaking down to granules under cultivation. Slight amounts of lime frequently occur at the surface. With extremely dry conditions, wide shrinkage cracks develop which extend well into the subsoil.

The subsoil is generally slightly heavier in texture than the surface soil, cloddy in structure and gray to brownish-gray in color. The subsoil is moderately high in lime.

Since the Sceptre soils are uniform in texture, and have smooth topography, the profile varies but little from place to place. In general characteristics and agricultural adaptations these soils are similar to the Regina Series.

Two types have been mapped, Sceptre Heavy Clay and Sceptre Clay. The former is the dominant type and is one of the heaviest upland soils in the surveyed area. For this reason it has a higher moisture-holding capacity and is slightly more productive than the clay. Otherwise these types are very similar. A few very small areas are mapped as Sceptre Heavy Clay with Alkali. This association is found in poorly drained flats or depressions. Some areas are also mapped as a mixture of Sceptre and Haverhill Series.

A profile description of the Sceptre Heavy Clay is given below. Profiles are in all cases of uncultivated soil, and are chosen so as to be representative of the series in depth of horizon, structure, color, etc.

Horizon	Depth	Description
A	0–1″	Fine granular, brownish-gray clay.
	1–3″	Granular to flaky gray heavy clay.
B	3–6″	Somewhat compact coarse granular to small cloddy, brownish heavy clay.
	6″ and below	Cloddy, brownish gray to dark gray, moderately calcareous clay grading into heavy somewhat cloddy dark gray calcareous parent material. Streaks and flecks of lime may occur in or below the third horizon.

Horizons are not strongly differentiated, but there is a suggestion of slight movement of material other than the more soluble constituents, such as lime, from the shallow surface layers to lower depths. Under cultivation the heavier, more compact, shallow subsoil is mixed with the shallow surface layers giving a heavy brown or grayish soil.

One of the greatest difficulties in farming the Sceptre soils is that of controlling soil drifting (wind erosion). The ease with which such soils break down to small granules through the effects of freezing and thawing, or wetting and drying, makes them particularly susceptible to drifting. The more common weeds are stinkweed, various mustards, wild sunflowers, poverty weed and Russian thistle.

Fox Valley Series.—The Fox Valley soils are of medium texture and are derived chiefly from silty water-deposited materials.

The topography is typically gently undulating, with a few areas mapped as gently to moderately rolling. This latter phase may be partly loessial in origin.

These soils are generally well drained, occasional poorly drained spots occurring in sloughs and in the vicinity of creeks.

Few stones occur except where this series is somewhat mixed with glacial soils.

The surface soil consists of a gray silty structureless layer, underlain by a soft, cloddy layer. Under cultivation the soil tends to form large lumps or clods, which, however, are easily broken down to a fine granular condition. Lime may be present at or near the surface.

The upper subsoil is long cloddy in structure, of medium heavy texture, and is underlain by a gray, less compact layer, which is high in lime. A sub-strata of very fine sand is frequently found in the deeper subsoils.

The moisture-holding capacity of these soils is fairly good on the heavier types, except where sandy strata occur near the surface. In all cases, however, the Fox Valley soils are inferior to the Sceptre soils in this respect.

The Fox Valley soils are generally quite fertile, and usually very little waste land occurs. However, the nitrogen and organic matter contents are relatively low. The silty nature of these soils makes them very susceptible to soil drifting under the prevailing climatic conditions.

Four types have been mapped in the Fox Valley Series, namely, Silty Clay, Silty Clay Loam, Silt Loam, and Loam.

The silt loam and loam are quite similar and are often found in association. The loam type tends to be more stony and is not quite so uniform. These types are typically gently undulating, and agriculturally differ very little from Haverhill loams of similar topography. A profile description of the Fox Valley silty clay loam is as follows:

Horizon	Depth	Description
A	0–2″	Drab gray fine granular to powdery silty clay loam.
	2–5″	Grayish slightly platy silty clay loam.
B	5–12″	Grayish brown long cloddy heavy silty clay loam, fairly compact.
	12–20″	Gray strongly calcareous silty clay loam, faintly long cloddy structure in upper portion and structureless below.
C		Dark gray structureless to slightly platy, calcareous, frequently with moderate quantities of soluble salts.

Haverhill Series.—This series consists of medium and light-textured soils derived from glacial till and morainic deposits. In area the Haverhill soils exceed that of any other series of the brown soils, and they are widely distributed throughout the zone.

The topography is variable, ranging from gently undulating to rolling and hilly. Much of the rougher land has a "knob and kettle" topography typical of morainic deposits.

The drainage is also quite variable, depending upon local conditions of topography and texture. Many of the smooth undulating phases are well drained, with but few depressions or sloughs. On the rougher phases, the surface drainage is frequently excessive on the steep upper slopes resulting in a large proportion of the precipitation being lost through run-off, while in the lower places many poorly drained saline, or "alkali" sloughs occur.

Stones are common to all Haverhill soils. The numbers vary from few to many, but in general they are numerous enough to require clearing. Rough morainic belts and eroded escarpments are frequently very stony. The stones vary in size from gravel to large boulders several feet in diameter. The boulders naturally offer the greatest obstacles to cultivation. Local patches of gravelly and sandy subsoils are common in the lighter types or in rolling phases. In general, the undulating phases of the Haverhill soils have comparatively few stones.

The surface soil is brown to light brown in color, and fine granular to small cloddy in structure.

The subsoil consists of a rusty brown upper layer of column-like structure, which breaks readily into flat-topped segments or clods. This layer is characteristically heavier in texture than the surface soil, and is frequently so compact that it approaches the "tough" impervious nature of the "blow-out" (Echo soils). This latter condition is generally found on undulating land in moderately low positions. The lower subsoil is gray in color, less compact, and has a high lime content. Gypsum and other salts are also common. Varying amounts of gravel and stones are frequently found throughout the profile.

The above features are typical of the smoother and more arable phases of the Haverhill soils. In rolling and hilly belts these soils are both shallower in depth and lighter in texture on the knolls and ridges, and in such areas the gray lime layer is frequently exposed at the surface of cultivated fields. The poorly drained soils of the lower depressions frequently have darker surfaces, while the subsoil is streaked with lime and soluble salts (alkali).

A profile description of the Haverhill loam, the most extensive type of the series, is given below.

Horizon	Depth	Description
A	0–1″	Grayish brown friable surface.
	1–5″	Grayish brown soft lumpy loam, easily powdered.
B	5–13″	Brown to coffee brown, long cloddy (column-like) clay loam, compact, changing to yellowish or grayish brown at the base.
	13–24″	Gray to brownish gray, faintly long cloddy, easily pulverized clay loam. Horizon of lime concentration.
C		Dark gray structureless calcareous clay loam, grading into dark gray to bluish gray boulder clay, with lime and gypsum concretions and small reddish brown flecks.

The following types have been mapped in the Haverhill Series: Clay Loam, Loam, Light Loam, and Fine Sandy Loam. The clay loam and loam types are the largest in extent, and are frequently mapped together. The loam belts contain numerous patches of clay loam. The silt loam is very inextensive, and for all practical purposes may be regarded as a stony phase of Fox Valley silt loam.

The lighter types of Haverhill Series are similar to the Hatton Series, but are frequently rougher, more stony and generally possess heavier subsoils.

The variable nature of the relief, drainage and texture of the parent materials of the Haverhill Series leads to a great diversity of soil conditions and agricultural adaptation. The undulating clay loam type, where not too stony is probably superior to the Fox Valley silty clay loam, due to its heavier subsoil and consequent better moisture-holding capacity. The Haverhill loams are somewhat inferior to the clay loam in this respect, and the light loams and sandy loams are definitely low in moisture-holding capacity.

Considerable waste land occurs in the Haverhill Series, and the proportion increases as the topography becomes rougher. On hilly phases stoniness, steep slopes, and numerous sloughs prevent cultivation of all save small, scattered areas.

Hatton Series.—This series consists of light-textured soils, mostly derived from alluvial deposits.

The topography is mostly undulating, with some areas mapped as gently rolling.

Surface drainage of the Hatton Series is generally good, but these soils frequently border old creek and lake beds, where heavier saline or alkali soils occur. Hence, where poorly drained depressions occur within this series, they are practically always high in soluble salts.

Stones are rarely encountered, but gravelly subsoils are very common.

The surface soils are light grayish brown, loose and structureless on top, and slightly compact below.

The upper subsoils are rusty brown in color, of large blocky structure, and the lower subsoils consist of loose, grayish sand. The lime layer is usually found at a depth of about 18 inches.

In many places a shallow water table is present in the Hatton soils. This provides a good farm-water supply, and it is possible that in some cases deep-rooting crops might be grown advantageously where such water tables are comparatively near the surface.

Following is a profile description of Hatton Fine Sandy Loam:

Horizon	Depth	Description
A	0–6″	Light grayish brown fine sandy loam; single grain (structureless) on top to soft cloddy below.
B	6–14″	Rusty brown heavy fine sandy loam, large angular clods or blocks, three to six sided, usually quite hard at the base.
	14–18″	Yellowish gray fine sand, incoherent and occasionally limy. This horizon is not always well marked, since it grades into:
	18″ & below	Gray to brownish gray incoherent fine sand, the layer of greatest lime carbonate accumulation.
C		Darker gray incoherent sand, calcareous but having less lime than above.

The following types have been mapped in the Hatton Series: Light Loam, Very Fine Sandy Loam, Fine Sandy Loam, Sandy Loam and Sands. The fine sandy loam and sandy loam are frequently associated with gravelly subsoils, and in such cases are mapped as gravelly phases of the Hatton Series.

Due to the prevailing light textures, these soils have low moisture-holding capacities. The light loam and very fine sandy loam soils are superior to the lighter types in this respect. Their sandy nature and low moisture-holding capacity favor wind erosion, and so the Hatton soils are subject to severe soil drifting.

The organic matter and nitrogen content is lower than that of the heavier soils of this zone.

The light loam and fine sandy loam types of the Hatton and Haverhill series are also very similar, and are frequently found together. The latter tend to have heavier subsoils, more stones, and are frequently rougher in topography than the Hatton types. Hatton sandy loams are often found adjacent to or mixed with fine sand or sand dune areas.

Echo Series.—This series consists chiefly of medium-textured soils derived from a glacial till which appears to be modified by the presence of certain pre-glacial material. The presence of shallow depressions, varying in size and number (the so-called "blow-outs" or "burn-outs"), is characteristic of this series. It is probable that the distinctive properties of this series are due to the influence of the pre-glacial material.

The topography of the Echo soils is usually undulating. A few rolling areas of Echo soils are mapped as mixtures with Haverhill types.

The surface drainage of the Echo soils is variable, but generally quite adequate. Due to the impervious nature of the subsoil, water penetration is greatly restricted. The lower subsoils have high concentrations of soluble salts. The "blow-outs" are depressions in which the impervious subsoil has been exposed. Consequently water which collects in these depressions following heavy rains is largely lost by evaporation.

The number of stones vary from few to many. On the whole, however, Echo soils are less stony than Haverhill soils.

The surface soil consists of a light brown (fawn) colored layer, powdery to soft cloddy or platy in structure.

The subsoil is dark grayish brown to coffee brown, of a heavy "tough" compact nature, breaking down into angular fragments. Below this is the grayish, less compact, lime layer, which, in addition to lime, also contains gypsum, sodium sulphate and other soluble salts ("alkali").

The above description covers the ordinary soil outside of the "blow-out" depressions. Where these occur the heavy subsoil forms the surface, although this is sometimes covered by a gray platy mulch of about one inch in thickness. A profile description of Echo clay loam is given below:

Horizon	Depth	Description
A	0–1″	Grayish brown, powdery mulch.
	1–4″	Thinly laminated, soft lumpy, brown horizon, friable and easily pulverized.
	4–8″	Horizon of faintly long cloddy or prismatic macro-structure and laminated micro-structure, grayish or light grayish brown in color, usually the lightest textured horizon of the profile.
B	8–18″	Horizon of round-topped columnar structure with grayish top coatings, which may be easily broken into angular or nut-like fragments, dark brown to dark grayish brown in color, high in colloids, very sticky when wet and very hard, with marked shrinkage cracks when dry.
	18–26″	Horizon with a high concentration of lime and usually soluble salts, particularly calcium, magnesium and sodium sulphates, structureless to faintly cloddy.
C		Dark gray horizon with splotches of lime and salts, usually thick platy in structure.

The depths of horizons vary greatly with micro relief and other factors, and only their approximate thickness is given. A deep exposure of the natural soil reveals a very uneven profile with the hard compact upper B horizon in the form of an uneven wave.

Three types have been mapped in the Echo Series: Clay, Clay Loam and Loam. These textures refer to the normal soil, the surface texture in the "blow-outs" being a heavy clay. The clay loam is the dominant type and represents the average texture found in the cultivated surface layer.

The Echo clay loam and loam are frequently mapped together, and the former is also found in mixtures with Haverhill loam.

The Echo soils possess certain characteristics that distinguish them from other Saskatchewan soils. From the standpoint of the soil scientist they are morphologically similar to the complex group of solonetz soils. The soil conditions are further complicated by the presence of the "blow-out" depressions. These are caused by the removal of the surface, probably by wind action, in some earlier period of time. As previously stated, these depressions vary greatly in size and number.

From the agricultural standpoint these soils are characterized by an uneven surface and varying textures, due to the succession of normal soils and eroded depressions. The subsoils are heavy in texture, but their compact structure does not allow the best possible retention and availability of moisture for the use of plants.

Where the heavy subsoil is exposed, or is near the surface, the productivity of the soil is low. This is mainly due to unfavorable physical nature, but low fertility due to relatively low organic matter, nitrogen and phosphorous content may also be a factor.

DARK BROWN SOILS

Regina Series.—These soils are very heavy in texture and like the Sceptre soils are derived from post-glacial lake deposits.

The topography is undulating, with the exception of a few small areas which are gently rolling. Poorly drained flats or sloughs are more common than in the Sceptre Series, but do not seriously interfere with cultivation except in a few local areas. Surface drainage, except in occasional years of higher than normal precipitation, is generally sufficient. "Alkali" salts are not usually present in excessive quantities. Stones are rarely encountered.

The surface layer is dark brown to dark grayish brown in color. The structure is small cloddy to granular, the clods readily weathering to small granules when under cultivation. Large shrinkage cracks occur when the soil is dry.

The subsoil is also dark brown, but somewhat more cloddy than the surface. While very similar to the Sceptre Series the Regina soils are higher in organic matter, are slightly more friable and have a deeper profile. A layer having a somewhat higher concentration of lime occurs in the subsoil, but this is not prominent, since the whole profile tends to be slightly calcareous.

The Regina soils are quite uniform, due to the nature of the parent material and the regular topography. The most important variation is a poorly drained phase, occurring in flats or depressions, usually containing slight to moderate amounts of soluble salts.

Three types are mapped: Regina Heavy Clay, Regina Clay, and Regina Clay Loam. The heavy clay is the dominant type and is the most productive, although all these soils are highly drought resistant.

The profile layers of the Regina soil are but slightly differentiated. A representative profile of Regina heavy clay may be described as follows:

Horizon	Depth	Description
A	0–5″	Dark brown, friable granular to cloddy.
B	5–10″	Dark brown, slightly more compact, small cloddy.
	10″ & below	Dark brown or brown cloddy with moderate lime content, grading into heavy, dark colored lacustrine parent material.

All horizons are heavy clay in texture, and usually lime carbonate is present throughout. The clay loam shows more definite horizon development than the clay or heavy clay.

Weyburn Series.—The Weyburn Series consists of medium to light-textured soils, derived from glacial till and morainic deposits.

Due to the type of deposit from which the Weyburn Series is derived, there are many areas of rolling or hilly topography. The number of stones usually increases as the topography becomes rougher, and is a serious additional handicap to the cultivation of the rolling phases. However, many fairly large areas of Weyburn soils are quite smooth in topography, and stones are usually so infrequently encountered on these undulating phases that they offer little handicap to cultivation. Sloughs or poorly drained areas occur quite frequently. In the rolling phases the typical knob and kettle topography results in numerous sloughs and excessively drained slopes. These factors prove serious obstacles to cultivation.

The surface soil is typically dark brown in color and of relatively hard cloddy structure, except in the lightest types.

The upper subsoil is brown or faintly reddish brown, heavier in texture than the surface, and of a compact, long-clod column-like structure. The subsoil is grayish, friable and calcareous. Gravel and stones are present in the profile, varying in amount in different places. On this account these soils are often noticeably gritty.

Moderate amounts of soluble salts (alkali) are sometimes present in the subsoils of the Weyburn series. In the depressions or sloughs, however, the quantity of these soluble salts is frequently excessive.

The Weyburn soils tend to lack uniformity. The textures and other characteristics vary over short distances. In areas of rolling or hilly topography, the variability is greater than in the smoother phases.

The profile is shallow wherever the surface conditions are such that considerable run-off takes place, as on slightly rising ground or on knolls. On hill tops and on slopes the lime layer is within a few inches of the surface. Under cultivation this becomes a factor in the fertility of the soil, as the lime layer is less productive than the surface soil. The upper subsoil layer varies in depth and compactness. In extreme phases it approaches the condition of the tough compact layer of the "blow-out" soils. (Cf. Echo Series). In such areas a marked lack of uniformity in crop growth may be observed. This condition is found near Estevan and Weyburn, and in other areas.

The effect of topographical position on the nature of the soil profile has already been mentioned, and the variation due to conditions of poor drainage with "alkali" (saline soils) or excessive number of stones are obvious factors of significance to the agriculturist.

The types mapped in this series are: Clay Loam and Loam.

A profile description of the loam which is the most extensive type of the Weyburn Series is given below.

Horizon	Depth	Description
A	0–½″	Grayish dark brown powdery mulch.
	½–4″	Dark brown to very dark brown soft lumpy or faintly platy loam.
B	4–8″	Grayish brown to dark brown long cloddy (columnar) somewhat heavy loam.
	8–11″	Dark brown or rusty brown heavy loam or clay loam of hard long cloddy structure.
	11″ & below	Grades through yellow brown softer long cloddy layer to lime layer, which is brownish gray and friable; lime begins at about 12″. Salts may occur at bottom of lime layer.
C		Parent material, dark gray calcareous till, flecked with reddish brown stains of iron oxide.

MISCELLANEOUS SOILS

Alluvium.—These consist of mixed textured soils occurring chiefly on recent flood plain deposits of rivers and creeks. Profile development varies, but on the whole the soils are immature and do not fit well into the profiles classified as soil series. The topography of the areas mapped as Alluvium is typically flat to very gently undulating. Drainage conditions range from fair to poor, and in many cases the soils are liable to flooding during seasons of higher than average precipitation. Stones are rarely encountered and are seldom an important factor. These soils vary from fair arable to poor pasture types.

Saline ("alkali") Soils.—These are mixed textured soils chiefly on recent alluvial-lacustrine deposits, and are characterized by undesirable amounts of soluble salts. The profiles show little horizon development, but the presence of the salts and the character of the native vegetation are the main features of the saline soils. Salt grass, greasewood, gumweed, wild barley and patches of bare ground encrusted with salts are characteristic of these soils. Although the texture varies, heavy types such as clay, heavy clay and very heavy clay ("gumbo") predominate. Most of the saline soils are non-arable although the less saline types may be used for the production of alkali tolerant crops.

Eroded Land Types.—These lands are associated with rough, broken areas bordering valleys and coulees, and with steep broken slopes on the Coteau. Hence they are in part topographic features. The profiles are chiefly thin eroded types, of varying textures and parent materials. These soils cannot be classified with the established soil series. They are non arable types and are used chiefly as rough grazing land.

COMPOSITION OF SOILS

A number of representative soil samples were secured for analysis. The samples include virgin sod and cultivated surface soils, taken to an average depth of six inches. The following determinations were made: hygroscopic moisture, loss on ignition, nitrogen, organic carbon, and in some cases phosphorus. All results are expressed as percentages on a moisture free basis. Analyses of profiles representing some of the main soil types are given in earlier soil survey reports.

A considerable number of samples of the different soil types were analyzed and the averages are shown in Table 3. The figures indicate lower values of all constituents for the light textured soils (Hatton Series) as compared to the heavier types. The lower values for nitrogen, organic carbon and loss on ignition indicate lower potential fertility. Hygroscopic moisture varies with the clay content of the soil, and hence is related to the texture. The low moisture content of the Hatton soils may, therefore, be correlated with their relatively low clay content and low drought resistance.

In the medium and heavy textured soils, the figures for nitrogen and organic carbon show relatively little variation. The nitrogen values are somewhat higher than the average for the brown soil zone, which is in accord with the position of the area on the borders of the brown and dark brown soils.

TABLE 2.—Main Characteristics of Soil Series, and Related Types and Phases

Series	Types	Parent Material Deposits	Profile Features	Topography	Drainage	Stoniness	Erosion: Wind	Erosion: Water	Other Features
Regina	HvC, C. CL.	Heavy glacial lacustrine	Dk. brown, gran. Surface, cloddy subsoil, some slight solonetz structure.	Chiefly gently undulating, some flat and some moderately undulating.	Good, restricted on flat topography.	Stones rare.	Slight to severe.	Slight sheet to moderately sever gully.	High % of arable land. High fertility and drought resistance.
Sceptre	HvC, C	Heavy glacial lacustrine	Br. granular surface, cloddy subsoil, some solonetz.	As above, with some gently rolling.	Good, restricted on flat topography.	Stones rare to few.	Slight to severe.	Slight sheet to moderately sever gully.	High % of arable land. High fertility and drought resistance.
Fox Valley	SiC, Si CL, SiL, L.	Silty glacial lacustrine	Grayish brown soft cloddy surface. Columnar subsoil some solonetz.	Chiefly gently undulating, some flat, mod. undulating, and gently rolling.	Good, somewhat excessive on rolling land.	Stones few.	Slight to very severe.	Slight to moderate sheet and gully on higher land.	Good fertility, mod. drought resistance. Liable to severe wind erosion in dry years.
Weyburn	CL, L.	Morainic and ground moraine	Dark brown cloddy surface. Columnar to solonetz subsoil.	Gently undulating and very gently to strongly rolling.	Good, excessive on mod. to strongly rolling land.	Few to many stones	Slight to mod.	Slight on moderately rolling land.	Satisfactory soils except where stony or rough.
Haverhill	CL, L, LL, FSL	Morainic and ground moraine	Brown cloddy surface columnar solonetz-like and solonetz sub-soils.	Gently undulating and very gently to strongly rolling.	Good, excessive on mod. to strongly rolling land.	Few to excessive number of stones.	Slight to Mod.	Slight to moderate on rolling land.	Clay loam and loam satisfactory except where stony or rough.

Hatton.............	Very fine to coarse sandy loams. GSL, S.	Sandy lacustrine and alluvial. Some outwash, lake-shore & dune.	Br. loose surface, large columnar subsoil over loose sand.	Chiefly undulating to very gently rolling. Some gently to strongly rolling.	Excessive on lighter types & rougher topography. Fair to good elsewhere.	Stones rare to few.	Severe to very severe on finer textures.	Slight.	Liable to severe erosion & loss of fertility after continuous cultivation.
Echo.................	C, CL, L.	Thin glacial till or glacial alluvial, modified by pre-glacial shales.	Gray-brown platy to cloddy surface. Round-topped heavy impervious subsoil.	Chiefly flat to undulating. Some gently rolling.	Chiefly restricted.	Stones few.	Slight.	Slight to moderate.	Moderate to low fertility. Difficult to cultivate.
Alluvium...........	Mixed	Recent alluvial.	Not uniform, some solonetz, but generally poorly developed profiles.	Chiefly flat.	Fair to poor.	Stones rare.	Slight.	Rare. Some deposition.	Well-drained phases, fair arable soils.
Alkali.....	Mixed	Recent saline alluvial	Chiefly structureless (solonchak).	Flat to depressional.	Poor.	Stones rare.	Rare, but occurs on dry lake beds.		Chiefly fair to poor pasture, some worthless.
Eroded.............	Mixed	Eroded glacial and pre-glacial.	Not uniform. shallow (truncated) profiles.	Rough broken slopes.	Excessive.	Few to many stones.	Rare.	Very severe where bare of vegetation.	Chiefly poor pasture & non-arable.

In Table 4 some interesting comparisons are made between associated soil types. The more favorable climatic conditions of the eastern edge or escarpment of the Coteau is indicated by the data for Weyburn-Haverhill soils. The losses of organic matter and nitrogen resulting from cultivation and cropping are shown by comparing adjacent sod and cultivated samples. The effect of local relief or topography is illustrated by the figures for samples taken on the knoll or ridge and in the adjacent lowland or depression. The knoll is seen to contain only about one-half as much nitrogen and less than one-half as much organic matter as the

TABLE 3.—Average Analyses of Surface Samples of Cultivated Soils.

Soil Type	Hygroscopic Moisture	Loss on Ignition	Nitrogen	Organic Carbon
Sceptre heavy clay	4.81	13.17	.22	1.78
Sceptre clay	4.26	10.86	.22	1.56
Fox Valley silty clay loam	2.73	9.33	.21	1.84
Fox Valley silt loam	2.47	7.49	.23	2.01
Haverhill clay loam	2.68	7.51	.22	1.84
Haverhill loam	2.05	7.00	.20	1.86
Haverhill light loam	1.46	6.80	.20	1.90
Hatton fine sandy loam	1.08	4.46	.16	1.65
Hatton sandy loam	0.86	3.44	.13	1.47

TABLE 4.—Effect of Cultivation, Topography and Erosion on Composition of Soils.

Soil Type		Hygroscopic Moisture	Loss on Ignition	Nitrogen	Organic Carbon
Haverhill and Weyburn clay loams	Escarpment of Coteau	2.30	11.56	0.32	3.33
Haverhill loam	sod	2.61	7.07	0.28	2.51
Haverhill loam	cultivated	2.24	5.59	0.19	1.61
Hatton fine sandy loam	sod	1.52	6.62	0.27	2.74
Hatton fine sandy loam	cultivated	0.73	3.84	0.16	1.18
Hatton coarse sandy loam	sod	1.17	3.82	0.15	1.58
Hatton coarse sandy loam	cultivated	1.06	2.88	0.14	1.25
Haverhill clay loam	knoll (16% slope)	2.37	9.31	0.21	1.69
Haverhill clay loam	depression	2.96	13.32	0.39	4.20
Haverhill loam	knoll (10% slope)	2.18	11.30	0.21	1.75
Haverhill loam	middle of slope	2.23	10.60	0.27	2.38
Haverhill loam	depression	3.77	15.50	0.45	4.62
Hatton fine sandy loam	sod	1.52	6.62	0.27	2.74
Hatton fine sandy loam	cultivated slight wind erosion	1.20	5.55	0.17	1.51
Hatton fine sandy loam	cultivated mod. wind erosion	0.87	3.56	0.13	---
Hatton fine sandy loam	cultivated severe wind erosion	0.67	2.60	0.06	1.11

depression. The figures reflect the loss of soil and water through erosion, and the more droughty condition and lower fertility of the knoll position.

Finally, Table 4 also indicates the loss of soil constituents effected by wind erosion or soil drifting. The quantity of nitrogen, organic matter and hygroscopic water in the soil decreases as wind erosion becomes more severe.

Values for phosphorus were not determined on all samples, but those available indicate a range from .044% to .072%. The lower values occur in the coarser textured types and in wind eroded phases of the Hatton soils.

SOILS IN RELATION TO AGRICULTURE

Agricultural Value of Soils.—There are many factors which may affect the value of soils as measured by their productive capabilities. In this report it is not proposed to deal with the economic aspects of the question except in an incidental way. The economic classification of land requires the methods and training of the qualified Economist. The fundamental basis of economic land classification is the soil, but superimposed on this physical basis are those important economic factors of price, cost of production, and so forth.

The present area has been covered by an Economic Survey * carried out under the direction of the Department of Farm Management in co-operation with the Dominion Department of Agriculture, Economics Branch. This is a valuable publication covering land use and the economic classification of land in this area.

The factors which affect the inherent ability of soils to produce crops are partially external and partially internal. The external factors include climate, topography, type of management, and the effectiveness with which the surface of the soil is protected from erosion by wind or water.

The internal factors which are more strictly dependent on the nature of the soil itself are structure, water-holding capacity, supply of organic matter, availability of plant nutrients, lack of injurious conditions such as excessive acidity, or alkalinity, and freedom from disease organisms.

The dominating factor affecting productivity in the area under discussion is that of moisture. As has already been pointed out under the discussion of climate, rainfall is limited, and evaporation loss is relatively high. As a result the heaviest soils are the best agricultural soils, providing they have good tilth as well as heavy texture, because such soils have the greatest capacity to retain moisture for the use of plants.

Similarly, nearly level land has an advantage over rolling land because less of the rainfall is lost by run-off.

The soils of this area are generally quite fertile, excepting such losses in fertility as have been caused by erosion. The effect of erosion on organic matter and nitrogen content is illustrated in Table 4 in connection with the losses suffered by a light soil such as Hatton fine sandy loam.

Such losses are undoubtedly one of the most serious aspects of the problem of soil erosion. The only factor of greater seriousness is that of the loss of clay and silt resulting from the sifting action of the wind when it moves the soil.

*An Economic Classification of Land in 56 Municipal Divisions, South Central Saskatchewan. Extension Department, University of Saskatchewan, Saskatoon.

The soils of this area are practically never acidic, but "alkali" (saline) soils are quite common. Most of this salinity is caused by "white alkali" salts such as Glauber's, Epsom, common salt, and gypsum. Occasionally there are patches of "black alkali" which is caused by the presence of washing soda. The latter type of alkali is much more detrimental than is white alkali.

Soil Types and Present Agricultural Use.—For convenience the soils of the area will be discussed in groups as follows: A, superior; B, very good; C, good; D, fair; E, poor; F, very poor.

A.—SUPERIOR SOILS

In this group are included Regina heavy clay and Sceptre heavy clay of gently undulating topography. The Regina soil is prominent in Caron Municipality, while the Sceptre occurs as smaller scattered areas throughout the remaining municipalities.

These two types are the best agricultural soils in the area and in fact rate among the best in the province. They are similar in origin and profile features, and are separated mainly on surface color and content of organic matter. The Regina heavy clay belongs to the dark brown zonal soils and has a higher organic matter-nitrogen content than the Sceptre heavy clay. The latter is placed with the brown soils. Both types are highly productive and drought resistant, are almost free of stones and are highly arable. They are, therefore, particularly well adapted to the growing of wheat. In recent years the use of the tractor and modern power implements has become more and more common on these soil types. On the other hand livestock are playing a less important part on the larger farms. This is not only due to the development of a mechanized type of agriculture, but is also partly due to the difficulty of securing an adequate water supply. The latter problem is frequently encountered on soils which are formed on glacial lake deposits.

B.—VERY GOOD SOILS

This group includes Regina clay, Fox Valley silty clay, and mixed areas of Sceptre clay and Haverhill clay loam.

The Regina clay occurs on the sloping (moderately undulating) land around Thunder Creek, and also on a gently undulating area in the northern portion of Caron municipality. The Fox Valley silty clay is quite inextensive and is found chiefly in Shamrock municipality among the silty soils of the Wiwa Creek-Wood River valleys. The mixed Sceptre clay—Haverhill clay loam soils are also relatively inextensive and occur chiefly on the Coteau, in Rodgers and Chaplin municipalities. The topography varies from undulating to gently rolling.

In general the above soil types are well adapted to wheat production and are used chiefly for this purpose. They are inferior to the Group A soils on account of their relatively lighter textures and hence lower drought resistance. The latter soils also tend to be less uniform than the heavy clays, often being associated with slightly rougher topography and shallower profiles. For these reasons wind and water erosion may eventually be more harmful than on the soils of the first group.

However, under good management, both group A and group B soils may be expected to remain the most productive agricultural soils of the area.

C.—GOOD SOILS

These include Fox Valley silty clay loam, the better drained alluvium silty clay, Weyburn clay loam, Haverhill clay loam and a number of mixed series. The latter comprise mixed Weyburn and Haverhill clay loams, and areas of Echo clay loam mixed with Regina clay loam and Sceptre clay respectively.

The Fox Valley silty clay loam is found chiefly in the Wood River drainage basin, in the western and southern portions of Shamrock and Chaplin municipalities. The topography ranges from nearly level to very gently rolling.

The alluvium silty clay occurs mainly on the narrow flood plain of the Wood River.

The Weyburn clay loam occupies a small strip along the northern border of Caron municipality. The land is moderately stony and for this reason the soil has been placed in Group C.

The Haverhill clay loam is found chiefly in Rodgers and Wheatlands municipalities, adjacent to the eroded area leading down from the Coteau. Smaller areas also occur in the other municipalities. The topography ranges from gently undulating to gently rolling.

The mixed Weyburn and Haverhill clay loams occur in the four eastern municipalities over the eastern section of the Coteau and on the lowland adjoining the Regina Plain. Topographic phases ranging from gently undulating to gently rolling are included in this group.

The mixed areas of Echo clay loam and other soil types occur chiefly along the eroded area in Rodgers and Wheatlands municipalities.

The larger areas of the Group C soils are used for wheat production. In general they do not stand drought as well as the Group A and B soils; and in the case of the mixed areas that include Echo soils, the poorer physical condition and lower fertility of this solonetz type are adverse factors.

D.—FAIR SOILS

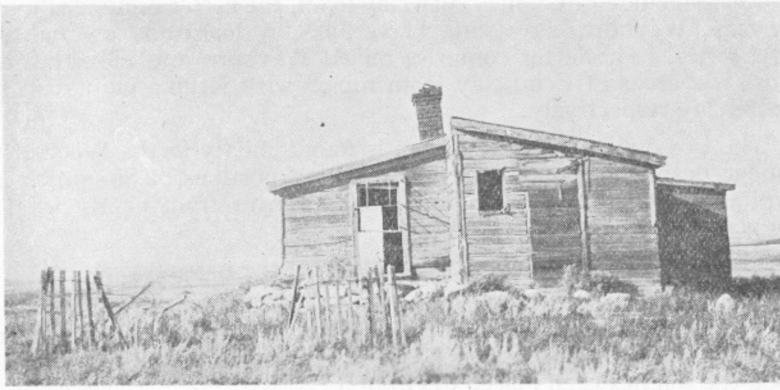
The Group D soils include Weyburn, Haverhill and Fox Valley loams of gently undulating to gently rolling topography; Echo and Haverhill clay loam and loam, undulating to gently rolling phases; and small areas of rolling Fox Valley silty clay loam, and Echo and Alluvium soils.

The Weyburn loam is inextensive, occurring above the Regina Plain in Caron municipality. The Haverhill loam is widely scattered throughout the area, particularly over the western half of the Coteau and adjacent lowlands. The Fox Valley silty loam and loam are found chiefly in Chaplin and Shamrock municipalities. The mixed Echo and Haverhill soils occur in Wheatlands and Rodgers, associated with the eroded belt already mentioned.

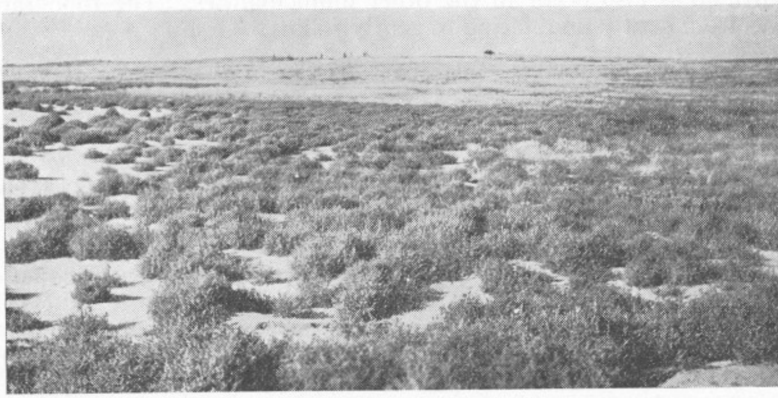
Echo clay and Alluvium occur along the Wood River and some Echo clay is also found on Wiwa Creek.

For convenience in estimating acreages, Group C and D soils have been combined. Both are definitely inferior to the soils of Groups A and B. This is due to lower moisture holding capacity and to increasing percentages of waste land, and in the case of the mixed areas that include

PLATE II



A prairie tragedy. Abandonment follows unwise use of land.



An abandoned severely drifted field on Hatton fine sandy loam. Nature has commenced the process of revegetation. This land produced quite well in the early years under cultivation.

Russian thistle forming the first line of defence against the sand. Eventually grasses and shrubs will gain possession.

Echo soils, the poorer physical condition and lower fertility of the latter type are additional adverse factors. The Group C and D soils are used principally for wheat production. Group D soils require more careful management if they are to be successfully retained under cultivation than do the soils of the more productive classes.

E.—POOR SOILS

This group includes Haverhill loam and clay loam of moderately rolling topography, and light loam, gravelly light loam, and fine sandy loam of smoother topography. Other soils in this group are: Hatton light loams to fine sandy loams, mixed Haverhill and Hatton soils of gently undulating to gently rolling topography, and mixed Fox Valley and Hatton types which have suffered considerable erosion by wind.

The rougher soils occur on and adjacent to the Coteau. The Hatton soils are encountered in Caron, Wheatlands, Chaplin and Shamrock municipalities, adjacent to the Regina Plain or to the Old Wives Lake drainage area. The mixed Fox Valley and Hatton soils occur chiefly in the south-west portion of Chaplin municipality.

The soils of this group offer the most difficult problems of any in the area. Soil types of slightly better quality with reasonable care may be kept under cultivation, even though they may produce little in times of severe drought. The poorest soils (Group F) are largely types that have never been broken up, or that have been definitely taken out of cultivation. On the other hand many of the Group E soils produced reasonable crops when first broken up, but have since deteriorated in productivity to the point where the possibility of successfully retaining them under cultivation is becoming doubtful.

Taking them together, the Group E soils have low drought resistance and are very susceptible to erosion. The latter problem has become more serious and widespread in recent years, and the effect is tending to reduce many of these soils into the non-arable class. The more desirable types are being used for wheat production, although rye is grown on many of the Hatton soils. Some sweet clover is also grown to some extent, and some land has been seeded to grass.

The poorer types in this group are often abandoned, but fortunately are tending to revegetate, sometimes with good stands of sweet clover and brome grass. Hence there is a tendency toward mixed farming rather than straight grain growing.

F.—VERY POOR SOILS

This group includes the very roughest lands and those most severely affected by soil drifting. The former types include strongly rolling, eroded and stony phases of the Haverhill and Hatton series. The severely drifted soils include the lighter types of Fox Valley and Hatton series. The undifferentiated saline soils, mapped as "alkali" land are also included in this group.

The Haverhill, Fox Valley and Hatton soils occur in the areas already referred to in connection with these soils. The most extensive areas of saline soils are found along Thunder Creek, Old Wives Lake basin, Wiwa Creek and Wood River. Numerous smaller areas of "alkali" are scattered throughout the region, particularly in the morainic soils, where they generally occur in the depressions. While the saline soils are not separated texturally, it may be noted that they are mostly heavy textured.

An exception occurs around the margin of Lake Chaplin, where more sandy types are common.

In general, the soils of Group F are non-arable and most of them have never been cultivated. Where cultivation has been attempted, the results have generally proved that these soils are correctly designated as non-arable types. They are largely used as grazing or hay land, and some of the rougher phases of the Haverhill soils support a good growth of native grasses. The sand dunes and eroded cultivated areas generally possess a poor grass cover and have a low stock carrying capacity. The better phases of the saline soils provide a considerable quantity of feed, although the grasses are not all of good quality.

The foregoing discussions of soil groupings and present land use have been conveniently summarized in the following tables and figures.

Table 5 gives the approximate acreages of the main soil groups, listed by municipalities. The location and extent of the groups is shown in Figure 4.

Table 6 gives the approximate acreage of cultivated, abandoned and unbroken (grazing) land in the area. These figures are derived chiefly from observations made in the field during the course of the survey. The distribution of the above use groupings is shown in Figure 5.

Some comparisons between the data of Tables 5 and 6 are given in Table 7, and in the discussion which follows.

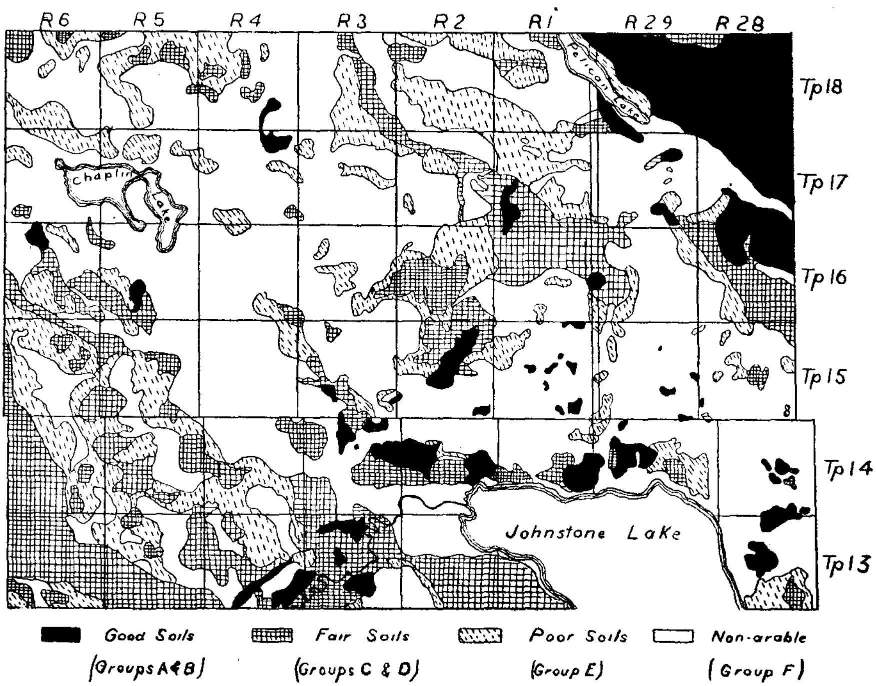


Fig. 4—Sketch Map Showing Generalized Grouping of Soils

TABLE 5.—Approximate Acreages of Soil Groups.

Municipality	Good Soils (Groups A & B)	Fair Soils (Groups C & D)	Poor Soils (Group E)	Very Poor Soils (Group F)
Caron	60,800	15,360	12,160	55,680
Wheatlands	1,500	36,480	32,640	134,820
Chaplin	7,680	12,160	36,480	151,040
Hillsborough	10,240	5,280	12,000	72,560
Rodgers	17,920	46,720	9,600	101,760
Shamrock	2,560	74,880	49,640	66,200
Total	100,700	190,880	152,520	582,140
Percentage	9.80	18.60	14.86	56.74

TABLE 6.—Approximate Acreages of Cultivated, Abandoned and Unbroken Land.

Municipality	Cultivated	Abandoned	Non-cultivated (grazing)	Total
Caron	96,320	9,600	38,080	144,000
Wheatlands	73,280	20,480	111,680	205,440
Chaplin	63,360	16,000	128,000	207,360*
Hillsborough	26,080	1,920	72,080	100,080*
Rodgers	76,480	5,120	94,400	176,000*
Shamrock	113,680	12,160	67,440	193,280
Total	449,200	65,280	511,680	1,026,160*
Percentage	43.76	6.36	49.88	100.0

*Excluding Johnstone and Chaplin Lakes.

TABLE 7.—Comparison Between Soil Groups and Present Land Use.

Percentage in Various Soil Groups—		Percentage in Land Use Classes—	
Superior to Fair Soils (Groups A-D)	28.40	Cultivated Land	43.76
Poor Soils (Group E)	14.86	Abandoned Land	6.36
Sum of possible arable soils	43.26	Sum of cultivated and abandoned land	50.12
Very Poor Soils (non arable)	56.74	Unbroken Land	49.88

Table 7 indicates that only 28.4% of the area consists of land well suited to grain production, whereas nearly 44% of the area is actually under cultivation. This suggests that much of the poorer land (Soil Groups E and F) is being farmed. Actually the total amount of land in Groups A to E is just under the total cultivated acreage. Stating the case in another way, the very poor soils, regarded as non-arable types, amount to 56.74%, while the total acreage of unbroken land in the area amounts to just under 50%. Evidently more land has been broken in the area than is suitable for arable agriculture. Some natural adjustment to this condition has already occurred through abandonment. A study of the data of Table 7 suggests that this adjustment is not yet complete, and that further retirement of poor soils from cultivation is likely to occur.

The relation between the soil groups and the present use of land is shown by a comparison of Figures 4 and 5. The areas of the better soils (Groups A to D) coincide reasonably well with the larger areas of cultivated land. Similarly the areas of poor soils (Group E) represent a

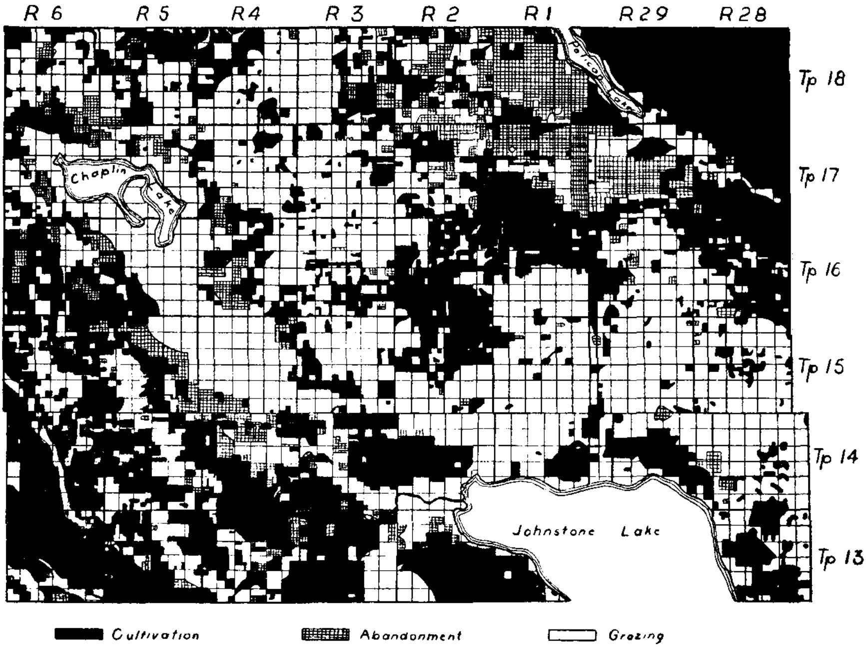


Fig. 5—Present Use of Land

great deal of the abandoned land. Finally, the non-arable soils (Group F) occur largely in the same locations as the unbroken lands.

SOIL PROBLEMS

The main soil problems of the area may be discussed under the topics of drought, wind and water erosion, and soil fertility.

Drought.—This is not strictly a soil problem, but a manifestation of climate. However, the effects of drought vary in degree with different soils, depending on their texture and structure, and from this point of view, drought may be treated as a soil problem. The occurrence of drought is the most serious drawback to the agriculture of the areas as a whole. When severe drought is experienced for a number of years in succession, the problem becomes very acute indeed.

The effects of drought are seen in poor yields or complete crop failure, but increasing severity and extent of soil drifting may accompany periods of drought and a progressive deterioration of the soil results from such erosion. The climatic conditions that produce periodic droughts cannot be changed. The only method of mitigating its effects lies in the adoption of the best possible cultural practices and cropping systems. In most cases in this province, the only practicable way is to adopt methods of tillage and cropping that conserve as much as possible of the moisture reaching the soil. Such methods include summerfallowing, the growing of crops best adapted to "dry-land" farming, and the adoption of tillage operations that facilitate the infiltration and storage of water in the soil, and above all, to protect the soil from the destructive forces of erosion.

In the surveyed area, as previously stated, variations in topography and soil texture are more important agriculturally than local differences in climate. Thus the drought problem is most serious in the soils of rolling to hilly topography and on those soils of light texture. The first consist chiefly of moderately to strongly rolling phases of Haverhill, Hatton and Fox Valley soils, while the light textured soils include all Hatton types and the Haverhill light loams, gravelly light loams and fine sandy loams. Severely eroded phases of heavier soil types may also be included in this class, since the result of wind erosion is to lower the water holding capacity, and on some soils to increase the run-off. Such soils include areas of rolling Fox Valley silty clay loam and silt loam.

It will be noted that the soils mentioned in the foregoing paragraph belong to Groups E and F. It is evident that ordinary methods of cropping and tillage will not solve the drought problem on such soils. Summerfallowing cannot be practiced on eroded Hatton sandy loams owing to the danger of further soil drifting. Suitable tillage methods may not be practicable on steeper sloping lands because of high costs. In fact, while a variety of methods may be used to conserve soil moisture, these are only likely to succeed on the better soils. The drought problem and the incidental problem of soil drifting are not capable of solution on the poorer soils if these are retained in arable agriculture, and the necessity of retiring them from cultivation should be more widely recognized.

Wind Erosion.—Wind erosion is generally more serious on the heavier and lighter textured soils, notably on heavy clays, clays, very fine to medium sandy loams and very fine and fine sands. Among the medium textured soils, severe wind erosion is most common on silty types. In general, soils formed on alluvial and aeolian deposits drift more readily than soils developed on glacial till. Hence in the surveyed area, wind erosion is most serious on the soils of the Regina, Sceptre, Fox Valley and Hatton series. However, the destructive effect is more quickly apparent on the sandy soils than on the heavier types. It has been shown * that wind erosion results in a serious loss of fertility through loss of plant food elements such as nitrogen and phosphorus and a reduction in clay and humus. Medium textured soils are less quickly affected than are sandy soils, but irreparable damage may occur even on the former types. The heavy soils on the other hand are only slightly affected since they tend to form drifted material essentially similar in composition to the original soil. Furthermore, the lighter soils are frequently of shallower depth than the heavier types, so that the removal of several inches of surface soil in Hatton sandy loam would represent a greater proportion of its original fertility than a similar loss in Regina heavy clay. However, it would be unwise to conclude that wind erosion cannot seriously affect the fertility of even the most fertile types.

The above statements indicate the serious nature of the wind erosion problem. Its effect is to bring about near destruction of the lighter textured soils insofar as their agricultural value is concerned, while the better classes of soils are seriously lowered in fertility.

Wind erosion is, therefore, the most serious soil problem of the area. It is related to the broader problem of drought through the fact that wind erosion increases in both severity and extent during abnormally dry years. However, soil drifting does not cease in seasons of favorable precipitation,

*Some field and laboratory studies of Soil Drifting in Saskatchewan. Sci. Agric. 15:10. June, 1935 although it is generally less destructive and more easily controlled in such seasons. The adverse effects of erosion on soil structure and soil fertility remain after drifting ceases and with each succeeding period of active erosion there is further progressive deterioration of the soil. It follows, therefore, that where severe wind erosion has occurred, it is unsafe to estimate the future productivity of the soil by its past performance.

It is impossible to do more than estimate the degree to which wind erosion has lowered the potential fertility of the various soils. However, in the case of the very severely drifted Hatton types, it may be stated that such land should no longer be considered arable. Many such areas have lost all their fertile surface horizons and frequently the erosion has resulted in the formation of blow-pits and small dunes. These areas not only represent a serious loss of productive soil, but where they adjoin better soils they present a serious menace because of the danger that such areas may spread. An outstanding example of this situation occurs in the municipalities of Wheatlands and Caron, where drifting sandy soils lie adjacent to the valuable Regina heavy clay. Another case occurs in Chaplin municipality where Hatton soils have accentuated the drifting of adjoining Fox Valley soils.

It is evident that these extreme cases of wind erosion require immediate attention. At the very least these soils should be left undisturbed by implements so that revegetation might naturally stabilize them. Better still, if they were to be seeded down to grass, or a grass-legume mixture. Most important of all, the vegetative cover should not again be destroyed when once it has become established, for these are no longer normal soils, but only a mixture of subsoils and loose sandy material. They will always be liable to further erosion if they are disturbed.

Table 8 indicates the approximate acreages of severely drifted soils in each municipality.

TABLE 8.—Approximate Acreages of Severely Drifted Lands.

Municipality	*Acreage*
Caron	13,500
Wheatlands	20,200
Chaplin	5,700
Hillsborough	nil
Rodgers	600
Shamrock	7,000
Total	47,000

Added to the problem of reclaiming the severely drifted soils is the task of preventing the destruction of the remainder of the light soils, and of controlling drifting on the better agricultural lands. It may be noted that the most severely drifted soils belong to soil Groups E and F. The areas most seriously affected by wind erosion are indicated by appropriate symbols placed on the soil map.

Water Erosion.—This soil problem is less spectacular in appearance than wind erosion, and is more localized in its occurrence. Nevertheless, it may become the more important problem to individual farmers. Like wind erosion, it is an indication of the misuse of land, and both result in lower soil fertility and poorer crop returns.

Water erosion occurs in three forms, *i.e.*, as sheet, rill and gully erosion. The latter is most easily observed, but sheet erosion is more widespread and the excess water from a sheet eroded area often unites into streams which form rills and gullies.

Water erosion occurs chiefly during and after heavy rains such as the so-called "cloud-burst". Where the land is sloping and soil conditions are such as to prevent rapid infiltration of water, considerable surface "run-off" occurs.

Water erosion is, therefore, most serious on sloping land, especially where the soil is heavy, or where the sub-soil is impervious.

In this area water erosion occurs most commonly on the heavier, rougher types of Haverhill and Fox Valley soils, on the long slopes found in areas of Regina and Sceptre soils, and on the Echo Series. Moderately to strongly rolling lands of all soil series that have been cultivated are affected by sheet erosion. This is shown by the light colored patches which appear on the knolls and upper slopes. The thin dark surface has been eroded, and the light colored limy (calcareous) sub-soil has been exposed.

Water erosion is quite widespread on soils of the Haverhill Series. The rougher phases may be regarded as subject to water erosion wherever such land is cultivated. Some of the worst gullying occurs on intermediate topographies where the soil is moderately heavy. For instance, considerable gully erosion was observed on Haverhill clay loam of moderately undulating to very gently rolling topography north-east of Coderre, in Rodgers municipality.

Gully erosion is becoming a problem on the Regina and Sceptre soils of moderately undulating topography. This is particularly true on the long slopes above Thunder Creek, in the municipality of Caron.

Water erosion is also affecting the moderately undulating to rolling Fox Valley soils adjacent to Wiwa Creek and Wood River in Shamrock municipality.

The problem of controlling and preventing water erosion is related to moisture conservation. Tillage and cropping practices that aid in controlling water erosion will also tend to conserve soil moisture since control of run-off must be accomplished mainly through increasing the relative amount of rainfall absorbed by the soil.

Soil Fertility.—As a general rule prairie soils are high in natural fertility. Such soils are relatively high in organic matter and nitrogen because of the accumulation of these materials during centuries of grassland vegetation. Prairie grass above any other type of natural vegetation is a source of humus, and is associated with soils of high native fertility. Under the prevailing dry climate, losses of nutrients by leaching are at a minimum, and acidic soils are practically non-existent.

However, not all the soils of this area were equally fertile and productive in their natural state. The heavier soils have an advantage over lighter soils in that they have the higher water-holding capacity, and such soils have, therefore, been more drought resistant and productive in the past as well as at the present. This is reflected in a greater total accumulation of organic matter and nitrogen. The heavier soils are also naturally richer in mineral nutrients such as phosphorus and potash and have an additional advantage due to this condition.

The productivity of a soil is not alone dependent on its chemical nature; there is also the physical condition of the soil to be considered.

The physical condition of a soil relates to and affects its state of granulation, and cloddiness, and to the resistance such granules or clods offer to wind or water action. A soil of good structure works well and is generally well granulated. Furthermore, granules and small clods have a certain inherent stability, and therefore offer considerable resistance to erosion by wind or water. Because they are resistant, they are not easily destroyed by a beating rain, whereby the surface soil might become so puddled and impermeable as to prevent the absorption of water.

The importance of good structure will easily be recognized when thought is given to its close relationship to soil erosion. The important relationship that structure bears to uptake and retention of moisture is not so generally recognized but nevertheless such relationship exists and can no more be neglected than can any other aspect of soil fertility.

Most prairie soils had good structure, as well as high fertility, at least in their natural state. Since the land was brought under cultivation there has been deterioration in structure and decrease in fertility. Not all soils are equally affected. In general it is the lighter textured soils which have suffered the most serious losses. Heavy soils, such as the Regina and Sceptre, have both high native fertility and a natural granular structure. The decrease of fertility which has resulted from cultivation and cropping of such soils is of comparatively little importance as yet. As far as their structure is concerned there is little apparent change from the virgin condition. However, the same cannot be assumed for lighter soils, especially in the case of very sandy types. The latter soils were somewhat less fertile in the beginning, and while some were originally well granulated and quite friable, the resistant quality of the clods and granules was never high. Deterioration of structure on these soils quickly followed cultivation and in turn this deterioration was followed by the destructive onset of wind erosion. Changes in the soil preceded destructive drifting, and not all the blame is to be attached to the mere fact of exposing bare soil to the elements, although this is undoubtedly a prime cause. Decreased fertility, and loss of water-holding capacity, as well as loss in resistant structure, were all factors leading up to the destruction wrought by the wind.

The increasing erosion caused by run-off water, which also involves the loss of precious soil moisture gives an additional indication of detrimental changes in the soil.

The most important materials of the soil, especially in drier areas, are clay and organic matter. Clay is entirely mineral, and has peculiar properties of plasticity and cohesion, with a high capacity for retaining moisture. The organic matter of the soil is largely present in the form of humus which accumulates through the processes of decay and decomposition of organic residues. Humus, like clay, has a high capacity to retain moisture, and associated with clay appears to supplement or even intensify the effects of the latter in forming a desirable structure.

Light, sandy soils have a low clay content and, therefore, the maintenance of humus becomes of so much greater importance. The fact that soil drifting results in a loss of both clay and humus gives additional point to the stress laid on the necessity of protecting all soils from erosion. The light soils deteriorate most rapidly, but even the heaviest soils will eventually be damaged if wind and water erosion should continue unchecked.

Once the clay is lost it cannot be replaced by any practicable means. Organic matter can be added to the soil, but only at considerable effort if depletion has reached a serious stage.

It might be suggested that the poorer sandy soils are not worth the effort required to maintain their productivity, and that only the better soils deserve attention. It is true that the better and more valuable soils do demand the most careful conservation, because of their higher productivity and value. On the other hand, many of the sandy loam soils of the present area were productive when first broken, and for a considerable number of years afterwards. They should still be productive, and no doubt can be as productive as they ever were, provided they have not been severely damaged, and providing also that some effort is made towards restoring and maintaining their fertility. It must be realized, however, that straight grain farming cannot be practised indefinitely on such soils.

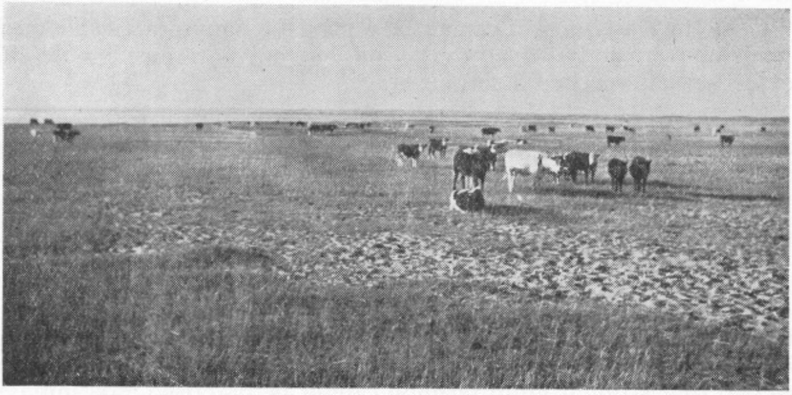
Even the poorest soils should be reclaimed to some useful production if for no other reason than to prevent them becoming a menace to the better lands. There is no area, and no country, which can afford the serious depletion or destruction of land, be it good or poor.

Conserving the Soil.—The term, soil conservation, may be defined as the use of those systems of land utilization, crop production, and soil management, which will give the highest practicable level of productivity, and yet maintain the land in a good state of fertility.

Land is the chief natural resource of this nation, and almost the only resource of importance in this Province. As a natural resource land is unique in that it can be used, and yet conserved. However, land can also be used and abused, even to the point of destruction, as we are well aware after the experience of the past ten years. Possibly some of the difficulties which have been encountered arose from a false logic regarding the nature of soil fertility. There has been an unfounded optimism abroad in the past as to the fertility of our soils. The term "inexhaustible fertility" has more foundation in fancy than in fact. Such optimism is without reason since no soil can be inexhaustible in its fertility. If plants are grown on the land and their products sold from that land there must evidently be some removal of the elements of fertility. In the case of some plant food elements, deficiencies may not appear in generations, in others it may only be a matter of years until the soil becomes depleted to the point where the growth of the plant is affected.

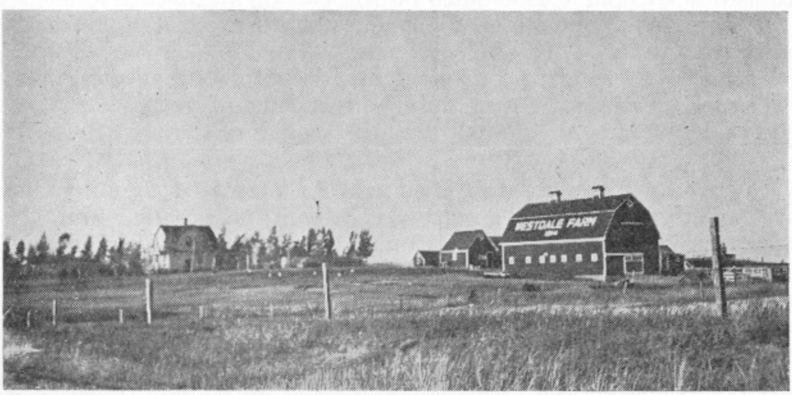
Cropping Methods and Cultural Practices—It is not proposed that the subject of cropping methods and cultural practices suitable for the best utilization and conservation of the lands in this area should be dealt with at length in this publication. Information on these subjects may be obtained from the Experimental Farms Service, particularly from the Experimental Station at Swift Current, from the Provincial Department of Agriculture, and from the University. The experimental work in the reclaiming of drifted land near Mortlach is carried on under the direction of the Experimental Station at Swift Current, and is of particular value and significance in relation to the problems of this and

PLATE III



Ranch land near Lake Chaplin. This sandy land is best used for grazing, but over grazing must be avoided, so that the soil is protected, and the best type of vegetation maintained.

Careful cultivation has prevented damage from erosion on this loam soil. The summerfallowed strips require protection by stubble trash, or the maintenance of a rough, cloddy surface.



A well developed farmstead on Fox Valley silt loam. A shelter belt not only adds to the comfort and appearance of the surroundings, but also is a great asset in gardening.

similar areas. The Guide to Farm Practice in Saskatchewan deals at some length with the questions of moisture conservation, control of soil drifting and general cropping practices, as well as many other subjects.

The better soils of the area (Fair to Superior groups) are still fertile and productive, except in cases where damage has occurred through erosion. Conservation of moisture is as yet of greater importance than conservation of fertility, providing such conservation is accomplished without increasing the danger of erosion. The importance of proper and carefully applied summerfallow practices cannot be over emphasized. Timeliness of summerfallow operations, so that loss of moisture through weeds is reduced to a minimum, is the keynote to moisture conservation. Protection of the surface soil against erosion while conserving moisture is an absolute requirement to complete the success of the summerfallow operation.

The first element likely to become a limiting factor in plant growth on the better soils is phosphorus. This element is never abundant in the soil, and much of that which is present may be unavailable to plants. When the soil becomes deficient in phosphorus it will be necessary to use phosphatic fertilizers. At the present time results obtained in this area are not uniform enough to warrant a general recommendation that such a fertilizer be used.

The maintenance of organic matter and nitrogen in the better soils is a less serious problem than it is commonly thought to be. In the first place loss of organic matter is not rapid under the prevailing cool and dry climatic conditions of the area. Furthermore, considerable crop residues are returned to the soil as stubble, roots, and trash of one kind and another. This is especially true where the best methods of controlling soil drifting are employed as through the use of trash covers. As far as the element nitrogen is concerned there are two fortuitous circumstances which tend to maintain the supply of this important nutrient. One is free fixation of nitrogen from the atmosphere, which contains a huge supply, by organisms of the soil, the other is the small but significant quantities reaching the soil with the precipitation. There has been depletion of both organic matter and nitrogen since the soil was cultivated but on the better soils at least, such depletion cannot be said to have reached serious proportions.

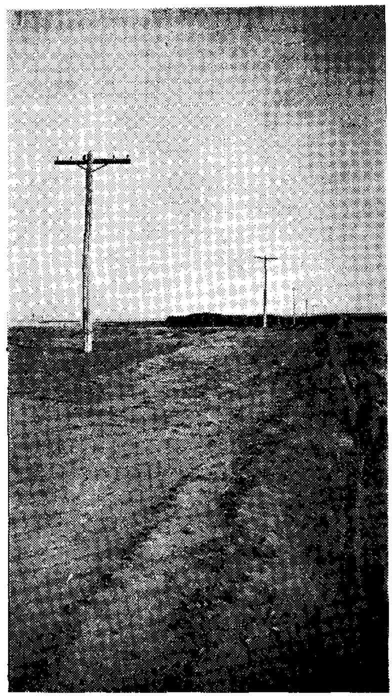
The matter of maintaining the structure of the soil may eventually require reconsideration of the above statement as to the present sufficiency of organic matter. However, this important matter of maintaining structure is far from being a simple question and it is one which cannot be resolved by any simple formula.

Organic matter plays an important part in maintaining a desirable structure but the source of that organic matter may greatly affect the result produced on the soil. The most effective source of organic matter is generally considered to be perennial grasses, and it is considered by some that the productivity and good structure of soils cannot be maintained without the use of grass in the cropping system. While there is reason to believe that a greater use of grass would be desirable on the better soil types, there remains the difficulty of its profitable utilization. Grass crops generally are utilized on the farm as feed for livestock but wheat farms are not organized to make such an enterprise possible except in a very few cases. If erosion can be controlled successfully it may be considered safe to leave the question of organic matter in abeyance for some future time.

When the poorer soils, such as light loams, sandy loams and sands are considered, an entirely different view must be taken as regards the maintenance of fertility. With such soils, organic matter and nitrogen become of comparatively much greater importance than even phosphorus, and the conservation of moisture must be attained by other methods than the ordinary summerfallow practice. To successfully continue farming the light soils it is essential that some provision for maintaining the organic matter be undertaken. The best and most practical method is through the use of soil improving crops, such as the grasses and legumes. Fortunately research and experiments have been conducted and have produced suitable crop plants and successful methods

PLATE IV

Below. This land had been drifting and was sown to sweet clover. The sweet clover will protect the soil, improve its fertility, and furnish a source of revenue. Mixtures of grasses and alfalfa may also be grown successfully on this sandy soil.



Above. This sandy land is severely damaged by drifting. It is non productive in its present state, and a grave menace to neighboring farms.

for obtaining stands of such plants. Crested wheat grass has proved to be a well adapted plant for the drier areas, and sweet clover is also a crop of considerable merit. In many places mixtures of grasses and legumes are desirable. On sandy soils particularly mixtures of crested wheat, or brome grass with alfalfa may be successful, because sandy lands commonly have a shallow water table to provide a source of moisture for the deep-rooted alfalfa.

OTHER PROBLEMS

The difficulty of cultivating stony land is well known on many farms in Saskatchewan. The stones range in size from small pebbles to large boulders several feet in diameter and are characteristic of glacial till soils. Hence in the surveyed area, they are most numerous in the Weyburn and Haverhill soils. They are also found in the Echo soils and in smaller numbers in the Sceptre and Fox Valley series. They are rarely a serious problem on the latter soils except where these soils occur as mixtures with a glacial till series such as Haverhill.

In the Weyburn and Haverhill series, the most stony lands are generally found in the distinctly morainic areas, and there is a general tendency towards greater stoniness with increasing roughness of topography. Occasionally, however, very stony lowland flats occur where past geological erosion has swept away the finer material. Where stones are so numerous or so large that clearing is impracticable, the area is mapped as a stony phase of a soil series, and indicated as such on the soil map.

"Alkali" soils are present to a considerable extent throughout the area, as was already mentioned. Where there is only slight to moderate amounts of alkali salts present the land may be successfully used to grow the more resistant crops. Of the grains, barley and oats are the most resistant, and of forage and hay crops, sweet clover, western rye grass, crested wheat grass, brome grass and alfalfa have fairly high tolerance. Sweet clover and western rye grass are the most tolerant or resistant of the common crops.

In many cases, especially where there is a considerable concentration of alkali salts, a condition which may usually be recognized by the appearance of a white crust in dry weather, the land is best left in its native state. There is generally some edible vegetation upon which animals can graze and the land has some value for this purpose. The feeding value of plants growing on alkali soil is generally lower than for upland hay growing on soils free of alkali.

Over grazing of alkali land may tend to increase the proportion of non-edible plants, and land which reverts from cultivation may also revegetate with less desirable species of plants, unless some effort is made to seed it down.

General Objectives of Land Conservation.—It is not within the scope of this report to discuss the actual practices which might be followed in carrying out a land utilization programme. However, from the standpoint of the soil problems, a number of objectives may be listed which must be considered if any comprehensive measure of soil conservation is to be achieved.

The chief of these objectives are:

1. The permanent removal of all unsuitable lands from cultivation.
2. The complete control of soil drifting on the above soils, with the primary object of preventing the spread of erosion to adjoining arable lands.
3. The proper use of these non-arable soils as grazing land when they have become re-vegetated, or have been seeded down.
4. Control of wind and water erosion on the arable soils and the maintenance of their fertility.
5. Use of water resources where available for irrigation and stock watering.
6. Improvement of water supply and proper grazing control in the unbroken grassland.
7. Co-operative measures and legal devices where necessary to prevent the misuse of land.
8. Adjustments in population, taxes, size of farm unit, system of agriculture, and municipal organization as necessary to the completion of the above objectives.

In conclusion it may be stated again that the surveyed area is representative of physical conditions, soils and agricultural problems of a considerable portion of southern Saskatchewan. A programme of soil conservation and land use for this area would in most respects be applicable to such districts. The full value of the soil survey can only be realized if the information is put into practical use as a basis of a sound land policy.

APPENDIX

TABLE 9.—Giving the Sizes of Soil Separates or Particles Used in Determining Soil Classes, and also the Proportions of These Particles for Each Class.

SOIL SEPARATES OR PARTICLES

Grade	Names of Separates	Diameter of Separates in Millimeters
1	Fine gravel	2.0 mm. to 1.0 mm.
2	Coarse sand	1.0 to 0.5
3	Medium sand	0.5 to 0.25
4	Fine sand	0.25 to 0.10
5	Very fine sand	0.10 to 0.05
6	Silt	0.05 to 0.005
7	Clay	Less than 0.005

SOIL CLASSES AND THE PROPORTIONS OF THE VARIOUS-SIZED SEPARATES FOR EACH CLASS.

I.—Soils containing less than 20% of silt and clay:

1. Coarse sand—over 25% fine gravel and coarse sand, and under 50% of any other grade.
2. Medium sand—over 25% fine gravel, coarse and medium sand, and under 50% fine sand.
3. Fine sand—over 50% fine sand, or under 25% fine gravel, coarse and medium sand.
4. Very fine sand—over 50% very fine sand.

II.—Soils containing 20% to 50% silt and clay:

1. Sandy loam—over 25% fine gravel, coarse and medium sand.
2. Fine sandy loam—over 50% fine sand, or under 25% fine gravel, coarse and medium sand.
3. Very fine sandy loam—over 50% very fine sand.
4. Sandy clay—under 20% silt.

III.—Soils containing over 50% silt and clay:

1. Loam—under 20% clay and under 50% silt.
2. Silt loam—under 20% clay and over 50% silt.
3. Clay loam—from 20% to 30% clay and under 50% silt.
4. Silty clay loam—from 20% to 30% clay, and over 50% silt.
5. Clay—over 30% clay.
6. Heavy clay—if over 50% clay.

TABLE 10.—Description of Water Eroded Classes Shown on Soil Map.

Symbol		Description
E	Slight sheet erosion.	Slight removal of surface soil in local spots. No serious loss of soil or fertility.
E_1	Moderate erosion.	Considerable proportion of A horizon removed. On steep upper slopes B horizon (lime layer) exposed. Direction of tillage operations across slope and other methods may be required to prevent further loss.
E_2	Severe erosion.	A horizon removed from most of the area, and subsoil exposed. Gullying likely to be associated with this condition. Productivity of soil impaired and erosion control methods required at once. Gullies and steep slopes may have to be taken out of cultivation.

TABLE 11.—Description of Wind Eroded Classes Shown on Soil Map.

Symbol		Description
d	Slight drifting.	Little damage to soil or crop; patchy surface drifting but no serious or widespread loss of structure.
d_1	Moderate drifting.	Some damage to soil and crop. Part of A horizon removed or disturbed, with consequent loss of original structure. Small accumulations of drift along fences, and a few in the field. Special tillage methods, strip farming, etc., may be required to control this class.
d_2	Severe drifting.	Growing crops may be badly damaged. Most of the A horizon removed from area as a whole, and in places B horizon exposed. Fence and field accumulations may reach height of several feet. Shallow blow-pits also occur when B horizon is exposed. Application of emergency control measures is required irrespective of land use or season of the year. Such land will probably require a grass cover for some years at least.
d_3	Very severe drifting.	Original profile largely destroyed and crop production impossible. B horizons removed or buried under small dunes, and in some blow-pits C horizon or parent material exposed. This class is generally found on newly abandoned cultivated land, and may be regarded as non-arable. Requires stabilization of surface by vegetative cover and permanent removal from cultivation.

TABLE 12.—Definition of Topographic Phases Shown on Soil Map.

Topographic Phase	Slope %	Frequency* per ½ mile
Flat to depressional	0–1	0
Gently undulating	1–3	2 or less
Moderately undulating	3–6	2 or less
Very gently rolling	2–4	3 or more
Gently rolling	4–8	3 or more
Moderately rolling	8–15	3 or more
Strongly rolling and hilly	15+	3 or more

Eroded—Rough, broken land of valley slopes and escarpments.

*Frequency refers to the number complete rolls, from ridge to ridge, occurring per half mile. The above classes cover the topographic conditions most frequently encountered, but occasionally high slopes and low frequency may occur, such as long smooth slopes of 7% or over. Such areas are usually mapped under one of the rolling phases.