



Issued May 7, 1913.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE KANSAS STATE AGRICULTURAL COLLEGE. H. J. WATERS, PRESIDENT, AND THE KANSAS AGRICULTURAL EXPERIMENT STATION, E. H. WEBSTER, DIRECTOR, W. M. JARDINE AGRONOMIST.

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SOIL SURVEY OF RENO COUNTY,  
KANSAS.

BY

WILLIAM T. CARTER, JR., F. V. EMEKSON, A. E. KOCHER,  
AND ALLEN L. HIGGINS, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND CHARLES S. MYSZKA AND H. C. LINT,  
OF THE KANSAS STATE AGRICULTURAL COLLEGE.

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J. E. LAPHAM, INSPECTOR IN CHARGE NORTHERN DIVISION.

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[Advance Sheets—Field Operations of the Bureau of Soils, 1911.]



WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1913.

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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., August 22, 1912.*

SIR: The accompanying report and soil map cover the survey of Reno County, Kans., one of the projects undertaken by the bureau during the field season of 1911. This work was done in cooperation with the Kansas State Agricultural College, and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area, and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1911, as authorized by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

Hon. JAMES WILSON,  
*Secretary of Agriculture.*

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## MAP.

Soil map, Reno County sheet, Kansas.

# SOIL SURVEY OF RENO COUNTY, KANSAS.

By WILLIAM T. CARTER, Jr., F. V. EMERSON, A. E. KOCHER, and ALLEN L. HIGGINS, of the U. S. Department of Agriculture, and CHARLES S. MYSZKA and H. C. LINT, of the Kansas Agricultural College.

## DESCRIPTION OF THE AREA.

Reno County, Kans., is situated in the south-central part of the State, its southern boundary being about 50 miles north of the Oklahoma State line. It is bounded on the north by McPherson and Rice Counties, on the east by Harvey and Sedgwick Counties, on the

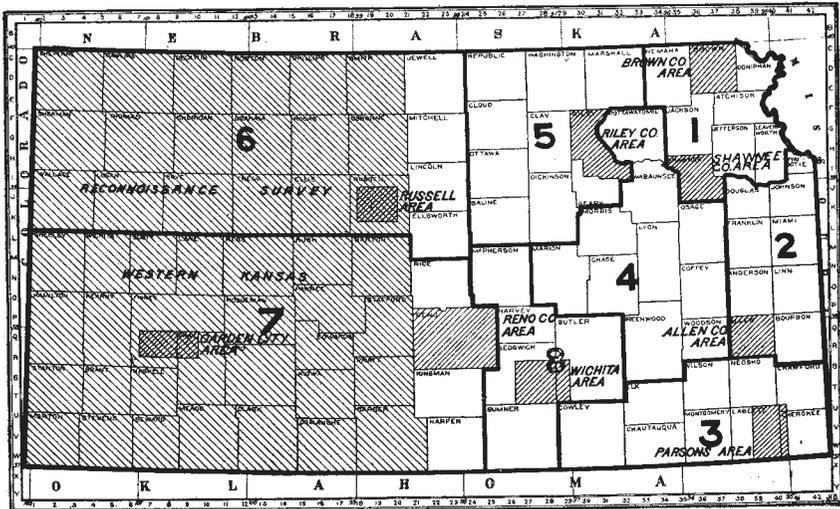


FIG. 1.—Sketch map showing areas surveyed in Kansas.

south by Sedgwick and Kingman Counties, and on the west by Pratt and Stafford Counties. The county is rectangular in form and about 30 miles wide north and south, and 42 miles long east and west. It is the third largest county in the State, having an area of 812,800 acres, or 1,270 square miles.

Reno County lies in the physiographic province known as the Great Plains, which extends westward to the Rocky Mountains. The general character of the surface of the county is that of a rolling plain intersected by three relatively narrow valleys (see fig. 2). The elevation varies from a little less than 1,400 feet above sea level at its

southeast corner to a little more than 1,800 feet along its western side, the general slope of the surface therefore being from the northwest to the southeast. The slope is very uniform and the surface is comparatively smooth, except in a few local areas where it is slightly hilly. In a small area in the central-southern portion of the county there is a hilly upland belonging to a division termed by Adams the Reno Hills Upland. (Bulletin American Geographical Society, vol. 34, 1902, p. 101.)

The surface of the county was doubtless once a nearly level plain, and the differences in the character of the present topography in various parts of the county is due to erosion and wind action. The

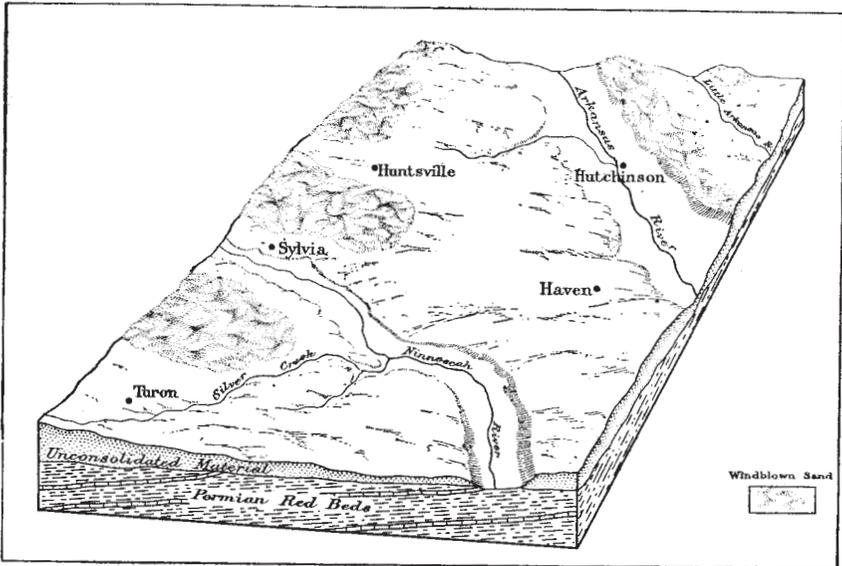


FIG. 2.—Block diagram of Reno County, Kans.

extent to which these factors have changed the original surface has varied with the hardness and other characteristics of the materials comprising the original geological formations.

There are four fairly distinct physiographic divisions in the county, each having a distinctive topography and soils. They are shown in figure 2, and are (1) the prairies, (2) the Arkansas River Valley, (3) the Ninnescah and Little Arkansas River Valleys, and (4) the dune belts.

(1) The prairie region occupies the greatest part of the county, and its surface may be described as rolling or undulating, although there are local relatively level areas and several areas of hilly topography. The ridges in the rolling areas are broad, with gentle slopes in a general north and south direction, and rarely rise over 20 feet above the intervening depressions. The topography is what geolo-

gists term youthful; that is, the drainage has not yet been fully established and the surface is comparatively little eroded by streams. Except near the larger valleys the streams are short, of low gradient, and flow in shallow, indistinct valleys. In the prairie region these short streams are intermittent in character, locally called draws, and do not contain flowing water except immediately following rains. The rolling topography of most of the prairies is the result of stream erosion in combination with the action of the wind. In the western part of the county there are areas of dunelike sandy hills whose approximate location is shown in figure 2. These hills are doubtless due to blown sand, though some appear to be due to the erosion of the original surface.

(2) The valley of the Arkansas River is from 5 to 10 miles wide and extends in a northwest and southeast direction through the northeastern corner of the county. It has the appearance of a shallow, level-bottomed trench 10 to 50 feet below the adjacent upland. The upland at the northern side of the valley is higher than at the southern and the slopes generally steeper. The river flows near the upland in the south side of the valley, and here in many places the valley and upland merge so gradually that a sharp line of separation can not be drawn. This broad trench has been occupied at different times by the constantly shifting channel of the river, and is filled to a depth of 100 feet or more by layers of sand, gravel, and clay, as shown by well borings, the coarser-textured material having been deposited during floods by swift currents and the finer-textured material in areas where the currents were sluggish. These alluvial sediments have been brought down from the Rocky Mountain region and from the areas of the Great Plains. Subsequently to their deposition they have been modified in part by wind action. Such materials collect and hold the water which falls as rain or snow and act as a reservoir for the supply of water for wells and crops.

(3) The Little Arkansas River Valley extends through the extreme northeastern corner of the county in a northwest and southeast direction. It is 1 to 3 miles wide, and, like the Arkansas Valley, it is a shallow trough filled with sand and clay which has been deposited from overflow waters. On the south side the valley merges into the upland formed of sand dunes, which are gradually encroaching upon the valley and in places have reached the river. On the north side of the valley the rolling prairies are topographically distinct, rising 40 feet above the flood plain. Following the river eastward, however, this prairie becomes much lower and more nearly level, in places being very little higher than the valley and having sometimes no sharp line between valley and upland.

Narrow valleys in the rock mantle of the prairies have been cut through the western and southern parts of the county by the North

Fork of Ninescah River and its main tributaries, Silver, Goose, and Rock Creeks. These valleys are from one-fourth to 1 mile in width, are shallow, flat-bottomed, trenched some 20 to 100 feet below the general surface of the surrounding prairies, and are bordered by belts of rolling to hilly prairie country on both sides. The valley soils along these smaller streams have been washed in from the surrounding uplands and in the western part of the county are marshy and poorly drained.

In its lower course in the southeastern part of Reno County, occupying a considerable portion of Castleton, Sumner, and adjoining townships, the Ninescah Valley and its drainage system has been cut down to the underlying Red Beds. This has given an area that is quite rolling and eroded. This eroded area lying just north of the North Fork of Ninescah River is from 20 to 40 feet below the rolling prairies and is bounded by a small, sloping, though somewhat broken, escarpment.

(4) The sand-hill or dune belts occupy several areas in the county. The largest extends along the northern border of the Arkansas Valley, in the northeastern part of the county; another lies in the extreme northwestern part of the county, just south of the Arkansas Valley; while other more or less disconnected areas are found in the western part of the county on each side of the Ninescah Valley.

The topography of the sand dunes possesses the characteristic rounded form, the hills generally being from 10 to 30 feet high, though some are higher. The dunes north of the valley are probably formed of sand blown from the river bed; those in the western part of the county are apparently derived from Tertiary sands exposed in areas farther west, partly weathered, and blown eastward.

Reno County is well drained by the Arkansas River and its principal local tributaries, the Little Arkansas and the North Fork of the Ninescah River, neither of which empties into the main stream within the county. The general direction of flow of the streams is southeasterly, indicating the general surface slope of the county.

The northern half of the county is drained by the Arkansas and Little Arkansas Rivers and their tributaries, while the drainage from approximately all of the southern half of the county escapes into the North Fork of Ninescah River. The Little Arkansas drains the extreme northeastern part of the county, with Blaze Fork as its largest tributary. Paralleling this and bisecting the northeastern quarter of the county diagonally in a northwest-southeast direction the Arkansas River exists as a relatively narrow channel which carries but a small percentage of the water precipitated into its upper drainage basin. The natural volume of the stream is diverted both for irrigation purposes in the upper part of its valley and by lateral

dispersal as a subsurface flow through the porous sandy and gravelly deposits which underlie the whole valley to the depth of 100 feet or more. One of the most striking evidences of the progressive accumulation of these alluvial deposits is the extent to which the sands are being built up under the bridges at Hutchinson and various other points along the river. It seems probable that this subsurface flow of water might be utilized to a considerable extent as a source for irrigation waters within the county.

The northwestern and north-central parts of the county are drained by Peace and Salt Creeks, small tributaries of the Arkansas which rise in the sandy areas, and are streams of constant flow. Little of the water which falls upon the sand belt in the northeastern part of the county, however, reaches the Arkansas River in definite channels, but is first absorbed by the sand and then dispersed and spread out over the valley. A portion of the immediate valley of the Arkansas is drained by Cow Creek, a running stream, which enters the county from the north a few miles east of the stream and empties into it several miles southeast of Hutchinson. The other tributaries of the Arkansas River which drain the eastern part of the county are short intermittent streams, little below the level of the prairie, and are generally termed draws.

The North Fork of Ninescaw River drains practically all of the southern part of the county, its main tributaries being Silver, Goose, and Rock Creeks. The erosion of the prairie by these creeks has been considerable in the southwestern and southeastern parts of the county.

Reno County was settled to a slight extent in the early seventies. At this time people mainly from the Middle Western States began to homestead land in the county. Many settlers, a large number of whom still live in the county, moved in and took farms as early as 1872-73. Considerable of the land in the county was owned by the railroads, and this was sold out to homesteaders at a low figure as rapidly as possible. The county continued to grow steadily in population with the advent of railroads and the development and growth of its industries have been steady. In the early history of the settlement of the county some bad seasons and the grasshopper pest temporarily checked the settlement, but this did not last long and development steadily progressed until at the present time Reno County ranks as one of the best counties of the State.

In most parts the county is well settled. In the western part, where there are considerable sandy areas, and in the sand-hill region just north of Hutchinson, there are the fewest inhabitants. The "Red Jaw" country in the southeastern part of the county is also thinly settled. Elsewhere there is a farmhouse to nearly every quarter section of land. According to the census of 1910, the county

has a population of 37,853, ranking eighth in the State. Probably approximately half of this population lives on farms.

The citizens are mainly American, coming from the older States. There are a number of colonies of Russian Germans and Germans in the eastern part of the county. Naturally the most thickly settled parts of the county are along railroads and on the best land.

Hutchinson, one of the largest cities of the State, has a population of nearly 17,000. Several railroads run through the city and it is a general distributing and shipping point for a very large part of western Kansas. Besides the railroad business, Hutchinson is the seat of a number of manufacturing plants, the most important being salt factories with a total output of about 5,000 barrels of salt a day, a soda-ash plant with a capacity of 80 tons per day, and 4 flour mills with a total capacity of 3,000 barrels a day. A straw-board plant with a capacity of 60 tons daily is in course of construction.

Hutchinson is also a great shipping point for wheat. Companies that buy in all parts of western Kansas ship wheat to Hutchinson, where it is cleaned, regraded, and shipped to the various markets, some of it going to Galveston for export and some to various other markets, while considerable is made into flour by the local mills.

Nickerson, a thriving town of 1,200 inhabitants, is the second largest place in Reno County. Haven, Arlington, Turon, Pretty Prairie, and Sylvia are towns of several hundred inhabitants which are important shipping and trading centers. Slightly smaller than these are the towns of Buhler, Medora, Partridge, Plevna, Abbyville, Langdon, Castleton, Yoder, Elmer, and Darlow. These towns are on the railroads. Practically all the county is served by the rural free delivery mail service. There are ample school and church facilities in all parts of the county and the telephone is found in nearly all the farmhouses.

Railroads radiate from Hutchinson in many directions, and most of the county is well supplied with shipping facilities. Some of the farmers in the northwestern part of the county are 10 or 12 miles from a railroad, though few of the farmers of the county are over 6 or 8 miles distant. The following railroads pass through the county: Atchison, Topeka & Santa Fe (main line and two branches); Chicago, Rock Island & Pacific; Missouri Pacific (two lines); and St. Louis & San Francisco. These railroads give connections direct with Kansas City, Chicago, Denver, and many other large markets. Hutchinson is a very good local market for a great many products of the farm.

Most of the wagon roads are in good condition. Through the very sandy areas the roads are very poor, but even in the sandy sections the more traveled roads have been surfaced with clay, rendering them

very good, and in the red land or "Red Jaw" country in the south-eastern part of the county the roads are sometimes very muddy and heavy in wet weather, but they soon dry out.

## CLIMATE.

While climatic conditions of Reno County are not so unfavorable as to retard greatly its agricultural development, the county lies far enough west in the region of diminished rainfall so that variations from year to year exert a marked influence on crop yields. The element of uncertainty is always present. No absolute failure of crops due to climatic causes, however, has ever been experienced.

The following table gives the highest, lowest, and mean seasonal and annual temperature and precipitation at Hutchinson:

*Normal monthly, seasonal, and annual temperature and precipitation at Hutchinson.*

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	36	80	-14	0.0	1.9	2.6	3.9
January.....	33	74	-14	.6	.1	1.5	4.7
February.....	32	77	-24	1.4	1.2	.5	9.4
Winter.....	34			2.9	2.3	4.6	18.0
March.....	44	95	2	1.4	.2	1.8	2.4
April.....	57	99	23	2.4	.3	6.4	.7
May.....	66	100	27	3.5	2.0	3.9	
Spring.....	56			7.3	2.5	12.1	3.1
June.....	74	105	39	4.8	3.9	5.9	
July.....	78	108	50	3.8	3.5	3.2	
August.....	78	107	43	2.8	1.7	5.5	
Summer.....	77			11.4	9.1	14.6	
September.....	70	109	30	3.0	2.1	3.5	
October.....	60	95	25	2.8	.1	1.9	
November.....	45	90	5	.8	.5	1.1	.3
Fall.....	58			6.6	2.7	6.5	.3
Year.....	56	109	-24	28.2	16.6	37.8	21.4

These figures show a considerable range of temperatures. The lowest temperatures are caused by cold waves, accompanied usually by high winds and extending over a period of several days. In this region of low humidity the cold seems less intense than the same temperature would in a damp climate. Some winters are mild and

there are many pleasant days, while other winters are severe. As a usual thing there is considerable mild weather during winter. The heavy winds of winter, with the attendant low temperatures, are sometimes referred to as blizzards, but these are nothing like as severe as the blizzards farther north and west. The cold of winter does little damage, though occasionally on the heavier soils wheat is killed. Some of the smaller peach shoots are also often killed in the late winter, probably where a preceding period of mild weather has caused the sap to start flowing. In summer high temperatures may be maintained for several days at a time, and occasionally dry, hot winds occur, though as a rule not many times during a single summer. Temperatures of 100° F. often occur at this season.

Frosts sufficiently severe to damage tender vegetation may be looked for from the latter part of September to the middle of October. In the spring there is little danger of frost after the first of May, though it sometimes occurs as late as the middle of May. The growing period thus ranges from 130 to 150 days, which gives ample time for the maturing of all the crops of the region.

Reno County is a part of the Great Plains and suffers the uncertainty in precipitation characteristic of the general region, though to a less degree than the country farther west. The average yearly rainfall is 28 inches and sufficient for crops if it comes at proper seasons. There are seasons, however, when the rainfall is far below this, or in which the rains do not come at the right time in the season to be of best advantage to growing crops, and this uncertainty has a marked influence on crop yields, because the mean of 28 inches is near the limit for profitable humid farming and any decided deficiency throws the area into the semiarid regions. It may be said, however, that no years are ever so dry as to cause a complete crop failure. On the other hand, there are many years when there is sufficient rainfall for the profitable production of crops.

As will be seen from the table on page 11, most of the rain comes in the spring and summer months, when most needed by the crops. On the other hand, in a region of such high summer temperatures and active wind movement evaporation is high, and the failure of rains to come at this time causes great damage to the growing crops.

The average annual snowfall is over 21 inches. Precipitation in this form is a decided benefit, as the run-off is less and more of the moisture is stored in the ground for the use of crops in the spring. It has been found good practice to leave the ground rough and trashy through the winter so that it will catch and hold the snow which otherwise would be blown away.

In this county, where so much of the surface is gently undulating and all of the soils are impervious, there is in general little run-off and most of the rainfall sinks into the soil. Many of the rains are

local, and it is common for one section of the county to receive showers that other sections do not receive.

Hailstorms sometimes occur, but these are not very common and are confined to small areas, being purely local in character. Sometimes crops are damaged by these hailstorms, but usually not over a large area. During the spring the hard winds of the plains are felt to a great degree in this area. These winds are prevailing from the south and not only cause a great loss of soil moisture by evaporation, but drift the looser soils, especially sands and sandy loams, so much as to damage the young crops. In the fall these winds are also very severe, coming sometimes from the north and sometimes from the south, and often injuring the young wheat.

#### AGRICULTURE.

Reno County first began to be settled in the early seventies. Prior to that the few people who lived in the region were buffalo hunters or were engaged in some pursuit other than farming. The first settlers homesteaded the land and opened up farms, while the railroad land, of which there was considerable in the county, was bought up at a low figure after all the Government land had been homesteaded. Stock raising was engaged in to some extent, but there were never the large ranching interests in the county that were common in the western part of the State. The crops first grown by the settlers were wheat and corn, with some oats. During some years there were partial crop failures, due mainly to dry weather and grasshoppers and inexperience of the settlers, and this caused some people to become discouraged and leave the country, but the exodus of settlers was never so general as was the case in the early days of the Kansas settlements farther west.

The principal crops grown in Reno County are wheat, corn, alfalfa, kafir, sorghum, and oats. A relatively small area is devoted to broom corn, rye, barley, peanuts, cowpeas, millet, and other crops. Orchard fruits, small fruits, vegetables, and berries are also produced. Stock raising is carried on to some extent.

Wheat, the important crop of western Kansas, occupies a leading place in Reno County, and will doubtless hold this position for many years to come. The reasons for this are that wheat is a crop that can be grown in large acreages with less labor than almost any other crop, while it also usually commands a good price and a ready market. Added to this is the fact that wheat, while subject to decided variations in yield, is well adapted to the soils over a large part of the county, and is probably the most certain crop of any of the small grains. Practically one-third of the land in cultivation in the county is utilized for wheat. During the season of 1910 there was harvested 1,766,052 bushels of wheat from a total acreage of

147,171 acres in Reno County.<sup>1</sup> According to the same authority there was nearly double this production of wheat in 1909, with only about 45,000 acres more in cultivation. The average yield per acre for 1910 was, on a basis of these estimates, 12 bushels and for 1909 17 bushels. Only winter wheat is grown, this being better adapted to local climatic conditions. The hard red winter wheats<sup>2</sup> have been found to do best in this general region, and the Turkey Red and Kharkoff are the main varieties grown in Reno County.

The Kansas Experiment Station has been testing varieties of wheat. The heaviest soils of the county, which fortunately exist in large areas, are the best adapted to wheat. These are the loams, clay loams, and silt loams. The crop is also grown extensively on the sandy loams, and while yields are not so high as on the heavier types, they are profitable.

A small acreage is devoted to small grains other than wheat. Of these oats occupies an acreage second to wheat, though in 1910 only 47,828 acres was used, yielding a total of 1,482,668 bushels. Only spring oats can be grown with success in this region, and owing to the climatic conditions of early spring the stand is often poor. Dry weather is likely to prevent germination and heavy winds blow the soil away from the young plants, which kills them. In a favorable season the yield is good, ranging from 40 to 60 bushels per acre on the best soils. As is the case with wheat, the heavier soils are best adapted to oats. Fair yields are often made on the sandy loams, though these being more subject to drifting the crop is uncertain. Barley and rye are grown only in a small way, and then usually for pasturage. These cereals especially do well on the heavier soils, but there seems to be less profit in their production than in wheat.

Emmer (speltz) is well adapted to the soils of this county and would make good yields on the loams and clay loams. It would also do fairly well on the sandy loams. Practically none of this crop is produced in Reno County, though it withstands drought better than most of the small grains and would prove a very valuable crop in this section. Very little millet is grown, though it yields well on the loams and sandy loams.

Corn is another important crop in the county. In 1910, 238,018 acres were in corn, yielding 3,332,252 bushels. The average yield was thus only 14 bushels per acre. In the preceding year the average yield was 19 bushels. Corn is more susceptible to seasonal variations than many other crops, and if rains do not come at just the right time the crop is seriously damaged. In favorable seasons corn yields run as high as 50 or 60 bushels per acre on the best soils. For the last two or three years the seasons have been such that corn yields

<sup>1</sup> The statistics in this chapter were taken from the Report of the Kansas State Board of Agriculture for the year 1909-10.

<sup>2</sup> Bul. No. 176, Kansas Expt. Sta.

have been scant over many parts of the county. The yield of corn could be greatly increased by better cultural methods. The loams are well adapted to corn and give the largest yields in good seasons with the methods at present in general use. The sandy loams are the most certain, however, as the moisture of the soil is not lost so freely by evaporation, and a large proportion of the corn is produced on these types. The loamy sands are also cultivated largely to corn. The latter are better adapted to corn than to wheat, and on them corn takes the place of wheat as a money crop.

Broom corn is grown extensively in the northwestern part of the county, though it is not as important a crop as in adjoining and nearby counties. In 1910 there were 3,676 acres in broom corn. It is well adapted to the soils of the area and is grown considerably on the loamy sands. It withstands drought well and is a profitable crop. It can be planted at various times during the season, thus allowing it to be harvested and cured systematically as it ripens.

Kafir is one of the most certain crops for this section, yielding some grain even in the driest years. It is adapted to all the soils of the area and makes a good yield of grain and forage. While it is grown by many farmers in a small way it is by no means as plentiful as it should be. The yields range from 20 to 50 bushels of grain and a large quantity of forage per acre. As a feed crop it is very valuable, and its wide adaptation to soils and ability to withstand drought make it worthy of more extended use in the cropping systems. It is much more certain than Indian corn and the yields are higher. It is not favored by farmers, as they say it is hard on the land. In 1910 7,180 acres of kafir were grown in Reno County.

Sorghum is grown widely, though in a small way. Like broom corn and kafir, it withstands dry conditions remarkably well and makes fair yields of grain seed and large yields of forage.

Milo is not grown in the county, though it is well adapted to the soils. Its place is taken by the kafir, which yields a better forage. Peanuts grow and do well in the sandy soils of the area, but they are grown only in a small way. Cowpeas are grown to a considerable extent for hay. These legumes are very beneficial to the soil and should enter into the cropping system of the area more largely.

Alfalfa is grown extensively in the county. In 1910 there were 15,749 acres in this crop. Sometimes difficulty is experienced in getting a stand owing to dry conditions, high winds, and the activity of insect pests. After the plants are once well started the fields last for many years. In the dry seasons the crop does not give good yields, but in seasons of normal rainfall large crops are secured. Some alfalfa seed is produced, yields ordinarily ranging from 4 to 8 bushels per acre. Much alfalfa hay is put up and fed to stock during the winter. The valley soils are best suited to alfalfa; that is, the

Arkansas loam and fine sandy loam, and on these types there are considerable areas utilized for the production of this crop. These soils are subirrigated and have the water table a few feet from the surface. Some seasons are so dry that the yields are lowered even here. It is believed that alfalfa could be grown much more extensively than is now done. The heavy soils of the prairies, the clay loams, and loams are well adapted to the crop. The lighter sandy soils are not so well adapted to alfalfa as the heavier soils. In 1910 Reno County stood twentieth among Kansas counties in acreage of alfalfa.

Considerable prairie hay is cut from the meadows along the smaller streams and from low, rather wet areas between the sandhills in various parts of the county. This prairie hay, while made of coarse and rank growing grasses, is nutritious, and is utilized extensively for feeding work stock and for fattening cattle.

According to the statistics of the State board of agriculture the value of animals slaughtered and sold for slaughter in Reno County was \$1,315,988 for the year 1910. There is practically no ranching done in the county, but cattle are raised in a small way by a number of farmers, and some make a specialty of raising cattle. Most of the cattle are shipped in as "feeders" from various sections and fattened during the winter and sold in Kansas City for slaughter. Some thin cattle are bought in Kansas City and shipped to this county for feeding. A few farmers buy sheep in the West and bring them to this county to fatten for the market. Flocks of several thousand each are fed by several farmers. The cattle and sheep are fed on corn, cowpea, alfalfa, and wild hay, kafir fodder, and corn fodder. Some silos have been built and are filled with corn silage for use in cattle feeding. The cattle raised in the county are principally Herefords and Shorthorns.

Many hogs are raised in connection with general farming. No very large droves are kept. The breeds that seem to do best in this region are the Poland-China and Duroc-Jersey, though some other breeds are raised.

In 1910 there were \$189,323 worth of poultry and eggs sold in Reno County. The butter produced amounted to 1,745,977 pounds, valued at \$486,323, and the milk sold was valued at \$114,042. There are a few dairies around Hutchinson which supply the local trade. A large creamery buying cream from this section of the State and making it into butter is located in Hutchinson. This plant turns out thousands of pounds of butter daily. Skimming stations are found in some of the smaller towns of the county. These ship cream to the plant in Hutchinson. There are also many farmers with a few cows who separate the cream and sell it at Hutchinson or at markets outside the county. A number of silos are being built by progressive farmers in the county.

Reno County is said to be the leading county in the State in the production of apples. The soils of the Arkansas Valley are well adapted to apples, and there are many good-sized orchards, and a few of several hundred acres in size, located here. Besides these larger orchards, nearly every farm has some apple trees. The Arkansas fine sandy loam is best suited to this fruit, and the Arkansas fine sand stands second. These soils are practically free from alkali and have a water table near enough the surface to give subirrigation. The Smithwick fine sand grows a very good quality of fruit. The Pratt loamy fine sand and loam are also fairly well adapted to apples, though the trees do not do so well as on the valley types. The apple crop is uncertain, owing to late spring frosts, but probably not more so than in many other sections of the country. Some of the large orchardists are beginning to use smudges to protect their orchards. The larger growers spray and cultivate their orchards carefully. Many apples are shipped from the county. The principal varieties are the Winesap, Missouri Pippin, and Ben Davis.

Though a few peach trees are growing in the county, they are liable to injury by winter and spring cold, and crops are very uncertain. Pears, plums, and cherries do well, though the first-named are subject to the blight.

Some large plantings of catalpa trees are found in Reno County. The trees grow well, and their production seems profitable.

Around Hutchinson some trucking is practiced, though this special line is not extensively developed. Melons, cantaloupes, and berries of various kinds are grown. Some vegetables, melons, etc., are shipped to outlying counties, but these shipments are not large. A few large greenhouses are found in Hutchinson. These produce large quantities of chrysanthemums, carnations, and other flowers. One firm devotes a considerable acreage under glass to the production of vegetables, such as lettuce, radishes, cucumbers, etc.

#### AGRICULTURAL METHODS.

While Reno County does not lie within the semiarid region, it has occasional years of dry weather, which curtails, in considerable degree, the crop yields, though the conditions are never so severe as to result in an entire failure of crops. One of the principal problems in the agriculture of the region is, therefore, the conservation of moisture in the soil, and this should be the main idea in the farm practice. Under the climatic conditions, however, it is not always practicable to perform the various operations necessary to attain ideal soil conditions, and the methods of culture will need modification from season to season to meet emergencies.

The farmers of Reno County are as a class progressive and make large use of improved tillage and harvesting machinery, but the

methods used are not always such as may be expected to give the maximum crops from year to year.

No systematic crop rotations are practiced in the county, though the land is changed frequently from crop to crop by the more progressive farmers. No commercial fertilizers are used, and probably this is not necessary in the production of the general farm crops, if all the natural methods of soil improvement are utilized. The land is plowed, usually listed, for wheat at any time from the middle of July until late in September. Some break the land with a turnplow, while many "double list" it. "Single" listing is probably the most common practice and has the advantage of allowing a larger acreage to be worked when the soil is in the proper condition for working than would be the case under any other method. After listing, the land is allowed to stand until a convenient time, when it is worked down to a level surface. Often the land stands too long in this listed condition, and an unnecessary loss of moisture results. Wheat is seeded in the fall from September 15 to November 1. Often the early seeding produces best, but there are many seasons when a seeding in the middle or latter part of October produces best results. This is due to the fact that the early seeding is sometimes subjected to great damage from insect pests, such as the Hessian fly, fall army worms, grasshoppers, and later the chinch bugs. Wheat is harvested from about June to July 1. Much of the land is plowed too late in the fall for wheat. According to experiments of the Kansas Experiment Station, the best results are obtained by plowing about July 15, turning the soil to a depth of 7 inches. However, in Reno County much land could be plowed for wheat one or two weeks earlier than July 15 with good results. Land listed at the same time 5 inches deep gave a yield of 4 bushels per acre less. The station experiments also show that where land is listed and worked down soon to avoid loss of moisture the yield of wheat is greater than where the land is listed and allowed to stand a month before working down. Probably in a region like Reno County, where it is of great importance to cover a large area while the soil is moist and in good condition for plowing, the practice of listing is a very good one, provided further preparation of the seed bed is not delayed too long. Disking the land without plowing gave the lowest yields in these experiments.<sup>1</sup>

These experiments covering a period of five years show the great importance of working the land early in order to conserve the soil moisture. The results probably apply more particularly to the loams, clay loams, and silt loams. On the sandy soils of the county deep plowing is not so necessary, as the soil is naturally porous and would be in better condition, especially for small grain, if compacted.

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<sup>1</sup>Jardine and Call, Bull. 176, Kansas Agr. Expt. Sta.

Corn land is not plowed in the fall as a usual thing, but is listed in the spring. While this method is not the best one to pursue, the practice is not without merit, because the land, if left smooth during winter and spring, drifts badly. By listing the corn land in the fall and leaving it rough a surface would be retained which, together with the stubble or stalks and other vegetation, would prevent drifting. The fields in this condition would also retain a larger percentage of the winter precipitation, which in the form of snow would be blown from the land if the surface were smooth.

Under the method of listing the corn is planted in the bottom of the furrow, thus protecting it from heavy spring wind. Subsequent operations then throw the soil into the trench around the corn roots until at the last cultivation the surface is practically level. On the very sandy soils it is generally practicable to plant corn very late, thus avoiding some of the hard winds of early spring.

There are no hard and fast methods of "dry farming" that may be followed under all conditions, but the general principles should be applied by the farmer to suit his particular conditions in so far as is possible. The essential features of "dry farming" methods consist of thorough preparation of the land and the maintenance as far as is possible of soil mulch to minimize evaporation. If the land is worked properly, it will not blow. It is doubtless true that a more thorough preparation of land for corn, with better cultivation, would produce much higher yields.

Alfalfa is grown in a small way by many farmers with varying success, the yields depending on the rainfall. Once established, the stand persists for several years in the better locations, though it is often damaged by gophers.

It is believed that a larger acreage devoted to kafir in the place of corn would be more profitable. The general idea that kafir and sorghum are hard on the land probably arises from the fact that these crops leave the land in a rather hard and compact condition, which is difficult to overcome in subsequent tillage operations. Probably if more attention were given to getting the soil in a loose, friable condition after these crops are harvested, the following crops would not show the lower yields generally attributed to the effect of kafir and sorghums on the soil.

The question of maintaining or improving the productiveness of the soils of Reno County is one of growing importance. As yet the soils produce good crops if sufficient moisture is available, but the yields are even then lower than they should be on some soils cultivated exhaustively for a number of years. There are farms where the same crop has been grown successively for a period of years and these have shown a marked deterioration in yields, and if present practices are continued all the soils will show a similar decline in

productiveness. This condition can not be best avoided by the use of commercial fertilizers, but rather by the practice of better cultural methods and the use of the natural fertilizing agents at hand. The essentials for keeping the soil productive are systematic crop rotation, keeping a good supply of humus-forming organic matter in the soil, growing leguminous crops, and applying barnyard manure. Any rotation adopted for Reno County should be such as to allow the annual use of at least a part of the farm for the chief money crop—wheat—with corn, alfalfa, or cowpeas as other crops. Of course it is not possible to change the alfalfa land every year, but a rotation of wheat with corn, with cowpeas as a catch crop in the corn, extending over a period of 3 or 4 years, would doubtless prove of benefit to the soil.

In general the State experiment station advises for this region two-crop of three-crop rotation, about as follows:

Bottom land capable of producing alfalfa: Alfalfa 4 to 6 years; hog pasture the last year; plow moderately shallow; crop to kafir, followed by corn for 2 or 3 years, followed by oats and a green manuring crop, or follow the oats with good deep preparation for wheat; after the wheat a green manuring crop, then kafir 1 year, corn 1 year, fall plow deeply, get a crop of oats, and plant to alfalfa.

On the sandy soils cowpeas and rye as green-manure crops, cowpeas as a legume for hay, and corn and kafir for grain.

On the heavier soils capable of growing wheat and somewhat unsuited for alfalfa owing to moisture conditions, wheat followed by cowpeas for either green manure or hay is quite successful. If the cowpeas were used for green manure, kafir should be the next crop; then corn. Plow the land in the fall for oats and follow the oats with wheat. If the cowpeas are used for hay, follow with corn, then oats, and then wheat again.

The soil requires considerable decomposed vegetable matter or humus to perform its functions to the best advantage, and when a soil becomes depleted in this substance low crop yields result. Humus can be easily kept in the soil by plowing under all kinds of vegetation which, on rotting, forms this valuable substance. Nitrogen, as well as humus, is added to the soil by plowing under the vines of cowpeas. This crop, which can be grown easily on all the soils in the county, greatly improves the soil. On the dark loam and clay loam and silt loam soils of Reno County cowpeas should precede corn, kafir, sorghum, etc., rather than wheat or other small grains, as these grains are apt to lodge if the ground is made too rich. Exception to this rule may be made in the case of the sandy soils and of these areas of the heavier soils that are in a run-down condition.

Alfalfa is an extremely valuable crop for building up the soil. It grows best on soils containing lime and on the loams, clay loams,

and silt loams. After well started, the crop lasts several years, and when plowed up the next crop should be corn rather than a small grain. In fact, on the dark loams and heavier soils in Reno County the first corn crop after alfalfa is liable sometimes to go too much to stalk, and therefore on such land the first corn crop on alfalfa land might well be substituted for ensilage or sorghums or kafir the first year, to be followed by corn for grain.

In view of the value of alfalfa, considerable labor and expense can be afforded in getting it established. It is rather difficult to start on soils not well drained or in soils that are thin. The seed bed must be put in good condition and the soil should be well pulverized. On the sandy soils or on the heavy soils that are thin, the land should be built up with manure and by turning under cowpeas as a green manure. Ten or 12 tons of manure per acre could well be used on crops preceding alfalfa. In Reno County soil inoculation for alfalfa is rarely practiced or necessary.

The great value of barnyard manure for building up soils demands that all of it should be used that is produced on the farm. Manure not only enriches the soil but makes it easier to cultivate and increases its moisture-holding capacity.

According to results obtained by the State experiment station, summer fallowing land has been found to be very advantageous in western Kansas. Under this practice the land is plowed in the fall or spring and repeated shallow cultivation given during the succeeding season to maintain a soil mulch. In this way much of the water in the soil is retained and wheat seeded in the fall has an abundant supply. Experiments have shown that this method has more than doubled the yields, thus showing a greater profit than if the land had been cropped every year. One farmer in McPherson County, just outside of Reno County, is said to have produced 37 bushels of wheat per acre by this method in the season of 1911, a rather poor one for wheat in that county. The experiment station authorities recommend spring plowing for summer fallow in western Kansas, and the maintaining of a clod mulch rather than a dust mulch so as to prevent blowing.

Many of the farmers of Reno County make no use of the wheat straw. Some allow it to stand for a year or more in the field and sow their crops around the stacks. When the field of wheat is grazed in the fall and winter the stock use some of this straw, but only a small part. Some farmers on the sandy soils spread this straw on the wheat land during the fall. This is an excellent practice, for the layer of straw prevents the soil from blowing to a considerable extent, acts as a mulch, and catches the drifting snow. Later becoming incorporated in the soil, it adds to the humus content and exerts a good effect on the physical condition of both sandy

soils and heavy soils. All the soils of the area would be benefited by spreading straw on the fields in the fall and winter. Straw should be scattered very thinly where a young crop occupies the ground.

#### ADAPTATION OF SOILS TO CROPS.

There is a wide range of soils of all classes in Reno County, but the same general crops are grown on nearly all. The method of farming most practiced is what is known as general farming, that is, wheat and corn are the main crops and money crops. Corn is grown largely as a means of producing feed for the farm animals, though in some years a surplus is available for sale. Probably two-thirds of the corn produced in the county is either sold for shipment or is sold to other farmers. Alfalfa, sorghums, and kafir are also grown as feed crops for the farm animals, though a part of these crops is also sold from the farm if the production is more than sufficient to meet the local demands. Some farmers specialize on a particular crop, there being not a few who grow wheat mainly, with small acreages of corn and other feed crops. These farmers as a rule are on the heavier types of soil, the loams and clay loams, thus showing that it is generally recognized that the heavier types are best adapted to wheat. However, on the Pratt fine sandy loam, a very extensive type and one best adapted to corn, kafir, and sorghum, a very large acreage of wheat is sowed. This type, while not giving such large yields of wheat, produces fair crops even in dry years, owing to its ability to hold moisture. On the Pratt loamy fine sand, another extensive type, wheat growing is not so general, and here a larger acreage is devoted to corn. Even in dry years fair yields of corn are made on this soil and corn here constitutes the money crop.

Owing to the better moisture conditions of the sandy and loam soils of the Arkansas Valley, these soils are generally better adapted to alfalfa than other soils of the area. The upland heavy soils, while adapted to alfalfa, suffer more from dry weather and the yield is proportional to the amount of rainfall. On the sandy loams and sands alfalfa is hard to get started, owing to the blowing of the soil when the plants are young. It also dies more rapidly on the sandy soils on account of the drying out of the surface soil and the heat absorbed by the surface soil in warm, dry weather. By building up these light soils with manure and vegetable matter, alfalfa could be started and would do well even on these light upland soils. Apples do best on the sandy soils of the Arkansas Valley.

#### TENURE AND SIZE OF FARMS.

All the land in Reno County has been taken up by homesteading and by purchase of railroad lands. It has thus been secured in comparatively small tracts of 160 acres or thereabouts, and to-day this

is the size of the majority of the farms. There are some farmers who rent considerable areas in addition to the land they own. Those who make a specialty of wheat growing often cultivate several hundred acres.

The areas of sand soils, where farming would not be profitable, are utilized in tracts of several hundred acres for grazing.

The majority of the farmers own the land they till, though there are some operating leaseholds. The rental paid for land is usually on a share basis and ranges from two-fifths to three-fifths of the crops grown, depending on what is furnished the tenant and by the owner. Some farms are rented for cash, the amount paid ranging from \$300 to \$400 per annum for a 160-acre farm with improvements. Where there is some alfalfa, as high as \$600 a quarter section is sometimes paid.

The supply of labor is usually sufficient throughout the county. Owing to the large use of machinery it is possible for one man to farm a considerable area, and many farmers with their sons do all their work, except during harvest. Farm laborers are usually efficient, being in most cases residents of this section of the State and so familiar with local conditions. Regular farm hands are paid \$20 to \$25 a month and board, while day labor in harvest is paid \$2 to \$2.50 a day. Corn is often husked by hired labor working by the piece, 4 or 5 cents a bushel being paid.

#### IRRIGATION.

Irrigation is not extensively practiced in Reno County, being principally confined to a few truck farms, using water pumped from wells. This has been found to be profitable, especially during the dry seasons. The immediate channel of the Arkansas River is of comparatively little value as a source of water supply, because irrigation projects farther up the stream in western Kansas and Colorado exhaust the greater part of it. Though the water from the North Fork of Ninnescah and Little Arkansas Rivers could be utilized for the irrigation of limited areas in the narrow valleys in which they occur, no use is at present made of it. However, in the Arkansas Valley there is a considerable supply of water in the underflow outside of the stream channel which could be secured by tapping with shallow wells and by pumping on the land. Comparatively inexpensive individual plants can be established throughout this valley, using gasoline engines for power, and in the aggregate considerable land can be brought under irrigation.

Among the crops at present grown, truck crops and alfalfa would probably be most successfully and profitably irrigated. Apple orchards could also be irrigated to advantage in the same way. Irrigation need not be confined to the valley, but could be profitably

extended to the upland prairie, where good water can be secured at depths of 25 to 30 feet and be handled by means of cheap pumping outfits. Undoubtedly sugar beets could be produced in the Arkansas Valley in a very satisfactory way by small irrigation plants, utilizing the Arkansas loam and fine sandy loam for this crop, though it is seriously affected by drifting soils at all stages of its early growth.

#### ALKALI.

There are no large tracts of land in Reno County carrying large quantities of salts deleterious to plant growth. On poorly drained areas of the heavier soils of the Arkansas Valley, namely, the Arkansas loam and clay loam, there are numerous small spots and streaks whose content of soluble salts is sufficient to prevent the growth of farm crops. The clay loam is particularly subject to such conditions in both the Arkansas and the Little Arkansas Valleys. The Lincoln very fine sandy loam is also affected to some extent in the same way, as are also the soils of the alkali phases of the Pratt fine sandy loam and Pratt silty clay loam series in the basin-like areas of the upland. Bicarbonates are the predominating salts in the river valleys and sulphates and chlorides in the upland basins. These areas are covered with a native growth of salt grass (*Distichlis spicata*), though in some places there is so much alkali present that even the growth of this plant is not heavy. Without doubt, the most effective way of removing this alkali and getting the land in a good productive condition is by installing tile drainage. Tiling would be rather expensive, and in many places the expense would be too great to be borne by individuals. While ditching the land would be of some value, it would not be nearly so effective as tile drainage. Probably some improvement could be effected in these spots by deep cultivation, which would scatter the accumulated salts. Subsequent cultivation which would provide a surface mulch should be given the land. Eventually cowpeas could be planted and the green vines plowed under. Finally, after a surface layer of rich soil was established, alfalfa could be started, and if a stand could be secured and allowed to remain for several years it is probable that a recurrence of the alkali condition would be avoided.

It is likely that the alkali is more abundant in the heavy soil because of the greater capillarity of such material, with a consequent greater evaporation of soil moisture and a deposition of salts dissolved in the water as it passes upward. Any treatment tending to prevent surface evaporation will produce a condition unfavorable to the accumulation of these salts. This would be accomplished by a covering of vegetation, which tends to retard evaporation, as does the maintenance of a soil mulch, and these two means should be made use of. If irrigation were carried on in the valley, a superabundant

use of water might tend to produce an alkali condition in the soils by dissolving the salts and bringing them to the surface. This danger would be avoided by tile drainage or by taking care to not use too much water. By irrigating land which is drained by tile there would be little trouble in removing the alkali from the soils by the process of washing out, but this method would undoubtedly prove expensive in most cases.

#### SOILS.

The rocks of Reno County are of two great classes—the bedrock, which underlies all of the county, and the mantle rock, which lies upon and covers the bedrock so deeply that it is seldom seen or reached in drilling wells. The term “mantle rock” is used to designate the unconsolidated soil material found on the surface of the prairies, as distinguished from the solid rock which underlies it. The bedrock belongs to what geologists term the Permian series, with possibly some of Cretaceous age in the northern part of the county. In the southeastern part of the county the Red Beds of the upper Permian are exposed, forming what is locally known as the “Red Jaw country.” The Red Beds are composed of red clay shale and red sandy shale interspersed with thin strata of greenish-gray shaly limestone. The general arrangement of the bed and mantle rocks is shown in figure 2.

The mantle rock is by far the most important from the standpoint of soils, since it is the surface formation of most of the county. Originally the entire county was covered by these deposits, but in places it has been eroded away. It consists of a mixture of gravel, sand, and clay in varying proportions. The gravel and sand particles are well rounded, indicating long-continued rolling by streams. The sand is mostly quartz, though there is some feldspar. The gravel is formed of many varieties of rock, including quartz, feldspar, granite, and other igneous rocks.

The surficial deposits are generally regarded as having been carried from points westward as far as the Rocky Mountains and laid down in their present position by somewhat sluggish interlacing streams. Rocks of mineralogical characteristics similar to those of the gravel are found in place in the Rocky Mountains. The age of this deposit is uncertain, some geologists holding it to be Tertiary and others believing it to belong to a later period called the Pleistocene.<sup>1</sup>

The soils in this area that have been formed by the weathering of the rocks of the Red Beds, that is, the residual types, do not

<sup>1</sup>Haworth, University Geological Survey of Kansas, 2, p. 280; also Williston, *ibid.*, pp. 299-308; Johnson, U. S. Geological Survey, Twenty-first Annual Report, Part IV, pp. 629-632.

occupy an area of over 80 square miles. The main type having this origin is the Kirkland clay. It occurs in a badly eroded region and in many places the parent rock is exposed or is very near the surface. The red color of the clay shale and resultant weathered product of this rock—the red clay—is everywhere so noticeable that this material is locally known as “red jaw.” The red shale is also often called “kiel” by the farmers of that section. An eroded phase of the Kirkland clay was also mapped.

The Vernon series is represented by a very fine sandy loam and an eroded phase of this type. In the southern part of the county are found small areas of a very fine grained red sandstone which on weathering give rise to the Vernon very fine sandy loam. This sandstone probably represents the upper horizon of the Permian in this region.

In a few very small areas throughout the Permian there is found a dark soil overlying the partially weathered shaly limestone. This soil is but a few inches deep in many places and the impervious layer of limestone gives rise to a thin soil covering. This has been called the Castleton silt loam. Many areas of it were too small to show on the map.

Eventually as the western part of the county is reached the Permian disappears entirely at an altitude of about 1,600 feet. Even in the main area of the Red Beds there are a number of small areas of the sedimentary deposits remaining as a thin covering over the rock. This has resulted in the formation of soils combining characteristics of the Kirkland series with those of the Pratt series. In many places the red clay of the Permian was found at a depth of less than 3 feet. These soils were placed in the Englewood series, being mapped as the sandy loam and loam.

As already stated, the sedimentary material still covers the greater part of the surface of the county except where removed by erosion, exposing the Red Beds. It constitutes the high rolling prairies. By weathering of this material, combined with some wind action, large groups of extensively developed soils have been formed. These groups are called the Pratt, the Albion, and the Clark series. Of these the Pratt series is the most extensive. The heavier types of this series, the loam and silty clay loam are probably the least changed since their first formation of any of the types. In the western part of the county the coarser material, consisting of fine and medium sand, has been blown considerably and being mixed with these heavier types has produced areas consisting of the Pratt fine sandy loam. Areas of the Pratt loamy fine sand are still blown to some extent and the Pratt fine sandy loam is probably still being formed gradually. The Pratt silty clay loam, black phase, has been

formed in much the same way as the heavier types of the Pratt series, though it is confined to areas more poorly drained.

The sedimentary deposits in large areas in the southern part of the county contain considerable fine gravel in the upper stratum. The soils resulting from the weathering of this material resemble topographically the Pratt series. However, they are more leachy and not so good agriculturally as the similarly textured soils of the Pratt series. They have been given the series name of Albion. In certain parts of the area there are found calcareous beds, which probably represent the base of the sedimentary deposits. These have been exposed by erosion in only a few areas and resemble the mortar beds of western Kansas. The soils derived by the weathering of these beds are dark in color and have been placed in the Clark series. The main type is a clay loam. The two other types, the loam and sandy loam, have probably been formed by the mixing of wind-blown sand with the heavier clay loam.

In the western part of Reno County there are a few small basin-like areas in the prairie which are so affected with alkali that the soils are unproductive. These soils have been classified as the Pratt fine sandy loam, alkali phase, and the Pratt silty clay loam, alkali phase. The origin of these areas is obscure, but it is thought that they may either have been formed by a subsidence of the upper strata into a cavity left by dissolved salt beds or that they may have been old lake beds. The alkali phase of the Pratt silty clay loam is probably the original material and the alkali phase of the Pratt fine sandy loam has been formed by the mingling of fine wind-blown sand with it.

Areas of soils are found covering the original sedimentary deposits that owe their origin to eolian agencies. These are the soils of the Smithwick series. In the northeastern part of the area the material has been blown onto the upland from the bed of the Arkansas River; in the western part it has probably been derived from areas of the upland soils or from material exposed farther west and south and classed as Tertiary. Much of this is in the form of Dunesand. Where this covering of sand has been deposited in thin layers the heavy material of the original mantle lies near the surface, and this has given rise to the heavy subsoil phase of the Smithwick fine sand.

There is a considerable area of alluvial soils in the Arkansas Valley. These have been formed by washing of soil material from the Rocky Mountain region and from areas of sediments in western Kansas and eastern Colorado. These soils are mostly dark in color and have been classed with the Arkansas series. The most recent of these deposits is still subject to overflow and is mapped as Meadow. "Meadow" is the term applied to areas of unassorted soil material and includes,

besides the areas in the Arkansas Valley, alluvial soils along the small streams in the southern and western parts of the county.

It will be seen, therefore, that according to origin there are several groups of soils in Reno County, namely, (1) residual, or those formed from shales and sandstones; (2) those formed from unconsolidated water-laid deposits; (3) those formed from a mixture of the above two groups; (4) those formed from wind-laid deposits; (5) alluvial soils, or those deposited as stream sediments.

The following table shows the classification and area of the different soils:

*Classification and area of soils.*

Soil groups and types.	Acres.	Per cent.	Soil groups and types.	Acres.	Per cent.
Residual soils:			Mixed residual and sedimentary soils:		
Vernon very fine sandy loam.....	7,616	0.9	Englewood sandy loam...	2,688	0.3
Eroded phase.....	64		Englewood loam.....	7,232	.9
Kirkland clay.....	39,808	4.9	Eolian soils:		
Eroded phase.....	256		Smithwick fine sand.....	17,344	2.8
Castleton silt loam.....	2,944	.4	Heavy subsoil phase..	5,760	
Soils from unconsolidated water-transported material:			Dunesand.....	43,456	5.3
Pratt loamy fine sand....	55,360	6.8	Alluvial soils:		
Pratt sandy clay loam....	1,408	.1	Lincoln sandy loam.....	6,272	.8
Pratt fine sandy loam....	78,080	15.1	loam.....	5,120	.6
Coarse phase.....	41,088		Lincoln fine sandy loam..	16,320	2.0
Alkali phase.....	3,904		Lincoln loam.....	2,560	.3
Pratt very fine sandy loam.....	20,864	2.6	Lincoln clay loam.....	1,536	.2
Pratt loam.....	134,976	16.6	Lincoln fine sand.....	1,600	.2
Pratt silty clay loam....	17,728	2.9	Arkansas fine sandy loam.	45,184	5.6
Black phase.....	3,968		Arkansas loam.....	24,128	3.0
Alkali phase.....	1,728		Arkansas clay loam.....	11,072	1.4
Albion loamy coarse sand.	11,968	1.5	Arkansas fine sand.....	4,480	.6
Albion sandy loam.....	89,984	11.1	Arkansas clay.....	1,152	.1
Albion loam.....	48,384	6.0	Meadow.....	13,696	1.7
Clark sandy loam.....	3,648	1.0	Total.....	812,800	
Coarse phase.....	4,672				
Clark loam.....	11,520	1.4			
Clark clay loam.....	23,232	2.9			

ENGLEWOOD SERIES.

The Englewood series of soils has been formed by the weathering of two different geological formations, the unconsolidated material of the Tertiary and the Permian Red Beds, which are made up for the most part of shales and sandstones. The soils range in color from brown or dark brown to reddish brown, while the subsoils are reddish brown to red. A large portion of southeastern Reno County is occupied by these soils. Owing to severe erosion these types are often thin and of no great productiveness. Two types were mapped in this series—the sandy loam and loam.

## ENGLEWOOD SANDY LOAM.

The surface soil of the Englewood sandy loam consists of 8 to 15 inches of a brown sandy loam. It is rather open in structure, the coarse soil grades predominating. Sometimes a small quantity of small gravel is present. The sand particles are well rounded and consist principally of quartz. The subsoil to 36 inches ranges in texture from a sandy loam to a sandy clay. The red clay of the Permian Red Beds is sometimes encountered at 18 to 30 inches or it may be several feet beneath the surface.

The Englewood sandy loam is found in small areas throughout the southeastern part of the county. It is surrounded by large areas of the Kirkland clay, into which it passes gradually.

The type is derived from two distinct classes of material, the water-laid Tertiary and the Permian rocks. It lies within the region where erosion has removed much of the former and has cut into and exposed the latter. The soil of the Englewood sandy loam represents the remains of the original rock mantle or Tertiary material, while the subsoil may be the same material or may be the red clay of the Permian. At any rate, the red clay is not very deep below the surface. Sometimes it may be touched by the auger over considerable areas, while again, cuts in banks show it to be several feet below the surface.

The surface of this type is gently rolling to undulating and the drainage is good.

Considerable areas of this soil are cultivated and good yields are secured during seasons of adequate rainfall. Corn, kafir, and sorghum, with wheat and alfalfa in small acreages, are the principal crops, the first three doing better than wheat and alfalfa. Yields of 20 to 40 bushels of corn and 25 to 40 bushels of kafir per acre are secured. Wheat yields 5 to 20 bushels per acre, depending on the season. The type is not a good wheat soil, being too light. Alfalfa gives fair yields where a good stand exists, but the type is not especially adapted to this crop. Cowpeas and truck crops of all kinds do well. The soil is greatly benefited by growing cowpeas on it and by the addition of barnyard manure and organic matter, as it is low in humus content. Owing to the fact that the type has a restricted development it is not considered especially desirable. There are few areas large enough for good-sized farms.

## ENGLEWOOD LOAM.

The surface soil of the Englewood loam consists of 8 to 15 inches of dark-brown or reddish-brown loam. Sometimes there is considerable sand in the soil, but there is sufficient clay to give a heavy texture. The subsoil to 36 inches consists of a neutral brown or reddish-brown loam or red clay. The subsoil of red clay may be

encountered at from 6 to 36 inches, or it may form a part of the deeper substratum. It often has white material in it. In some places on the top of knolls there are beds of small gravel, in part quartz gravel and in part a black ferruginous sandstone. These gravelly areas, which are not numerous, were too small to show on the map. The soil is easily cultivated and has good tilth, though it often contains very little organic matter.

The areas of the Englewood loam are not very large and are scattered throughout the southeastern part of the county. It is closely associated with the Kirkland clay, into which it merges gradually. It is also closely associated with the Englewood sandy loam and differs from it only in percentage of sandy material. Some areas of the type are found extending up into the high Tertiary covering, and in these places the subsoil is the red clay.

The Englewood loam, like the sandy loam, represents areas where a thin covering of Tertiary material rests on the Permian Red Beds. Thus the surface soil consists of Tertiary material and the subsoil in some places of this material and in others of the red clay weathered from the Red Beds.

The Englewood loam is gently rolling in topography and has good drainage. It occupies the higher positions where surrounded, as it is usually, by areas of the Kirkland clay. It often occurs as ridges and minor elevations.

A considerable area of the Englewood loam is in cultivation. It is better adapted to farming than the heavier Kirkland clay. The principal crops are corn, wheat, alfalfa, kafir, and sorghum. In seasons of normal rainfall good yields of these crops are secured. From year to year corn yields from 10 to 40 bushels, wheat from 8 to 25 bushels, kafir 20 to 40 bushels per acre. Alfalfa yields medium crops where a good stand is secured. Sorghum gives a large yield. Vegetables and small fruits do well. In order to increase its productiveness cowpeas should be grown and barnyard manure and other organic matter should be added to it. At present the humus content is low. Where uncultivated the soil supports a heavy growth of native grasses.

#### KIRKLAND SERIES.

##### KIRKLAND CLAY.

The surface soil of the Kirkland clay consists of a brown or reddish-brown clay having a depth ranging from 6 to 15 inches. The subsoil consists of red or reddish-brown clay, very heavy and massive, that may continue to depths of 36 inches or may grade into red shale or a greenish gray shaly material at from 18 to 36 inches. Even where the subsoil is a red clay to 36 inches it very often contains numerous spots of a white or greenish material, which is undoubtedly recently disintegrated shale.

The Kirkland clay is quite heavy and difficult to cultivate. On steep or moderate slopes where erosion has been active the surface soil is often partly or wholly absent, the material possessing a pronounced reddish cast. On the more gentle slopes the surface soil is several inches deep, while in some of the level areas it may be 16 inches deep and quite dark. Thus nearly every field of the type has a number of phases which vary in productiveness according to the topography and depth of soil. The red clay spots where large enough were mapped as the eroded phase of the Kirkland clay, but most of them were too small to indicate on the map as a separate phase. There are spots of undifferentiated Englewood loam and sandy loam scattered throughout the type.

The Kirkland clay is located in a large connected area in the southeastern part of the county, where it forms the surface of the drainage basin of the North Fork of Ninnescah River north of that stream. It lies entirely on the geological formation known as the Permian Red Beds and constitutes a large part of Sumner, Ninnescah, and Castleton Townships.

The Kirkland clay has been formed by the weathering of the Permian Red Beds, which consist here of interbedded red clay shale and a thin shaly limestone. In cuts there is a greenish-gray clay shale interbedded with the red clay shale. The former, more or less disintegrated and softened, forms the greenish-gray material encountered in some places at depths of about 18 inches.

The large area of the Kirkland clay occupies a broad, rolling to undulating prairie, with a few areas very rolling to hilly. The type lies at an altitude of 1,400 to 1,500 feet above sea level and is from 20 to 40 feet lower than the general surface of the Tertiary prairie. On the northern edge of the area there is a definite but gently sloping escarpment leading down from the Tertiary prairie. This escarpment may be from one-fourth mile to a mile in width and represents a descent of 15 to 40 feet. A great number of small streams of intermittent flow cut the area, and the drainage is excessive. Erosion has been severe, also, and there are few areas of a quarter section in extent that do not show in part a washed and eroded or gullied condition.

Owing to this condition and to the intractable nature of the soil, the type is not a desirable one. Its red exposures of clay and shale are locally called "kiel," and the general term of "red jaw" is applied to the red clay subsoil and to the type as a whole. Much of the land is left in pasture, and in most places there is a heavy growth of coarse native grasses consisting of poverty grass (*Aristida longiseta?*), windmill grass (*Chloris verticillata*), *Sporobolus cryptandrus*, grama grass (*Bouteloua gracilis?*), and others.

There are quite a number of farms on the type. The crops consist of corn, wheat, kafir, sorghum, and some alfalfa. Yields depend

largely on the season, depth of the surface soil, and the condition as regards erosion. On the better areas yields are good in favorable seasons. Corn yields from 10 to 25 bushels, wheat from 8 to 25 bushels, and kafir from 20 to 45 bushels per acre. Sorghum yields well. On the lower areas near the creeks alfalfa gives 3 or 4 cuttings a year. On the shallow areas the yields are very light in dry seasons. The soil is better adapted to wheat, kafir, and sorghum than to corn.

The soil is difficult to cultivate. When dry it bakes into a hard, compact mass; when wet it is sticky and heavy, and if worked then it will form hard clods that are broken down with difficulty. In dry weather, when cultivation is very necessary to conserve moisture, the structure of the soil is such as to make tillage arduous. The type is better adapted to crops like wheat that do not require cultivation. The physical condition of the soil could be improved by turning under organic manures and all available coarse, trashy litter such as the straw and stubble of wheat, none of which should be burned or allowed to rot in the stalk.

The type is valued at from \$20 to \$50 an acre.

*Kirkland clay, eroded phase.*—The Kirkland clay, eroded phase, consists of a red heavy clay ranging in depth from 18 to 36 inches or deeper, where it is underlain by red and green argillaceous shale.

Small areas of this phase are found in the southeastern part of the county. Most of these are too small to show on the map and are included with the typical soil which forms the surrounding areas.

The Kirkland clay, eroded phase, has been formed by the weathering of argillaceous strata of the Permian formation. It has in general a rolling to rather hilly surface, though some areas are nearly level. In the Permian escarpment it is found occupying small areas of a rather rough and broken surface. It is subject to excessive drainage and erosion, the latter being an important fact in its formation.

Owing to the slight extent of this phase none of it is utilized except where it occurs in fields of the typical Kirkland clay. In its native state it is rather bare of vegetation and is of practically no value agriculturally.

The following table gives the average results of mechanical analyses of samples of the typical soil and subsoil of the Kirkland clay:

*Mechanical analyses of Kirkland clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381035, 381042.....	Soil.....	0.7	3.1	2.6	3.9	8.1	41.8	39.8
381036, 381043.....	Subsoil.....	.7	2.9	2.5	4.4	4.8	47.2	37.2

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 381036, 14.54 per cent; No. 381042, 3.20 per cent; No. 381043, 16.70 per cent.

## VERNON SERIES.

The Vernon series comprises the soils derived exclusively from the weathering of material of the Permian Red Beds. These soils are red to brownish red in color, and have red subsoils. The color is a marked characteristic of the series. In this area the Vernon soils are not so extensively nor so typically developed as in other areas. Only one type was encountered, the Vernon very fine sandy loam.

## VERNON VERY FINE SANDY LOAM.

The surface soil of the Vernon very fine sandy loam consists of a neutral brown, reddish brown, or dark brown very fine sandy loam, 12 to 18 inches deep. The subsoil to 24 inches consists of a red or reddish-brown very fine sandy loam. At 24 to 36 inches a red fine-grained soft red sandstone is often encountered, though it may occur at a depth of several feet. In some places where the surface is sloping and erosion has been active the soil may have a decidedly red color. Many such areas are too small to show on the map, though where this was practicable these were separated and classed with the eroded phase of this soil. The surface soil of the Vernon very fine sandy loam is easily tilled and a good surface mulch may be easily maintained.

This type is developed in the region a few miles south of Arlington, in the southern part of the county. It is not a very important soil in this county.

The Vernon very fine sandy loam is residual in origin, having been formed by the weathering of Permian red beds material. The underlying rock is a fine-grained red sandstone and it would seem that the soil must have been formed from this rock, though the dark color of the surface soil would indicate that it may have been influenced to some extent by the material of the Tertiary formation, or the darker color of the surface may be due to the presence of organic matter. No strata of darker sandstone were found. The fine-grained red sandstone seems to represent the upper horizon of the Permian in Reno County, for it is found in the western part of the county at higher altitudes than the shales of the same formation farther east in the county. Erosion has removed only a small part of the Tertiary from the sections underlain by this sandstone, and consequently only small areas of the soil derived from it are found. They occur over the partly eroded elevations and high points along the tributaries of the North Fork of Ninnescah River. These areas occupy an intermediate position between the high Tertiary prairie and the rather deeply carved valleys of the streams. A rolling to hilly surface is found in these areas in places. Erosion has cut rather steep slopes in some places, exposing the red subsoil. The type has very good drainage.

Corn, alfalfa, wheat, kafir, and sorghum are the principal crops. Corn yields 20 to 40 bushels and wheat 10 to 20 bushels per acre. The other crops produce good yields. It is considered a very good soil, withstanding unfavorable weather conditions better than some of the heavier types.

*Vernon very fine sandy loam, eroded phase.*—The surface soil of the Vernon very fine sandy loam, eroded phase, consists of 12 or 15 inches of a red very fine sandy loam. The surface soil is slightly darker than the subsoil, with which it is otherwise seemingly identical. The subsoil sometimes is underlain by the fine-grained red sandstone at a depth of less than 36 inches, just as in case of the typical soil.

This phase occupies a few very small areas in the southern part of Reno County and has little importance. It has been formed in the same way as the typical soil, except that erosion has been more active in the first instance. This also accounts for the more rolling to hilly topography. Surface washing causes the surface soil to be very shallow.

The most of this type is in pasture, though a few small spots in fields of other types are cultivated. The type has little value agriculturally, owing to the thin and eroded condition of the surface.

#### CASTLETON SERIES.

##### CASTLETON SILT LOAM.

The surface soil of the Castleton silt loam consists of 12 inches of a dark-brown or grayish-brown rather heavy loam. The substratum consists of gray clay and shaly limestone, more or less disintegrated, which at varying depths less than 36 inches rests on the thin shaly limestone. In some areas the limestone is encountered at 20 inches and is so thin and broken as to be penetrated by the auger. Red clay occurs underneath the limestone.

The Castleton silt loam is found as a few small spots scattered through the southeastern part of the county along the escarpment between the Tertiary and Permian formations. Many areas of this type too small to be shown separately were included with the Kirklund clay, with which type it is associated.

The Castleton silt loam is derived from the weathering of the thin shaly limestone which is found occupying the highest positions in the Permian Red Beds. It has a gently undulating to nearly level topography and occupies a shelf-like position just below the Tertiary formation. The narrow areas of this type have been cut into by the streams and reduced in extent by erosion. The land is cultivated in some places and fair yields of corn and wheat are secured during good seasons. Kafir and sorghum produce good yields. Owing to the impervious nature of the subsoil and the presence of

the thin shaly limestone stratum the soil has a tendency to dry out rapidly.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Castleton silt loam:

*Mechanical analyses of Castleton silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381045.....	Soil.....	0.8	5.1	4.0	5.0	6.3	60.7	18.1
381046.....	Subsoil.....	.5	1.8	1.1	1.8	10.0	72.9	11.7

The following samples contained more than one-half of 1 per cent calcium carbonate (CaCO<sub>3</sub>): No. 381045, 2.50 per cent; No. 381046, 10.11 per cent.

#### PRATT SERIES.

Over a very large proportion of Reno County the soils are derived from the Tertiary deposits. These soils have dark-brown surface soils and reddish-brown to yellowish-brown or dark-brown subsoils. These soils have been grouped in the Pratt series. The sands are thought to be composed to a large extent of feldspar and minerals other than quartz, and wherever the sandy deposits have been exposed to long weathering they have become slightly loamy in texture. These soils occupy the high rolling prairie. The Pratt series is represented by a loamy fine sand, sandy clay loam, fine sandy loam, very fine sandy loam, loam, and silty clay loam.

#### PRATT LOAMY FINE SAND.

The Pratt loamy fine sand consists of 10 to 18 inches of a dark-gray to brown loamy fine sand, underlain by brown or yellowish-brown material of the same texture as the soil, though sometimes considerably more medium sand is present. The subsoil becomes heavier and more compact, as well as lighter in color, with increase in depth. The sand grains are well rounded and consist of quartz, feldspar, and other minerals. The surface soil is deficient in organic matter and the structure is light and incoherent, though slightly more compact than that of a fine sand. Where the surface is somewhat billowy the soil is lighter in texture on the elevations than in the depressions. This soil is easily cultivated, though unless special care is taken the soil blows badly and bare areas are formed.

This type is represented by a number of good-sized areas in the western part of the county.

The Pratt loamy fine sand is derived from the Tertiary sands of the plains region, and probably the type has been placed in its present position by wind action. During heavy winds it still drifts badly, and the surface is rolling to undulating or billowy, with a dunelike topography in some places, the small rounded hills being 10 or 15 feet above the lower areas. The type is well drained,

water sinking down rapidly through the soil. Lower lying areas catch the run-off water and are kept moist by the seepage, though as a rule they are not too wet for cultivation.

A considerable proportion of the Pratt loamy fine sand is cultivated, though some areas are still covered with a heavy growth of coarse prairie grasses, principally bluestem, broom sedge, Indian grass, and eragrostis. Corn, kafir, sorghum, and wheat are the chief crops. Corn is the most important crop. It is profitable, especially in the low spots, kept more or less moist by seepage. The soil holds considerable moisture and the crop is reasonably certain even in dry years. The yield ranges from 15 to 20 bushels per acre. Kafir corn yields well and sorghum makes a heavy growth. A smaller acreage is devoted to wheat than to either of the crops mentioned. The soil is rather too light in texture for this cereal. The yields vary greatly, depending on seasons, the range being from 4 to 12 bushels per acre. Land sown to wheat is liable to drift badly unless the plants attain considerable growth by early spring. It is said that the quality of wheat is not so good on this soil, as it inclines to develop yellow berry. Apples do fairly well. Vegetables and melons do well. This land is valued at \$10 to \$25 an acre.

PRATT SANDY CLAY LOAM.

The surface soil of the Pratt sandy clay loam consists of 8 to 12 inches of a dark-brown sandy clay loam. The subsoil to 36 inches is a brown sandy clay or sandy loam. Soil of this type forms small areas in the extreme southeastern corner of the county. It is derived from the weathering of Tertiary material which has been more or less modified by wind-blown sand. The type is gently rolling and undulating and has good drainage. Areas with the texture of a true clay loam are included in this type. These were not differentiated on the map for the reason that they were too small.

The crops grown on the Pratt sandy clay loam are corn, wheat, kafir, and sorghum. Owing to its rather heavy texture, it is a fairly good soil for wheat, producing from 10 to 20 bushels per acre. Corn yields from 15 to 40 bushels per acre. Kafir and sorghum produce excellently. Alfalfa will give fairly good crops. Owing to the small extent of the type in this area, it is not an important soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Pratt sandy clay loam:

*Mechanical analyses of Pratt sandy clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381070.....	Soil.....	0.1	5.3	13.9	26.6	12.2	22.6	18.9
381071.....	Subsoil.....	.2	7.0	15.4	24.0	8.6	23.3	20.7

## PRATT FINE SANDY LOAM.

The Pratt fine sandy loam consists of 10 to 18 inches of dark-gray to dark-brown fine sandy loam underlain to 36 inches by a brown loam to sandy clay. There is some variation from this typical description. In the western part of the county, where influenced by proximity to sandy types, the material may be a loamy fine sand of somewhat lighter color. Occasionally the brown subsoil has a reddish or a yellowish tinge. The typical surface soil clods slightly when plowed, but the lighter areas are rather loose and friable. On the whole, the soil is easy to cultivate and to maintain in good tilth. It normally contains only a small quantity of organic matter.

Large areas of this type are found in the northwestern part of the county, and a number of small areas in various other sections in the western part. It has been formed by the blowing of weathered Tertiary sandy material onto areas of heavier material, though it is possible that some of the type has been formed in place by the weathering of exposed Tertiary sand.

The Pratt fine sandy loam has for the most part a gently rolling to undulating surface, though in some areas there occurs a slightly billowy or dunelike topography. The type has good drainage throughout. The surface is sufficiently loose in structure to absorb the rainfall readily. The heavier subsoil tends to retain the moisture and the capillary movement is free, and the crops are able to draw upon this supply.

The Pratt fine sandy loam is cultivated extensively and is esteemed for its ease of cultivation, wide adaptation to crops, and drought resistance. The cultivated areas are covered with a heavy growth of prairie grasses of the varieties already mentioned. While coarse, these grasses afford good grazing. The soil is adapted to the production of corn, kafir, sorghum, broom corn, alfalfa, and in a moderate degree to wheat. These at present are the principal crops, corn and wheat leading. All yields depend on the seasons, of course, though this type, having a loose surface soil which retards evaporation, withstands droughty conditions remarkably well. Corn is a rather certain crop, and probably has never been an entire failure, though sometimes in dry seasons the yields are very low. The range is from 10 or 15 to 40 bushels, and the average is probably a little over 25 bushels per acre. Wheat is grown quite extensively and yields from 8 to 25 bushels per acre, though it probably does not average over 12 or 15 bushels, taking every year into consideration. Sometimes the wheat is damaged in the fall by the blowing of the soil by heavy winds. Kafir, which withstands dry weather remarkably well, yields 20 to 40 bushels per acre. Sorghum as well as kafir is grown extensively and gives large yields of fodder and grain. Alfalfa is not grown extensively on this type, but where a good stand

is secured and the rainfall is sufficient good yields result. The yield is light in the dry seasons. A little broom corn is produced, and is a profitable crop. The ordinary yield is about 1 ton of straw to every 4 or 5 acres.

This soil is splendidly adapted to vegetables and truck crops, cow-peas, peanuts, melons, and cantaloupes, though these crops are little grown for market. Apples, pears, peaches, plums, cherries, and small fruits do well. Frost and dry weather curtail the yields. Apples are probably the surest fruit crop. The soil is quick to respond to good treatment and is greatly benefited by the addition of stable manure and other organic matter. Cowpeas and other legumes suited to the region should be grown, as they are of great value in increasing the nitrogen content of the soil. If the vines be turned under they not only increase the humus-forming matter of the soil but make the soil more retentive of moisture and improve its physical condition generally. Straw added to the land in the fall and winter has a good effect in protecting the soil from winds and in acting as a mulch to hold the soil moisture. It is also beneficial after it becomes decomposed and mixed with the soil.

The Pratt fine sandy loam is valued at from \$35 to \$75 an acre, the price depending mainly on the improvements and location.

*Pratt fine sandy loam, coarse phase.*—The Pratt fine sandy loam, coarse phase, consists of a brown to dark-gray sandy loam 8 to 15 inches deep, underlain to 36 inches by a sandy loam to sandy clay, usually light brown, though sometimes slightly reddish or yellowish. The areas of dark-gray surface soil occur in the western part of the county, in close proximity to the more sandy soils. The soil here contains less fine material than farther east. The heaviest winds drift this soil to some extent where the surface is not protected. As a rule, in its most easterly development, which is in the central part of the county, the Pratt fine sandy loam, coarse phase, is a rather heavy loam, and it clods slightly when broken, though plowing is not difficult.

A number of irregular shaped patchy areas of this phase, of variable size, occur in the central and west-central parts of the county. The phase is associated with the Pratt loam, and in some good-sized areas there are many areas of the Pratt loam too small to show separately on the map.

In derivation, surface features, crop adaptation, crops grown, yields, and valuation the phase is very similar to the typical soil.

*Pratt fine sandy loam, alkali phase.*—The surface soil of the Pratt fine sandy loam, alkali phase, is not very uniform in depth or texture. However, in general it consists of 8 or 10 inches of a gray fine sand or fine sandy loam. The subsoil to 36 inches consists of a yellow and gray mottled clay more or less sandy, but very heavy and rather

impervious. The surface of the soil is more or less white with an incrustation of alkali salts, and the subsoil contains white spots and concretions of the same substances. The surface presents a rough and patchy appearance with a white coating of salt and alkali most apparent on the bare spots.

A few small spots of this phase occur in the northwestern part of the county. The largest area is found about 10 miles north of Sylvia along Peace Creek.

This alkali phase seems to have been formed from the same material as the typical soil with the addition of alkali. It is locally known as "salt flats." It exists as low basinlike areas, formed perhaps by the subsidence of the surface into cavities left by dissolved salt beds. The surface sandy covering is doubtless due to the action of wind, which has blown the sand from near-by slightly higher areas.

Little of this phase is used except as pasture. It could be reclaimed by underdrainage and would then be productive land. Most of the areas are crossed by streams, which will assist in the work of reclamation.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the alkali phase of the Pratt fine sandy loam:

*Mechanical analyses of Pratt fine sandy loam, alkali phase.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381080.....	Soil.....	0.3	4.4	9.6	31.5	25.4	21.4	7.3
381081.....	Subsoil.....	.0	6.0	11.9	42.8	12.0	8.1	18.3

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 381080, 3.38 per cent; No. 381081, 0.54 per cent.

PRATT VERY FINE SANDY LOAM.

The surface soil of the Pratt very fine sandy loam consists of 12 or 15 inches of medium-brown or sometimes light-brown very fine sandy loam, which is rather heavy in texture, on account of a relatively high silt content, but of friable structure. The subsoil to 36 inches is variable in texture and color. It is usually a reddish-brown or yellowish-brown silty clay loam. In some places it is a dark-brown loam to heavy clay loam. The surface soil clods and bakes in the field on drying, except in areas containing more than the usual quantity of sand.

Only small areas of this soil were found. These are scattered over a considerable part of the county, but the total area is not sufficient to make it an important type. The largest areas are principally found in the north-central and eastern parts of the country, along the south side of the Arkansas River Valley. The type merges gradually

into the Pratt loam to the south. A few small areas are also found in the western part of the county.

The Pratt very fine sandy loam occurs on the Tertiary prairie, usually adjacent to stream valleys. The indications are that the soil has been formed by the weathering of Tertiary material. The sandy character of the surface may have resulted from gentle erosion, which has removed a portion of the finer soil material, but it seems that it may in part be due to wind action.

The surface is gently undulating to nearly level. Along the southern border of the Arkansas River Valley, where the type occupies low terraces, it is comparatively level. Here near the valley the yellowish color seen in the subsoil and vertical erosion give the material somewhat the appearance of loess. The areas have fairly good drainage in most places. In the central part of the county, near the Salt Creek flats, a few small poorly drained spots are found. Some salt grass is found here, indicating the presence of some alkali.

Practically all of this soil is under cultivation and considered a very good soil. It is easy to handle, and while it is subject to some wind erosion it does not drift so badly as the coarser textured soils. The same crops are grown as on the fine sandy loam. Corn yields from 15 to 50 bushels per acre, averaging probably about 25 bushels. Wheat yields from 15 to 35 bushels per acre, averaging 20 bushels or a little more. The soil is quite well adapted to corn and it is better for wheat than the coarser soils. Alfalfa produces fair yields, giving about four cuttings a year of one-half ton or more per cutting in good seasons. Kafir and sorghum yield heavily. The type is also adapted to the growth of milo, broom corn, emmer (speltz), rye, oats, and barley, but these crops are not grown to any extent. Deficiency of rainfall is more injurious in case of some of these crops than in case of those at present grown, while on others the profit is not considered so sure as with the staples produced. The soil is well adapted to the production of apples and many good though small orchards are found. Peaches, pears, plums, cherries, and grapes do well, though frosts make crops uncertain. Garden vegetables, potatoes, melons, canteloupes, and other truck crops are successfully grown for home use.

Land of this type of soil is valued at \$50 to \$75 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Pratt very fine sandy loam:

*Mechanical analyses of Pratt very fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381072.....	Soil.....	0.0	0.5	1.2	5.2	21.2	56.9	14.6
381073.....	Subsoil.....	.0	.4	2.4	10.1	26.7	42.9	17.3

## PRATT LOAM.

The Pratt loam consists of 8 to 15 inches of a heavy loam, medium brown to dark brown in color, underlain by a reddish-brown to dark-brown clay loam or clay, which extends to depths of 36 inches or more. Both soil and subsoil contain a considerable proportion of silt. From this typical description some variations were noted. In the more level prairie, where the type is found in large bodies, there are small flat areas or depressions, too small to show on the map, in which the soil closely resembles the black phase of the Pratt silty clay loam, except that the surface soil is a black clay loam. In other places the type includes patches of the fine sandy loam, also too small to map separately, especially as the textural characteristics of the loam at these points were more than normally sandy.

The soil is easily tilled, though when wet it is somewhat adhesive, and in uncultivated fields it bakes into a rather hard and compact mass in dry weather. Generally the soil is in good condition for tillage and readily works up into an excellent seed bed which can be cultivated at any time except when extremely wet. This soil does not drift enough to injure crops, except in the highest winds and where the soil is unusually light.

The development of this type is the most extensive of any, and it probably constitutes the most important soil in the county. Its most typical areas are to be found in the eastern part around Haven and south of Hutchinson. It occurs in large areas as far west as Plevna and occupies the greater part of the high prairie country lying just south of Hutchinson and extending to the Permian Red Beds on the south.

The Pratt loam has been formed by the weathering of the sedimentary materials, and according to some geologists this is classed as of Tertiary age and by others is considered more recent. Apparently the material has been little changed since its original deposition, except that in places sand has been blown over it to some extent. The substratum to the depth of 20 to 30 feet seems to be the same reddish brown or brown clay as the subsoil and sometimes contains calcareous concretions, but not often gravel to any extent. Sand beds are found at varying depths in these deposits, often at a depth of only 20 to 25 feet.

This type of soil has a gently undulating to nearly level surface, becoming gently rolling near the larger streams. Fairly good drainage exists, the surplus surface water being carried off by small shallow draws, which head in the more level, rather poorly drained areas of the type. In some cases the water may stand for several days after heavy rains, but as a rule the rainfall is not sufficient to make artificial drainage necessary even in the most level spots.

Nearly all the Pratt loam is in cultivation and is considered a very valuable soil type. It is adapted to a large number of crops and is very productive in seasons of normal rainfall. The soil warms up early in the spring and responds quickly with larger yields where better cultural methods are employed. Where uncultivated the soil supports a heavy sod, composed of buffalo grass (*Bulbils dactyloides*) and grama grass (*Bouteloua curtipendula*), besides white grama or mesquite grass (*Bouteloua gracilis*?). Wheat grass (*Agropyron smithii* Rydb.?) is also found on the type. After the native sod has been broken the original grasses give way in cultivated fields to crab grass and wild millet or green foxtail (*Chaetochloa viridis*).

While this soil is adapted to a large variety of crops cultivation has been confined to those that have been found the surest and most profitable for this region. The crops raised are corn, wheat, alfalfa, kafir, sorghum, and a small amount of oats. The soil is well adapted to and produces good yields of corn in favorable seasons, but when the rainfall is light or fails to come when needed the yields are cut very short. With good seasons and sufficient rain 40 to 60 bushels of corn per acre may be secured, while in very dry seasons the yields may be as low as 15 bushels per acre or less, though probably an absolute failure has never occurred. Even in dry seasons the yields may be increased by frequent shallow cultivation.

This soil is an excellent wheat soil, yields ranging from 10 to 20 bushels in dry years to as much as 30 and 35 bushels per acre in years of ample rainfall. Much depends on the time and method of preparing land. Experiments have shown that early preparation is best, preferably before July 15.

Alfalfa grows well and gives good yields. Three or four cuttings a season are secured, each yielding one-half to 1 ton per acre if the rainfall has been sufficient. In seasons of light rainfall the yield may be cut in half.

Kafir yields 25 to 50 bushels per acre, besides a large amount of fodder and is a more certain crop than corn, being able better to withstand a dry season. Sorghum gives large yields of fodder and seed. Oats are grown to some extent for pasturage, though if the crop is good it is harvested. Fifty to sixty bushels per acre have been secured when under favorable conditions, but owing to frequent dry springs it is not a dependable crop for the grain. While no emmer (speltz) is grown the type is well adapted to its production. Barley, rye, and millet will do well, but little is grown, as the other crops are considered more profitable. Broom corn should produce good yields. Cowpeas can be produced advantageously. Apples, peaches, pears, plums, cherries, and grapes grow well on this soil, apples being most successful. Small fruits will also yield well. The type is well adapted to all kinds of vegetables, melons, potatoes, and cantaloupes.

While this soil is naturally very productive, long-continued cropping may diminish the yields. For this reason the land should be handled to maintain the natural productiveness. Rotation of crops, the application of stable manure, and other vegetable matter, such as green manuring crops, straw, etc., to keep up the humus content will be effective to this end. A careful farmer need have little difficulty in keeping this soil in a high state of productiveness, and many fine farms in Reno County attest this fact.

Land of this character is valued at from \$50 to \$100 an acre and more in some special cases.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Pratt loam:

*Mechanical analyses of Pratt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381033, 381049 ....	Soil.....	0.1	3.3	6.7	9.1	18.7	42.1	19.9
381034, 381050 ....	Subsoil.....	.1	2.2	3.5	5.4	12.9	44.5	31.1

PRATT SILTY CLAY LOAM.

The Pratt silty clay loam consists of 10 or 12 inches of a dark reddish-brown rather heavy silty loam, underlain by a dark reddish-brown heavy silty clay loam or clay. The surface soil is nearly black when wet and contains enough clay to cause it to be somewhat sticky, though it works up into excellent tilth when properly cultivated. In uncultivated fields it bakes hard in dry weather and like the Pratt loam supports a heavy growth of buffalo and grama grass. In a few places along some of the steeper slopes the fine material has been washed out, leaving a relatively large percentage of the coarser particles. In these places the texture closely approaches a loam. Where the surface is more rolling the subsoil has a more pronounced reddish tinge than where greatly undulating.

The Pratt silty clay loam is found in a large area in the northeast corner of the county and in a number of smaller areas in the eastern and central parts, where it is surrounded usually by areas of the Pratt loam. It resembles greatly the latter type and differs from it only in texture. In derivation the two are identical.

A rolling to undulating surface gives good drainage in most places, though in the small areas, where surrounded by the Pratt loam, the surface is rather flat and may be wet for a few days after heavy rains. The whole type is easily cultivated without artificial drainage, though this would prove beneficial in some cases. As a usual thing the rainfall is not sufficient to make the question of drainage a serious one.

This is a very productive soil and the greater part of it is farmed. It is adapted to a number of crops, probably being best suited to small grains, alfalfa, and corn. The crops grown are practically the same as those grown on the Pratt loam. In the northeastern part of the county around the town of Buhler, where the largest body of this type is located, the land is sown very largely to wheat, though some corn is also planted. Wheat yields are from 10 to 20 bushels in dry seasons, and in seasons of ample rainfall from 35 to 40 bushels per acre. Corn yields range from 10 to 20 bushels in poor years to 40 or 50 bushels per acre in good seasons. The low yield of corn on this type is in many instances due to lack of proper cultivation. Alfalfa, grown to a considerable extent, yields one-half to 1 ton per cutting with ample rainfall, with 3 or 4 cuttings per season. Oats yield from 40 to 60 bushels per acre, though few sow this crop, the dry springs often causing a failure. Kafir and sorghum produce very good yields. While no emmer is now grown the type is well adapted to it and it is believed that its introduction would be profitable for the farmers. Barley, rye, millet, and other crops will do well on this soil but are not at present grown. Apple trees grow well on the type and good small orchards are found on nearly every farm. So far as the soil is concerned the other tree fruits do well, though uncertainty of yield caused by climatic conditions prevent extensive plantings.

Of the vegetables the type is well adapted to onions, potatoes, and cabbage. Small gardens are to be found on every farm, though truck crops are not raised for the market on this soil. The soil is too heavy for the smaller and earlier vegetables.

In places where wheat has been grown continuously for many years the yields have materially declined. This emphasizes the fact that even on this naturally strong soil it is necessary to use methods designed to maintain productiveness. Crop rotations should be followed and barnyard manure, which is very beneficial, should be used. Growing cowpeas on the land improves it materially, and plowing under this or some other green crop should be a part of the practice on every farm. Summer fallowing has been found greatly to increase the yields, but with the methods outlined the same results may be attained without the loss of time involved in fallowing.

Many fine farms are found on this type. The land is valued at from \$75 to more than \$100 an acre, depending on location and state of improvement.

*Pratt silty clay loam, black phase.*—The Pratt silty clay loam, black phase, consists of 10 or 12 inches of a dark-brown to black silty clay loam, underlain to a depth of 36 inches or more by dark-brown to black clay. The surface is rather heavy, and when dry unculti-

rated fields bake rather hard, but if cultivated at the proper time the soil works easily into good loamy structure.

The phase differs from the typical soil in being darker in color and more nearly level. It is the same in derivation and probably owes its darker color to the moister condition existing in the flatter areas and to the wash of material from surrounding areas.

A few small bodies of this phase are found in the extreme north-eastern part of the county. Some of these areas are undoubtedly old lake beds, and at times water may stand on the surface. In wet seasons these depressions are too wet for crops, but most of the type may be cultivated without artificial drainage.

This phase is considered somewhat more productive than the typical soil. It is especially adapted to wheat, corn, and alfalfa, and nearly all is now cultivated to these crops. Yields depend on seasons, but as a rule they are slightly higher than on the typical soil. Wheat yields from 15 to 35 bushels per acre, depending on rainfall and general condition of the soil. Where the land has been sowed to wheat for many years in succession, as is often the case, the yields have declined to some extent. While not so extensively planted as wheat, corn is grown and yields from 10 or 15 bushels per acre in poor seasons to 40 or 50 bushels in good seasons. The other crops mentioned in connection with the typical soil are also produced on this phase, with yields about the same.

Land of this phase is highly valued, being held at \$75 to \$100 an acre. Many fine farms are composed in whole or in part of it.

*Pratt silty clay loam, alkali phase.*—The Pratt silty clay loam, alkali phase, consists of 10 to 18 inches of a brown to dark-gray clay loam, underlain to 36 inches or more by a mottled gray and brown or gray and yellow clay showing alkali spots, and small alkali concretions and brown iron stains. The surface often has 2 or 3 inches of fine sandy material on it, and sometimes the areas of this phase and the alkali phase of the Pratt fine sandy loam are so badly mixed together that they can hardly be separated.

Like the alkali phase already described, this soil is found in very small poorly drained areas in the western part of the county. The alkali present may have come from strongly impregnated beds in the original deposits or, which seems more probable, may have accumulated through the evaporation of seepage waters draining into the depressions occupied by this soil. In any event, there are now sufficient quantities of the salts present to cause efflorescence and to render many small spots bare of vegetation.

The phase is not cultivated to any extent. Salt grass and coarse marsh grass covering much of the land afford some pasturage. The land could be reclaimed and made productive by methods already outlined.

The following table gives the results of mechanical analyses of samples of the typical soil and subsoil and of the black phase of the Pratt silty clay loam:

*Mechanical analyses of Pratt silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		<i>Per cent.</i>	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
381022.....	Soil.....	0.1	0.1	0.5	3.5	16.1	55.5	24.0
381023.....	Subsoil.....	.2	.0	.2	1.5	10.2	50.7	36.8
Black phase:								
381024.....	Soil.....	.0	.4	.7	3.1	10.4	60.4	24.7
381025.....	Subsoil.....	.0	.2	.8	6.3	13.2	40.5	39.0

#### ALBION SERIES.

In the southern and southwestern part of Reno County the Tertiary formation has given three soils which have been placed in the Albion series. The types of this series are characterized by dark-brown surface soils and reddish-brown or brownish-red subsoils, the latter usually containing some coarse sand and fine gravel. The soils resemble the Pratt soils, but the presence of the fine gravel in the subsoil makes a difference that is distinctive. The agricultural value of the Albion soils is not quite so high as soils of the same class in the Pratt series. A considerable part of the sand is composed of feldspar and minerals other than quartz, though the latter is most abundant. The soils mapped in this series are a loamy coarse sand, sandy loam, and loam.

#### ALBION LOAMY COARSE SAND.

The Albion loamy coarse sand consists of about 12 inches of dark-brown loamy coarse sand, underlain to 36 inches by a somewhat coarser material, ranging from a coarse sand containing some fine gravel to a bed of fine gravel with only a small amount of interstitial fine material. The color of the subsoil is some shade of brown, not infrequently with a reddish tinge. In areas where the type is lightest in texture the color is grayish to light brown. The surface soil contains more fine material than the subsoil, though it often contains a small percentage of fine gravel. The gravel found in the soil and that in the subsoil is usually less than one-half inch in diameter, the greater number of particles being not greater than one-eighth inch in diameter. The surface soil is loose and porous, and where unprotected it drifts considerably.

No very large areas of the Albion loamy coarse sand are found, though several of 100 acres or more were mapped. The areas are scattered over the southwestern part of the county, usually in close association with the Albion sandy loam.

The Albion loamy coarse sand has been formed by the reworking and weathering of the sedimentary material. Wind, as well as water action, has had some influence in its formation. It seems in many places to be due to the gentle erosion of the Albion sandy loam, the finer material having been removed by the gently flowing surface waters, leaving the coarser material behind. In some cases material seems to have been washed into lower lying areas and here appears to be in part colluvial in origin.

The surface of this type is gently undulating to slightly rolling. In some areas it is developed as the slopes leading down to small streams. These are narrow and of small extent. The surface drainage is good and the internal movement of water so free that the soil is leachy and does not retain water well.

As the result of inextensive development this type is farmed with other types with which it is associated, and usually with the Albion sandy loam. The crops are about the same as grown on that type, but the yields are much less, mainly because it does not withstand drought as well. The leading crops are corn, kafir, and sorghum, with some wheat and some alfalfa. Corn yields from 10 to 25 bushels per acre, wheat 5 to 15 bushels per acre. Alfalfa does not do very well. Kafir and sorghum produce very good yields. The soil is improved by the addition of barnyard manures and by any other organic material, such as straw, etc. This type is not valued very highly.

#### ALBION SANDY LOAM.

The surface soil of the Albion sandy loam consists of 8 to 14 inches of a dark-brown rather coarse sandy loam. The subsoil, to 36 inches, is a red to a reddish-brown sandy clay, containing a considerable quantity of coarse sand and fine gravel. The subsoil, from 24 to 36 inches, often becomes lighter and yellowish in color and contains numerous fine white rock particles. Some areas have a rather grayish surface soil, and here the structure is loose and incoherent. The subsoil is also sometimes very sandy and porous. In the vicinity of Pretty Prairie the surface soil is very heavy, owing to a relatively high content of clay and silt, but farther west the surface soil becomes lighter in texture. Though the subsoil usually contains considerable coarse sand and fine gravel, the fine material present binds this material together and gives a rather massive structure. The clay content of the subsoil, though relatively small, is of such a qual-

ity that it imparts a sticky nature to the mass, making it very adhesive. The sand and gravel of both soil and subsoil are composed of quartz and feldspar. The surface soil is loose and easily plowed, though it clods slightly. It drifts some during heavy winds, but in the case of the heavy phase not so much as the more sandy soils of the area. This type resembles the coarse phase of the Pratt fine sandy loam, the main difference being the presence of fine gravel in the subsoil.

The Albion sandy loam occupies a considerable part of the southwestern part of Reno County. It occurs in areas of considerable size and in close association with the Albion loamy coarse sand and the Albion loam. It has been formed by the weathering of the gravelly sandy stratum found at the base of the Tertiary deposits. Its formation has also been influenced to some extent by shifting of the material by the wind.

The surface is gently undulating to rolling. Sometimes the areas form ridges, surrounded by areas of the Albion loam. The type is well drained, and on some of the slopes drainage is excessive. In the more level areas the relatively large moisture supply is retained, owing to the clay content of the otherwise coarse-textured subsoil.

A considerable area of this type is in cultivation. In its natural state it supports a heavy growth of native grasses, mostly coarse but fairly good for pasturage. The more nearly level areas of the type are the most productive, though yields vary greatly with the seasons. Corn, wheat, kafir, sorghum, and alfalfa are the leading crops, as on the other soils, though little of the last is grown. The soil is well adapted to all the crops except wheat and alfalfa, and even these are grown with some success in seasons of ample rainfall. Corn yields from 10 to 30 bushels and kafir from 20 to 40 bushels per acre. Sorghum gives very good yields. Wheat yields from 5 to 20 bushels per acre. Alfalfa does fairly well when there is plenty of rain, but in dry seasons it gives very light yields. The surest crops are kafir and sorghum. Milo and broom corn should prove profitable. Apples do fairly well, and many small, thrifty orchards are found. Peaches, pears, plums, cherries, and grapes grow well, but yields are uncertain owing to climatic conditions. The soil is well adapted to vegetables of all kinds, including watermelons and cantaloupes. Small fruits succeed. Peanuts also thrive. All these crops are produced in a small way on many of the farms of this type.

The Albion sandy loam could be greatly improved by growing legumes, such as cowpeas, and by the addition of barnyard manure. Plowing under green crops will also be found beneficial. Land of this type is valued at \$30 to \$60 an acre, depending on improvement, location, and general character of the soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Albion sandy loam:

*Mechanical analyses of Albion sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381003.....	Soil.....	5.2	14.8	11.9	19.3	10.2	27.7	11.0
381004.....	Subsoil.....	10.5	16.4	10.7	20.8	10.4	15.5	15.5

ALBION LOAM.

The surface soil of the Albion loam is a dark-brown or when wet nearly black heavy loam. It is from 10 to 14 inches deep and often contains considerable coarse sand. The subsoil is a reddish-brown or brownish-red clay, carrying a large quantity of coarse sand or fine gravel or both. Often at 18 or 24 inches the subsoil becomes a yellowish-brown and contains numerous very fine chert particles. This type though as a rule less productive resembles the Pratt loam in all respects except in gravel content. There is some variation in texture and the surface soil may be somewhat finer and heavier than the typical description of the type. In other places the presence of coarse sand may make it considerably lighter. The soil contains enough clay to be sticky when wet, but it soon dries and can be easily cultivated. The clay of the subsoil is quite sticky and binds the coarse particles into a very compact mass. Where the percentage of clay is low and the subsoil is extremely coarse the crop value of the type is lessened.

The Albion loam is found in the extreme south-central part of the county, in areas of considerable size. It occurs in close association with the Albion sandy loam. Like the Albion sandy loam it has been formed by the weathering of the sandy and gravelly material of Tertiary age. The type occupies higher and more level areas than the sandy loam and may be formed from material identical with that which through reworking in surface waters has given the more sandy type. This view is substantiated in many sections of the region by the position of the loam in the higher more level areas, while the slopes and ridges are composed of the sandy loam type.

The Albion loam is gently undulating to rolling in topography. It occupies higher levels of the region where found and has good drainage in most places, though a few level areas are wet for a short time after rains. The subsoil is, however, rather porous, owing to the content of coarse sand and fine gravel, and practically none of the type is ever so wet as to require artificial drainage.

The greater part of the Albion loam is under cultivation. The native vegetation consists of buffalo grass, the grama grasses, blue stem, wheat grass, and others. The land is considered valuable for general farming and many fine farms are composed of it. The crops grown are those common to the region. The soil is well adapted to these crops, and produces good yields in favorable seasons. Corn yields from 10 bushels per acre in very dry seasons to 50 bushels in good seasons. Wheat with the same conditions yields from 8 to 30 or 35 bushels per acre. Oats, when not a failure as a result of dry weather in spring, yield from 20 to 60 bushels per acre. Kafir and sorghum make good yields, even in dry years. Alfalfa does not thrive on this type, though with a good stand it should yield fair crops in seasons of ample rainfall. The soil is also adapted to the production of barley and rye, though these are not planted except occasionally in a small way for pasturage. Emmer, milo, and broom corn are not planted to any considerable extent, though the soil is adapted to them and they are capable of giving good yields even in very dry seasons. Apples, as well as other tree fruits, small fruits, and berries, make a good growth and yield satisfactorily in normal seasons. Truck crops, especially potatoes, cabbage, and onions, should prove profitable on this soil type, though it is rather heavy for the production of the lighter crops of this sort.

Land of this type is valued at from \$40 to \$75 an acre and in exceptional cases as high as \$100, the last where the improvements are very good and where the distance from railroads is not great. The land has been exhaustively cultivated in some instances, but can be built up again and maintained in a good productive condition by the use of organic manures, the growing of legumes, and the practice of systematic rotation of crops.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Albion loam:

*Mechanical analyses of Albion loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381001.....	Soil.....	2.2	10.0	8.6	14.1	10.7	33.2	20.8
381002.....	Subsoil.....	2.7	14.9	11.1	15.8	9.5	16.7	29.4

CLARK SERIES.

The Clark series includes three types, a clay loam, loam, and sandy loam. The surface soils are dark colored and the subsoils grayish. The surface soil and subsoil are high in lime, and the latter contains more or less soft white calcareous chalky material

and calcareous concretions. These soils are found usually along the margin of the prairie where the streams have carved their valleys in the southern part of the county. They seem to be derived from a calcareous Tertiary material, though very frequently there seems to be some association between it and the Permian formation, which is found exposed lower on the slopes. The series occupies no great extent of territory, though the clay loam forms some moderate sized areas.

This material giving these soils is seen in cuts to consist of several feet of gray clay in which a large quantity of chalky calcareous substance is mixed. On exposure to the air the clay becomes hard. It has the chemical composition of a magnesian limestone, though no beds of true rock were found. The beds probably represent an eastern remnant of the Mortar Beds.

#### CLARK SANDY LOAM.

The surface soil of the Clark sandy loam consists of 10 to 15 inches of a dark brown fine sandy loam, containing considerable medium and some coarse sand. A few calcareous concretions are also present in some places. The subsoil to a depth of 36 inches or more consists of a friable gray sandy clay, containing a large proportion of calcareous concretions, grading at 30 inches into a soft calcareous mass. The subsoil is sometimes mottled with yellow. The type is neither extensive nor very uniform and the surface soil is sometimes compact and approximately a loam. Spots of the coarse phase of the Pratt fine sandy loam are also found throughout the type.

Small areas of this type exist in the western part of the county, mostly in Sylvia and Plevna Townships. It is closely associated with the sandy soils of the Pratt series and on account of the similarity of the materials it required to be mapped more or less arbitrarily.

The Clark sandy loam is derived from the weathering of calcareous material and added sandy material of the Tertiary formation. The calcareous material seems to be a deposit of calcareous clay rather than a weathered product of limestone, and is probably the rather poorly developed Mortar Bed formation of western Kansas. The surface is undulating to nearly level, but drainage is efficient throughout.

Agriculturally this is a very good type, but owing to its small extent it is of little importance in the county. Much of it is in cultivation. It produces some alfalfa, while wheat, corn, and feed crops do well. Yields depend of course on the season. Wheat yields from 10 to 20 bushels per acre, alfalfa 3 or 4 cuttings, averaging one-fourth ton per acre, and corn 15 to 40 bushels per acre. Kafir and sorghum yield profitable crops.

*Clark sandy loam, coarse phase.*—The Clark sandy loam, coarse phase, is a dark-gray or dark-brown to nearly black sandy loam 8 to 12 inches deep, resting on a subsoil consisting, in its typical development, of gray sandy clay or loam containing soft calcareous material and concretions. The subsoil in some cases may consist of a loose brown sandy loam or sandy clay to a depth of 24 inches, the calcareous material extending from this to a depth of several feet. The surface soil is loose in structure and easily cultivated. Where darker than usual it may sometimes contain calcareous concretions, though in other places it has much the same appearance as the coarse phase of the Pratt fine sandy loam.

The Clark sandy loam, coarse phase, occupies but a few small areas in the southwestern part of the county, mainly in Arlington and Langdon Townships. Owing to its slight extent it is of little importance, though there are some areas containing several hundred acres each. It is more or less intermingled with small areas of the coarse phase of the Pratt fine sandy loam.

The Clark sandy loam, coarse phase, has been derived in part by the weathering of the underlying calcareous material, which is probably identical with the Mortar Beds of the Tertiary in areas farther west. The surface soil has undoubtedly been formed by the drifting of sandy material from the adjacent areas of the sandy soils.

The surface is gently undulating to slightly rolling, and the drainage is uniformly good.

Most of the area of this soil is cultivated, the yields being about the same as those secured on the other sandy loams of the area. Corn, kafir, and sorghum are the principal crops. Some wheat and alfalfa are grown, though the soil is not so well adapted to these crops as those first mentioned.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of the Clark sandy loam:

*Mechanical analyses of Clark sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381091.....	Soil.....	1.2	12.5	17.0	35.0	14.9	11.3	7.9
381092.....	Subsoil.....	1.0	6.1	9.5	19.9	14.3	28.9	20.3

The following sample contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 381092, 23.43 per cent.

CLARK LOAM.

The surface soil of the Clark loam is a dark brown to black loam, quite heavy and sticky in places, in others containing considerable sandy material. If the clay content were not so high. it might be

called a fine sandy loam. However, the field characteristics are those of a loam. It ranges in depth from 6 to 15 inches, though its average depth is about 12 inches. The subsoil consists of a gray sandy clay to sandy loam very calcareous and grading into a bed of soft chalky material containing numerous lime nodules. Very often the subsoil to 18 or 24 inches consists of a brown loam to sandy clay, the characteristic chalky bed of gray clay and calcareous material appearing below this. The subsoil is sometimes mottled with yellowish clay. Occasionally on slopes the soil has been washed away, and the white chalky material is exposed.

This type is found in the south-central part of the county in close association with the clay loam of the same series. It occurs in small areas in Langdon, Arlington, and Roscoe Townships and is not a very extensively developed type. Like the other members of this series, it has been formed by the weathering of the underlying calcareous beds and the drifting of a sandy covering over this heavier material, though there is a possibility that the lighter surface soil may have been derived from a sandy layer of the Mortar Beds.

With a gently rolling to undulating topography, good drainage, and good tilth, most of the soil is cultivated. It occurs, however, in small areas, and no entire farm is composed of it. The crops to which it is best adapted are corn, wheat, alfalfa, kafir, and sorghum, all of which are grown with success. Corn yields from 15 to 40 bushels per acre, wheat from 10 to 30 bushels per acre, alfalfa from 1 to 3 tons per acre in three or four cuttings. Kafir produces from 25 to 40 bushels per acre. Sorghum is an important feed crop and gives very heavy yields. Oats and other small grains do well on this soil when the season is favorable.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Clark loam:

*Mechanical analyses of Clark loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381009.....	Soil.....	0.3	6.3	13.1	24.2	13.9	23.2	18.7
381010.....	Subsoil.....	1.1	2.6	6.2	33.3	8.7	20.2	27.7

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 381009, 0.93 per cent; No. 381010, 14.97 per cent.

CLARK CLAY LOAM.

The Clark clay loam is composed of a dark-brown or black clay loam surface soil, with an average depth of 10 or 12 inches, underlain by a subsoil of gray calcareous clay containing a great deal of soft white chalky material and lime nodules. At a depth of 3 or 4 feet

or sometimes less the subsoil grades into a white calcareous mass. Sometimes the subsoil is brown or yellowish in color. The soil of this type is heavy, being sticky when wet and packing hard when dry. If cultivated when in the proper condition as regards moisture it has excellent tilth, and much resembles a loam soil.

The main areas of the Clark clay loam are found throughout the southern part of the county, the largest lying a few miles south of Haven in the southeastern part of the county. It is found bordering the Permian formation on one side and the higher areas of the Tertiary prairie on the other, where the North Fork of Ninescah River and its tributaries have cut below the Tertiary into the Permian. Thus the type extends in a disconnected way nearly across the county from east to west. It merges into the lighter types of the series, the sandy loam and the loam, as the western part of the county is approached.

The Clark clay loam has been formed by the weathering of the white calcareous material that seems to be similar to the Mortar Beds formation found more characteristically developed farther west. The areas appear to lie fully as high as much of the Tertiary prairie. It is adjacent to and a little higher than the highest stratum of the Permian.

The surface is undulating to nearly level in all but a few places where it is somewhat rolling. In some large areas the surface is so flat that the drainage is poor, and if the region were one of considerable rainfall, some form of artificial drainage would be advantageous. As it is the land is not too wet for cultivation, though sometimes water may stand on the surface in depressions for a short time.

The Clark clay loam is a productive soil and is utilized extensively for all the staple crops of the region. It is best adapted to wheat, alfalfa and the small grains, though the latter, except wheat, are not grown to any extent owing to generally unfavorable climatic conditions. Corn, wheat, alfalfa, kafir, and sorghum are the leading crops. Corn yields from 15 to 50 bushels per acre. The heavy texture of the type prevents as thorough cultivation as is desirable and for this reason the more loamy and sandy soils are preferred for corn. Wheat yields from 15 to 35 bushels per acre. Probably 20 to 25 bushels is about the average yield. The spring season is too dry for oats to attain a good growth, and for this reason the crop is seldom grown. The other small grains are not looked on with favor. Among these emmer, a valuable drought-resisting grain, should be given more attention. This soil is well adapted to its production. Alfalfa does comparatively well on this type, except during dry seasons. It yields from one-half to three-fourths ton or more per cutting, and three or four cuttings may be secured in a season.

The soil is rather heavy for the production of vegetables, though these are raised to some extent in a small way by many farmers. The soil is probably better adapted to onions, cabbage, and Irish potatoes than to the lighter truck crops. Orchards of apple trees seem to be thrifty, though apples are not produced commercially on this soil. The land is locally called "black land" and the underlying white calcareous material is referred to as "magnesia."

Land of this type is valued at \$50 to \$75 or even \$100 an acre, depending on location.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Clark clay loam:

*Mechanical analyses of Clark clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381007.....	Soil.....	0.2	3.9	8.4	19.9	11.5	32.1	23.8
381008.....	Subsoil.....	1.4	8.7	13.9	22.0	8.8	22.3	22.7

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 381007, 5.09 per cent; No. 381008, 21.61 per cent.

#### SMITHWICK SERIES.

The Smithwick series of soils includes those types of unquestioned eolian origin excepting Dunesand. These soils are light in color and very sandy. One type developed in two phases is shown in the accompanying map.

#### SMITHWICK FINE SAND.

The Smithwick fine sand consists of 8 to 15 inches of gray to light-brown fine sand, underlain by a subsoil of yellow to brown fine sand. The sand extends to a depth of 3 feet to as much as 25 feet or more. The principal difference between this soil and Dunesand is in topography, and the separation of the two is rather general.

The sand particles consist of quartz, feldspar, and other minerals, and are well rounded and for the most of the finer grades. The soil is loose and light in structure. The Smithwick fine sand is very similar to the Pratt loamy fine sand, the latter type containing slightly more fine material, and for this reason being more loamy.

The Smithwick fine sand is found in one long area extending in a northwest and southeast direction along the upland just at the edge of and following the Arkansas River Valley. There are also a few other areas in the Dunesand region in the northeastern part of the county. The area reaches down the slope of the upland and into the edge of the valley.

This soil has been formed by the blowing of river-washed sand from the bed of the Arkansas onto the upland. In its course through the valley this sand forms the Arkansas fine sand. Over much of the area this forms a rather shallow covering over the Tertiary clays, but usually it is several feet deep.

The surface of this soil is rolling to gently rolling and sometimes undulating. Few areas where the dunes are small are included in the type. The soil has excellent drainage. A number of small draws extend through it to the areas of Dunesand lying farther back on the upland where small springs seep out, giving a constant flow of water.

The native grasses which grow on this soil are rather coarse, consisting of brown sedge, blue stem, bunch grass, and other species as found on the Pratt loamy fine sand. A common larger growth on this type is the wild plum. Much of the type is cultivated, though some is used for pasture, as the soil blows quite badly where unprotected. The principal crops are corn, kafir, sorghum, and vegetables. Fair yields are made in seasons of ample rainfall and when winds of high velocity have not been too prevalent. Broom corn should do well on this type. Some apple orchards are found. Vegetables, among them watermelons and cantaloupes, yield good crops, and if there is sufficient rainfall the soil where protected from the winds is well adapted to trucking. Catalpa trees are grown rather extensively on this type. Some plantings of several hundred acres exist.

Land of this type is valued at \$20 to \$35 an acre.

*Smithwick fine sand, heavy subsoil phase.*—The surface soil of the Smithwick fine sand, heavy subsoil phase, is a fine sand, sometimes light-brown in color, but usually gray. It ranges from 14 to 30 inches in depth and rests upon a subsoil consisting of a brown fine sandy clay, often mottled yellow and gray. The subsoil, while frequently heavy, usually contains some fine sand. In some areas of this phase the surface soil is nearly black, owing to an accumulation of organic matter where seepage has produced a rather rank growth of vegetation.

The Smithwick fine sand, heavy subsoil phase, is not a very extensive soil, being found principally in small areas within the typical soil. The areas are found in the northeastern part of the county in the slightly developed valleys of small streams or draws. They lie on the slopes adjacent to the Arkansas and Little Arkansas River valleys.

In origin the phase is identical with the typical soil and with Dunesand, the only difference being in the depth of eolian deposits, which in case of the phase is much less, the Tertiary clay being found near the surface. The surface is gently rolling and the drainage in most places fair. Lower lying spots receive seepage waters and are in a

more or less wet condition in seasons which have considerable rainfall. The heavy subsoil tends to retard the movement of the water downward. Usually small draws traverse the areas and carry off most of the surface water. Even in the driest seasons these low-lying areas are in a moist condition.

A considerable area of this phase is under cultivation, and areas not under the plow produce some prairie grass hay, which, though coarse, is of fairly good quality. The yield is one-half ton to 1 ton per acre. The land farmed is used more extensively for corn than for any other crop, and fair yields are made even in the driest years, as the heavy subsoil lying at a depth of a foot or two acts as a good reservoir for water. Seepage along this heavier stratum from the sand hills also has the effect of subirrigation. The yields of corn range from 15 to 40 bushels per acre.

This soil drifts badly, and this is especially harmful to young crops. To prevent damage as far as practicable, corn and other cultivated crops are listed in rows running east and west, which leaves the small plants in furrows and protected to some extent from the wind. The land is also left as rough as possible, and all trash is left on the surface to hold the soil.

A few good-sized apple orchards are found in which the trees are apparently thrifty. Considerable fruit is sold from these orchards. Pears and peaches also grow well, as do plums and other small fruits and berries. The soil is also especially adapted to truck crops, including watermelons and cantaloupes, and some truck is produced near Hutchinson for the market. Some fields of kafir and sorghum are found and good yields are obtained. The soil is too light for wheat. Alfalfa does fairly well where a good stand can be secured, but owing to the tendency to drift alfalfa can not be established easily on this soil.

Land of this phase is valued at \$25 to \$50 an acre.

#### DUNESAND.

There are two large areas of the Dunesand in Reno County, one in the northeastern part of the county just north of Hutchinson, occupying a considerable part of the region lying between the Arkansas and Little Arkansas River Valleys, and the other in the northwestern part of the county just south of the Arkansas River Valley. There are also a few other smaller areas in the western part of the county. The latter grade into the Pratt loamy fine sand, and in many places resemble these types so closely that exact boundaries can not be drawn between them.

From the position of the large area of the type just north of the Arkansas River Valley, it would seem that this sand once formed the sandy deposits of the river bed and was blown out upon the higher

areas of the upland. Originally this sand came from the weathering of rocks of the Rocky Mountain region and from Tertiary sand strata which form soils west of Reno County. The other areas of Dunesand doubtless represent wind-blown sand derived from the Tertiary deposits.

The Dunesand lies on the rolling prairie in the highest parts of the county. The dunes for the most part range from 5 to 15 or 20 feet in height, though some are higher. Between the dunes there are many small flat marshy areas that remain wet for long periods, not only on account of standing rainwater but on account of seepage from the surrounding dunes. The underlying Tertiary material of heavy gray or mottled clay is found only a few feet beneath the surface in these low places, and this clay is rather heavy and impervious and holds the water until it is removed by evaporation. No streams extend through areas of Dunesand, though some head in the edge of the areas. Nevertheless the Dunesand is well drained, for the water sinks rapidly into the loose, porous sand.

The Dunesand is rarely cultivated, though some of the smoother areas have been planted in corn. The land is utilized principally for grazing, and herds of cattle find fair pasturage, though the grasses are rather coarse and not of great feeding value.

#### ARKANSAS SERIES.

The soils of the Arkansas River Valley have been grouped in the Arkansas series. They are alluvial in origin, though lying at present above overflow. They are dark brown to black in color and are composed of materials brought down by the Arkansas River from the Tertiary prairies of western Kansas and Colorado. These soils are all underlain by beds of sand and gravel at a depth of a few feet, and since deposition have been more or less influenced by the action of the wind. This factor has been most active in the case of the more sandy types. In texture the soils vary from sandy loam to clay, the fine sandy loam and loam being by far the most important and together constituting the greater part of the river valley.

#### ARKANSAS FINE SANDY LOAM.

The texture of the Arkansas fine sandy loam, as is often the case with alluvial types, is quite variable, ranging from a heavy fine sandy loam to a loamy fine sand. Usually the surface soil consists of a dark-brown fine sandy loam 12 to 18 inches deep, and the subsoil of material ranging from a fine sandy loam to a sandy clay, the color being some shade of brown, often a yellowish brown. At 30 to 36 inches the subsoil usually becomes a yellow or light-brown fine sand.

Near the Arkansas River the type is much lighter in texture than in areas that lie well toward the upland. In the former situation the

surface soil is a dark-gray loamy fine sand, having a depth of 15 to 24 inches and underlain by a yellowish fine sandy loam. The heavy and light phases merge one into the other gradually. In a few places near some of the small creeks that flow through the valley is found a small amount of coarse sand and fine gravel. Again, in some small areas of the type closely associated with the Arkansas loam the soil has a large amount of very fine sand and silt in it.

The Arkansas fine sandy loam is found in areas of considerable size throughout the Arkansas River Valley. It is closely associated with the Arkansas loam and the Arkansas fine sand and represents the mean of texture between these types.

The type has been formed of material deposited by the waters of the Arkansas River. The heavier phases of the type doubtless result from mingling of wind-blown sand from the river channel with the heavier loam, which usually occurs farthest from the stream channel.

Throughout the main valley of the Arkansas River the Arkansas fine sandy loam usually occupies second or third terraces, above overflow. The topography is nearly level to gently undulating. The type has good drainage throughout most of its extent, though some areas are so level that some water remains on the surface after heavy rains. Such places would be improved by underdrainage or by ditching.

The Arkansas fine sandy loam is practically free from harmful quantities of alkali, though occasionally small spots may be seen that show evidences of small accumulations. The type is considered very good for the production of a number of crops and throughout the area is largely utilized for farming. The soil withstands drought well, as it is retentive of the moisture falling as rain and the water table lies only a few feet below and doubtless within capillary reach of the surface.

The type is largely under cultivation, corn, alfalfa, sorghum, and kafir being the principal crops, though considerable wheat is grown on the heavier phases, which are more productive for this and other staple crops than the more sandy areas. The type is especially adapted to the production of truck crops, fruits, corn, and alfalfa. Some vegetables are grown for the local markets. A great many apple orchards are located on this soil and this fruit is produced commercially. The type is considered the best in the area for this fruit. Peaches do not do so well as apples—the main fruit crop—climatic conditions being less favorable. Small fruits and berries do well.

Yields of all farm crops vary largely with the seasons. Corn yields from 15 to 50 bushels per acre; alfalfa gives three to four cuttings a year, ranging from one-fourth to one-half ton or more per cutting. Sorghum and kafir produce good yields. Cowpeas are

grown to some extent. These not only yield well but improve the soil. On the heavier phases of the type wheat produces from 8 to 20 bushels, and under especially good conditions may yield even more. Oats are little more satisfactory here than on the upland soils, owing to dry conditions which usually obtain early in the spring. Yields of 30 to 40 bushels per acre have been secured in favorable seasons.

Where the land has been cultivated for a number of years the soil, especially where light, is becoming deficient in organic matter. This condition tends to diminish the productiveness, both because of physical changes and lack of the organic substances needed in vigorous plant growth. Plowing under organic matter in the form of barnyard manure or green manuring crops should be practiced whenever practicable. The lighter phases of the soil drift where unprotected and crops are sometimes damaged. The Arkansas fine sandy loam is valued at from \$60 to \$100 an acre.

#### ARKANSAS LOAM.

The Arkansas loam is a dark-brown to black loam of varying texture, 8 to 15 inches deep, underlain by loam to clay loam, brown in color and often very compact, becoming lighter in color and texture below and changing at 30 to 36 inches to yellow or light-brown fine sand or fine sandy loam. Over the surface of the Arkansas loam are found small spots of light-colored soil, locally termed "alkali spots." These spots are a few feet across and occupy slightly lower positions than the general surface level. The soil on these spots is a silty loam or clay loam a few inches deep, underlain by heavy brown clay or clay loam containing numerous white particles or concretions which effervesce with hydrochloric acid. These spots are bare of vegetation excepting for a scant growth of salt grass, and are easily recognized by their different color and vegetation. Where spots of this character are found in considerable numbers the general area including them was mapped as the Arkansas clay loam.

The surface soil of the Arkansas loam bakes into a rather compact mass when dry, but if cultivated when moisture conditions are favorable it forms an excellent tilth. It clods slightly, but the clods are easily broken down by tillage.

Relatively large areas in the Arkansas Valley are composed of the Arkansas loam. It is an alluvial soil of the finer soil particles laid down by comparatively quiet or gently flowing water. At the present it is not subject to overflow. In places fine sand has drifted upon this soil, forming small sandy areas, too small to map. This has made it necessary in some instances to draw somewhat arbitrary boundary lines between this type and the Arkansas fine sandy loam.

Areas of the Arkansas loam occupy high second and third terraces above the Arkansas River. Their surface is nearly level to very slightly undulating and usually drainage is fairly good. Some low and basinlike areas exist which would be improved by drainage. Some surface ditching has been done with beneficial results, but no underdrainage has been attempted. This would doubtless be of value in many areas of the type and would probably cause the alkali in these low spots to disappear.

The Arkansas loam is an easily cultivated productive soil. It is one of the most extensively farmed types of the area. A variety of crops are grown on it. In its native state the soil is covered with a heavy growth of grasses, including buffalo, grama, and other valuable species.

This soil is especially adapted to corn, alfalfa, and wheat, and all these crops are grown extensively. Kafir, sorghum, cowpeas, and other forage crops are also grown extensively. During seasons of light rainfall the yields are sometimes light, but this type, like the Arkansas fine sandy loam, is to some extent subirrigated, and it withstands drought remarkably well. By careful cultivation fair crops of corn and other cultivated crops may be secured even in dry years. Corn yields from 20 to 60 bushels per acre, wheat from 10 to 35 bushels, and alfalfa one-fourth to three-fourths ton per cutting, with three to five cuttings during the season. Kafir yields from 20 to 45 bushels per acre and is a comparatively certain crop. Apples do fairly well, but not so well as on the Arkansas fine sandy loam. Vegetables, especially cabbage, onions, and potatoes, are grown successfully. This type is not so good for the lighter truck crops as the fine sandy loam.

The Arkansas loam is valued at \$60 to \$125 an acre, depending on location and condition of the farm.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Arkansas loam:

*Mechanical analyses of Arkansas loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381028.....	Soil.....	0.2	3.1	6.4	18.5	21.5	31.5	18.4
381029.....	Subsoil.....	.2	2.7	4.2	13.8	21.7	38.7	17.7
381030.....	Lower subsoil.	1.9	9.3	12.7	16.5	14.7	28.9	15.2

ARKANSAS FINE SAND.

The surface soil of the Arkansas fine sand consists of 12 to 18 inches of a gray to light-brown fine sand. The soil is variable in

texture and sometimes considerable silt is mixed with the fine sand. Usually, however, it is a rather light soil. The subsoil to a depth of 36 inches and more is a yellow or brown fine sand.

The Arkansas fine sand is not a very extensive type in the county. It is found in the Arkansas River Valley, usually as a narrow strip adjacent to the river. Small isolated areas are also found throughout the valley. One narrow area near Nickerson follows an old stream bed for several miles. In the soil of this area there is considerable small gravel and coarse sand, but fine material predominates.

The Arkansas fine sand is of alluvial origin, the materials of which it is formed having been carried down by the Arkansas River during floods and deposited in its bed and along its banks. Thence the sand has been drifted over portions of the valley. Some small dunes are found in the type. Doubtless some of the more level areas have been deposited directly by the waters of the river and wind has had only a minor influence in the formation of the type.

The surface of the Arkansas fine sand is nearly level to gently undulating, with a few small areas rather dunelike. The type is well drained in all places, the rains sinking quickly into the loose underlying sands. The type is closely associated with the Arkansas fine sandy loam and in some places differs from that type only in the presence of the heavy subsoil in the latter. Small areas of the Arkansas fine sand are found as small ridges extending through level areas of the Arkansas fine sandy loam. These ridges seem to be the result of wind action.

The Arkansas fine sand drifts badly in heavy winds where the surface is not protected by vegetation or by windbreaks. The type is, nevertheless, cultivated extensively. While not a strong soil it is adapted to a wide range of crops. The land is naturally sub-irrigated to some extent, for which reason crops withstand the effect of dry weather to a marked degree. Corn yields 15 to 25 bushels per acre. The type also produces good yields of kafir and sorghum. Truck crops are grown to a considerable extent, especially around Hutchinson, where there is a good local market. Apples do well and some of the largest commercial orchards are located partly on this soil.

The Arkansas fine sand is practically free from harmful amounts of alkali, and its main deficiency is its tendency to drift. Care should be taken to protect the soil in every practicable way. Additions of organic matter in any form will be found of great value in handling land of this type. From \$30 to \$75 an acre is about the range in price for farms composed of the Arkansas fine sand. The highest value of the type is for fruit and truck growing, and location near market or railroads is of primary importance.

## ARKANSAS CLAY LOAM.

The Arkansas clay loam is a variable type. Typically it consists of 6 to 12 inches of dark-brown clay loam, resting on a subsoil of grayish brown or dark-brown heavy clay, which often contains considerable sand, though it is very compact and impervious. Over much of the type the immediate surface soil consists of 4 or 5 inches of a silty or very fine sandy loam, underlain by the heavy clay subsoil, and the greater part of the surface is everywhere characterized by whitish alkali incrustations and the absence of vegetation. Probably not more than 50 per cent of the surface of the alkali areas is composed of the heavy soil, while the remainder has the loamy surface. These spots of the typical soil often occur in areas of Arkansas loam. It is only where they are quite numerous that the areas are mapped as the clay loam type.

Just north of Haven the surface soil consists of 14 inches of a dark clay loam underlain to 36 inches by a yellow loamy fine sand, occasionally mottled with yellow and gray clay. The type packs very hard when dry, and when wet it is very heavy and under these extremes of moisture conditions it is difficult to work, and is locally known as "gumbo."

This type though not extensive is found in many small spots throughout the Arkansas River Valley. The areas are irregular in outline and represent low areas in the valley plain. These areas lie at a distance from the river.

The Arkansas clay loam is alluvial in origin and formed of the finer grades of soil particles deposited from quiet water, the coarser particles having been deposited nearer the channels of the streams where the currents were stronger.

The areas of this soil are rather poorly drained, though in this region, where the rainfall is not great, they may be dry for months at a time. In fact most bodies of the type are sufficiently dry for cultivation during ordinary seasons. Some areas of the type form long, narrow swales or depressions running parallel to the upland on the sides of the valley and adjacent to the higher land. At present these receive much surface drainage and seepage from the upland slopes, small draws from the higher areas emptying therein.

It seems probable that the alkali condition of the Arkansas clay loam is due to the evaporation of the water accumulating from time to time in these depressions. Capillarity is also greatly favored by the texture and structure of the soil and subsoil, and consequently the salts may readily be brought to the surface from below. At any rate the salts in the soil are sufficiently concentrated to prevent the growth of any vegetation except a grass locally called "salt grass." Some ditching has been done in these areas, and this has

proved helpful in keeping water from accumulating on the surface, but probably a system of tile drainage will be necessary in order to bring about the removal of the alkali to a degree that will enable the soil to be farmed.

Some areas with a loam surface soil contain so little alkali that crops may be grown, but where the clay loam spots predominate no attempt is made to cultivate the land. The loam spots are covered with a rank growth of grasses, and the type is used for pasture.

The following table gives the results of mechanical analyses of samples of soil, subsoil, and lower subsoil of the Arkansas clay loam:

*Mechanical analyses of Arkansas clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
381015.....	Soil.....	0.3	2.0	4.9	14.7	18.4	38.8	20.9
381016.....	Subsoil.....	.8	2.0	3.9	13.9	19.4	32.5	27.8
381017.....	Lower sub-soil.	.6	2.7	5.3	20.1	18.3	28.9	24.0

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 381015, 0.61 per cent; No. 381016, 0.72 per cent; No. 381017, 3.31 per cent.

#### ARKANSAS CLAY.

The Arkansas clay consists of a very dark gray to black extremely heavy and tenacious clay 8 to 12 inches deep, underlain by a dark-gray or drab clay, very tenacious and heavy and sometimes slightly mottled with red or brown streaks. This clay subsoil may extend to a depth of 36 inches, or it may be entirely absent, the surface soil resting on a bed of brown sand at varying depths below 8 or 10 inches. The soil of the Arkansas clay is extremely heavy and is difficult to cultivate, except when moisture conditions are just right. When wet it is very adhesive, and if plowed when in this condition it bakes into a mass of hard clods, which are subsequently broken down with great difficulty. When dry it bakes into a hard, compact condition and can hardly be plowed at all. If cultivated when not too wet or too dry, it breaks down into a fairly friable structure. The soil seems to contain considerable organic matter.

The Arkansas clay is found in only two bodies having a total area of about 2 square miles in the extreme northwestern corner of Reno County.

The area which this type occupies has much the topographic appearance of an old lake bed, and it is believed that the soil has been formed by the deposition of material from water. It is probable that at one time Peace Creek flowed through the area occupied by the type. This creek has been diverted into its present bed just west of the Reno County line by the drifting of sand into its old channel, and

it is likely that when the sand first dammed the stream a large lake was formed and remained for years, receiving the accumulations of fine earth from the stream. After a time another bed for the creek was worked out and the lake bed became dry, leaving the clay soil deposited over the underlying beds of sand.

The area of the Arkansas clay is almost level in topography and occupies a basin-shaped depression surrounded by higher sandy soils. Sand has in places been blown over the surface of the clay, forming small spots of sandy soil. Excess surface water passes through a small draw which extends through the type. The substratum of sand beneath the soil makes subdrainage fairly good also.

A considerable area of the type is cultivated. It is considered best adapted to wheat and alfalfa. The former yields from 10 to 30 bushels per acre and the latter nearly a ton to the cutting, with 4 cuttings a year. In dry years the yield is less than one-third that stated. Broom corn in good seasons will yield about 1 ton to 4 acres. Kafir and sorghum produce fine yields on the type. Corn does not give a large yield of grain, though the yield of fodder is heavy.

The type is not especially desirable owing to the difficulty with which it is cultivated. It is valued at \$20 to \$30 an acre.

#### LINCOLN SERIES.

##### LINCOLN SANDY LOAM.

The Lincoln sandy loam is a type of variable texture, but usually the surface soil to a depth of 12 or 15 inches consists of a dark brown or dark gray sandy loam light and loose in character and containing little fine material, often bordering on a loamy sand. The subsoil ranges from a loamy coarse sand to a heavy sandy loam, usually light brown in color, though sometimes mottled gray and yellow and in texture a sandy clay. There is considerable coarse material in the soil and subsoil, and sometimes there is a little fine gravel present in the subsoil.

This type is not an extensive one in Reno County, being found only in a few small areas as bottoms along small creeks in the southwestern part of the county. These valleys are only a few hundred yards to one-half mile in width, the largest lying along Silver Creek.

The Lincoln sandy loam has been formed by the deposition by streams of the coarser material washed from the upland soils of the Pratt and Albion series. In some places where the stream valleys are very narrow it appears to be partially colluvial.

Areas of this type are level, except in the narrower bottoms, where the surface often extends in a gentle slope to the upland. Usually this condition is found only where some smaller valley follows the small draws that reach back from the main stream courses. The

streams have cut their channels several feet below the surface of these bottoms and the type is not subject to frequent overflows, though these sometimes occur. The drainage is good.

Little of the Lincoln sandy loam is in cultivation, though some is utilized for corn, alfalfa, and feed crops, such as sorghum and kafir. The type is rather light and porous for the production of large yields, the heavier phases being more productive than the lighter. The water table lies at no great depth and this assists the crops to withstand dry weather where the percentage of fine material is sufficient to give a rather loamy texture. A considerable part of the type is used for pasture, as it maintains a rather abundant growth of coarse native grasses. Corn yields from 10 to 30 bushels per acre; alfalfa 3 or 4 cuttings in most seasons, with an average of one-fourth ton per acre. Owing to its small extent and relatively low agricultural value the type is not important in the county.

#### LINCOLN VERY FINE SANDY LOAM.

The Lincoln very fine sandy loam consists of 12 to 20 inches of dark-brown very fine sandy loam, resting on a brown or yellowish very fine sandy loam which grades at 30 inches into fine sand. The surface soil is loose and light, though in many places a relatively high percentage of silt gives it the compact structure of a loam.

The soil is located in the Salt Creek Valley and extends a short distance into the Arkansas River Valley, where these valleys join. It is not extensive. It has been formed by the deposition of fine sand and silt from overflow waters of Salt Creek, though it has probably been somewhat modified by wind action.

The Lincoln very fine sandy loam has a nearly level to sometimes basin-like topography. In some places the drainage is rather poor, and throughout the greater part of its area only moderately good drainage exists.

Some of the Lincoln very fine sandy loam is cultivated. It is well adapted to alfalfa and corn and fairly well to wheat. It is also well suited to the production of kafir, sorghum, and kindred crops. Considerable areas are strongly impregnated with alkali and are covered with salt grass (*Distichlis spicata*).

#### LINCOLN FINE SANDY LOAM.

The texture of Lincoln fine sandy loam ranges from a fine sandy loam to a loamy fine sand. Typically the surface soil is a dark-gray or brown fine sandy loam 12 to 18 inches deep. The subsoil to 36 inches consists of a brown to yellowish material, ranging in texture from a fine sandy loam to sandy clay.

Areas of the Lincoln fine sandy loam are found in the narrow valleys lying along the Little Arkansas and the North Fork of Ninnescah

Rivers. Its extent is not large. It has been formed by deposition of soil particles from swollen streams, these particles having been washed from the surface of the surrounding prairie soils.

This type has level surface and lies from 4 to 10 feet above the stream beds. Overflows are infrequent, though they sometimes occur. The areas are fairly well drained.

Practically no instances where alkali occurs in harmful quantities exist, the type is easily cultivated, and on the whole it is considered a fairly good soil. It is farmed to a considerable extent, the principal crop being corn, which yields from 15 to 40 bushels per acre. Alfalfa produces from one-fourth to one-half ton per cutting. The soil is fairly retentive of moisture. Owing to its small extent this soil is unimportant. It drifts badly where unprotected. It may be greatly improved by the incorporation of organic matter, either in the form of stable manure, green-manuring crops, or the coarse trash resulting from crops or native vegetation.

#### LINCOLN FINE SAND.

The Lincoln fine sand consists of 12 or 15 inches of a gray to light-brown fine sand, underlain to a depth of several feet by a yellow or brown fine sand. The structure of the soil and subsoil is that of a true sand—that is, it is very light and incoherent.

This type is of very slight extent in this area, being found in only a few small areas in the narrow valleys along the North Fork of Ninnescah and Little Arkansas River Valleys.

The Lincoln fine sand is alluvial in origin, having been deposited by these streams, during floods, along the banks. The sandy material comprising these soils has been washed from the areas of sandy soils on the plains at no great distance from the present type. The type as found in the Little Arkansas Valley is due largely to wind agency, having been drifted into that location from areas of sandy soils which occupy the upland immediately south of this valley.

Topographically these small areas are gently undulating, though in a few places small dunelike areas have been formed by the action of the wind. The type is well drained, though the lower-lying areas are sometimes overflowed during floods along the Ninnescah River.

Agriculturally, the type is not highly esteemed, and not a great deal of it is cultivated. Its productive capacity is limited and its loose structure allows it to blow and drift badly in heavy winds where not protected by a heavy growth. However, the water table lies near the surface and crops on the undulating areas withstand dry weather conditions quite well. Corn, kafir, and sorghum do well on this type and are grown successfully. The soil is also well adapted to truck crops, melons, cantaloupes, and berries. Probably from 15 to 25 bushels of corn per acre are usually produced on the type.

This soil should have liberal amounts of barnyard manure and organic matter added. It is a type of very slight extent and is very much like the Arkansas fine sand in the Arkansas River Valley.

#### LINCOLN LOAM.

The Lincoln loam is a dark-brown to black loam from 8 to 15 inches in depth, resting on a brown loam or clay loam, which extends to a depth of 36 inches or more. The surface soil is rather compact when dry, but is easily put in good tilth if cultivated when moisture conditions are favorable.

Only small areas of this type are found. These are in the western part of the county in the Ninnescah Valley, and in the northeastern part along the Little Arkansas River and some other smaller streams. It is an alluvial type and is subject to overflow at times, but not so frequently as to prevent cultivation.

The areas occupy first bottoms and have a level topography. Their surface is from 4 to 10 feet above the stream bed, and fairly good drainage exists. Some areas would be improved by artificial drainage, and in such places some alkali is found.

The Lincoln loam is an easily cultivated, productive soil. It is utilized for practically the same crops as the Arkansas loam, which it closely resembles. It is especially adapted to corn, alfalfa, wheat, kafir, sorghum, and cowpeas, and these crops are at present grown with profit. The yields are practically the same as on the Arkansas loam.

#### LINCOLN CLAY LOAM.

The Lincoln clay loam is practically the same soil as the Arkansas clay loam, except that a lighter substratum of sand more uniformly underlies the latter type. The surface soil is a dark-brown clay loam 6 to 12 inches deep. The subsoil consists of grayish-brown or dark-brown heavy clay. Over considerable areas the surface soil consists of several inches of compact silty or fine sandy loam, and sometimes the clay of the subsoil is found at the surface. These variations occur over very small areas. The soil packs into a hard mass when dry, and is very tenacious and heavy when wet. It is therefore a difficult soil to work. It has the local name of "gumbo."

Areas of this type are found in the small stream valleys leading into the Ninnescah and Little Arkansas Valleys. It is of very slight extent, being found in very small spots.

This type is alluvial in origin, and the areas are low, flat, and poorly drained, though most of the type can be cultivated even during rather wet seasons. The surface usually shows alkali incrustations, and the soil is nearly bare of vegetation. Salt grass grows over considerable of the type.

Open ditch or tile drainage would greatly improve the land.

Little of this type is in cultivation on account of the presence of harmful quantities of alkali and because of difficulty in cultivating. Grasses other than salt grass grow where there is a thin covering of loamy material, and where the surface is very heavy there is sometimes found a growth of prickly pear. By the addition of organic manures the soil could be built up and made quite productive. The better phases of the type now produce fair yields of corn, alfalfa, kafir, wheat, and sorghum in favorable seasons.

#### MEADOW.

Some areas of alluvial soils in Reno County have such a variable texture that they could not be mapped on any definite textural basis. These are shown in the map as Meadow. The areas of Meadow are small, forming narrow strips along streams. The areas mapped along the Arkansas River differ somewhat from those along the smaller streams of the county.

The Meadow of the Arkansas River consists of sand banks and bars along the stream intermingled with small areas of finer soil material. The soil in places consists of a gray silt loam to silty clay of varying depths, ranging from 2 inches to 16 inches, and underlain always by the river-washed sand. A few small sand dunes are also scattered over the areas of Meadow in this part of the county. This phase is found as narrow strips along the Arkansas River. Here it has been formed by the deposition of sand, silt, and clay during periods of overflow. The areas are subject to overflow and though lying 4 to 6 feet above the river bed and having fair drainage, the water readily inundates the land during overflows.

The surface is practically level and has in some places farther from the river a basinlike topography. It is marked by a number of old channels and sloughs. There are a number of very small islands in the river which belong to this class of Meadow.

This type is practically worthless for cultivation, though in some of the areas of heavier soil a small acreage of corn is grown. This type of Meadow is worth very little. It supports a growth of coarse grass and cottonwood trees and is utilized for pasture.

The Meadow along the smaller streams is found in the southwestern part of the county on Silver Creek and the North Fork of Ninescah River. The soil here consists of dark sand and sandy loam, often in a rather marshy condition. It occurs in narrow strips one-fourth to one-half mile wide. It has been formed by the deposition of sand and other soil particles from overflow water and in some places by colluvial wash from the adjoining uplands. It is flat and poorly drained, and lies only 3 or 4 feet above the creek beds. These areas are poorly drained and marshy in many places. They are

covered with a heavy growth of coarse water-loving grasses, and are used mainly for grazing, though the less marshy areas supply considerable hay. This is cut every year and yields from one-half ton to 1 ton per acre. The areas are subject to overflow every year and no crops are planted. The land affords good grazing.

#### SUMMARY.

Reno County is located in the south-central part of Kansas, within the Great Plains province. It is an undulating to rolling plain, dissected by several stream valleys, lying at an elevation of 1,400 to 1,800 feet above sea level.

All the drainage is into the Arkansas River, which flows through the northeastern part of the county. The main tributaries of the Arkansas are the Little Arkansas and the Ninnescah Rivers, which empty into the Arkansas some distance southeast of the county.

The county is well settled in all parts excepting in a few areas of very sandy soil. The people are mostly Americans, though some are of Russian and German descent.

The mean annual temperature is 56° F. and the mean annual precipitation is 28.2 inches. Ordinarily the precipitation is sufficient for the production of crops, but there are some years of marked deficiency. In no year has there been an absolute crop failure of all crops. The heaviest yearly rainfall recorded is 41.16 inches in 1898, and the lightest is 16.15 inches in 1910. Heavy winds sometimes damage young crops; these are most frequent in the spring.

Transportation facilities are very good. There are a number of good-sized towns in the county. Wagon roads are good in most sections.

Agricultural settlement began in the early seventies and has been rapid. The county is now a prosperous and progressive farming country.

One general type of agriculture prevails, and that is general farming and stock raising and feeding, with some fruit growing. Wheat is the main money crop with the majority of the farmers. Corn is produced to some extent as a money crop, while oats, alfalfa, sorghum, kafir, etc., are grown for feeding cattle. There are some large apple orchards in operation. A few specialize in the production of broom corn. Cattle and sheep feeding in the winter is an important industry, and some stock is raised. The greater part of the land in the county is cultivated. There are some important plantings of catalpa trees. The average size of the farms is 160 acres.

No systematic crop rotation is practiced, though many change the crops and recognize the value of doing so. Wheat and corn, the

main crops, are alternated occasionally. Most of the farmers live on and cultivate their own land, though some rent land. Land values are rather high, ranging from \$25 an acre for the least desirable to over \$100 an acre for the best land.

The soils are of many different types. In texture they range from sands to clay. In origin they are residual, sedimentary, eolian, and alluvial. Ten leading types constitute the greater part of the area. Of these the Pratt loamy fine sand and the Smithwick fine sand and Dunesand have the lowest value. These types, where the surface is dunelike, are utilized principally for grazing. Considerable areas of the better agricultural phases are cultivated to corn, broom corn, kafir corn, and sorghum. These soils are best adapted to these crops and are not adapted to wheat.

The Pratt fine sandy loam and Albion sandy loam are somewhat similar. Wheat, corn, kafir, and sorghum are the principal crops. The soils are rather light for wheat and sometimes drift badly. These sandy soils grow crops well in dry weather, and fair yields of wheat are secured. An extension of stock raising and the growing of feed crops would doubtless prove more profitable on these soils than wheat growing.

The Pratt loam and Pratt silty clay loam, with the Albion loam and Clark clay loam, are rather heavy soils, occupying a large proportion of the high prairies. These soils are best adapted to wheat and other small grains. They are also good corn soils, but this crop does not do so well on them as on the sandy loams in dry seasons. These types are utilized for wheat, oats, corn, alfalfa, kafir, and sorghum. Emmer ("speltz") could doubtless be more profitably used to take the place of oats. Kafir should be planted on a part of the acreage now given to corn. Alfalfa on these soils would do much better if more care was given to preparing the land and getting the crop well started.

The Kirkland clay is badly washed in many places, and, except in some small spots, it is not a very good soil. It is essentially a small-grain soil.

The Arkansas fine sandy loam and loam are the most extensive alluvial soils. They are utilized for corn, wheat, alfalfa, and various feed crops. The fine sandy loam is the best apple soil in the area. It is also an excellent soil for truck crops and corn. The loam is especially adapted to alfalfa and corn. The Arkansas fine sand is a good type for apples and truck crops.

The Arkansas clay loam is intrinsically a good soil, but includes many alkali areas. The Arkansas loam also shows some alkali. To reclaim the alkali areas the land should be underdrained.

A systematic crop rotation should be practiced in this region to maintain the productiveness of the soils. Organic matter should be

incorporated, especially in the lighter types. Legumes, such as alfalfa and cowpeas, should enter more largely into the cropping systems in any attempt to build up the soils to a higher state of productiveness. The use of manure, while to some extent practiced, should be greatly increased, especially on the lighter types. More thorough preparation of the land at the proper time would materially increase the yields of wheat and corn and overcome to some extent the effects of dry seasons.



[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,* That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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