

SOIL SURVEY OF RICHLAND COUNTY, NORTH DAKOTA.

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DESCRIPTION OF THE AREA.

Richland County, N. Dak., is located in the extreme southeastern corner of the State. It is bounded on the north by Cass County, on the west by Ransom and Sargent counties, on the south by South Dakota, and on the east by Minnesota. The greater portion of the county lies north of the forty-sixth parallel north latitude, and east of the forty-eighth meridian west longitude, and has an area of 929,920 acres, or 1,453 square miles.

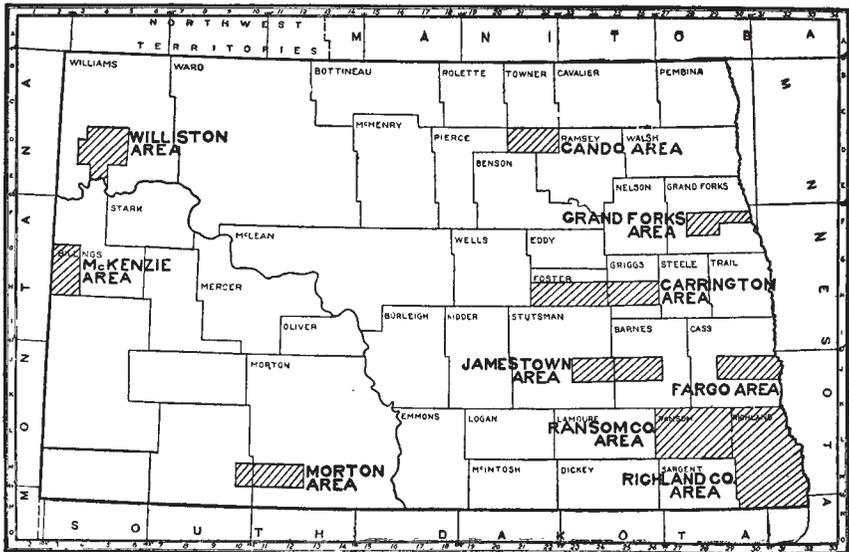


FIG. 32.—Sketch map showing location of the Richland County area, North Dakota.

There are three distinct topographic divisions in Richland County. One consists of the country formed by the deposition of glacial till in the form of moraines, another is the region occupied by lacustrine deposits of Lake Agassiz, and the third is the territory comprising the delta deposits of the Sheyenne River in the old lake bed. The country formed by the glacial till in the southwestern part of the county is rolling to roughly hilly, with intervening sloughs and depressions. Characteristic bowlders and gravel are found scattered

over the surface. The lacustrine deposits occupy the eastern portion of the area and are level to undulating, while that formed by the delta is rolling to hilly.

The Sheyenne, Red, and Wild Rice rivers are the most important streams of the area. The Sheyenne River enters the northwestern corner of the county near Power and flows in a northeasterly direction, leaving the county near the center of the northern boundary line. Short and deep tributaries have cut back from the river and drain the county for a few miles on each side. The Red River, with its tributary, the Bois de Sioux, forming the eastern boundary line of the county, drains a portion of the area. There are a few small coulees^a tributary to this stream. The Wild Rice River enters the county in Wyndmere Township, about 3½ miles south of the Northern Pacific Railway, and flows in a southeasterly direction toward Great Bend, where it turns and flows northward. From a point 5 miles west of Wahpeton its course is almost parallel to that of the Red River for a distance of about 25 miles to the northern boundary of the county. A few coulées are tributary to the Wild Rice River, the largest being Antelope Creek.

The population of the county is 19,379. It includes many Germans, Norwegians, and Swedes. In the vicinity of Great Bend, and in the northeastern portion of the county, many prosperous farmers are found. At the time this section was opened for settlement many settlers came from Iowa and other older States. The eastern and southern portions of the county are the most thickly populated, the western portion being quite sparsely settled. A few quarter sections among the sand dunes are still open for entry. When the western and northwestern portions have a proper drainage system there should be an influx of population, as much of the now uncultivated land is capable of producing good crops.

Wahpeton, the county seat and largest town of the county, has a population of about 3,000. Hankinson and Lidgerwood, located in the southern part of the county, are next in population, while Abercrombie, Fairmount, and Wyndmere are the more prosperous of the smaller towns.

The county is crossed by several railways, which furnish good transportation facilities. One of the main lines of the Great Northern from St. Paul to the West passes through Wahpeton, and thence northwest. The main line of the Minneapolis, St. Paul and Sault Ste. Marie enters the county at Fairmount and passes through Hankinson and Wyndmere northwest into Ransom County. A branch of the Great Northern from Tintah Junction, Minn., to Aberdeen,

^a The word "coulee" is used in the local sense.

S. Dak., crosses the southern portion of the county near Fairmount and passes through Hankinson and Lidgerwood. The branch of the Chicago, Milwaukee and St. Paul Railway from Ortonville, Minn., to Fargo, N. Dak., crosses the eastern part of the county. Fairmount, Wahpeton, and Abercrombie are the principal towns located on this line. A branch of the Northern Pacific crosses the county, Wahpeton, Mooreton, and Wyndmere being the chief towns on the line. Besides these lines, the Fargo and Southwestern, a branch of the Northern Pacific, passes just outside the northwestern border of the county, affording shipping points for farmers in this section.

The principal grain markets for the county are Minneapolis and Duluth, and frequent elevator stations are found on all the railroads. Each of the above-named towns in the area have three or more grain elevators, which are usually owned by the larger elevator companies. However, there are a few elevators owned by a company of farmers. Live stock is shipped to South St. Paul or Chicago.

The condition of the county roads varies according to the soil type over which they pass. Those along the Red River over the Fargo loam, Fargo clay loam, and Fargo clay are hard and smooth when dry, but when wet they are frequently almost impassable. In the spring they are usually in the worst condition, but in the fall, when the produce is hauled to market, they are generally good.

CLIMATE.

The climate of Richland County is typical of the northwest, the winters being long and cold and the summers short and cool. The summer nights are short and generally cool and the twilights long. The last killing frost in spring is about May 8 and the first in the fall about September 15, giving a growing season of about four months. Lighter frosts frequently occur between these dates, and frosts have been known to occur every month in the year in this region. Short periods of extremely cold weather occur in winter, when the mercury stands at -40° F., but as the atmosphere is dry the cold is not so severe as this low reading would indicate. The soil generally freezes in November to a depth of from 5 to 8 feet and remains frozen until spring, or about the 1st of April. From the 10th to the 20th of April plowing and cultivation are possible, even though the ground is frozen below.

Hailstorms occasionally damage the crops, but as these occur in small areas the damage is only local.

There are a few large windbreaks over the level prairie, but the northwest winds sometimes sweep across and do considerable damage.

The following table shows the normal monthly and annual temperature and precipitation, the absolute maximum and minimum temperatures, and the total precipitation for the wettest and driest years:

Normal monthly, seasonal, and annual temperature and precipitation at Wahpeton.

| 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 | 15 | 54 | -32 | 0.4 | 0.4 | 0.2 | 2.2 |
| January | 11 | 51 | -30 | .4 | .4 | .4 | 3.2 |
| February | 11 | 58 | -44 | .6 | Trace. | 1.2 | 4.9 |
| Winter | 12 | | | 1.4 | .8 | 1.8 | 10.3 |
| March | 26 | 67 | -33 | 1.2 | 1.9 | 1.8 | 8.2 |
| April | 46 | 92 | - 2 | 2.5 | 3.4 | 5.1 | 1.1 |
| May | FA | 98 | -22 | 2.2 | 1.0 | 7.4 | .0 |
| Spring | 43 | | | 5.9 | 6.3 | 14.3 | 9.3 |
| June | 67 | 101 | 27 | 3.4 | 2.6 | 5.8 | .0 |
| July | 70 | 105 | 39 | 3.6 | .2 | 4.8 | .0 |
| August | 68 | 96 | 33 | 3.1 | 2.0 | 2.7 | 0 |
| Summer | 68 | | | 10.1 | 4.8 | 13.3 | .0 |
| September | 59 | 98 | 19 | 1.7 | .8 | 2.7 | .0 |
| October | 47 | 88 | 13 | 1.8 | 2.3 | .5 | 1.3 |
| November | 27 | 72 | -25 | .4 | .7 | .8 | 2.7 |
| Fall | 44 | | | 3.9 | 3.8 | 4.0 | 4.5 |
| Year | 42 | 105 | -44 | 21.3 | 15.7 | 33.4 | 24.1 |

AGRICULTURE.

It was in the vicinity of Fort Abercrombie, where the town of Abercrombie is now situated, that the fertility of the famous Red River Valley was first revealed to the pioneers who settled on the prairies at a time when the presence of United States soldiers was necessary for protection from the Sioux. However, it was not until about 1880, when the Great Northern Railway entered the county, that real agriculture was begun. The first settlements were made along the Red and Wild Rice rivers. The timber along these streams was a protection in winter and was also convenient for building and for fuel.

Wheat and oats were the first crops grown, and later flax was found to give excellent results upon newly broken sod. This crop was grown very little in the early days owing to the low price, but in 1890 it became an important crop. At this time the price of flaxseed ranged from 60 to 85 cents a bushel. Since that time the price has gradually increased, and it has been as high as \$1.50 a bushel.

It was not until 1890 that barley came to be grown in considerable quantities. At the present time it is an important crop.

The broad prairies that surrounded the early settlers afforded large quantities of wild hay, and it was not until the country was well settled that it became necessary to grow the tame grasses. Timothy was found well adapted to the soil and has been quite extensively grown since the early nineties. In the last eight or ten years some clover has been grown, but it is not an important crop, as it does not withstand the severe winters.

Spelt has been grown to a considerable extent since the early nineties. It produces from 30 to 50 bushels per acre and occasionally more, and is chiefly used for feeding, being considered one of the surest crops for this purpose, as it never rusts and is not injured by frosts. Spelt is frequently mixed with oats and barley and ground for feed.

For the last eight or ten years several varieties of millet have been grown in small areas and are considered excellent crops for feeding purposes. Scarcely any of the crop is harvested for seed.

Corn has been grown for the last twelve years or more, the first good crop being grown about 1895. When first planted much difficulty was experienced in finding a variety that would mature before the early fall frosts. This has been overcome to a great extent by seed selection and acclimatization.

Wheat has always been the leading crop in the region. The next important crops are oats, barley, corn, and flax. The constant growing of wheat gradually decreased the yield from year to year until it was found necessary to introduce other crops for the purpose of rotation. The farmers have been forced to realize the importance of crop rotation and the successful farmers are at the present time growing a succession of crops.

In the early days the soil was so productive and gave such good yields of wheat year after year that the average settler considered it as inexhaustible. For this reason some land in the county has been so badly run down that only rotation and careful cultivation will ever bring it back to its former productiveness.

Upon the heavy, flat areas adjacent to the Red River considerable difficulty is experienced with the wheat crop during wet years, and for this reason it is often difficult for those who rent their farms to obtain desirable tenants. The landowners find that letting their farms out to tenants is often very unsatisfactory for the reason that the renter seldom takes the same interest in improving the soil and keeping up repairs as does the owner.

The following dates are about the average time of seeding: Wheat, April 1 to 10; barley, April 20 to May 10, sometimes a little later;

flax, May 15 to June 10; corn, May 8 to 20. It is considered that the latter part of August is the best time for sowing rye, although some of it is sown just before the ground freezes. Barley is the first crop to be harvested, which is generally the latter part of July. Wheat and oats are usually harvested in the early part of September.

Practically all of the wheat grown in the region is spring wheat, the winters being too severe for winter wheat.

The Twelfth Census returned the acreage of wheat in 1899 as 317,746 acres. According to the county records the production of wheat has ranged from less than 2,000,000 to more than 4,000,000 bushels annually for the last five years, although within the last three years there has been considerable decrease in the acreage. The rotation of crops has been one of the causes for this decrease. The census gives the acreage of oats in 1899 as 57,016 acres. Since that time there has been a considerable increase. The production in recent years has ranged from 1,000,000 to 2,250,000 bushels. The acreage in corn in 1899 was 10,110 and in barley 8,937 acres. The production of flax in recent years has ranged from 21,000 to 30,000 bushels annually. The census returned the acreage in 1899 as 39,564. All of the wheat and flax is shipped to eastern markets, except a small amount of wheat which is consumed by the local mills. Practically all the hay and corn and a considerable amount of the barley and oats are used for feeding purposes.

The grain is thrashed as soon after harvest as possible. Some of the grain is stacked, but a large proportion is handled from the shock. In the latter case more men are required and the cost of thrashing is therefore considerably higher. There are two advantages in having the grain stacked for thrashing—the cost is considerably less and there is less loss of grain. Where the entire crew is furnished by a thrasher the following prices are about the average: Four to 5 cents per bushel for oats, barley, and spelt; 8 to 10 cents for wheat; 16 to 20 cents for flax. Where all of the crew and teams are furnished by the farmer the prices are approximately as follows: Two to 3 cents per bushel for oats, barley, and spelt; 5 to 6 cents for wheat; 8 to 10 cents for flax.

Twenty-five to 30 horsepower traction engines are generally used with a blow-stacker separator. Straw is usually the fuel used. Sometimes, however, portable gasoline engines are used in place of the traction engine. These have become more popular in the last few years.

Several of the more wealthy farmers own thrashing outfits, and do their own thrashing as well as that of some of their neighbors. The plan of exchanging work, one farmer with another, is now practiced in some parts of the county. In this way considerable expense is eliminated.

Up to a few years ago stock raising was not common in the county, but since the yields of wheat have begun to decline this industry is becoming more important as an adjunct to general farming. Many of the more progressive farmers are now devoting about one-fourth of their farms to pasture or the production of hay. Sometimes, however, feed, such as corn or millet, is raised in place of pasturing the land. This is one step in the system of rotation. Cattle, horses, and hogs are beginning to be raised to a considerable extent. A very few sheep are also being raised. In 1907 county records show that there were about 21,000 head of cattle of all ages in the county, an increase of about 100 per cent in the last nine years. In the same year there were about 14,000 horses, about 7,000 hogs, and 2,000 sheep. The raising of sheep is declining, while the number of all other stock is increasing from year to year. The value of live stock is about \$750,000.

Dairying is becoming an important industry. At the present time there are over 10,000 milch cows in the county. There are five creameries in active operation. Most farmers who are carrying on the dairy business have cream separators on the farms. Many make the cream into butter, while others ship it to St. Paul.

It is believed that great advantage will result from stock raising, for with only a small number of stock on the farm there is a sure income every year; whereas with grain growing alone there is an occasional year of failure. The straw that is now almost all burned should be used as feed or bedding for the stock, and thus converted into manure. If it is seen that the corn will not mature, it can be made use of for feeding purposes. On nearly every farm, particularly in the western part of the county, there is a considerable acreage of land that is uncultivable, owing either to lack of drainage or to the sandy nature of the soil, or to the roughness of the surface. Practically all of this unused land supports a good growth of grass, which should afford pasturage for five or six months of the year. Much of the uncultivated land of the western part of this county is now pastured, but there are still many square miles which are not bringing in any return, except the small amount of prairie hay that is cut from them.

The farm buildings of the county are generally fair. Large, well-constructed barns frequently appear. It is noticeable, however, that little care is given to housing the farm machinery, only a comparatively few of the farmers having sufficient shelter for the purpose.

In the northwestern part of the county there are a few cattle ranches. Some horses and a few sheep are also kept. There is considerable wild hay in this section of the county, but it is practically all consumed upon the ranches.

The United States census of 1900 gives the average size of farms in Richland County as 318.7 acres. It is probably smaller at the present time, as the large farms are gradually being cut up into smaller ones. The total acreage in farms in 1900 was 719,051; the value of farm lands and improvements, except buildings, was \$11,399,940.

The greater part of the farm work, even in harvest time, is done by the farmer and his family. About 71 per cent of the farms are operated by the owners, the remainder being rented on the share or cash system. In case the renter furnishes the seed and pays the thrashing bill he receives three-fourths of the crop. Where the owner furnishes the seed and pays half the thrashing bill, the crop is divided equally. In recent years some of the more prosperous farmers have moved into town, generally leaving the farms in the care of tenants.

The development of Richland County has been rapid, and its present prosperous condition has been reached in about twenty-five years. In the early eighties the best land in Richland County could be bought for \$5 to \$8 an acre, while at the present time the price of the same land ranges from \$25 to \$50. Thus much of the present wealth of the county is a result of the advances in the prices of the land, and at the present valuation the farmer will have to practice more intensive methods in order to realize a good percentage of profit on his investment. The rotation of crops and careful cultivation can not be too highly recommended. The fact that flax can not be grown on the same soil year after year demonstrates to the farmer that rotation is a necessity in order to get the best returns. The great variety of soils in the county present opportunities for many lines of farming, and it is not necessary to depend upon wheat as the money crop.

The most important problem in the county in connection with a diversified system of farming is to maintain permanently on the farms a number of live stock. Feed can be produced at a moderate cost from such crops as are necessary in a systematic rotation. A combination of timothy, clover, and brome-grass continues to give a good crop the fourth and fifth years. After these crops wheat will produce from 6 to 12 bushels more per acre.

Summer fallowing is quite general throughout the county and is becoming more so, especially upon the heavier soils. Plowing generally begins as soon as the grain is cut, and as much of the stubble as possible is turned under before the ground freezes. Some of the farmers burn the stubble, but as many of the fields need organic matter it is much better to plow the stubble under. Where the soil is very sandy it is not considered best to summer fallow it, because of the tendency of the soil to drift.

Most of the plowing is done by gang plows drawn by four or more horses. Some of the plowing, however, is done with traction engines, which turn from 8 to 10 furrows at a time. After plowing the land

it is left until spring. If the farmers are rushed with work in the spring they sometimes dispense with plowing, and where the grain is to be sown upon sandy soil they merely disk the ground and drill the grain into the old stubble. The corn crop is generally planted in check rows and is cultivated with sulky cultivators. The cultivation is usually insufficient, and sometimes the ground between the rows is allowed to become filled with wild oats and other weeds and grasses. More thorough cultivation would materially improve the corn crop and at the same time keep down the weeds.

The extermination of wild oats and quack grass is one of the serious problems confronting every farmer. It is believed, however, that by crop rotation, and by thorough, clean cultivation in the case of cultivated crops like corn, much can be done to control these pests.

Potatoes are not grown except for home consumption. The lighter soils of the western part of the county are well adapted to them. This would be a profitable crop to include in rotation with grains. The yield ranges from 200 to 300 bushels per acre.

There are a few small patches of alfalfa in the county. Very little interest has as yet been taken in this crop, but it is believed that when properly handled it will do well.

As already noted, the farmers and their families do the most of the farm work. Some labor is hired by the month, however, the usual wage being \$25 to \$35 a month for a period of seven months. A little labor is hired by the year, and when such is the case the price per month is somewhat less than when hired for shorter periods. During harvest time a good deal of day labor is required, the wages ranging from \$2.25 to \$2.75 a day. At this season of the year much of the labor is supplied by transients who come from eastern sections to take advantage of the high wages. According to the Twelfth Census the farmers expended in 1899 \$705,520 for labor.

Apples are being tried to some extent in this section, and it is hoped that in time a variety will be developed which will withstand the severe winters and mature its fruit during the short growing season. It is believed that the higher elevations in the western part of the county will be better adapted to fruit than the region of heavier soils adjacent to the Red River.

As a protection against the severe winds during the winter, nearly every farmer sets out a grove of trees on the north side of his house and farm buildings. Such rapid growing trees as the box elder, cottonwood, elm, and willow, are used for this purpose.

There are two sources of water supply in Richland County—surface wells and artesian wells. The former furnish a sufficient supply of water except in very dry seasons. An artesian supply may be found at depths ranging from 150 to 300 feet in most of the county, excepting the northwestern portion.

Much interest is being taken at present in the question of drainage. Open ditches are now being constructed by the county and in the northwestern section the drainage of large areas, heretofore used only for grazing, is being undertaken. Each landowner is taxed according to the benefit he will receive. In these poorly drained areas some alkali is found, but it is believed that this will be removed when drainage is established.

SOILS.

The soils of Richland County fall naturally into three groups, namely, those of glacial origin, those of delta origin, and those of lacustrine origin.

The soils of glacial origin are confined to the southwestern corner of the county and include practically all of the county west of Hankinson and south of the Wild Rice River. This portion of the county was once covered by an extension of the ice sheet known as the Dakota glacier. As the ice sheet moved slowly southward it ground up the rocks, granite, gneiss, schist, limestone, shale, etc., over which it passed. This ground-up material was left as a veneer over the region upon the recession of the ice sheet. The surface features of this portion of the county are typical of a glaciated area, being made up mainly of low, rolling prairie with a succession of morainic hills, between which are often found kettlelike depressions. Through this portion of the county passes a chain of small, shallow lakes which extend from 6 miles northwest of Lidgerwood to Hankinson and southward. These lakes represent depressions in the glacial channel of the Sheyenne River. The soils in the southwestern portion of the county are derived mainly from the weathering of the unassorted glacial material, and the principal types represented are Fargo loam, Marshall loam, Fargo sandy loam, and Marshall gravelly sandy loam.

The remaining portion of the county was formerly covered by a great lake, known to geologists as "Glacial Lake Agassiz." At that time the whole of what is now the Red River Valley, including Lake Winnepeg, was one continuous sheet of water. The surface of the region formerly covered by the lake is so level that in traveling over it one is reminded of being at sea, the plain being visible for only a few miles ahead. The tops of buildings and grain stacks are seen first, after which they, gradually come into full view. This levelness is well shown by the fact that at Wyndmere the altitude is 1,065 feet, while at Wahpeton, 28 miles directly eastward, the altitude is 960 feet. In a north and south direction the fall per mile is even less, the average being less than 2 feet.

At the close of the Glacial period the melting ice swelled the streams to many times their present volumes, and large quantities of sand, silt, and clay were carried along by the streams and spread out over the

bottom of the lake. The Sheyenne River at that time emptied into Lake Agassiz at a point near the present site of Hankinson, and that portion of the ancient lake bottom covered by the sediments brought down by the river is known as the "Sheyenne Delta." The eastern boundary of the delta in Richland County is approximately a line connecting Colfax, Galchutt, Fairview Junction, Great Bend, and Oswald. All of the county west of this line, and not included in the glaciated area, belongs to the Sheyenne Delta. As would be expected, the soils derived from delta deposits predominate in sands. At the first checking of the river's current the coarser materials, like gravel and sand were deposited, while the finer sands and silt were carried farther into the lake. The gravels and sands were often reworked by the waves and piled up into beach lines, and this accounts for some of the small gravel areas in the western part of the county. The following are the main soil types derived from the deposits of the Sheyenne Delta: Fargo fine sandy loam, Fargo fine sand, and Fargo sandy loam.

The soils of lacustrine origin are confined mainly to that portion of the area between the eastern boundary of the Sheyenne Delta and the Red River. The materials from which these soils are derived represent the depositions which took place in the middle of the old lake beyond the influence of inflowing glacial streams. In these deep, quiet waters only the finer materials, like clay and silt, were carried in suspension. The region as a whole is flat and poorly drained and the soils are heavy. The following are the main soil types of lacustrine origin: Fargo clay loam, Fargo loam, and Fargo clay.

Besides the above classes of soils, there are several small areas where the sandy material of the Sheyenne Delta has been blown about and formed into dunes.

Associated with all of the soil types in the county there are sometimes small, swampy, poorly drained depressions, and these were mapped as Meadow.

The following table gives the names and areas of the various types of soil. The accompanying map distinguishes the soils by means of colors.

Areas of different soils.

| Soil. | Acres. | Per cent. | Soil. | Acres. | Per cent. |
|-----------------------------|----------|-----------|-----------------------------|----------|-----------|
| Fargo fine sandy loam | 218, 112 | 23.5 | Fargo clay | 11, 136 | 1.2 |
| Fargo loam | 204, 800 | 22.0 | Lidgerwood fine sandy loam. | 10, 048 | 1.1 |
| Fargo fine sand | 144, 256 | 15.5 | Marshall gravelly sandy | | |
| Fargo clay loam | 113, 280 | 12.2 | loam | 10, 048 | 1.1 |
| Marshall loam | 91, 264 | 9.8 | Wabash loam | 4, 544 | .5 |
| Fargo sandy loam | 53, 504 | 5.7 | Fargo gravelly loam | 3, 840 | .4 |
| Meadow | 28, 672 | 3.1 | Walcott sandy loam | 3, 264 | .4 |
| Dunesand | 19, 008 | 2.0 | Total | 929, 920 | ..... |
| Fargo silt loam | 14, 144 | 1.5 | | | |

FARGO CLAY.

The Fargo clay to a depth of 15 inches is a very heavy, tenacious, black clay. The subsoil is practically the same as the soil, although it is a little heavier in texture and lighter in color, being blue or mottled. When wet the soil is very gummy and sticky and frequently clogs the wagon wheels. It is locally known as "gumbo," and is the heaviest soil found in the area. Pockets of gypsum are frequently encountered in the subsoil and decomposed limestone nodules forming gray or white spots are sometimes found.

Practically all of the type is covered by a growth of wild grass and very little of it is cultivated. Occasional barren spots occur, which are due to the presence of alkali, but they are not of sufficient size to be of importance. It is the most difficult soil in the area to cultivate. When broken it forms very large clods which bake hard, and considerable harrowing is necessary to put it in fair condition. The mechanical condition is much improved by the application of straw and coarse manures. In dry seasons large cracks occur in the soil, which often extend to a depth of several feet.

The Fargo clay has a level to flat topography. It occurs in slight basins in the eastern part of the county, and occupies but a small percentage of its area. The largest body is found west of Woodhall, and is about 4 miles long and $1\frac{1}{2}$ miles wide. The only cultivated areas occur south of Christine and along the northern border of the county.

Nearly all the areas of this soil are poorly drained, which accounts for the fact that little of it is under cultivation. In many places attempts have been made to drain the land, but with little success, except in the northern part of the county, which has been well drained by open ditches and is producing good crops. In many places the expense of draining the small areas is so great that reclamation is not practicable.

The soil is derived from reworked glacial débris and consists of the finest part of that material which was deposited in the center of the old bed of Lake Agassiz.

The Fargo clay is most commonly used for the growing of wild hay, although frequently the grass is not of good quality. A great accumulation of organic matter makes the soil very fertile. As so little of the type is cultivated it is impossible to give accurate crop yields.

WABASH LOAM.

The Wabash loam to a depth of about 18 inches is generally a dark-brown or black loam, which contains considerable organic matter. The subsoil is lighter in color and slightly heavier in texture than the soil; otherwise it is about the same. The soil presents some

variation, however, in that it has a sandy loam and clay loam phase, but these occur in areas too small to be indicated. Stones and gravel are absent from both soil and subsoil.

The soil is found in a continuous strip bordering on both sides of the Sheyenne River for a distance of 8 or 9 miles. It is about one-half mile wide and extends from the west county line to Barrie. It is also found in the oxbows of the Red and Wild Rice rivers and to a small extent along Antelope Creek. The areas occurring along the Red and Wild Rice rivers are very small and generally contain considerable very fine sand.

The topography of the soil along the Sheyenne River is undulating, while along the Wild Rice and Red rivers and Antelope Creek it is practically level. The drainage is generally good, with the exception of the clay loam phase along the Sheyenne River.

The soil is of alluvial origin, being deposits of the streams along which it occurs. A sandy loam phase is found, where the soil is modified by material blown from adjoining sand areas.

Except the clay loam phase, which is sometimes too wet, the Wabash loam is easily cultivated, and is, in general, farmed. The uncultivated portion, occurring along the Sheyenne and Red rivers, is covered with a growth of timber consisting mainly of oak, ash, elm, and box elder.

The soil is adapted to the production of oats, wheat, barley, and corn. Wheat yields from 12 to 25 bushels per acre, varying according to the phase on which grown, and oats from 25 to 50 bushels per acre. Corn produces good yields, but along the Sheyenne River there is danger of it not maturing on account of early frosts. On the Wild Rice and Red rivers truck products are grown in gardens, where, owing to the light texture of the soil, it warms up early in the spring. The chief truck products are onions, radishes, potatoes, lettuce, beets, and cabbage. Potatoes are grown quite extensively and yield from 200 to 300 bushels per acre. The loamy phase is the most productive of the type.

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

Mechanical analyses of Wabash 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> |
| 19595 | Soil..... | 0.0 | 8.8 | 3.5 | 23.1 | 9.8 | 38.6 | 16.3 |
| 19596 | Subsoil..... | .0 | 3.7 | 2.4 | 17.8 | 10.6 | 39.6 | 25.7 |

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 19596. 3.49 per cent.

FARGO FINE SAND.

The Fargo fine sand consists of 10 to 12 inches of grayish-brown fine sand, underlain by a subsoil of lighter colored fine sand. The areas are composed of a succession of rounded mounds with broad, shallow, intervening depressions. The soil in these depressions is slightly heavier and deeper and contains more organic matter, which gives it a darker color. The knolls are from 5 to 15 feet high and vary in width from one-fourth acre to several acres in extent. The type sometimes occurs on slight ridges, evidently beach formations, which give it a gently rolling topography.

Owing to the peculiar topography the drainage is not generally good. The tops of the knolls are usually very dry, while the depressions are wet, some of them containing water the year around. Several short, deep channels cut through the sand dunes along the Sheyenne River and drain a portion of the soil. The drainage of the beach ridges is good. These occur in the vicinity west of Colfax, in the northwest corner of the county, and in the neighborhood of Hankinson.

About one-half of the area of Fargo fine sand is in a poorly drained condition, and such areas have been shown in the soil map by means of symbols. As would be expected, there is considerable variation in the soil of the swampy areas, especially as regards the organic-matter content.

The county is attempting to improve this soil by means of artificial drainage, and great interest is manifested in the question of its fertility and adaptability after being satisfactorily drained. In dry seasons, such as that of 1908, little drainage is necessary, except in the very lowest areas, but in ordinary or very wet years much of this type is under water, and for the last several years it would have been impossible to map the soil, as it was covered with water. None of the poorly drained areas are at present under cultivation.

This soil occupies the greater portion of the northwestern part of the county. The more swampy areas are found in Garborg, Homestead, Freeman, Sheyenne, and Viking townships. Two large areas in which the drainage is better occur—one north and the other south of the Sheyenne River. An area from 12 to 14 miles in length is found west of the Great Northern Railway near Walcott and Colfax, varying from about one-fourth mile to 3 miles in width. The other large area occurs west of Hankinson, where it is intermixed with several other types of soil. In the northwest corner of the county the type generally surrounds the sand dunes, and an area of considerable extent, surrounding sand dunes, occurs west of Homestead. Several small areas are scattered over the northwestern and south-central portions of the county.

The Fargo fine sand is a delta formation, and it has been reworked to some extent by the winds, which accounts for the presence of many low knolls. The sand extends to a depth of more than 3 feet, except in a small area bordering the Sheyenne channel. The entire delta, and hence the Fargo fine sand, is underlain at from 4 feet to unknown depths by a stratum of clayey silt. South of the Sheyenne River in the cuts of the short channels the silty material outcrops. Here, though the land is broken, good crops are grown, owing to the fact that this heavier stratum is near the surface. In the north-western part of the county the silt is covered by a shallower deposit of the sand than elsewhere.

The native vegetation consists of a good growth of prairie grass, with occasional areas of scrubby timber or bushes. Russian thistle appears in great quantities along the roads upon soil which has been broken and allowed to revert to sod. A large proportion of the type is used for pasture. Good prairie hay is cut in the wetter areas and, when the season is favorable, on some of the higher land. The greater proportion of the soil is uncultivated, but a considerable area along the Sheyenne River and north of it produces good crops. Here the characteristic knolls are less numerous and the surface is more level. Generally when recently plowed the soil is shifted by the wind, and on this account the sod or stubble is seldom broken until spring.

The Fargo fine sand yields from 8 to 12 bushels of Bluestem or Fife wheat, but it is better adapted to the macaroni or durum varieties. Oats and corn produce fair yields, but not as good as on many of the other soils of the area. Owing to the lack of organic matter in the soil crop rotation is very essential.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Fargo fine sand.

| 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> |
| 19567, 19597 | Soil | 0.1 | 0.5 | 1.4 | 62.3 | 25.2 | 7.1 | 3.2 |
| 9568, 19598 | Subsoil | .1 | .3 | 1.3 | 67.4 | 20.7 | 3.9 | 6.0 |

DUNESAND.

Dunesand to a depth of 6 inches consists of a fine gray sand underlain by a yellow sand of practically the same texture. The only difference between the soil and subsoil is the presence of slight quantities of organic matter in the former which gives it a darker color and a somewhat loamy texture. In barren areas the soil and subsoil are identical, both being a yellowish fine sand.

Most of the Dunesand occurs in three comparatively large areas. The largest of these borders the Sheyenne River in the northwest corner of the county, the next largest is found northwest of Hankinson, and the third occurs near the county line west of Homestead. Smaller areas are scattered throughout the Fargo fine sand.

The surface of the soil is rough and broken, and composed of knolls and hills which rise abruptly from 25 to 125 feet above the surrounding prairie. The soil in the intervening depressions generally bears a fair growth of grass, and is more fertile than that on top of the knolls, which is frequently barren and constantly being moved by the wind. In the deeper depressions and along some of the slopes a stunted growth of scrub oak and choke cherry appears. There is an excess of drainage from the hills to the intervening depressions, which contain water in wet seasons.

Dunesand is a delta deposit which has been reworked by the winds, and probably varies in depth from a few feet to over 150 feet.

The type is uncultivated, and has scarcely any agricultural value. It is held at \$5 to \$10 an acre for pasturage, but if pastured too closely it soon becomes barren, and is then drifted by the wind. The greater proportion of this soil used for grazing occurs in the northwestern part of the county.

FARGO CLAY LOAM.

The soil of the Fargo clay loam to a depth of 12 inches consists of a black clay loam containing a high percentage of organic matter. Below this to a depth of 18 inches the soil is a lighter colored clay loam, and frequently a clay. The vegetable matter content decreases with depth, and consequently the subsoil to a depth of 18 to 36 inches is a lighter color than the soil. The typical material is a dark-yellow stiff, silty clay or yellow clay, sometimes containing decomposed lime nodules, which form white spots, and pockets of gypsum crystals.

Some gravel is occasionally found in both soil and subsoil, but this is not characteristic of the type. The largest quantity was found in an area about 8 miles long, extending north and south, the greater portion being north of Wahpeton. This was practically the only area where gravel was noticeable to any extent, and here it occurred mostly in the subsoil.

The soil is very uniform and only slight variations can be detected, even in widely separated areas. Sometimes the gradation zone between this and other types is rather broad. The type is generally bordered by the Fargo loam, and in many places along this boundary both soil and subsoil are a little lighter in texture. There are occasional spots where the subsoil approaches a heavy silt loam, this being most noticeable southwest of Abercrombie.

Another slight departure from the type was encountered in small areas in depressions. Here the soil is a little heavier and frequently extends to a depth of 24 inches with very little change in texture or color. The subsoil from 24 to 36 inches is much darker than that of the true type, being a very dark yellow or drab color, while the texture is a stiff clay. The areas covered by this phase are generally small and of comparatively little importance.

The Fargo clay loam is sticky when wet, and appears to be quite difficult to cultivate. When plowed it breaks into large clods. However, after these have been subjected to the weather and are dry they crumble beneath the harrow and form a good seed bed. Even if the soil is plowed when slightly wet there is not much difficulty in getting it in a good mechanical condition. During the summer, when the soil is comparatively dry, the first 4 or 5 inches is very loose and may be very easily dug up by hand. Below this the soil is moist and sticky.

The Fargo clay loam and Fargo loam are closely related. The surface soil of the former is generally a clay loam, though in some cases the first 4 inches may be a loam, and where the loam exceeds 4 or 5 inches in depth it is mapped as Fargo loam.

Practically all the Fargo clay loam occurs in the eastern part of the county. About four-fifths of the type is found in one rather broad, uniform area parallel to the Red River, which flows almost due north. This area extends from the northern boundary of the county, at which point is about 7 miles wide, southward to a point 7 miles south of Wahpeton. It is broken but once by an area of Fargo loam about 2 miles wide, although there are some included areas of Fargo clay and Fargo loam. The next largest area is found west of Tyler. The remainder of the soil is in comparatively small spots.

The soil is drained by the Red and Wild Rice rivers. Most of it occurs as a broad, slightly depressed basin, which reaches its greatest elevation along or near the streams, the height gradually diminishing as the distance from them increases. The soil has the poorest drainage of any of those used for farming. During an average season it has sufficient drainage, with the exception of an occasional depression, but in seasons of excessive rainfall crops are sometimes damaged. In some places ditches are utilized to carry off the surplus water.

The Fargo clay loam is one of the most productive soils in the county and has contributed much to the fame of the Red River Valley as a wheat-growing section. It retains moisture well and during droughts crops frequently flourish while those on the lighter soils suffer badly for lack of moisture. It is particularly well adapted to wheat, oats, barley, and flax. Corn grows well, but its chances for maturing are not as good as upon some of the lighter and better

drained soils. Wheat ordinarily yields from 12 to 25 bushels per acre, and where crop rotation is practiced the yields in good seasons reach 35 bushels. Corn yields from 35 to 50 bushels per acre; oats from 35 to 60 bushels per acre; and flax from 7 to 12 bushels per acre. Where native grass appears it is luxuriant.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Fargo 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> |
| 19589 | Soil | 0.0 | 5.0 | 3.8 | 7.3 | 6.0 | 37.6 | 40.3 |
| 19590 | Subsoil | .0 | 3.1 | 1.9 | 8.4 | 4.1 | 34.6 | 47.8 |

FARGO SANDY LOAM.

The surface soil of the Fargo sandy loam is a dark-brown to brown fine sandy loam to a depth of 18 inches. From 18 to 24 inches a yellowish sandy loam is found which contains more fine sand than the material above. Immediately below this to a depth of 36 inches is a grayish-yellow silt loam in which the finer grades of sand predominate. Gravel is often found in small quantities in both soil and subsoil, the proportion being greater in the subsoil. This was most noticeable along the Wild Rice River, where generally a narrow strip about one-fourth mile in width occurs on either side of the stream. From a depth of 12 to 20 inches the sand is somewhat coarser than in the surface soil.

The Fargo sandy loam is somewhat similar to the Fargo fine sandy loam, and the two are generally associated. The principal difference is that the Fargo sandy loam has a silty subsoil, while the Fargo fine sandy loam has a sandy loam subsoil. It was difficult from the surface to make a distinction between the two types, and in tracing the boundary lines it was necessary to make a large number of borings.

Owing to the sandy nature of the soil, it is very easy to cultivate. Only a few stones are found in the soil. The soil is generally very uniform, there being only one or two variations, the greatest of these occurring west and southwest of Barney, where the surface soil was quite heavy, approaching a loam. In this vicinity there is a stratum of 6 or 8 inches of very fine yellowish silty sand between the soil and the subsoil. Occasionally the silty material of the subsoil is not encountered until a depth of 30 inches is reached, the soil being a sandy loam to this depth. Where the silt was barely reached at a depth of 3 feet the soil was classified as Fargo fine sandy loam.

The Fargo sandy loam is located chiefly in the southwestern part of the county, near the Wild Rice River, and extends from the county line, west of Wyndmere, to within a few miles north of Hankinson. The only other areas of importance are found south and west of Hankinson, for the most part near the old Sheyenne channel, which crosses this section of the county. The soil usually occurs in comparatively large areas, and there are only a few that cover less than half a section.

The topography is generally undulating, but on account of the short channels reaching back from that stream it is slightly broken along the Wild Rice River, which drains the greater part of the type. As the areas generally have an elevation of from 20 to 60 feet above the normal water level of the stream, the drainage is good. In the vicinity of Wyndmere, where it borders the Fargo fine sandy loam, the soil is nearly level and is not so well drained, but crops do not suffer except in very, wet seasons.

The soil is derived from reworked glacial material, but the Wild Rice River in times of overflow has deposited the gravel and some coarse sand.

The soil appears to be free from alkali, but an abundance of lime is evidently present, as the gray silty material contains a large percentage of carbonate.

This soil is the most desirable sandy loam in the area for general farming. The silty subsoil holds water well, so that the type withstands drought very satisfactorily. Where the silty subsoil is within 12 to 20 inches of the surface the soil is more desirable than where found at a depth of 30 inches, as the crop yields are generally better. The soil is well adapted to all the crops generally grown in the county. There is a small area along the Wild Rice River which is not farmed, owing chiefly to the fact that it is cut by stream channels, and is, therefore, too rough for cultivation. Wheat yields from 15 to 25 bushels and oats from 25 to 40 bushels per acre. Barley yields from 20 to 40 bushels and flax from 8 to 15 bushels per acre. However, there is little of the latter grown at present. The soil ranks among the best in the county for the production of corn and durum wheat. It is not often that corn fails to mature on this type when an early variety is grown, and yields of from 35 to 60 bushels per acre are secured. The soil is also well adapted to potatoes and various other truck products.

The following analyses of soil and subsoil show the composition of the fine earth of the Fargo sandy loam:

Mechanical analyses of Fargo 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> |
| 19551 | Soil..... | 0.0 | 0.4 | 0.4 | 16.1 | 38.6 | 39.9 | 3.9 |
| 19552 | Subsoil | .0 | .5 | .4 | 4.9 | 28.7 | 57.1 | 8.2 |

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 19552, 9.05 per cent.

MARSHALL GRAVELLY SANDY LOAM.

In general the Marshall gravelly sandy loam to depth of 10 inches has a dark-gray color and is composed of a light loam or a heavy sandy loam which contains a relatively large proportion of coarse sand and fine gravel. The subsoil to a depth of from 10 to 36 inches consists of a sandy silty material containing some gravel, the content of which increases with depth. Sometimes the gravel and sand in the subsoil are irregularly stratified. Both soil and subsoil have a number of variations, but the material is so complex it is impossible to separate them.

The topography is broken and hilly, being composed of morainic knolls and hills with intervening depressions or sometimes small valleys. On the tops of the knolls and hills the soil is generally loam, and it was frequently impossible to make a boring more than 12 inches deep, the subsoil in such places consisting of coarse and fine gravel and coarse sand. Along the slopes the soil becomes more loamy and the gravel content generally decreases toward the foot of the hills. In the intervening depressions the soil is usually a black loam containing considerable quantities of organic matter to a depth of about 15 inches. Here the subsoil from 15 to 36 inches is a rather heavy, yellow silty clay. These phases occur only in spots of a few acres. In some of the depressions water is found until early summer. Glacial boulders, consisting of granite, gneiss, schist, and limestone, are frequently scattered over the surface, being most numerous in the vicinity of Elsie Lake. In some places where they occur in large numbers they are shown on the map by symbol.

Not over one-third of this type is under cultivation, the fields being located chiefly on some of the slopes and in a few depressions where the soil is better than the average. Where gravel and stones appear the soil is sometimes difficult to cultivate, but where these are not numerous very little trouble is experienced. Such areas, however, are comparatively small. The hilly topography makes the use of improved machinery laborious.

The larger bodies of the Marshall gravelly sandy loam occur southwest of Hankinson, where there are areas containing more than 2 square miles. Between Hankinson and Lidgerwood, south of the old channel of the Sheyenne River, there is a continuous strip bordering this channel. The next larger area is found west of Lidgerwood along the county line. Northwest of Lidgerwood on both sides of the old channel of the Sheyenne River are found many small ridges and knolls of this soil. The small ridge south of the Wild Rice River is part of an ancient beach formation.

Areas of this type lie at altitudes over 1,100 feet above sea level, and the highest point in the county occurs on this type southwest of Hankinson, where the altitude is about 1,280 feet. On account of the gravelly and sandy nature of the soil and its rolling to hilly topography the natural drainage is excessive, except in the depressions. The drainage is chiefly into small lakes found throughout the areas; the greater proportion of the gravel and stones is found bordering these lakes.

The Marshall gravelly sandy loam consists of glacial deposits which are terminal and ground moraine. None of the type south of the Sheyenne River has been reworked by water, but the smaller areas north of the channel have the appearance of having been slightly altered by the action of water.

A slight trace of white alkali occurs in a few of the small depressions, and in some of the larger lakes the water contains considerable alkali. In no case, however, is the amount sufficient to be of any importance.

The native vegetation consists of prairie grass, and slough grass of poor quality for hay is found in the depressions. A few small oak, elm, and box-elder trees border some of the lakes. No accurate estimate can be made of the crop yields, as they vary on the different phases. Wheat, oats, and flax are grown and a few apple orchards are found. This type is probably better adapted to apple growing than any other in the area, especially in areas having a silty clayey subsoil.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of the Marshall gravelly sandy loam are given in the following table:

Mechanical analyses of Marshall gravelly 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> |
| 19569 | Soil | 10.4 | 20.4 | 9.4 | 14.0 | 10.8 | 28.8 | 6. |
| 19570 | Subsoil | 9.9 | 14.3 | 4.1 | 8.2 | 7.8 | 40.1 | 15.9 |

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO₃): No. 19570, 36.40 per cent.

FARGO FINE SANDY LOAM.

The surface soil of the Fargo fine sandy loam to a depth of 6 inches is a dark-brown fine sandy loam containing considerable organic matter. From a depth of 6 to 12 inches the soil has about the same texture, but is slightly lighter in color, indicating the presence of less organic matter. The subsoil to a depth of 18 inches is slightly heavier than the soil and is of a yellowish or grayish color, becoming slightly lighter in color at a depth of 30 inches, and at 36 inches contains considerable more fine sand. It is sometimes mottled with red and white and continues to a depth of at least 4 feet, as shown by cuts and ditches, where it is underlain by a silty clay of unknown depth. This latter material is usually a bluish-drab color, mottled with white, evidently the result of decayed limestone nodules, and with red and black. This stratum of heavy subsoil underlies practically all of the Sheyenne Delta at varying depths, and comes to the surface in limited erosions south of the Sheyenne River. It appears nearer the surface in the heavy phase of the type and at the surface in the Fargo silt loam.

The Fargo fine sandy loam forms about 23 per cent of the area of the county, having an extent of about 341 square miles. It is the predominant type north of the center of the county, while large areas of it are found in the southeastern part. In the area north of the Sheyenne River the silty clay substratum lies from 4 to 10 feet below the surface. Between Wyndmere and the sand dunes along the Sheyenne River it is broken by areas of the Fargo fine sand, too small to be shown on the map, and by other areas of the same type, which extend into this locality from the vicinity of McLeod, in Ransom County.

In the vicinity of Great Bend and also in the southern part of the county the Fargo fine sandy loam forms the better class of farming land, and in the former locality some of the most prosperous farms in the county are found. The small areas that occur interspersed in other soils are generally good land. In the southern part of the area the sand dunes and Fargo fine sand border the Fargo fine sandy loam and are closely associated with it in origin and formation. Where the type borders the former it is somewhat sandier than the typical soil. On the other hand, where it borders heavier soils it has a slightly heavier texture. In both of these cases there is no distinct dividing line between the soils, and the soil conditions in the zone of gradation are frequently complex.

An important instance in the modification in the Fargo fine sandy loam due to the influence of another type of soil is found in the southern part of the county, where it grades into the Fargo loam. Here there is a strip of country about 1 mile wide and 5 miles

long where the soil is slightly heavier and is considered a little more fertile than the typical soil.

The topography is undulating to slightly rolling and practically all areas have good drainage, except those lying next to the Fargo fine sand, where, in wet seasons, the drainage is inadequate. Antelope Creek is the only stream of any size flowing through the type, and bordering this creek the soil has its highest elevations. Some of the drainage passes through the Wild Rice River, but evidently a large part of the rainfall seeps into the soil and is carried off underground.

The Fargo fine sandy loam is found entirely within the area of the Sheyenne Delta and is derived from reworked glacial material brought to its present position by the Sheyenne River. It represents the finer deposits of the delta, along the western and southern edges of which it lies.

There are occasional slight indications of alkali in the soil, but the quantity is not sufficient materially to injure crops. The alkali is found chiefly in areas of deficient drainage.

The soil is easily cultivated, and it is generally farmed, though there are a few areas left for hay, of which the yield and quality are good. There is no apparent reason why these areas should not be cultivated, if this were desirable. Wheat, oats, barley, and corn are the principal crops, with some flax. Macaroni or durum wheat is much better adapted to the soil than the Fife or Bluestem varieties. The type is excellent for corn, and some of the best crops in the area were seen growing on this soil. In some fields corn reached the height of 10 feet. The earlier varieties mature in average seasons. Small grains yield nearly as well on the Fargo fine sandy loam as upon the Fargo clay loam, but the former is not as durable as the latter and crops should be rotated in order to maintain its productiveness. Various truck crops are also well adapted to this type.

Fargo fine sandy loam, heavy phase.—The surface soil of the Fargo fine sandy loam, heavy phase, consists of 8 or 12 inches of fine sandy loam which to a depth of about 10 inches contains considerable organic matter. From 10 to 20 inches the material is a yellowish fine sand and underlying this to a depth of 3 feet or more is a heavy, drab-colored clay or clay loam, usually mottled with white or grayish calcareous silty material due in part to decomposed limestone concretions. Where the silty material is absent the subsoil is usually a clay. Though somewhat heavier than the typical soil, this phase is friable and easily cultivated. It does not bake or puddle and the heavy subsoil, which retains water well, enables the crops to withstand drought.

Areas of this phase occur chiefly in the vicinity of Mooreton, in the central part of the county. The topography is generally level, and owing to the impervious nature of the subsoil there is very little seepage. A small coulée in the eastern part of the largest area carries off the greater portion of the drainage water.

The soil occurs near the edge of the delta, and the subsoil is a heavy phase of the stratum of silt which underlies the greater part of the delta. In the low spots there is a slight indication of alkali in the soil, but not sufficient to be injurious to vegetation. The subsoil contains a considerable percentage of lime, derived largely from decayed limestone.

The greater proportion of the heavy phase of the Fargo fine sandy loam is under cultivation, and the crops are generally good. Occasionally there are small areas that are uncultivated. The soil is well adapted to grasses, such as timothy, brome grass, and clover. Where native grass appears, it is of good quality and yields from 1 to 2 tons of hay per acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the two phases of the Fargo fine sandy loam:

Mechanical analyses of Fargo 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> |
| 19555 | Soil | 0.2 | 0.3 | 0.8 | 27.0 | 44.0 | 23.7 | 3.5 |
| 19556 | Subsoil | .0 | .1 | .5 | 23.3 | 55.5 | 18.0 | 2.5 |
| Heavy phase: | | | | | | | | |
| 19593 | Soil | .0 | 2.4 | .5 | 47.3 | 20.8 | 22.3 | 6.4 |
| 19594 | Subsoil | .0 | 1.9 | 1.5 | 19.2 | 12.7 | 46.0 | 18.0 |

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 19594, 13.03 per cent.

MARSHALL LOAM.

The soil of the Marshall loam to a depth of 14 inches is a brown to black loam containing a large proportion of silt and a considerable quantity of organic matter. At 10 to 14 inches below the surface it becomes somewhat heavier in texture and lighter in color. The subsoil from 14 to 36 inches is a yellowish-gray heavy silt loam or silty clay. Where the surface is rolling some gravel is usually found in the soil, and it is generally found in the subsoil. There is some variation in the texture of the subsoil. It is heavier in the more level areas, which are generally found near the boundary line between this and the Fargo loam. A few stones are scattered over the soil, and both gravel and stone are frequently found surrounding the small lakes

and basins and where the type joins the Marshall gravelly sandy loam. This soil is a gradation between the Marshall gravelly sandy loam and the Fargo loam, but has the same origin as the Marshall gravelly sandy loam.

The type is confined to the southwestern corner of the county, and is found principally north and south of Lidgerwood, where it covers low, gravelly hills. Two phases occur, one north and the other south of the old channel of the Sheyenne River near Lidgerwood, that north being somewhat modified by the action of the water, and that south being typical drift. The area in the extreme southwest is pitted by many small basins and potholes, which range in extent from a few acres to more than a section. The small areas contain water a large part of the year and have been represented on the map as Meadow. This is the principal type in the southwestern portion of the county south of the ancient Sheyenne channel.

The topography is generally rolling and sometimes slightly hilly, the more rolling portion occurring south and west of Lidgerwood. The more level or gently rolling areas lie in the extreme southwestern corner of the county, near the county line south of Hankinson, and in that part north of the old glacial channel. The areas range in elevation from 1,090 to 1,250 feet above sea level.

The drainage is generally good, the type being one of the best drained in the area, though occasionally there are small depressions of a few acres each in which drainage is inadequate. Even here crops are damaged only in seasons of abnormal rainfall. Much of the rain water passes into the soil, and is removed by underdrainage. The surface run-off drains into the Wild Rice River.

The soil is glacial in origin, and is derived mainly from morainal deposits, though in the more northern part of the area, which was near the shore line of glacial Lake Agassiz, the material has been subjected to some extent to the action of water.

The greater portion of the type is under cultivation. Native grass grows well on the uncultivated areas, which generally occur near the small lakes or where the type is more rough or gravelly. The soil ranks in general with the best soils of the county for general agriculture, there scarcely ever being an entire crop failure. It is well adapted to wheat, oats, barley, and corn. Oats yield from 20 to 40 bushels per acre, and wheat from 21 to 25 bushels per acre. Corn generally matures on this soil.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Marshall 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> |
| 19573 | Soil | 1.1 | 6.1 | 3.0 | 14.0 | 7.5 | 50.6 | 17.7 |
| 19574 | Subsoil | 1.4 | 4.5 | 3.7 | 11.7 | 8.7 | 41.3 | 28.4 |

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 19574, 13.55 per cent.

MEADOW.

The term "Meadow" is used to cover the low-lying areas which are too wet to produce crops. The texture of the soil varies from sandy loam to clay loam, but it is generally a black loam overlying a black loam or clay loam containing a high percentage of organic matter. Occasionally the percentage of organic matter is so high that the soil to a depth of 10 or 15 inches presents the characteristics of muck. Areas of this nature are found in the old channel of the Sheyenne River and in a few of the larger depressions elsewhere.

There are two distinct phases of Meadow as mapped in Richland County. That part of the soil along the bottom of the Wild Rice River and in the old channel of the Sheyenne River constitutes one phase, while the small areas on the rolling prairie in the southwestern part of the county chiefly make up the other. The area along the Wild Rice River is an alluvial deposit varying in width from about one-sixteenth to a little over one-half mile, and follows the river from the western county line for about 20 miles, covering practically the whole bottom of the channel. The other phase is lake deposit or material washed from the hillsides into the depressions. The character of the soil varies according to that surrounding the depressions. During a wet season water stands in these throughout the entire summer, and they nearly all contain water at some season of the year. Frequently in the old Sheyenne channel the subsoil contains a large percentage of gray silty material, or it may be a gray, mottled impervious clay.

Meadow occurs generally in the southwestern part of the county, and a few scattering areas are found in the north and one larger area in the southeast. A comparatively large area of Meadow borders the Bois de Sioux and extends from about 1 mile north of Fairmount to the county line. The soil in this area is rather uniform in texture, being generally a clay loam underlain by a clay.

The phase occurring along the Wild Rice River would be well drained if it were not for the impervious nature of the soil. There is no surface drainage over the remainder of the type. As the areas are usually small and scattered, the cost of draining them would be too great to make it practicable.

The topography is level or flat, the areas generally being surrounded by bluffs or hills. The areas along the Wild Rice River and the old Sheyenne channel are from 40 to 60 feet lower than the surrounding prairie.

None of the soil is under cultivation. It is covered with prairie and slough grasses, though often the latter is not of good quality. However, in some of the depressions good prairie hay is cut, the yields ranging from 1 to 2½ tons per acre.

WALCOTT SANDY LOAM.

There is an area in the northern part of the county where the soil varied so much within short distances that it was impossible to show the distinctions on a map of the scale used in the present survey. The materials were consequently grouped together and given the name "Walcott sandy loam," as the dominant texture of the surface material is a sandy loam. The soil varies from a dark-brown loam to a gray sandy loam and the subsoil from a clay to a sand. The profile may consist of a sandy loam 8 or 10 inches deep, underlain by a yellow sandy clay, or by a yellow sand. Where the top soil consists of a loam the subsoil is generally a yellowish-drab clay, but it is frequently a yellow sand or sandy loam. Another phase, composed of small sand mounds from 1 to 2 feet above the adjacent soil, is scattered through this type, and is practically the same as the Fargo fine sand. The sand extends to a depth of 3 or more feet and is sometimes drifted by the action of winds.

The topography of the Walcott sandy loam is level, with the exception of the small sand mounds or ridges already mentioned. A considerable part of the soil is poorly drained and uncultivated. It is in these areas of deficient drainage that the heavier phase is found. Excepting the sand mounds, which are always well drained, artificial drainage would benefit the whole type, especially during wet seasons.

The Walcott sandy loam is found in the northern part of the county near Walcott in a single area 5 miles long and 1 mile wide. It is the least extensive soil type in the county.

The soil is a mixture of Fargo fine sand, Dunesand, and Fargo loam. Some portions of the soil possibly have the same origin as the Fargo loam, but it is difficult to explain the formation of the type as a whole. The sand content of the level areas and the sand found in the dunes may possibly have been drifted originally from the Fargo fine sand which lies just west of the type.

The crop yields vary with the character of the soil, and it is practically impossible to form an accurate estimate for the county as a whole. The undrained portions of the type are used for the production of prairie hay, and yields of 1 to 2 tons per acre are obtained. A considerable part of the uncultivated area is used for pasturage.

On account of the great variation in this soil no samples were collected for analysis.

FARGO SILT LOAM.

The soil of the Fargo silt loam is a brown silt loam 14 to 20 inches deep, with an average depth of 18 inches. The sand content is almost entirely of the fine and very fine grades and the content of organic matter is relatively large. The subsoil consists of a yellowish-gray or gray silt loam of practically the same texture as the soil. In some places the upper 4 inches of the soil are almost a fine sandy loam, and sometimes the subsoil consists of a drab or brown clay loam having a substratum of very fine, yellowish, sandy, silty material. This irregularity in the subsoil is found near the Fargo loam.

The Fargo silt loam as it occurs south of the Wild Rice River is frequently difficult to distinguish from the Fargo sandy loam, as the latter type in this vicinity contains considerable silt in the surface soil. When typically developed there are no stones or gravel in the soil or subsoil, though occasionally a small quantity of gravel is found in the latter. The area in the vicinity of Mantador and the one near the southern county line contain more fine sand than the area near the Wild Rice River on the western county line.

The soil is easily cultivated and can be put in a good state of productiveness without much difficulty. The small area near the jog in the western boundary line of the county, however, being lower and not well drained, is less valuable farming land.

The largest area of Fargo silt loam occurs in the western part of the county near the Wild Rice River. Two areas are located a few miles southwest of Mooreton and a small area is found in Freeman Township. Another small area occurs in the vicinity of Mantador, and a larger one is found near the county line in the southern part of the area.

The topography is generally undulating, and the soil is well drained, except a small area near the county line west of Wyndmere. The Wild Rice River receives the greater part of the drainage from the type.

The soil occurs within the Sheyenne Delta, and is therefore derived from reworked glacial material brought into Lake Agassiz during its higher stage. It is in this type that the stratum of silty clay, already mentioned as underlying much of the delta, comes to the surface, and it is the principal factor in forming the soil.

The type is apparently free from alkali, but there is a considerable amount of lime in the subsoil.

Almost the entire area of the Fargo silt loam is under cultivation, and it is considered one of the best soils in the area. It is well adapted to timothy and other grasses, as well as to various small grains. Wheat yields from 15 to 30 bushels per acre, and macaroni wheat somewhat more. Oats yield from 25 to 50 bushels per acre. The native vegetation consists of prairie grass of good quality. The soil retains moisture well, and there is little evidence of any decline in its productiveness from year to year.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Fargo 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> |
| 19557 | Soil..... | 0.2 | 1.4 | 0.8 | 7.1 | 10.8 | 70.1 | 9.6 |
| 19558 | Subsoil..... | .0 | .4 | .6 | 4.0 | 13.9 | 69.1 | 12.1 |

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 19558, 10.45 per cent.

FARGO GRAVELLY LOAM.

The Fargo gravelly loam consists of 12 inches of a brownish loam underlain by a dark-brown loam to a depth of 3 feet. A few glacial boulders are scattered over the surface, and both soil and subsoil contain some gravel. The soil is closely related to the Marshall loam, which occurs immediately south of it. The chief difference between the two types is found in the subsoil. The subsoil of the Marshall loam consists of a gray, silty, calcareous material, while that of the Fargo gravelly loam is a loam or a slightly sandy loam. This may be due to the fact that the type under discussion is located within the area of the delta, while the Marshall loam is found chiefly outside of the old lake bottom.

The Fargo gravelly loam is located in the western part of the county, south of the Wild Rice River. The largest areas are found from 1 to 3 miles from its channel, and a few small areas are located nearer the channel. The topography is undulating to gently rolling, with a slight slope toward the Wild Rice River. The natural drainage is good. There are a few short, deep channels that have cut back from the stream to the type, but the areas adjoining these are not under cultivation.

The soil is of delta and beach formation, and occurs near the edge of the delta deposits. A ridge passing through the main body of soil is a part of the Herman beach of Lake Agassiz.

The Fargo gravelly loam is generally easy to cultivate, though a portion of it has never been broken. Where not under cultivation the native prairie grass is good. There are no trees or shrubs occurring on the type. The principal crops now grown are wheat, oats, and corn, and the yields are about the same as on the Fargo fine sandy loam.

LIDGERWOOD FINE SANDY LOAM.

The soil of the Lidgerwood fine sandy loam generally consists of a brown or dark-brown fine sandy loam to a depth of 18 inches. Frequently the soil becomes slightly coarser in the lower depths. The subsoil is a light-brown medium sand frequently mottled with white and reddish material. The areas show some variation. In places the soil is a fine sand underlain by sand; in others a sandy loam underlain by sand or sandy loam. The lighter textured soil appears along the old channel of the Sheyenne River near Lidgerwood, where there is a slight ridge having some of the characteristics of a beach formation.

The soil is located in the southwestern portion of the county, bordering the old glacial channel of the Sheyenne River. It extends from the western county line in Dexter Township to a point about 4 miles east of Stiles, and occurs in the bottom of the channel and on the slopes and low hills bordering it.

In topography the Lidgerwood fine sandy loam varies from nearly level in the channel to rolling on the hills. A small proportion of the soil in the bottom is poorly drained, but that found on the slopes and on the hills is well drained.

The soil is of alluvial origin, being the deposit of the waters of the Sheyenne River during, or before, the earlier stages of Lake Agassiz. The fine sandy loam in the bottom is irregularly interspersed with areas of heavier deposits mapped as Meadow.

The type contains considerable organic matter and is very productive, especially in the hilly areas. It is easily cultivated, and the greater part is under cultivation. Some areas in the poorly drained bottom support a good growth of grass, which makes hay of excellent quality. Along the roads and in a few abandoned plowed fields some Russian thistle, locally known as "tumble weed," was observed. The chief crops now grown are wheat, oats, barley, and corn. The yields of small grains are not as good as upon the Fargo fine sandy loam, but corn should do exceedingly well on this type. Potatoes and other truck crops are well adapted to this soil, though not extensively raised at present.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lidgerwood 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> |
| 19579 | Soil..... | 1.7 | 7.6 | 8.0 | 47.1 | 12.0 | 19.4 | 4.3 |
| 19580 | Subsoil | 1.2 | 6.1 | 6.9 | 52.1 | 16.6 | 12.0 | 5.3 |

FARGO LOAM.

The Fargo loam to a depth of about 15 inches consists of a dark or almost black mellow loam in which the sand content is practically all of the fine and very fine grades. Below this to a depth of 20 inches is found a yellowish loam, sometimes heavier in texture than the surface soil, and this grades at a depth of 3 or more feet into a yellowish silty clay containing in the upper portion some fine sand, the content of which decreases as the depth increases. Occasionally both soil and subsoil contain a small percentage of gravel, this being most noticeable in the area bordering the Red River north of Wahpeton. At the northern end of this area a few small boulders occur on the surface. In a few areas the quantity of gravel was sufficient to warrant the use of a symbol in the map. It occurs here and there in beds on slight ridges or knolls, and is most abundant in the subsoil. Occasionally small boulders appear on the surface. Surrounding this gravelly phase for some distance very little gravel is found in the soil, but it is reached in the subsoil at depths of 15 to 24 inches below the surface. Pockets of gypsum frequently occur in the subsoil, and partially decomposed limestone nodules are also encountered.

The Fargo loam is comparatively uniform. One of the most marked variations occurs along the contact with the Fargo sandy loam. In places there is a strip a half mile wide between the two types where the soil is not typical of either. Here the surface soil of the Fargo loam contains considerable more fine sand than the true type, and the subsoil is also lighter in texture, being in places a heavy silt loam containing a high percentage of fine sand and very fine sand. This phase is less productive than the remainder of the soil.

There is another phase, which consists of the areas bordering the Red and Wild Rice rivers, paralleling these streams and varying from one-quarter to 1 mile in width. Here the soil has at some time been affected to a certain extent by small alluvial deposits laid down by the streams. Along the Red River the influence of such deposits has been more marked than along the Wild Rice River. The soil generally occurs upon slight terraces, and as a rule is a very mellow

loam containing more fine and very fine sand than the typical soil. There is not much difference, however, in the subsoil, although it is a little lighter both in texture and color. The highest percentage of sand in these areas was found north of Abercrombie, though the type generally has its heaviest texture in the northern part of the county.

The greater proportion of the Fargo loam occurs in one very irregular continuous area extending from the center of the northern boundary of the county to the southeastern corner. It varies in width from one-fourth mile to 13 miles, gradually becoming wider toward the south until it reaches its maximum width about 3 miles south of Fairmount. In the vicinity of Mooreton, and a few miles south of Barney, irregular areas of the main body extend toward the west. There are areas in which artificial drainage would be beneficial, but the main body of the type is well drained. Small depressions only a few rods wide are sometimes quite numerous. These are generally round and from 2 to 4 feet below the level of the surrounding country. Water frequently stands in these depressions until early summer. The soil in them is very black, and rich in organic matter, the first few inches sometimes having the characteristics of peat. Nearly all of these spots are found south of Wahpeton, very few being found in the northern part of the area. They were too small to be represented on the map.

The soil is easily cultivated. Both soil and subsoil are sufficiently heavy to hold a relatively large quantity of moisture and to retain it in time of drought. When the soil is broken up clods are formed, but these do not bake hard, and a good seed bed is easily prepared by light harrowing. The percentage of organic matter in this soil is generally less than that in the Fargo clay loam. It is probably not as strong a soil as the latter, but it is for the most part better drained.

The following table gives the results of mechanical analyses of a fine-earth sample of the soil and subsoil of the Fargo loam:

Mechanical analyses of Fargo 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> |
| 19587 | Soil..... | 0.1 | 3.2 | 0.3 | 18.1 | 27.3 | 36.5 | 14.2 |
| 19588 | Subsoil | .0 | .4 | .4 | 5.5 | 11.9 | 49.5 | 32.2 |

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3); No. 19588, 6.15 per cent.

SUMMARY.

Richland County, N. Dak., area 1,453 square miles, is situated in the southeastern corner of the State. The eastern third of the county is flat or level. The remainder is quite rolling and in the

western part some of the surface is rough. The county is drained by the Sheyenne, Red, Wild Rice, and Bois de Sioux rivers. These streams have few tributaries, and in parts of the county the drainage system is immature.

Although there is a wide range in temperature the climate is healthful. The rainfall is generally ample for crop growth. Nearly one-half of the annual precipitation occurs during the months of April, May, and June.

The population of the county is 19,379, the greater part being of foreign descent. Wahpeton, the county seat and the largest town, has a population of about 3,000. It is a junction point of several railroads.

There are four different railway systems in the county, which afford excellent transportation facilities, and, besides these, the Fargo and Southwestern, a branch of the Northern Pacific, passes within 1 mile of the northwestern corner of the county. There are 75 elevators in the county, which handle grain for Minneapolis and Duluth markets.

About 71.6 per cent of the farms of the area are operated by the owners. The tenanted farms are leased on a share basis, usually for one-half the crop. Wheat, oats, barley, and corn are the principal crops. Land ranges in value from \$10 to \$50 an acre, depending on location, type of soil, market facilities, etc.

The soils range from clay to sand and are derived from glacial material, either laid down as terminal and ground moraines, or as the same material reworked by streams and deposited in ancient Lake Agassiz, a part of these deposits being in the form of a delta at the ancient mouth of the Sheyenne River. Fifteen different soils, two of them phases of established types, are shown on the soil map.

The Fargo loam, 320 square miles or 22 per cent of the area of the county, is well adapted to general farming, producing good yields of wheat, oats, barley, and corn. The drainage is fair and crops seldom suffer from drought. This land is valued at from \$30 to \$40 an acre, and ranks among the best soils in the county.

The Fargo clay loam is the heaviest soil in the county cultivated to any extent. It generally contains a high percentage of organic matter and in average seasons produces excellent yields of small grains. In wet seasons, however, there is an excess of moisture and the yields are sometimes small. It is not well adapted to durum wheat, and Bluestem is generally grown. Its value is about the same as that of the Fargo loam, or possibly slightly less.

The Fargo clay is the heaviest soil in the county and is generally uncultivated. It occurs near the Red River and is poorly drained. Its organic matter content is very high, and with perfect drainage it would produce fine crops. It is a difficult soil to cultivate.

The Fargo fine sandy loam, 341 square miles or 23 per cent of the area of the county, is the most extensive type mapped in the county. It is well adapted to general farming and especially to durum wheat and corn. It is valued at \$20 to \$35 an acre.

The Fargo sandy loam is very similar to the Fargo fine sandy loam, practically the only difference being in the subsoil. It produces slightly better yields than the latter type and its value is therefore slightly higher.

The Marshall loam occupies most of the unmodified drift area of the county, and the topography is from gently rolling to hilly. In seasons of excessive rainfall or of drought the soil is one of the best in the area, and an entire crop failure rarely occurs. It is valued at \$30 to \$40 an acre.

The Fargo silt loam covers a comparatively small area, but it is one of the best soils of the county, being well adapted to general farming. Its value is about the same as that of the Fargo loam.

The Wabash loam is the only alluvial soil in the county. It has a wide variation in texture, but all phases generally produce good yields.

The Fargo fine sand, Dunesand, and Meadow are types having the lowest agricultural value. They are practically all uncultivated, being generally used for hay or pasture land. The swamp phase of the first type is uncultivated at present because poorly drained. If reclaimed it would have a much higher crop value than the rest of the soil.

The Fargo gravelly loam covers small areas and is unimportant.

The county is generally in a prosperous condition and offers opportunities for various lines of farming and stock raising.

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