

UNITED STATES DEPARTMENT OF AGRICULTURE

**Soil Survey**  
of  
**Pocahontas County, Iowa**

By

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United States Department of Agriculture



**Bureau of Chemistry and Soils**

In cooperation with the Iowa Agricultural Experiment Station

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## SOIL SURVEY

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# SOIL SURVEY OF POCAHONTAS COUNTY, IOWA

By A. M. O'NEAL, Iowa Agricultural Experiment Station, in Charge, and  
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## COUNTY SURVEYED

Pocahontas County is in the northwest part of Iowa, in the third tier of counties south of the Minnesota State line and the fourth tier east of Missouri River. It is 24 miles square and contains 576 square miles, or 368,640 acres.

The county is included within the area covered by the late Wisconsin drift sheet, and in common with a large part of that area in Iowa it is characterized by an immature topographic development. Near the center of the county, east and west of the town of Pocahontas and extending southeastward, is a smooth, nearly level plain almost without slope or drainage. In other parts of the county the upland is traversed by streams flowing southeast or south, and the monotony of the interstream flats is broken by low ridges and isolated knobs. In the southeast corner the level plain merges rather abruptly with a section of strong relief and the greater part of Lizard and Lake Townships is rolling or moderately hilly. Narrow ribbonlike areas of similar relief occur along West Des Moines River and Beaver Creek in the extreme northeast corner of the county and bordering Little Cedar and Cedar Creeks in the western half.

Rather extensive terraces are developed along West Des Moines River, which cuts through the northeast corner, and narrow first bottoms occur along all the creeks and smaller streams. The total bottom-land area is small, however, in proportion to the total area of the county.

Pocahontas County lies at an average elevation above sea level of about 1,240 feet. Laurens, in the northwest corner, has an elevation of 1,312 feet; Rolfe, in the northeast part, 1,160 feet; Fonda, in the southwest, 1,234 feet; Palmer, in the southeast, 1,244 feet; and Pocahontas, in the central part, 1,222 feet.<sup>1</sup> The western half of the county slopes toward the south, and the eastern part drains to the east.

The streams are winding with shallow valleys and have few tributaries penetrating and draining the interstream flats. At the time of settlement local drainage had not been established in the greater part of the county. Most of the lakes, marshes, and poorly drained soils have since been artificially drained.

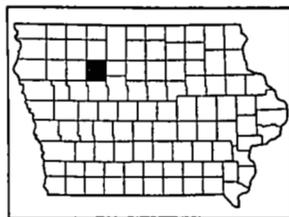


FIGURE 1.—Sketch map showing location of Pocahontas County, Iowa

<sup>1</sup> GANNETT, H. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bul. 274, Ed. 4, 1,072 p. 1908.

Pocahontas County was created in 1851, but the first settlement had been made some years prior to this date. The early pioneers came from States to the east and south, and a few emigrated from Germany, Sweden, Denmark, and Norway. People of Irish descent predominate around Varina, Bohemians in Roosevelt and Sherman Townships, Germans in the southeast corner of the county, Swedes in Colfax and Bellville Townships, and Danes and Norwegians around Rolfe.

The population of the county, according to the 1930 census report <sup>2</sup> is 15,687. It is all classed as rural and is rather evenly distributed throughout the county. Pocahontas, the county seat, with a population of 1,308, is located near the center of the county. Fonda has a population of 1,027, Rolfe 1,012, Laurens 1,071, Palmer 279, Havelock 339, and Varina 184. Gilmore City, which is partly in Pocahontas and partly in Humboldt County, has a total population of 896. A number of smaller towns and villages are scattered along the railroads and highways throughout the county.

Pocahontas County is well supplied with railroads, and no point is more than 8 miles from a shipping center. The Illinois Central Railroad and the Chicago, Milwaukee, St. Paul & Pacific Railroad serve the southwest part. A branch of the Chicago, Rock Island & Pacific Railway passes through Laurens, Pocahontas, and Palmer, and a line of the Chicago & North Western Railway, passing through Laurens, Havelock, and Rolfe, connects the northern part of the county with points east and west. A branch of the Minneapolis & St. Louis Railroad passes through the northeast quarter.

The highway system is well developed. Most of the main county roads are graded and graveled and are in excellent condition at all times. Most of the dirt roads are well ditched and during dry weather are excellent. They are dragged after rains.

Rural mail delivery and telephone service are established over the entire county. Churches are located at convenient places and are well kept. Schools are well cared for, and many districts have been consolidated and large brick schoolhouses built in near-by towns.

The principal markets for the sale of livestock and produce are Chicago, Sioux City, Des Moines, and St. Paul.

### CLIMATE

The climate of Pocahontas County is characterized by wide extremes in temperature. The winters are in general long and severe, broken now and then by a few days or a week of more moderate, crisp weather. The summers are short, with occasional periods of severe heat. During the spring months considerable damp, murky weather occurs, and strong northwest winds are more prevalent than at any other time. September and October are usually delightful, with a large proportion of sunshiny days.

The mean annual precipitation of 30.80 inches is favorably distributed for crops. The greatest amount of rainfall occurs during the growing season, from April to September. Heavy spring rains occasionally delay planting, and droughts during July and August have been recorded but are rare. The precipitation from the last part of

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<sup>2</sup> Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given whenever possible.

November to the first part of March usually occurs in the form of snow, the average annual snowfall being 32.7 inches.

Temperatures are favorable for the production of corn and other staple crops of this section. The average date of the last killing frost is May 8 and of the first is October 3. This gives an average frost-free season of 148 days. Killing frosts have occurred as late as May 27 and as early as September 14.

Table 1, showing the normal monthly, seasonal, and annual temperature and precipitation, is compiled from records of the Weather Bureau station at Pocahontas.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Pocahontas

[Elevation, 1,248 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1905)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December.....	21.7	58	-28	0.92	0.22	0.21	5.9
January.....	16.0	59	-38	.78	1.04	1.15	7.4
February.....	19.7	60	-30	1.12	.17	1.55	7.4
Winter.....	19.1	60	-36	2.82	1.43	2.91	20.7
March.....	32.3	87	-17	1.37	.03	1.75	5.6
April.....	47.1	94	13	2.72	.23	4.29	2.1
May.....	58.8	93	22	4.43	1.97	8.04	.3
Spring.....	46.1	94	-17	8.52	2.23	14.08	8.0
June.....	65.3	99	37	4.64	3.67	4.25	.0
July.....	72.7	102	41	3.45	1.87	1.83	.0
August.....	70.6	103	35	3.37	3.10	5.87	.0
Summer.....	70.5	103	35	11.46	8.64	11.95	.0
September.....	63.5	97	24	3.59	2.91	3.25	( <sup>1</sup> )
October.....	50.7	88	5	2.73	.85	3.35	1.2
November.....	34.7	79	-3	1.68	.11	4.32	2.8
Fall.....	49.6	97	-3	8.00	3.87	10.92	4.0
Year.....	46.3	103	-36	30.80	16.17	39.86	32.7

<sup>1</sup> Trace.

## AGRICULTURE

Pocahontas County, in the early days, was covered to a large extent by low poorly drained areas, marshes, and shallow lakes, which formed a natural habitat for wild animals. The first pioneers took up their abode in the more rolling sections near the watercourses and lived largely by hunting and trapping. Only enough land was reclaimed for the production of small quantities of wheat, corn, and vegetables for home use. A few cattle were kept and pastured on the prairies where grass was plentiful. As settlement increased and the quantity of game decreased more of the land was put in cultivation. Settlement was necessarily slow prior to the building of the railroads, but from that time on it was steady and comparatively rapid.

In the early days wheat was the chief money crop, and corn was grown for feed. The 1880 census reports 3,913 acres in wheat in 1879 and 20,390 acres in corn. Wheat production decreased in subsequent years, owing to unfavorable prices and the ravages of disease, and corn production increased.

At the present time agriculture consists of the production of corn, oats, barley, rye, wheat, potatoes, and all kinds of fruits and vegetables common to this section. The raising and feeding of cattle and hogs are also important, and dairying is engaged in to a limited extent.

Corn is the principal crop and occupies the largest total acreage. The 1928 Iowa Yearbook of Agriculture reports 151,483 acres in corn and a production of 6,159,210 bushels, or 40.3 bushels to the acre. Yields on individual farms range from 25 to 65 bushels to the acre. Black smut and dry rot are the principal corn diseases and in some years cut down yields to a slight extent. The greater part of the corn crop is used on the farms as feed for the work animals, beef cattle, and hogs, though about a million bushels are shipped to outside markets each year through cooperative elevators and shipping associations.

Oats fit well in the general rotation centered around the production of corn, and they are grown on all farms. Rust is prevalent but does not seem seriously to affect yields. Some farmers, approximately 10 per cent, are using the formaldehyde treatment on seed oats. The 1928 Iowa Yearbook reports 4,431,844 bushels of oats produced on 107,673 acres, or an average of 41.2 bushels to the acre. Yields of 65 bushels are not uncommon. Most of the oats are fed on the farm where produced, and only a small part is shipped out of the county. Oats are being replaced to some extent by sweetclover, which is a more profitable crop.

Barley was grown on 9,254 acres in 1927 and produced 290,016 bushels. It is used almost exclusively for hog feed. Both winter and spring wheat are grown as well as some rye. The rye is used as hog feed, and the wheat is sold.

Hay is an important crop and is used on the farms where produced as feed for the work animals, beef cattle, and dairy cows. The 1928 Iowa Yearbook reports a total production of 26,965 tons of tame hay in 1927. Of this, 15,658 tons was alfalfa and the rest clover and timothy grown separately or together. In addition, 4,228 tons of wild hay were cut from areas too wet for profitable cultivation. The quantity of hay produced is not sufficient, and a considerable tonnage is shipped into the county each season.

Potatoes are the most important special crop. In 1927, according to the Iowa Yearbook of 1928, 55,350 bushels were produced on 410 acres. After the demands of the home are satisfied the rest is sold locally.

The production of soybeans for seed is an important side line in the northern part of the county, the 1928 Iowa Yearbook reporting 3,485 bushels produced the preceding year. Soybeans are grown in other parts of the county with corn that is to be cut for silage. Pop corn, flax, and buckwheat are grown on a small scale.

Practically every farm includes a garden in which vegetables are grown for home consumption and local sale. Apple orchards are found on some farms, and where sprayed and cultivated the trees

produce choice fruit. Some raspberries, gooseberries, and strawberries are grown for home use.

The principal livestock industries, named in the order of their importance, are raising of hogs, feeding of beef cattle, dairying, raising of horses and mules, and to a small extent the raising and feeding of a few sheep.

Hogs are raised on all farms and constitute one of the chief sources of revenue. Duroc-Jersey, Poland China, Chester White, Spotted Poland China, and Tamworth are the favorite breeds. The number of sows ordinarily kept on a farm ranges from 10 to 15, from which between 60 and 75 pigs are farrowed. Throughout the northern part of the county, especially in the vicinity of Laurens and Plover, a number of feeders are shipped in in the fall from Omaha, Nebr., and Sioux City, Iowa, fed for six months, and resold and shipped. The hogs are pastured to some extent on alfalfa and sweetclover and in cornfields after harvest. Most farmers include mineral feeds in the hog ration. On nearly all farms the animals are fed in inclosures on corn, alfalfa, and tankage before shipping, self-feeders being used for this purpose. Hogs are usually sold through cooperative shipping associations.

The raising and feeding of beef cattle is engaged in extensively. The 1920 Federal census reported 21,314 beef cattle in the county, having a value of \$1,141,565. The Hereford and Shorthorn breeds predominate, with a few Angus. In addition to the cattle raised on the farms, the majority of farmers ship in one or two carloads of feeders from the western range. A few operators buy as many as five or six carloads of feeders each year. The animals are bought in the fall and are turned into the cornfields after harvest or are pastured on sweetclover and bluegrass. During the winter they are fed silage and corn. Most of the animals are kept from 60 to 90 days. A few farmers raise purebred cattle for sale. The 1930 census reports 26,864 cattle in the county on January 1, 1930.

Dairying may be considered a side line. There were 12,156 dairy cattle on the farms in 1920. The average farmer keeps from 1 to 3 milk cows, and approximately 50 farmers have herds ranging from 10 to 15. Near the larger towns there are a few farms devoted entirely to dairying. The milk is separated on the farms and the cream is sold to creameries or cream stations. The skim milk is used for hog and chicken feed. The dairy cows are mostly of the Holstein, Guernsey, and Jersey breeds, named in the order of their preference. The 1930 census reports 9,784 milk cows in the county on January 1, 1930.

Only a few farmers raise sheep. Occasionally a carload of western animals are brought in for feeding. The census reports the number of sheep in 1920 as 2,635, and in 1925 as 1,673.

The Federal census gives the value of poultry as \$293,187 in 1919 and as \$287,845 in 1924. The number of chickens raised has increased considerably in the last decade. The poultry industry is carried on only as a side line. The chickens and eggs are either traded or sold to the grocery stores and produce houses, and these houses, in turn, ship to outside markets.

There were 11,856 horses and 682 mules in Pocahontas County in 1930. The common practice among farmers is to raise enough colts

each year to maintain the requisite number of work animals. Very few animals are sold.

Except in a few instances little attention is given to the adaptability of crops to soil types. Corn is grown extensively in all parts of the county, but the more poorly drained areas are nearly always left for pasture. It has been recognized from the beginning that flax returns the best yields on new ground. Alfalfa is always seeded on the better-drained soils. Potatoes are grown on peat and muck areas.

The more progressive farmers of the county use systematic crop rotations in which the legumes play an important part. The 4-year rotation of corn, corn, oats, and clover seems to be most popular. On the majority of farms, however, little consideration is given to rotations other than that corn is produced for several years in succession, followed by oats and possibly clover and timothy.

Drainage conditions have been greatly improved in Pocahontas County and at present there are few poorly drained areas of any size. Practically all the creeks and important drainage ways have been ditched and straightened and lateral ditches cut back into the more poorly drained soils. Nearly every farm has been tiled under the direction of competent engineers, and in general the intervals between lateral tiles vary with the soil type.

In preparing the soil for corn, it is usually broken deep in the fall. Tractors are employed on many farms for this purpose, though four and six horse teams are in general use. Rye is often used as a cover crop. The following spring the land is cross disked and harrowed just prior to planting with a checkrow planter. A short time after planting, before the corn is up, some fields are dragged. Many farmers begin cultivating immediately after the corn comes up, but on the lighter-textured soils this is not good practice. Weather allowing, corn should be planted the last part of April or the first part of May. During abnormal years late freezes may injure some of the corn on the low, poorly drained soils, thereby necessitating replanting. The crop is cultivated as often as possible, usually from three to five times. It is laid by around July 4. Harvest starts about the middle of October and ends near December 1. Some corn is hogged down. The 1928 Iowa Yearbook of Agriculture reports that 7,846 acres were utilized in this way in 1927. The greater part of the crop is husked in the field. Some corn is cut and stacked in the field until winter, and some is cut for silage. Soybeans are planted with the corn to be used for silage. Yellow varieties of corn are most popular, those most commonly used being Reid Yellow Dent and King Yellow Dent. A considerable acreage of Silver Mine, Silver King, and Calico is also grown. Care is exercised in selecting seed corn for early maturity, and an excellent grade of corn is produced. Where corn follows corn, a stalk chopper is run through the field in the spring or the stalks are raked and burned prior to disking and harrowing the land.

When oats or other small grain follows corn, the land is disked before the seed is sown, though occasionally the disking is dispensed with. Oats are usually broadcast and disked and harrowed in. Iowa 103, Iowa 105, Early Champion, and Kherson are the most popular early varieties, and Green Russian is the late variety generally grown. The early oats are sown around April 1 and harvested the early part of July, and the late oats mature approximately 10 days later. Oats

are all cut with a binder and shocked in the field. Threshing is mostly from the shock, though a small number of farmers stack the oats and wait until later to thresh.

Most of the alfalfa is sown in the spring with oats which serve as a nurse crop. The seed is generally inoculated and the soil limed. The first year's growth is seldom removed. In the second and succeeding years the alfalfa is cut two or three times. Care should be exercised not to cut too close in late fall but always to leave a few inches above the stool to insure against winterkilling. Northern-grown Grimm and Dakota No. 12 are the varieties best adapted to this climate. Alfalfa is seldom pastured and then very lightly. It will last from three to six years before bluegrass chokes it out. Alfalfa should be cultivated each year with a spring-tooth harrow.

Sweetclover is planted and cultivated in much the same manner as alfalfa, but unlike alfalfa it is used largely for pasture.

Manure is saved on most farms. It is usually carried from the barn by automatic carriers and dumped in the barnyard where it remains in open piles until winter or early spring when it is carted to the fields in manure spreaders. The supply is never sufficient. Commercial fertilizers are used only in an experimental way.

Most of the farms of Pocahontas County are well kept. Many of the owners and some of the tenants have large well-appointed homes, and the barns and outhouses are well kept and spacious. Most farms are under fence. The combination hog-tight wire and barbed-wire fence is common, though the majority of fences are of the three or four strand barbed-wire type. Where dwellings are near power lines they are wired for light and power. In other sections unit power plants are fairly common. Farm machinery in general use includes tractors, gang plows, disk harrows, turning plows, one and two row cultivators of the riding and walking types, corn planters, corn binders, corn huskers, manure spreaders, grain drills, and hayrakes. The work animals are mainly of the medium-draft type.

The labor situation is never acute in Pocahontas County. Many farms operate without hired labor, owing to the use of power machinery and good crop rotations. The 1925 census reports that 70 per cent of the farms hired laborers in 1924, at an expenditure of \$420,249, or an average of \$312.22 a farm. Day laborers usually receive \$2, and the monthly wage of single men is \$50 and board. Married men are generally paid \$50 a month and in addition are given a house to live in, a cow, chickens, from 200 to 250 pounds of meat, and a garden plot. Corn pickers during 1928 received 6 or 7 cents a bushel and board.

According to the 1930 census report there are 2,086 farms in the county. Most of the farms are between 80 and 500 acres in size, the majority including about 150 acres. Practically all the land in farms is improved. In 1930, 859 farms were operated by owners, 1,198 by tenants, and 29 by managers. Cash rent for grassland ranges from \$6 to \$7 an acre, and the usual share rent is half the corn and two-fifths of the small grain. There are many variations in the rental system, formulated to meet local conditions.

Land values in Pocahontas County vary according to location, condition of improvements, and the character of the land. Few transfers were made during the year of the survey. The average price is between \$150 and \$200 an acre.

SOILS<sup>1</sup>

The soils of any region owe their characteristics, first, to the composition of the parent materials and, second, to the agencies of soil formation which have acted on the parent materials. These agencies include the physical and chemical forces that result in the leaching, oxidation, and translocation of soil material, and microorganisms, plants, and animals that change the soil. The soil-forming processes acting on the parent soil material give to the soil, after a sufficient period of time, a profile characterized by a succession of layers which are distinguished by differences in color, texture, structure, consistence, and other physical properties and by various chemical constituents.

Pocahontas County lies entirely within the limits of the late Wisconsin drift sheet. The upper 2 or 3 feet of soil material has been altered by the forces of nature, but below this depth a more uniform material is present, which consists of a mixture of pale-yellow, pale yellowish-brown, and gray clay, silt, and sand, together with varying amounts of fine gravel and small bowlders. Calcareous material and fragments of limestone are abundant, and there is a considerable sprinkling of granite, quartzite, diabase, and gneiss. The mass is not compact but has a crumbly structure.

The county is in the prairie region of the United States where a temperate climate, smooth land surface, and a moderately plentiful supply of moisture have favored a luxuriant growth of grasses and prevented the spread of forests. The most striking characteristic of prairie soils and one common to all soils developed under a grass vegetation is the dark color of the surface layer. The color is imparted by finely divided carbonaceous matter derived through the decay of grass roots. Drainage conditions determined by surface relief and the character of the substratum influence the thickness of the dark-colored surface layer and other features of the soils.

Two divisions may be made of the soils of the county on the basis of characteristics produced by drainage. Throughout the level or gently undulating sections where drainage is, or was formerly, more or less restricted and the soil-moisture content high, a characteristic profile has developed. The surface layer to a depth ranging from about 10 to 15 inches is very dark grayish brown or almost black. When wet the soil clods badly but on drying breaks into a fine granular mass. Below this and extending to a depth of 25 or 30 inches the texture becomes heavier and the color slightly lighter, with a few faint gray and yellowish-brown spots. The mass has a slightly columnar structure and when disturbed breaks down to soft grains. The next layer, which has a thickness ranging from 8 to 12 inches, is transitional. In the upper part the color is dominantly dark grayish brown which grades into yellowish brown mottled with gray. The texture is equally as heavy or heavier than in the layer above. Between depths of 40 and 65 inches the mass is more friable and the content of sand and fine gravel increases, with here and there a bowlder. The color is dominantly gray or pale grayish

<sup>1</sup> Buena Vista County adjoins Pocahontas County on the west and Webster County joins the southern part of the eastern boundary. The soil maps of these counties do not agree along the boundaries. This is due to changes in correlation resulting from a fuller understanding of the soils of the State. The greater part of the Carrington loam mapped in Buena Vista and Webster Counties is mapped as Clarion loam in Pocahontas County, and the greater parts of the areas of the Fargo soils in Webster County are placed in the Webster series in Pocahontas County.

yellow, with streaks of dark material. Below this is the partly weathered gray or grayish-brown calcareous parent material which in most places is sandy clay mixed with sand, fine gravel, and boulders. The above are characteristic features of the Webster, Lamoure, and Rogers soils. The Bremer and Wabash soils are similar to these soils, but the carbonates have been entirely leached from the soil profile.

In the more rolling sections and the better-drained areas of the terraces two other groups of soils have been developed, one under the influence of moderately well-developed drainage and the other under good drainage. The soils of the first group have very dark grayish-brown surface soils, but the color is not so dark and does not extend to so great a depth as in the Webster soils. The transitional layer is not so thick, and in many places the change from surface soil to subsoil is abrupt. The upper subsoil layer is composed of light-brown or yellowish-brown well-oxidized material, grading at a depth ranging from 22 to 30 inches into light-gray and grayish-yellow material. The subsoils are invariably heavier than the surface soils, but they become more sandy and friable with depth. The lower subsoil layer is calcareous. This group includes the soils of the Clarion, Pierce, Sioux, and Cass series.

The second group of well-drained soils have profiles similar to those of the first group except that leaching has entirely removed the carbonates from the soil profile. The surface soils to a depth ranging from 12 to 16 inches are very dark grayish brown, and the subsoils are dominantly yellowish brown. Drainage of both surface soil and subsoil ranges from good to excessive. This group embraces the Waukesha, O'Neill, and Judson soils.

The various soils in the county are grouped in series on the basis of similarities in color, origin, surface relief, composition, and structural characteristics. The series are subdivided into soil types on the basis of the texture of the surface soil. Each series description given lists the common characteristics of the soils of that series as they occur in Pocahontas County and elsewhere.

The soils of the Webster series have very dark grayish-brown or black surface soils. The subsoils are gray or mottled gray and brown, are much heavier than the topsoils, and effervesce when treated with acid. The Webster soils occur on flats or in depressions and have been formed by the weathering of drift under poor drainage.

The soils of the Clarion series have very dark grayish-brown or almost black surface soils. The upper subsoil layers are brown or yellowish brown and are heavier than the surface soils. The lower subsoil layers are in general pale grayish yellow or grayish brown and are more friable. Sufficient lime is present in the lower part of the subsoil to cause effervescence when the soil material is treated with acid, and streaks of nearly white lime-bearing materials are common. The Clarion soils are derived from calcareous drift.

The soils included in the Pierce series have very dark grayish-brown surface soils underlain by brown or yellowish-brown gravelly subsoils that rest, at a depth ranging from 20 to 24 inches, on beds of calcareous sand and gravel. These soils generally occur on knolls and ridges.

The Waukesha soils have very dark grayish-brown surface soils and yellowish-brown heavier-textured subsoils. These soils have

developed on thoroughly oxidized alluvial deposits which occur at elevations now above the reach of overflow.

The O'Neill series includes soils having very dark grayish-brown surface soils underlain by light-brown or yellowish-brown subsoils which, in turn, rest on beds of stratified sand and gravel lying within 3 feet of the surface. These soils differ from the Sioux soils in that they are not calcareous. They occupy high terraces which are level or slightly eroded. The O'Neill soils are inclined to be droughty.

The Judson series includes soils having very dark grayish-brown or almost black surface soils and slightly lighter-colored subsoils of much the same texture. Neither surface soils nor subsoils are calcareous. The soils of this series are developed from materials washed from loess or silty drift soils. They occupy terrace positions, generally occurring near the outer edge of the terraces on colluvial slopes bordering the bluffs.

The surface soils of the Bremer soils are very dark grayish brown or black, and the subsoils are dark gray, almost black, or drab, mottled with yellowish-brown and black iron stains. The subsoils are as heavy as, or heavier than, the surface soils and are tough and plastic. They are not calcareous. The soils of this series are developed on poorly drained terraces and resemble the Wabash soils of the first bottoms.

The Sioux series includes soils having very dark grayish-brown surface soils underlain by calcareous gravelly subsoils. In many places a brown layer, slightly heavier than the surface soil, lies between the dark surface soil and the gravel. These soils occur on the higher stream terraces and are above the present limits of overflow.

The soils of the Lamoure series have very dark grayish-brown or black surface soils. The subsoils range from yellowish brown to gray or dark drab and in most places are mottled dark gray and brown. The subsoils are heavier than the topsoils and differ from the Wabash soils in that both surface soils and subsoils are calcareous. They occupy first bottoms and are, in general, poorly drained.

The Wabash soils have very dark grayish-brown or black surface soils and dark-drab, gray, and grayish-brown mottled subsoils. These soils are not calcareous. They are subject to overflow but in many places are well drained.

The soils of the Cass series have very dark grayish-brown or black surface soils. The subsoils are lighter textured than the surface soils and pass within a depth of 3 feet into beds of sand and gravel. Both surface soils and subsoils are calcareous. These soils differ from the Lamoure soils in having the gravel stratum.

The surface soils of the Rogers soils are gray or grayish brown, and the subsoils are gray or drab. Both surface soils and subsoils generally contain quantities of small shells, and the soil mass is highly calcareous. These soils occupy poorly drained depressions and old lake beds in the glaciated part of the county. They have poor natural drainage.

In the following pages the soil types of each series are described in detail and their utilization for agriculture is discussed. The distribution of the soils in the county is shown on the soil map accompanying this report, and their acreage and proportionate extent are given in Table 2.

TABLE 2.—*Acres and proportionate extent of the soils mapped in Pocahontas County, Iowa*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Webster silty clay loam.....	103, 104	28. 0	Sioux loam.....	4, 416	1. 2
Webster loam.....	67, 840	18. 4	Rogers silt loam.....	1, 216	. 3
Clarion loam.....	157, 248	43. 2	Lamoure loam.....	2, 496	. 7
Steep phase.....	1, 792		Lamoure silty clay loam.....	18, 944	5. 1
Pierce sandy loam.....	1, 216	. 3	Cass loam.....	512	. 1
Waukesha loam.....	384	. 1	Wabash silty clay.....	1, 024	. 3
O'Neill fine sandy loam.....	1, 536	. 4	Muck and peat.....	5, 056	1. 4
O'Neill loam.....	864	. 2			
Judson fine sandy loam.....	128	. 1	Total.....	368, 640	-----
Bremer loam.....	832	. 2			

## WEBSTER SILTY CLAY LOAM

The upper 2 or 3 inches of Webster silty clay loam, as observed in virgin areas, consists of very dark grayish-brown silty clay loam filled with a mass of grass roots. The structure is dominantly fine granular. The granules are soft and range in size from one-sixteenth to one-eighth inch in diameter. The next layer, which generally has a thickness ranging from 7 to 9 inches, is very dark grayish-brown or almost black silty clay loam that also has an imperfectly developed fine-granular structure. When the soil material is crushed between the fingers the color becomes slightly lighter and a few small mica flakes are observed. Between depths of 10 and 30 inches the color is dominantly very dark grayish-brown except in the lower part of the layer where there is a gradual change to drab or yellowish brown. The texture is heavy silty clay or clay, and when dry exposed faces of the soil material break or crack in vertical columns. When disturbed the mass breaks down to small irregular-shaped clods. A few rock fragments and small bowlders occur in this layer. At an approximate depth of 30 inches the material is dark-brown or yellowish-brown slightly calcareous silty clay, mottled with gray and yellowish brown, which, in turn, is underlain at a depth of 40 inches by gray or pale-yellow silty clay, streaked and spotted with yellowish brown, yellow, and rust brown. This layer generally extends to a depth of 60 or 65 inches and in the lower part contains a considerable quantity of fine sand and some soft and hard iron concretions. Most of the yellow splotches are silty. Even at this depth dark coloration is present where the organic matter from the surface soil has come down through old root channels and animal burrows. Crushed surfaces appear light gray or grayish yellow, and the soil mass is slightly calcareous. Below a depth of 60 inches the partly weathered till is gray or grayish-brown sandy clay containing various quantities of fine gravel, bowlders, and nearly white lime-bearing materials which are generally segregated in streaks. The sand content increases with depth, and at a depth of 72 inches the material in most places is sandy clay loam or sticky sand.

When the soil is cultivated the upper two layers become thoroughly mixed, and the dominant color is very dark grayish brown. After rains, plowed fields have an intense black color. The organic-matter content is extremely high and masks the true texture of the soil to such an extent that many dry cultivated areas seem to be very heavy loams.

Webster silty clay loam is rather uniform throughout the county, but the areas as mapped include a few small bodies of loam and silt loam, which could not well be shown on the soil map.

This soil covers a large total area and is developed in all parts of the county. It occurs in the more level situations, and the continuity of the areas is broken only by low, narrow, tortuous ridges, by small knolls of Clarion loam, and by shallow stream bottoms. Natural drainage is not sufficient and tiles are necessary for best results. Practically 80 per cent of the farms on this soil have been tiled, and the drainage systems have proved extremely satisfactory.

Webster silty clay loam is recognized as a strong agricultural soil and is highly prized. Corn is the principal crop and makes excellent returns. Although the average yield is 40 bushels to the acre, yields of 60, and even 80 bushels, are not uncommon on the better farms. The yellow varieties seem to be grown most extensively, and an excellent grade of corn is produced. The larger part of the crop is used on the farms as feed for work animals, beef cattle, and hogs, and a small amount is shipped to outside markets. Oats are grown extensively and produce from 40 to 70 bushels to the acre. Some damage is caused by lodging, a difficulty that has been largely overcome by the use of the short-stemmed varieties, Iowar, Iowa 105, and Iowa 103. Oats, like corn, are used on the farms where produced, except a small tonnage which finds its way to outside markets. Barley is produced on a small scale for hog feed. Flax is occasionally grown on new ground, and buckwheat is often used as a catch crop. Potatoes and truck crops seem to make good returns, and on almost every farm a small plot of land is set aside for a garden.

The well-drained areas of Webster silty clay loam are admirably suited to alfalfa and sweetclover, as such areas have good drainage to a depth of 6 or 7 feet. Alfalfa generally remains on the same piece of ground from five to seven years, and most of the crop is used for hay, though some farmers pasture it very lightly. Usually three cuttings of more than a ton to the cutting are obtained. The yellow varieties of sweetclover are grown almost exclusively, and this crop is pastured.

The raising and feeding of beef cattle is an important industry on this soil.

Webster silty clay loam can be maintained in a high state of productivity by the use of well-planned rotations. Care must be exercised in plowing the land when under proper moisture condition. Where drainage is not sufficient this difficulty can be corrected by placing the laterals at closer intervals.

This soil is valued at prices ranging from \$190 to \$225 an acre, depending on the locality, condition of improvements, and efficiency of drainage.

#### WEBSTER LOAM

The surface soil of Webster loam is very dark grayish-brown or almost black heavy friable loam, from 12 to 14 inches deep. In virgin areas it is composed of two persistent layers, a very dark grayish-brown slightly granular loam layer, from 2 to 3 inches thick, that is filled with grass roots, and a layer of very dark grayish-brown or almost black heavy loam in which some fine white sand is noticeable when the material is dry. When wet, however, the sand grains are not dis-

cernible. Below a depth of 10 inches the material gives a slight reaction for carbonates. The third distinct layer, which extends from a depth of approximately 14 to a depth of 18 inches, is much like the one above except that the color becomes increasingly more brown. This layer is underlain by dark-gray slightly gritty clay loam or clay spotted with dark brown and some rust brown. A few rock fragments and sand occur in the lower part of the layer, and enough carbonates are present to cause effervescence when the soil is treated with acid. Between depths of 26 and 42 inches the material is mottled gray, rust-brown, and yellowish-brown sandy clay containing oxide of iron stains and streaks of dirty-white carbonaceous material. Below this and extending to a depth ranging from 4 to 5 feet, the color is dominantly mottled dark gray, light gray, yellowish brown, and orange, and the texture is gritty silty clay. In most places this layer is compact and heavy, and the content of sand decreases with depth whereas the orange and rust-brown mottlings increase.

Webster loam occurs in close association with Webster silty clay loam, and separation was difficult owing to the transitional areas between the two soils. The loam generally lies at a higher elevation and in most places occurs between Webster silty clay loam and Clarion loam.

Drainage of Webster loam is superior to that of the silty clay loam but is hardly adequate for best results. Open ditches and tiles are used in practically all areas.

Webster loam is considered a valuable soil, and practically its total area is in cultivation or pasture. Corn, oats, and hay are the principal crops, practically all of which are used locally as feed for work animals, hogs, beef cattle, and milk cows. The various crops yield much the same as on Webster silty clay loam. Alfalfa makes a better return on the loam, due to superior drainage conditions. Garden truck does well and on most farms enough is produced for home consumption.

The value of Webster loam is practically the same as of Webster silty clay loam.

Webster loam can be handled under slightly wider moisture conditions than the silty clay loam and usually warms up earlier in the spring. It can be improved by the same methods recommended for the improvement of Webster silty clay loam and Clarion loam.

#### CLARION LOAM

The surface soil of Clarion loam as typically developed consists of very dark grayish-brown friable loam from 12 to 15 inches deep. In virgin areas the upper 2 or 3 inches is filled with a mass of grass roots and there is little granulation, whereas the lower 10 or 12 inches has a soft granular structure. Plowed fields, when wet, are almost black. Between depths of 15 and 20 inches a transitional layer occurs that is dominantly yellowish-brown silty clay loam streaked with tongues and splotches of dark material from above. This layer is underlain by brownish-yellow or yellow friable silty clay loam or silty clay that generally grades at a depth ranging from 30 to 35 inches into yellowish-brown gritty silty clay mottled with gray, rust brown, and dirty white. From a depth of 24 inches downward an increasing number of small rock fragments occur, many of them containing lime-bearing material. The soil in this layer shows rather strong effervescence

when treated with acid. Below a depth of 48 inches the mass is mottled gray, rust-brown, and yellowish-brown gritty sandy clay streaked with reddish-brown, orange, and white lime-bearing materials. Numerous rock fragments and small boulders occur, and the material is slightly calcareous.

Through the more rolling areas of this soil the surface covering has been thinned somewhat by sheet erosion and ranges in thickness from 8 to 10 inches. The subsoil is rather uniform except in its depth to the lime zone. Included with this soil in mapping are a few areas of Clarion fine sandy loam too small to separate on the map. Most of the included bodies occur on small isolated knolls.

Clarion loam is one of the most extensive soils in the county. It is developed in all parts, the largest continuous bodies occurring in the extreme northwest corner and in the eastern half along the breaks to West Des Moines River and the larger creeks.

Areas of Clarion loam are gently rolling, and in few places are the slopes steep enough to cause serious damage from erosion. Surface drainage and subsoil drainage are good, and the subsoils are moderately retentive of moisture.

The greater part of this soil is in cultivation or pasture and is considered valuable for all crops. Along the larger streams, where the surface is more rolling, a few wooded areas occur in which the tree growth consists mainly of oak, elm, cottonwood, maple, and walnut. Bluegrass makes an excellent growth.

Corn is the principal crop grown on this soil. The average yield is about 40 bushels to the acre, though much larger yields have been reported by the better farmers. Oats fit well in the rotations that are centered around the production of corn, and they are grown on all farms. Iowar, Iowa 105, and Iowa 103 are the varieties best liked. Yields range from 35 to 65 bushels to the acre. As a rule the oats stand up well and the quality is good. Barley is produced on some farms, mostly for hog feed. Wheat is not a paying crop and the total acreage is very small, but alfalfa is a profitable hay crop and the acreage is increasing each year. Light applications of lime are generally necessary to give the alfalfa plants a vigorous start but the roots soon penetrate the lime zone. Alfalfa can be profitably grown from five to eight years. Sweetclover is grown for forage and makes excellent pasture for milk cows and hogs. Soybeans are grown extensively on this soil in all parts of the county. They are generally planted with corn that is to be cut for silage, though a small acreage in the northwest part of the county is used for the production of seed. There are no special crops grown on this soil. On most farms small gardens furnish enough vegetables for home consumption.

Clarion loam is valued at prices ranging from \$200 to \$225 an acre. However, very few transfers of land of this kind were made during the year of the survey.

This soil can be handled under rather wide moisture conditions, due to excellent drainage and the open friable character of the surface soil. Most of the land is broken in the fall, and as a general rule crops receive very good cultivation at all times. Rotations are in rather general use and legumes are grown more extensively each year for forage, hay, and green manure.

Clarion loam can be improved by the use of more systematic rotations, preferably a 4-year rotation in which legumes are grown for

green manure. The depth of the seed bed should be gradually increased. This will not only increase the root range but will allow the absorption of larger amounts of water for use during dry spells. The use of stable manure is strongly recommended.

Table 3 shows the range in pH values of a sample of virgin Clarion loam taken in Pocahontas County. Determinations were made by the electrometric method, the hydrogen electrode being used.

TABLE 3.—pH determinations of Clarion loam in Pocahontas County, Iowa

[1:2 soil-water]

Sample No.	Depth	pH value	Sample No.	Depth	pH value
	<i>Inches</i>			<i>Inches</i>	
337401	0 to 3	7.37	337404	23 to 37	8.05
337402	3 to 12	5.83	337405	37 to 57+	8.13
337403	12 to 23	5.83			

*Clarion loam, steep phase.*—Clarion loam, steep phase, has a very dark grayish-brown friable surface layer from 9 to 11 inches deep. The content of sand is high and in some areas soil of this phase approaches fine sandy loam in texture. Between depths of 11 and 17 inches is a transitional layer of dark-brown crumbly loam streaked in places with darker colors. This is underlain by the true subsoil which is yellowish-brown sandy clay loam or clay loam in the upper part of the layer and changes at a depth of 22 or 24 inches to grayish-yellow distinctly calcareous sandy clay. Below a depth of 34 inches the calcareous till is grayish yellow or pale yellow streaked with white carbonaceous materials. On the steeper slopes the surface covering may be much less than 8 inches thick, owing to erosion, whereas on the lower slopes and more gently rolling areas the surface layer is rather thick.

Clarion loam, steep phase, differs little from the typical soil except in relief which is prevalingly strongly rolling. The slopes are steep and in many places gullied. Drainage is well established and in places is excessive.

This steep soil is inextensive. It occurs as narrow ribbonlike areas bordering the bottoms of West Des Moines River and Pilot, Beaver, and Lizard Creeks.

Practically none of the land is in cultivation, but it is used for pasture. Bluegrass makes a very good growth. Some of the slopes are forested with oak, elm, cottonwood, and walnut. The more gentle slopes could be profitably used for the production of corn and other staple crops. Alfalfa, sweetclover, and red clover could be grown for forage and for hay. Plowing should always be at right angles to the slope in order to check erosion.

Clarion loam, steep phase, has a much lower value than typical Clarion loam. It is sold only in connection with the adjoining soils.

#### PIERCE SANDY LOAM

Pierce sandy loam is characterized by a 2-inch layer of dark grayish-brown sandy loam underlain by very dark grayish-brown sandy loam which at a depth of about 10 inches passes into brown gravelly sandy loam mottled with rust brown and gray. Some fine and coarse

gravel are present, and many of the gravel are coated with white carbonates. At a depth of 22 inches a gray slightly sticky calcareous layer occurs, which is underlain at a depth of 36 inches by a succession of fine gravel and sand layers. Much carbonaceous material is present, and when the material is treated with acid effervescence is strong.

This soil varies in the color and texture of the surface soil and in the thickness of the underlying beds of sand and gravel. In sec. 12, T. 91 N., R. 31 W., the surface is rather flat, resembling an outwash plain, and the surface soil is much thicker and is dominantly very dark grayish brown or almost black.

This soil occupies a small total area. It occurs on small isolated high knolls and narrow ridges in all parts of the uplands. The most extensive development is in the vicinity of Gilmore City.

Pierce sandy loam has practically no agricultural value, except the area 1 mile southwest of Gilmore City. Corn is the chief crop and the yields are fair, and oats are grown to some extent. Most of the areas are used for gravel pits which furnish an excellent grade of road material.

#### WAUKESHA LOAM

A profile of Waukesha loam observed in sec. 13, T. 93 N., R. 31 W., is typical of this soil in all parts of the county. The surface soil consists of dark grayish-brown mellow friable loam 10 or 12 inches deep. The upper 2 or 3 inches contains considerable amounts of silt and is structureless, whereas the lower part has slight granulation. When crushed the color of the soil mass changes to a slightly lighter hue. A transitional layer occurs between depths of 12 and 20 inches, consisting of dark grayish-brown loam in the upper part and gradually changing to yellowish-brown heavy loam. The material in this layer is friable and crumbly but shows no granulation. From 20 inches downward to about 42 inches is the true subsoil consisting of yellowish-brown or light-yellow friable silty clay loam or heavy loam, with a few dark streaks where organic matter has come down through animal burrows and old root channels. Below 42 inches and extending to a depth of 5 feet or deeper the mass is brownish-yellow or yellowish-brown friable silty clay loam somewhat mottled with gray and with faint iron stains. Neither soil nor subsoil shows a trace of carbonates. Included with mapped areas of Waukesha loam are several bodies that might have been separated as Waukesha fine sandy loam had they been sufficiently important.

Waukesha loam does not cover a large area. The most extensive bodies occur on the terraces of West Des Moines River. They are flat or gently sloping and occupy positions from 10 to 20 feet above the first bottoms. Both surface and internal drainage are excellent, and the subsoil is retentive of moisture.

Practically all this soil is in cultivation or in pasture, and it is highly prized. Corn is the principal crop and returns an average yield of 40 bushels to the acre. Oats, wheat, and barley are grown to some extent. The grain is all used as feed on the farms.

Waukesha loam is handled in much the same manner as the adjoining upland soils, Webster loam and Clarion loam. All available barnyard manure is usually scattered over the grass and stubble land. Liming is practiced where legumes are to be grown.

This soil has much the same value as Clarion loam. Waukesha loam can be easily improved by the use of crop rotations in which legumes play an important part. Gradual deepening of the seed bed and more thorough cultivation are recommended.

#### O'NEILL FINE SANDY LOAM

The profile of O'Neill fine sandy loam herewith described was observed in sec. 12, T. 93 N., R. 31 W., and is representative of this soil. The surface soil consists of dark-brown fine sandy loam underlain at a depth of 2 or 3 inches by very dark grayish-brown fine sandy loam. Plowed fields when wet appear almost black. When lumps of the soil are disturbed they break into small irregular particles from one-eighth to one-fourth inch in diameter, and these, in turn, crumble into a mellow, friable mass. Between depths of 16 and 40 inches the material is yellowish-brown slightly loamy fine sand containing an abundance of coarse sand and fine gravel. At a depth of 40 inches pale grayish-yellow gravelly sand, that becomes increasingly more gravelly with depth, occurs. Below a depth of 50 inches white carbonates are present, and the soil mass shows an alkaline reaction.

Areas of O'Neill fine sandy loam are uniform throughout the county except on a few small isolated knolls in which the surface soil is fine sand underlain to a depth of 3 feet or more by beds of stratified sand and very fine gravel.

O'Neill fine sandy loam is not an extensive soil, covering only 2.4 square miles. It occurs only in the extreme northeast corner of the county where it is developed on the terraces of West Des Moines River.

The surface is level or very gently sloping, but owing to the slight depth to the underlying sand and gravel layers the soil is droughty.

All the land is in cultivation or in pasture. Practically 80 per cent was in corn during the year of the survey (1928). The growth was much less thrifty than on the Clarion and Webster soils of the uplands; the stalks were small and the ears not so long or so well developed. Yields of corn average between 25 and 35 bushels to the acre. Oats make a fair growth and produce from 30 to 45 bushels to the acre.

O'Neill fine sandy loam is handled in much the same manner as Clarion loam of the uplands. It can, however, be plowed under wider moisture conditions and seems to warm up earlier in the spring. It can be improved by the growing and turning under of green-manure crops, as such a practice will add greatly to the moisture-holding capacity of the soil. Barnyard manure is valuable for this purpose. Applications of lime should give excellent results, especially where alfalfa and sweetclover are to be grown.

#### O'NEILL LOAM

The surface soil of O'Neill loam to a depth ranging from 10 to 13 inches is very dark grayish-brown loose mellow friable loam underlain by brown or yellowish-brown fine sandy loam. Below a depth ranging from 24 to 27 inches the material becomes more sandy and the dominant texture is gritty somewhat sticky sand. Neither surface soil nor subsoil is calcareous.

O'Neill loam is of small total extent and occurs as low terraces along Pilot and Beaver Creeks which traverse the northeast quarter of the county. The surface is flat and lies from 2 to 3 feet above the general level of the first bottoms. Drainage is well established. During dry seasons crops suffer from lack of moisture.

All this soil is devoted to the production of corn and small grain. In seasons of ample rainfall crop yields are as good as on Clarion loam of the uplands. Corn produces, during average years, from 30 to 35 bushels to the acre and oats from 35 to 50 bushels. All the corn and oats are used on the farms of the county.

O'Neill loam can be improved by the same methods as those suggested for O'Neill fine sandy loam. The incorporation of large quantities of green manure is very beneficial.

#### JUDSON FINE SANDY LOAM

Judson fine sandy loam has a very dark grayish-brown surface soil and a slightly lighter-colored subsoil of much the same texture. The transition between surface soil and subsoil is gradual in most places. The soil shows no trace of carbonates throughout.

Judson fine sandy loam occurs only in the extreme northeast corner of the county, on the terraces of West Des Moines River. It is developed along the outer edge of the bottoms on the colluvial benches bordering the uplands. The areas are smooth or very gently sloping, and drainage is good.

This is not an important soil in Pocahontas County, and it occupies a small total area. Corn, which makes excellent returns on this soil, oats, and barley are grown. All the corn and small grain are used on the farms where produced as feed. The hay crops consist of clover, timothy, and alfalfa. Corn yields from 35 to 45 bushels to the acre, oats from 35 to 60 bushels, and barley from 15 to 18 bushels. The hay crops usually produce from 1½ to 3 tons to the acre.

Judson fine sandy loam is handled in practically the same manner as Waukesha loam and has about the same value.

#### BREMER LOAM

The surface soil of Bremer loam, in its typical development, consists of grayish-brown loam underlain at an average depth of 4 inches by a layer of very dark grayish-brown mellow loam 11 inches thick. The upper layer contains some fine gravel and sand and the lower layer has a small content of fine sand. At a depth of 15 inches the true subsoil occurs, which consists of grayish-brown silty clay containing a small amount of fine sand. Below a depth of 24 inches and extending to variable depths the soil mass has a grayish-brown color and silty clay texture. Some gray and rust-brown mottles occur in the lower part of the soil profile. The subsoil layers show no trace of carbonates. Included with this soil as mapped are a few small areas of Bremer silty clay loam.

Bremer loam occurs as small more or less isolated bodies on the terraces of West Des Moines River and North Branch Lizard, and South Branch Lizard Creeks. It is of small total extent. Both surface drainage and underdrainage are poor.

This soil is handled in much the same manner as Webster silty clay loam and Webster loam of the uplands. Corn is the principal crop on the better-drained areas, and the more poorly drained bodies are left in their native state and used for pasture. Corn yields about 35 bushels to the acre. Oats have a tendency to lodge.

Land of this kind is always sold in connection with adjoining upland and bottom soils. Its value is lower than that of Waukesha loam.

#### SIoux LOAM

The surface soil of Sioux loam to a depth of 12 inches is dark-brown loam or fine sandy loam containing some white fine sand. In virgin areas the upper 2 inches is darker and is filled with grass roots. Between depths of 12 and 20 inches the color is dominantly brown or yellowish brown and the texture is gritty loamy sand. Some rounded gravel and small bowlders occur in this layer, but no trace of carbonates is evident. Underlying this layer and continuing to a depth ranging from 10 to 12 feet are beds of stratified gravel, fine sand, and rounded gravel. Much of the gravel is coated with white carbonates and the entire soil mass is calcareous. The size and number of gravel decrease with depth.

Sioux loam occurs on the terraces of practically all the streams of the county. Most of the bodies are small and widely separated. The most extensive development is along Beaver Creek in the northeast quarter of Powhatan Township. This soil lies some 2 to 5 feet above the first bottoms. Drainage is excessive, and during periods of low rainfall the soil is droughty.

Approximately 60 per cent of the total area of Sioux loam is in cultivation. Corn is the principal crop and during favorable years produces from 25 to 45 bushels to the acre. Where legumes are turned under and the land is well prepared higher yields have been reported. Oats are grown on most farms and produce from 35 to 40 bushels to the acre.

Sioux loam is generally sold with adjoining soils. Its value ranges from \$125 to \$200 an acre, depending on location and improvements.

Sioux loam can be improved by the growing and turning under of green-manure crops. As the subsoil is rich in carbonates, liming for legumes is necessary only to increase the stand and for initial growth.

#### ROGERS SILT LOAM

The surface soil of Rogers silt loam to an average depth of 12 inches is gray or light grayish-brown silt loam. When dry the color is light gray and the soil mass has a light, fluffy consistence. Large clods that are thoroughly dried have a porous appearance and are extremely light in weight. Scattered over the surface and throughout the surface soil are large quantities of small shells. The subsoil is much like the surface soil except that the color is dominantly lighter. The entire soil shows strong effervescence when treated with acid.

Rogers silt loam is rather uniform in color and texture. It occurs only in the depressions that were formerly shallow lakes. The most extensive bodies are in the northwest corner of the county.

Land of this kind is very well drained. Most of the fields have been thoroughly tiled, the main tile lines leading into large open ditches.

Corn and oats are the crops most extensively grown. Corn yields from 25 to 40 bushels to the acre and oats from 35 to 50 bushels. Oats lodge badly, a difficulty that has been somewhat overcome by the use of short-stemmed varieties. Potatoes are grown but do not produce so well as on muck and peat.

This soil is handled in much the same manner as the adjoining Webster and Clarion soils. Most of the land is subject to early frost, and corn is sometimes injured.

Rogers silt loam sells at prices ranging from \$150 to \$200 an acre, depending on drainage and location.

#### LAMOURE LOAM

The surface soil of Lamoure loam in most places is very dark grayish-brown friable somewhat sticky loam having an average thickness of about 14 inches. The soil mass when disturbed breaks down into soft irregular granules or clods. It generally effervesces when treated with acid. In virgin areas the upper 2 or 3 inch layer is grayish-brown friable loam filled with a mass of grass roots. Between depths of 14 and 18 inches a transitional layer occurs that is dominantly dark grayish-brown structureless clay loam mottled in the lower part with faint gray and rust brown. Tongues and splotches of dark material occur where the organic matter has come down through old wormholes and animal burrows. At a depth of 18 inches the material is dark grayish-brown friable silty clay mottled with dark gray. This is underlain at a depth ranging from 22 to 24 inches by mottled gray, dark-gray, and grayish-brown friable clay that becomes distinctly more gray with depth. A few rust-brown spots and white sand particles occur in this layer. Below a depth of 30 inches the color is mottled light gray and dark gray, and the texture is gritty clay containing some fine gravel and soft carbonaceous material, the carbonates usually occurring in streaks. At a depth ranging from 36 to 40 inches the material is gray or pale grayish-yellow sandy clay, faintly mottled with rust brown and dark gray, resting at a depth of 42 or 45 inches on gray sticky sand splotched with orange and yellow.

Lamoure loam shows a wide range in profile characteristics, as is true of so many overflow soils. As mapped this soil includes small areas of very fine sandy loam and clay loam, whereas the subsoils may or may not show effervescence in all the layers. Small areas of a silty phase of Lamoure loam occur along Cedar Creek in the western part of the county and along Pilot Creek in the northeastern part. This soil differs from typical Lamoure loam in the higher silt content of its surface layer and the higher average content of organic matter. A few areas of Lamoure loam occupy glacial depressions. In these areas, sediments from the higher lands have covered the glacial drift to greater or less depth, and the soils in most places are intermediate between Lamoure and Webster soils, and could have been mapped with either soil.

This soil occurs most extensively in the extreme northeast corner of the county in the first bottoms of West Des Moines River. The bodies lie from 8 to 10 feet above the normal water level and are subject to overflow.

Lamoure loam is not an extensive soil in Pocahontas County and is not very important agriculturally. Practically all the land is in

pasture and supports a very good growth of grass. There are a few wooded areas in which the tree growth consists mainly of elm, ash, cottonwood, hickory, and ironwood.

In the included silty soil mentioned natural drainage is poor, but where the creeks have been straightened and the land tilled drainage has been improved so that crops can be grown. Corn is the principal crop, and yields range from 35 to 60 bushels an acre with an average of about 37 bushels. Some small grain is grown but lodging decreases yields. In late years the use of Iowa 105 and Iowa 103 oats has reduced losses from this cause. The poorly drained areas of this included soil are used as pasture.

Lamoure loam is generally included with adjoining soils when sold. Its value can scarcely be estimated at more than \$50 or \$75 an acre.

#### LAMOURE SILTY CLAY LOAM

To a depth of 10 or 12 inches the surface soil of Lamoure silty clay loam is very dark grayish-brown or almost black mellow silty clay loam containing a large amount of organic matter. Below this is black or very dark grayish-brown silty clay mottled with white carbonaceous materials and some yellow specks. The third distinct layer, which extends from a depth of 20 inches to 3 feet or deeper is dark grayish-brown or black silty clay mottled with dirty white, yellowish brown, gray, and yellow. The entire soil shows traces of carbonates, and the upper subsoil layer seems to be the zone of lime accumulation. Some few areas of Lamoure silt loam, Wabash silty clay loam, and Wabash silty clay, too small to separate on the map, are included with this soil in mapping. Along the headwaters of some of the creeks the profile of Lamoure silty clay loam closely resembles that of Webster silty clay loam, and separation of the two soils was more or less arbitrary.

Lamoure silty clay loam is an extensive first-bottom soil, occurring along practically every creek in the county. The surface is flat or gently sloping toward the streams and is from 5 to 9 feet above normal water level. Since most of the streams have been straightened and ditched, drainage is sufficient for crop needs.

Lamoure silty clay loam areas are inherently rich and productive. A large area is devoted to the growing of corn, and during favorable years yields are much the same as on the adjoining Webster soils. Oats are grown to a limited extent, and yields range from 35 to 60 bushels to the acre. The most popular varieties are Iowar, Iowa 105, and Iowa 103. Alfalfa and sweetclover do well where internal drainage is good. All the corn and oats are used on the farms where grown, as feed for the work animals, beef cattle, and hogs. A considerable acreage is left in its natural state, because of poor drainage, and is used for pasture. Bluegrass makes a fair growth.

Lamoure silty clay loam is handled in much the same manner as Webster silty clay loam. Its value is almost identical with that of the Webster soils.

#### CASS LOAM

Cass loam to a depth of 8 inches is dark grayish-brown or almost black loam containing some fine sand. From 8 to 15 inches a somewhat darker-colored layer occurs that is distinctly lighter textured, in most places very fine sandy loam. This layer, in turn, is under-

lain at a depth of 28 or 30 inches by dark grayish-brown loam which has a yellowish-brown cast when crushed. None of the layers described shows a trace of carbonates when treated with acid. The fourth distinct layer, which extends to a depth of 49 or more inches, is gray or grayish brown in color and fine sandy loam or loamy fine sand in texture. Some white carbonaceous material is present and the soil mass is calcareous.

The profile of Cass loam varies greatly both in color and texture, and some small areas of very fine sandy loam and sandy loam are included.

Cass loam occurs almost exclusively in the northeast quarter of the county, where it is developed on the first bottoms of Pilot and Beaver Creeks. The land is flat and lies from 2 to 4 feet above normal stream level.

Practically none of this soil is farmed. It supports a very good growth of natural grasses and is used for pasture.

Cass loam is seldom sold, except with adjoining soils. Its sale value is much lower than that of Sioux loam.

#### WABASH SILTY CLAY

The surface soil of Wabash silty clay is very dark grayish-brown or almost black silty clay 10 or 12 inches deep. The subsoil is black silty clay that at a depth ranging from 24 to 28 inches is underlain by dark-gray or dark slate-colored plastic clay. The change from surface soil to subsoil is gradual. This soil differs from the Lamoure soils in that it shows no trace of carbonates throughout.

Wabash silty clay is an unimportant soil and covers a small total area in the county. It occurs only in the first bottoms of West Des Moines River. Drainage is poor, and the land is subject to overflow.

Approximately 60 per cent of the total area of this soil is devoted to the production of corn, and the rest is left in its natural state and used for pasture. Corn yields, during favorable years, are much the same as on Webster silty clay loam. The average yield is lower.

Land of this kind is difficult to handle as it must be plowed under the proper moisture conditions. The growing and turning under of green-manure crops will improve its physical condition.

#### MUCK AND PEAT

Deposits of muck and peat occur in the western and southeastern parts of Pocahontas County. A few of the bodies contain about 300 acres but they average between 10 and 20 acres. Very finely divided peat, closely resembling muck, is the predominating material. It consists of a layer of black finely divided carbonaceous material, from 20 inches to 3 feet thick, underlain by drab-colored clay or clayey material. Very little mineral matter seems to be mixed with this material except at lower depths where the clay strata occur. Plowed land has a fluffy consistence. Small shells occur on the surface and throughout the material, and the entire mass is calcareous. The few small undisturbed areas are brown and more fibrous.

The muck and peat areas have been well drained, and they are used for general-farm and truck crops. As a rule, corn and small grain grow much more slowly at first and do not ripen so quickly as on normal soils. The result is injury from frost. Oats lodge to con-

siderable extent and this makes harvesting more difficult. The growing of potatoes is most important and an excellent product is obtained if proper fertilization is practiced. Most of the potatoes are sold locally.

Small applications of barnyard manure are beneficial to muck and peat as this practice adds bacteria to the material, but large quantities should not be used. Potash and phosphoric acid add greatly to the productivity of muck and peat, but the rate of application and the mode of application (whether separately or together) should be based on tests conducted on each separate area. Adequate drainage is important for best results.

#### SUMMARY

Pocahontas County is in the northwest part of Iowa. It includes an area of 576 square miles.

The population of the county, as reported by the 1930 census is 15,687, all classed as rural and fairly evenly distributed. Pocahontas, with a population of 1,308 in 1930, is the county seat.

The county is within the limits of the area covered by the late Wisconsin ice sheet. The surface relief is, in general, gently undulating or flat, with smaller areas of gently rolling or smoothly rolling country in the southeast and northwest corners. Along West Des Moines River, which cuts through the extreme northeast corner, and along some of the larger creeks narrow ribbonlike areas, which are strongly rolling and eroded, occur. Extensive terraces lie along West Des Moines River, but the bottom lands along the creeks and other streams are narrow.

All the principal streams have been dredged and straightened, and most of the farms are well tiled. Surface and internal drainage are now sufficient for crop needs except in rather restricted sections of the county.

The highway system is well developed. Most of the county roads have been graded and graveled, and all roads are dragged after rains.

The mean annual precipitation is 30.80 inches and is favorably distributed for crops. The winters are severe and the summers short and hot. The average frost-free season is 148 days.

Agriculture consists of the growing of corn, small grains, and hay. The livestock industries include the raising of hogs, the raising and feeding of beef cattle, and, to a limited extent, dairying.

Pocahontas County is in the prairie section of the Middle West. The soils are loams, silty clay loams, and silt loams. Over the greater part of the county they are now sufficiently well drained for crop needs, are rich and productive, and are moderately easy to handle.

The upland soils have been developed from the late Wisconsin drift under the influence of a grass cover and are classified in the Clarion, Webster, and Pierce series. The terrace soils are included in the Waukesha, O'Neill, Bremer, Judson, and Sioux series. The Lamoure, Wabash, and Cass soils constitute the first-bottom soils. Rogers silt loam is of lacustrine origin.

Clarion loam is one of the most extensive soils in the county and is a highly prized agricultural soil, being well suited for the growing of corn, oats, barley, and hay. Alfalfa does particularly well on this soil.

Webster silty clay loam and Webster loam cover a slightly larger area than Clarion loam. Drainage is not so well established as in the Clarion soil, and the Webster soils are slightly more difficult to handle under as wide moisture range. They are rich and productive, and yields of corn, oats, and hay are high.

Pierce sandy loam occupies a small total acreage, and the soil is used largely for road material. It is not an important agricultural soil, only one area being farmed.

Waukesha silt loam is an excellent corn and general-farming soil. It occurs on the terraces.

The O'Neill soils of the second bottoms, or terraces, are more or less droughty, and crop yields are below those on Waukesha silt loam. These soils are used for the production of corn and other staple crops of the county.

Bremer loam is of comparatively small total extent. It occurs in small isolated bodies on the terraces of West Des Moines River and some of the larger creeks. This soil is handled in the same manner as Waukesha silt loam, but crop yields are not so good. Owing to poor drainage much of the land is left in its natural condition and is used for pasture.

Sioux loam, a droughty terrace soil, is used in the production of corn and other staple crops.

Rogers silt loam occupies low depressed areas that were formerly shallow lakes. This soil does not cover a large area. Practically all of it is used for corn.

Lamoure loam and Lamoure silty clay loam are first-bottom soils. Most of the areas have been adequately drained and produce excellent yields of corn, oats, and hay. The more poorly drained areas are left in their natural state and used for pasture.

Wabash silty clay is of small extent and occurs only in the first bottoms of West Des Moines River. It differs from the Lamoure soils in the lack of carbonates throughout the soil. Natural drainage is poor. A little more than one-half of the land is in cultivation, principally to corn.

Cass loam also is a first-bottom soil and is subject to overflow. Practically all this land is left in its natural state and is used for pasture.



[PUBLIC RESOLUTION—No. 9]

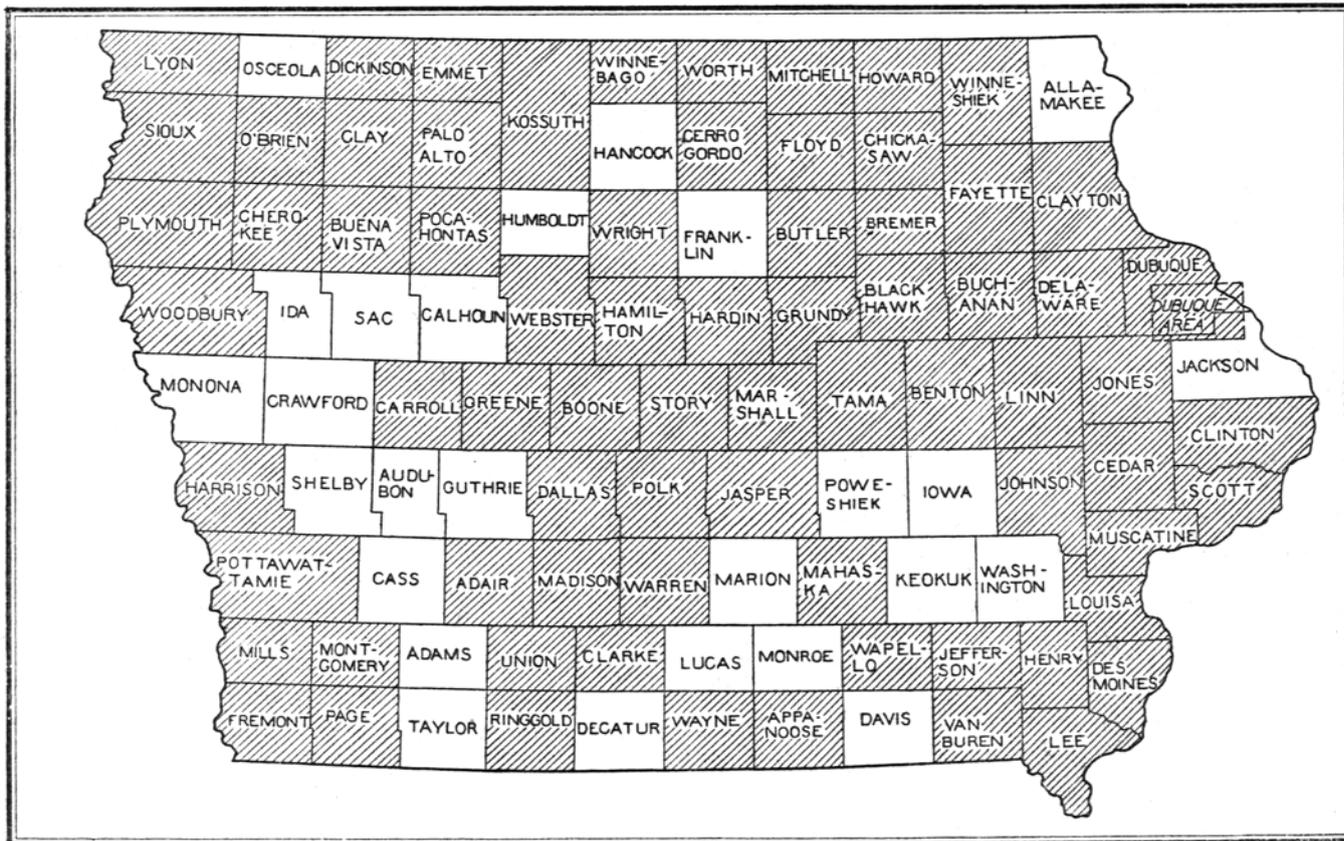
JOINT RESOLUTION Amending public resolution numbered eight, fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

*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, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Iowa, shown by shading

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Washington, D.C. 20250-9410;
- (2) fax: (202) 690-7442; or
- (3) email: [program.intake@usda.gov](mailto:program.intake@usda.gov).

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