SOIL SURVEY OF THE WACO AREA, TEXAS.

By A. W. MANGUM and M. EARL CARR.

LOCATION AND BOUNDARIES OF THE AREA.

The Waco area is located in the Black Prairie Belt of east-central Texas. It is rectangular in shape, being bounded by the parallels of 31° 30′ and 31° 45′ north latitude and the meridians of 97° and 97° 30′ west longitude. The area thus embraced is 29½ miles long and 17 miles wide, making a total area of 316,864 acres, or about 495 square miles. The main body of the area lies in McLennan County, although about 50 square miles in the northwestern corner lies in Bosque County.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Several surveys were made and a great many claims were located in the area during the period 1840 to 1845, but there were very few inhabitants except Indians until 1848. In 1849 a number of white settlers

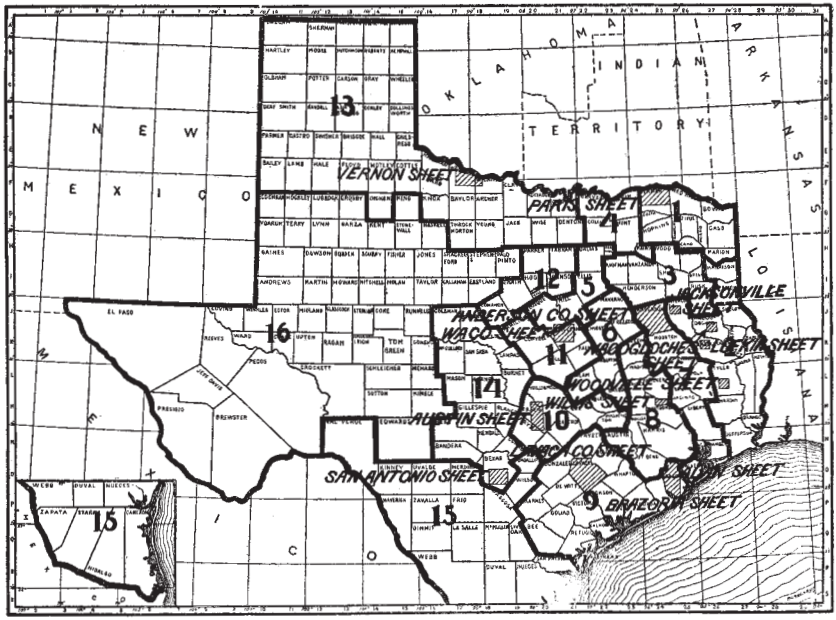

FIG. 23.—Sketch map showing location of the Waco area, Texas.

arrived and established a village at Waco Springs, which later became the county seat of McLennan County. McLennan County was formed from parts of Limestone, Navarro, and Milam counties on January

22, 1850, and thereafter the settlement of the area progressed rapidly and the population of the county increased from a few hundred in 1850 to 6,200 in 1860, and to 13,500 in 1870.

During the next decade the railroads reached the area, establishing communication with the eastern States and with the older settlements in Texas. Many new settlers soon began to arrive from Tennessee, Georgia, and other States farther east, causing the agriculture of the county to develop rapidly and resulting in a great increase in the value of farm and grazing lands.

The bottom lands along the larger streams were the first to be put under cultivation, as the treeless prairies were used exclusively as open ranges for cattle. The lands of the area were primarily taken up for the purpose of stock raising, the abundance of native grasses on the rolling prairies and the large number of small streams which flow through the section making the country especially adapted to this industry, but there has been a steady agricultural development until farming is now the chief industry. As the acreage of cultivated lands increased the area of the open ranges was gradually reduced, and the larger herds of range cattle gave way to smaller herds of improved stock. At the present time only the more stony or shallow types of soil, which are least adapted to agricultural purposes, are utilized as grazing lands for cattle, and the larger stock ranches are located in the more broken and hilly section of the area.

Wheat, corn, and cotton were at first the principal crops grown, although oats, rye, potatoes, and vegetables were also cultivated to some extent. The acreage of almost every crop grown in the county has greatly increased within the last fifteen years, but cotton is the staple crop, and a large proportion of the cultivated land is devoted to its production. The acreage of cotton, corn, and wheat in 1891 was estimated to be, cotton 51,537, corn 28,244, and wheat 3,582 acres, while the census of 1900 gives the acreage of these crops as cotton 170,854, corn 91,189, wheat 31,485 acres, and also shows a large increase in the production of oats, rye, potatoes, vegetables, forage crops, and orchard products.

There is one city and a number of small towns and villages in the area. These contain a considerable proportion of the total population, but the rural districts, with the exception of the rough and more broken sections in the northwestern part of the area that are utilized for grazing purposes, are fairly well settled, and there is a constant demand for the better grades of farming land at good prices.

The rapid agricultural development of the area has been largely due to its central location and to the fact that profitable yields of cotton can be annually obtained on almost any type of soil in the area without the aid of commercial fertilizers and at a comparatively small cost for labor.

There are now 571,345 acres of farm land in McLennan County, of which 385,672 acres are improved, and the total valuation of the farms and improvements, not considering the buildings, is given by the census of 1900 as $12,152,210.

CLIMATE.

The climate of this part of Texas is, as a rule, mild and agreeable during the entire year. The rainfall is distributed rather evenly through the year, being greatest, however, during the spring months or growing season, when it is most needed. Sometimes severe droughts occur, but seldom before the grain crops have matured and are harvested. Cotton, being more resistant, is generally not much damaged by these droughts. The shallow soils of the grazing land in the western part of the area are most affected.

The winters are usually mild and open. The mean minimum temperature for January, the coldest month, being 16.1° F. above the freezing point. The most characteristic feature of the winter climate of this section is the "norther"—a cold wind that sweeps in from the higher latitudes without warning and lowers the temperature many degrees in an incredibly short time. These winds are sometimes accompanied by sleet and snow and cause considerable suffering and loss of life to the exposed cattle.

Sometimes in summer the opposite extreme is experienced and crops suffer materially from the hot, dry winds. Usually the extreme heat of the summer months is somewhat modified by the movements of the air, and the hot days are nearly always followed by cool, restful nights.

The following table, compiled from the records of the Weather Bureau, gives the mean annual and monthly temperature and precipitation for Waco and Temple. Temple is located about 30 miles south of the area:

Normal monthly and annual temperature and precipitation.

Month.	Waco.		Temple.		Month.	Waco.		Temple.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*Inches.*	° F.	*Inches.*		° F.	*Inches.*	° F.	*Inches.*
January	48.1	2.73	46.9	2.73	August	84.8	2.08	82.6	1.99
February	50.0	1.93	49.0	1.74	September	78.4	2.90	76.9	2.65
March	58.6	3.04	57.6	2.67	October	68.3	2.41	69.2	2.52
April	67.8	4.49	68.7	4.01	November	57.3	2.79	56.9	2.89
May	75.7	3.64	73.6	3.68	December	51.0	2.06	49.7	2.92
June	82.4	2.70	80.0	4.13	Year	67.3	32.77	66.2	34.77
July	85.4	2.00	83.0	2.84					

The following table, compiled from the same source, gives the date of the last killing frost in spring and the first in the fall for the past eight years.

From this table it will be seen that the shortest growing season, 219 days, occurred in 1899, and the longest, 274 days, in 1896, the average being about 250 days, or a little over eight months:

Dates of first and last killing frosts.

Year.	Waco.		Temple.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1896	Feb. 7	Nov. 8	Mar. 16	.....
1897	Mar. 24	Nov. 18	.....	Nov. 16
1898	Mar. 24	Nov. 23	Mar. 23	Nov. 21
1899	Mar. 29	Nov. 3	Apr. 9	Nov. 2
1900	Mar. 2	Nov. 10	Mar. 15	Nov. 11
1901	Mar. 6	Nov. 5	Mar. 5	Nov. 4
1902	Mar. 6	Dec. 4	Mar. 6	Nov. 26
1903	Mar. 2	Nov. 18	Mar. 2	Nov. 17
Average	Mar. 9	Nov. 15	Mar. 15	Nov. 14

PHYSIOGRAPHY AND GEOLOGY.

The greater part of the area, on both sides of the Brazos River, consists of rolling upland prairies intersected by numerous small streams and rivers. These prairies have a general tendency to slope toward the Brazos and slightly southeast with the direction of the river. The general appearance of the upland prairies is that of a gently undulating plain, but the low, rounded hills with gentle slopes and shallow intervening depressions give them a gently rolling topography.

Along the small streams and rivers which traverse the prairies of the western section of the area the topography becomes rougher and more broken and the soils suffer to a considerable extent from the effects of erosion, causing them to be shallow, stony, and of low agricultural value. Here the slopes of the rounded hills become steeper and many draws and deep erosions extend from the more level prairies to the narrow bottoms along the stream courses. In this section of the area the streams that flow through the rolling prairies have cut their channels a considerable depth below the level of the neighboring uplands. There is frequently a narrow strip of level bottom land between the present channel of the stream and the precipitous bluffs which extend upward to the adjacent prairie, but many of the streams flow between almost perpendicular walls of limestone, which rise to an elevation of 50 to 75 feet above stream level and which seldom widen out sufficiently to permit of any alluvial bottom lands.

The highest point in the area is on the rolling plateau in the northwestern part of the area, where some of the rounded hills reach an

elevation of from 750 to 800 feet. The topography of this section is slightly more hilly than the greater part of the prairie, and many of the rounded hills have a slightly terraced appearance. The soil on the steeper slopes and on the rounded summits is seldom more than 1 foot deep, and small areas frequently occur where the soil has been entirely eroded off and the underlying limestone is exposed on the surface. The lowest point, where the Brazos River leaves the area, has an elevation of about 400 feet above sea level.

One of the principal topographic features is the escarpment of Austin chalk that extends across the area from northeast to southwest, crossing the Brazos River above Waco. The western boundary of the escarpment rises abruptly many feet above the gently rolling prairie to the west in a series of steep and precipitous limestone hills, intersected by many deep and narrow gorges. The soil along the western slope is shallow and easily eroded and frequent exposures of the white chalky limestone occur along the hillsides and deep erosions. The narrow strip of country occupied by this chalky formation has a slightly more rolling topography than that of the greater part of the prairie section, and where the Brazos River or small streams have cut their channels through this formation, they flow between high, perpendicular bluffs of soft white limestone. The eastern boundary of the Austin chalk escarpment is much less distinct, the chalky hills passing gradually into the low, rolling topography of the upland prairie. A series of old river terraces extends along each side of the Brazos River, except where this stream has cut its channel through the chalk escarpment. These terraces have a level or very gently undulating topography and are composed of material deposited by the stream in comparatively recent time. Flood waters originating in or traversing the Permian red beds have brought down a large amount of this material, which causes these valley lands to have a red to reddish-brown color. The remnant of an older alluvial formation occurs along the low ridges and rounded elevations adjacent to these bottom lands. This frequently contains a large percentage of rounded, waterworn gravel, and owes its origin to material deposited by floods at a much earlier period. This deposit is of no great extent on the western side of the Brazos River, but covers a considerable area on the eastern side. It overlies the older geological formations to a depth varying from a few feet to about 40 feet and often has an elevation of more than 100 feet above the present valley of the river. The smaller rivers and principal creeks, with the exception of those traversing the western part of the area, flow through broad, flat alluvial valleys which have only a slight elevation above stream level.

With the exception of these alluvial deposits, the geological formations from which the soils of the area are derived belong to the Gulf series of the Upper Cretaceous and to the Comanche series of the

Lower Cretaceous period. The entire western half of the area is underlain by the Fort Worth limestone, which forms by its disintegration the soils of the rolling prairie in that locality. This formation belongs to the Lower Cretaceous and consists of a group of impure, slightly arenaceous, compact white limestone strata, separated by layers of argillaceous lime marl. The compact layers often reach a thickness of several feet, but the average thickness varies from a few inches to about 2 feet. The difference in the weathering of these alternating layers of hard limestone and softer marly material has caused the slightly terraced appearance of the slopes of the higher elevations in the western part of the area.

The Fort Worth formation is encountered at no great depth below the surface, even on the more level portions of the prairie, and where the topography is very rolling it outcrops frequently and seldom has more than a shallow covering of soil.

The Denison formation of the Lower Cretaceous has entered largely into the composition of the soil in a small area situated just north of the Bosque River. It consists of laminated ferruginous clays, sandy clays, and impure limestone. A few fragments of sandstone are also encountered in the upper soil. The soils derived from this formation contain a larger proportion of sand than those originating from the Fort Worth limestone and usually have a slightly redder color.

The Austin chalk, which forms the escarpment already mentioned as extending across the area in a northeast-southwest direction, is a stratified chalky limestone, the strata varying in thickness from 1 foot to about 8 feet. Pockets of marl occur in this formation and layers of marl frequently separate the limestone strata. The Austin chalk is very fossiliferous and also often contains many small concretions of iron pyrite embedded in the strata. It weathers rapidly and forms a black clay soil, which is estimated to vary in depth from 1 foot to more than 30 feet. The small streams cut rapidly through this soft formation and flow in deep canyonlike erosions with almost perpendicular walls. The thickness of this chalky formation in the area has been estimated to be from 35 to about 170 feet. Lying immediately under the Austin chalk and outcropping along the western boundary of the escarpment is a series of blue laminated clays and blue argillaceous shale, known as the Eagle Ford formation. Where this formation is exposed it also weathers rapidly into a stiff black clay soil. The rolling black prairie lands, south and east of Waco, are underlain by the Taylor marl. This, together with the Austin chalk and Eagle Ford formations, belongs to the Gulf series of the Upper Cretaceous. The Taylor marl consists of massive beds of calcareous clay marls, which are sometimes known as joint clays. These marls are yellowish in color and are said to have a laminated structure, but they weather rapidly to a considerable depth and appear compact and massive.

Every section of the area, with the exception of a few small depressions in the flat bottom lands along some of the smaller streams, has good natural drainage. The Brazos River flows through the area in a general northwest to southeast course and serves as the outlet for the drainage waters of the entire area. The drainage waters of the western half of the area reach the Brazos through Childress Creek and the Bosque River. Hog Creek and the Middle Fork of the Bosque, which empty into the South Bosque, drain the southwestern part of the area. Childress Creek drains a considerable part of the northwestern section of the area and empties directly into the Brazos River. The North Fork of the Bosque carries off the drainage waters of the west central section. It unites with the South Bosque about 5 miles northwest of Waco, forming the Bosque River, which empties into the Brazos River about 3 miles above that city.

The rolling country east of the Brazos River is intersected by many small streams that flow in a general southerly direction. Those east of the Houston and Texas Central Railroad finally empty into Tehuacan Creek, which receives the drainage water of the extreme eastern section of the area and empties into the Brazos River a short distance south of the area. Whiterock and Aquilla creeks, together with their small tributaries, drain a large proportion of the northeastern part of the area.

SOILS.

Sixteen types of soil were mapped in the area. Five are derived directly from the decomposition of the geological formations of the Cretaceous period, which underlie the area, eight are derived from material deposited by stream, either in comparatively recent time or during floods which occurred at an earlier date, and two are composed of transported material combined with that derived from the weathering of the underlying formations.

The following table shows the total area embraced by each type:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Crawford clay	112,320	35.5	Yazoo clay	7,488	2.4
Houston black clay	57,280	18.1	Crawford loam	6,784	2.2
Crawford stony clay	27,264	8.6	Miller heavy clay	4,608	1.5
Susquehanna fine sandy loam	24,512	7.7	Rock outcrop	2,880	.9
Miller fine sandy loam	22,208	7.0	Houston gravelly clay	1,984	.6
Yazoo heavy clay	13,248	4.2	Miller fine sand	1,408	.4
Houston clay	12,864	4.0	Miller silt loam	960	.3
Travis gravelly loam	12,416	3.9	Total	316,864	.....
Houston loam	8,640	2.7			

HOUSTON BLACK CLAY.

The Houston black clay, locally known as "black waxy prairie land," is one of the most productive soils in the area. To a depth of 10 inches the soil is a black to very dark drab clay, sticky and tenacious when wet, but friable and loamy when in a well-cultivated condition. The fine tilth is particularly noticeable in areas that have been under cultivation for a considerable time, where the upper part of the soil is loose and friable, though in its virgin state or in areas utilized for grazing purposes the surface becomes hard, baked, and sun cracked. The soil grades at about 10 inches into a stiff, tenacious dark-drab to slate-colored clay, which becomes stiffer and slightly heavier as the depth increases, and at 36 inches is a very stiff compact clay of a slightly lighter color than the upper part of the section. Upon drying, a very thin, baked crust is frequently formed on the surface, which has a grayish or slate-colored appearance.

The heaviest phase of this soil occurs in the low depressions of the rolling prairie, which are not so thoroughly drained as the greater part of the type. The upper soil in these depressions is usually of a darker color, and upon drying it becomes baked and sun cracked to a greater degree than that of the better drained areas. Again, where this type borders on some of the sandier soils, the texture is often lighter than the typical section would indicate and the surface soil frequently contains a slightly larger proportion of sand. Where these conditions exist to any great extent, or where enough sandy material has been combined with the clay to alter materially the texture, the areas have been classified and indicated on the map as a distinct soil type. In like manner, very small areas occurring on the summits of the higher elevations in the northeastern part of the area surveyed and having loose rounded gravel scattered over the surface have been classified separately where they are of sufficient extent.

With the exception of the western one-fourth of the area the Houston black clay occurs in bodies of more or less extent in almost every part of the survey. The largest unbroken tract occurs south and southwest of Waco, but this type also covers a large proportion of the rolling prairies in the eastern and northeastern sections of the area. Two other tracts of considerable extent occur in the west-central part of the territory surveyed, one lying southwest of Speegleville, and the other occupying the rolling prairie just south and east of China Spring.

The general appearance of the black prairie region occupied by this soil type is that of a very gently rolling plain. The topography varies from an almost level plain to low, rounded hills, with level or very gently undulating areas intervening. In the northeastern part of the

area the surface is slightly more rolling, but the hillsides are never steep and very little erosion takes place.

The Houston black clay has good natural drainage and can be cultivated within a comparatively short time after heavy rains, the rolling topography serving to carry the excess water to the many small streams which traverse this section of the prairies. A few low depressions occur which are not so rapidly drained as the more rolling areas, but they do not remain in a wet condition for any considerable length of time.

The greater part of the area of this soil is formed from the weathering of a compact, apparently massive calcareous clay, known as the Taylor marl formation. Smaller areas also occur, which owe their origin to material derived through decomposition either from a soft chalky limestone or from the marly clays of the Eagle Ford formation. These clay marls and soft limestones weather rapidly to a great depth, forming a deep black clay soil.

The Houston black clay is well adapted to general farming and produces excellent yields of all the crops cultivated in the area. Oats and wheat produce larger yields than on any of the lighter-textured soils, and a very profitable yield of corn is almost always secured. The stiff clay subsoil enables this type to conserve enough moisture for the maturing of the crops grown, and they suffer less from drought or hot winds than those cultivated on the sandy soils.

Throughout the area occupied by this soil occur small areas on which potatoes, cotton, and fruit trees are seriously damaged and usually die. This is thought to be due to a fungus disease, mentioned later in this report.

The Houston black clay is considered best adapted to cotton and grain. A few vegetables are grown for home use, but the soil is not well adapted to orchards, small fruits, or vegetables. The yield of cotton, when not injured by the boll weevil, averages about one-half bale per acre. A larger yield is frequently obtained in particularly favorable seasons, and some farms on this type of soil have, with careful management, continuously produced a yield of three-fourths of a bale per acre. Corn gives an average yield of 30 to 35 bushels, but larger yields are secured in a wet season. Wheat averages about 15 bushels per acre, but is not extensively grown. The yield of oats, considered a sure crop, is seldom less than 35 to 40 bushels, and often more than 50 bushels. Barley and rye are also grown to a very limited extent and very fair yields are obtained.

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

Mechanical analyses of Houston black clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12883, 12887.....	Soil	0.2	1.3	1.7	7.9	10.0	46.5	32.0
12884, 12888.....	Subsoil.....	.1	1.0	1.5	7.6	9.0	45.7	35.1

YAZOO CLAY.

The Yazoo clay consists of a dark-brown clay loam, having an average depth of 8 to 10 inches. On drying, the surface cracks and the thin baked crust formed has a lighter color than that of the cultivated areas. This soil grades at about 10 inches into a very heavy dark-drab clay loam which rapidly becomes stiffer and heavier as the depth increases, until at 30 to 36 inches it is usually a stiff, dark-drab, tenacious, silty clay.

The type occurs along the valleys of the North and South forks of the Bosque River, and reaches the greatest extent between the junction of these streams and the mouth of the river. The topography is comparatively level, but low ridges, shallow depressions, and gentle swales give it a gently undulating character; the whole valley, however, has a general slope toward the stream. The greater proportion of the type is not at present subject to overflow, and the valleys, with the exception of the small, basinlike depressions, are well drained.

The Yazoo clay is of alluvial origin, being derived from material deposited along the valleys of the small rivers before the streams had cut their channels down to their present level. A large amount of material has also been washed down to these bottom lands from the high, rolling uplands which border them. The texture of the soil along the immediate banks of the streams is sometimes slightly sandier than the main body of the type, a condition due to the deposition of coarser material by the swifter currents during overflows. The area of this type, occupying the river valley at Valley Mills, has scattered over it low sandy ridges, too small to indicate on a map of the scale used, and the sand content of the surface soil in this section of the river valley is to some extent greater than in the typical areas.

The Yazoo clay is one of the strongest and most productive soils mapped in the area and well adapted to a great diversity of crops. A large yield of all those crops grown on the heavy upland soils is always obtained on this type, and truck, alfalfa, sorghum, and millet are successfully produced. The average yields of the important crops given below are based on the estimates of planters having this type of soil. Cotton yields from one-third to one-half bale per acre, and before the

crop was annually damaged by the boll weevil a considerably higher average was maintained. Corn yields from 35 to 40 bushels, and oats from 40 to 50 bushels per acre. Very little wheat is grown, but it is estimated to give an average yield of from 12 to 15 bushels per acre. Alfalfa does exceedingly well, and from three to four cuttings are always secured. Onions and potatoes are grown for the local markets with excellent results. Large yields are also obtained from millet and sorghum, which are extensively grown for feed.

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

Mechanical analyses of Yazoo clay.

Nnmber.	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.*	*Per cent.*
12909, 12911.....	Soil	0.2	0.5	0.4	4.4	8.8	48.6	36.8
12910, 12912.....	Subsoil.....	.0	.2	.4	3.5	7.7	49.3	38.9

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12910, 32.30 per cent; No.12911, 32.71 per cent; No. 12912, 32.45 per cent.

YAZOO HEAVY CLAY.

The Yazoo heavy clay consists of a very heavy dark-drab to black clay, having an average depth of about 10 inches and grading into a subsoil of slightly lighter color, but stiffer and more tenacious structure. The subsoil gets heavier as the depth increases, and at 36 inches it is a drab to dark slate-colored, stiff, tenacious clay. Where properly cultivated the surface breaks up into a loose loamy soil, but if plowed when in a wet condition the clods become hard and baked, making it very difficult to get the soil into a condition suitable for the cultivation of crops and lessening its productivity in no small degree. When not under cultivation, or in areas where the drainage is poor, the surface upon drying becomes baked and sun cracked and has a lighter color than that of the cultivated areas.

The largest area of this type of soil occupies the broad flat valley of Tehuacan Creek, which traverses the eastern part of the area and extends some distance up the valleys of the principal tributaries. A second area of considerable extent occurs in the low bottom lands along the course of Aquilla Creek in the north-central part of the area. The narrow areas extending up the valleys of the smaller streams are not as subject to overflow as those along the large creeks, and they are usually of a lighter color. The opposite is true of the small, poorly drained depressions that often occur in the larger areas. The water collects in these depressions after heavy rains or overflows, and the sediment deposited, together with a large accumulation of organic matter, has formed a black clay soil of a stiffer character than that occupying the better drained areas.

The topography of these bottom lands is comparatively level. The gentle swells and ridges are low and rounded and the depressions are shallow and of small extent. The greater proportion of the type has a sufficient elevation above the level of the neighboring stream to cause it to be well drained, but ditching or tiling would greatly increase the agricultural value of some of the lower lying areas.

The Yazoo heavy clay is an alluvial soil, being composed partly of material deposited during overflows in the bottom lands bordering the large streams and partly of material washed down from the neighboring uplands during times of excessive rain. The larger streams overflow their banks and flood the broad flat valley lands about once in every three or four years. The finer material, composing the upland prairie soils, is taken in suspension by the small streams and deposited during overflows over the flooded areas adjacent to the larger stream courses.

The Yazoo heavy clay is very productive and with careful management gives large yields of cotton, corn, oats, and forage crops. Wheat is seldom grown and oats only to a limited extent, corn and cotton being the principal crops cultivated. The yield of cotton is annually greatly reduced by the boll weevil, as this crop is usually injured to a greater extent on these bottom lands than on the prairie. Before the advent of the boll weevil a yield of from two-thirds to 1 bale per acre was always expected, but at present the average yield is about one-half bale per acre. Corn gives an average yield of from 35 to 40 bushels per acre and is seldom a failure even in dry seasons. The yield of oats, a crop frequently grown, is about 35 or 40 bushels per acre. The fact that these lands are subject to overflow during the spring months makes the production of wheat uncertain and it is seldom grown.

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

Mechanical analyses of Yazoo heavy clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12913, 12915	Soil	0.0	1.6	1.1	5.3	5.9	34.2	51.9
12914, 12916	Subsoil.....	.0	.3	.4	3.6	8.9	39.4	47.2

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12913, 5.93 per cent; No. 12914, 2.68 per cent; No. 12915, 1.87 per cent; No. 12916, 4.85 per cent.

MILLER FINE SAND.

The Miller fine sand consists of a loose gray to white, fine to medium sand, which grades at 12 to 15 inches into a sand of about the same texture, but of a slightly yellow or brown color, and extending to a depth of from 4 to more than 6 feet.

The Miller fine sand occurs in small hillocks, covering only a few square yards throughout the valley of the Brazos River, but the largest area occupies a ridge on the eastern side of the Brazos in the northern part of the area surveyed. A ridge of this type, seldom more than a few rods wide, is sometimes found bordering the banks of the river. These areas often have the general appearance of low sand dunes and, with the exception of the narrow strip along the river banks, they are mainly of wind-blown origin, the strong winds causing the fine sand of the Miller fine sandy loam to drift into the small sand mounds which finally cover the underlying alluvial material to a depth of many feet.

The largest area north of Gholson is not cultivated to any extent and is of small agricultural value. However, cotton and corn are sometimes grown on limited areas, and these crops in a wet season give fair yields. The small sand mounds, associated with the Miller fine sandy loam, are cultivated, but where the sand reaches any great depth they are of small agricultural value.

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

Mechanical analyses of Miller 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.*	*Per cent.*
12858	Soil	0.0	0.9	7.1	66.7	22.8	1.0	1.4
12859	Subsoil	.0	1.6	13.2	62.7	18.3	2.0	2.0

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam is a gray to very light-brown fine sandy loam, having an average depth of from 10 to 12 inches. A few small rounded gravel are frequently encountered, scattered on the surface and mixed with the soil. The subsoil consists of heavy sandy clay of a red to reddish-brown color, also containing an occasional waterworn pebble. This subsoil rapidly becomes stiffer and the depth increases until at 36 inches it is a stiff, slightly mottled clay, though still containing a perceptible quantity of sand.

Small areas of this type are often encountered where the underlying subsoil ranges from a yellowish-brown to drab-colored sandy clay. Other small areas occur, scattered over the territory embraced by this type, which contain a larger percentage of rounded gravel and small pebbles than is found in the greater proportion of the soil. Where the gravel content is of sufficient importance to warrant, and the areas are large enough to be shown on a map of the scale used, the soil has been given a separate classification.

The largest areas of the Susquehanna fine sandy loam are scattered over that section of the area surveyed which lies east of the Brazos River. Other small detached areas are encountered on the west side of the Brazos, but they cover no great extent of territory. The larger areas are usually found at no great distance from the valley of the Brazos and their trend is northwest to southeast, with the general direction of the river.

The topography of the Susquehanna fine sandy loam is rolling. The hills are low and rounded, but the valleys between them are usually narrower than those of the rolling prairies, and the small streams, which flow through them, frequently cut out deep erosions. The hillsides are seldom steep, but the soil is easily eroded and small areas are often encountered along the steeper slopes where the sandy soil has been washed off, leaving the underlying sandy clay exposed on the surface. The topography of the areas of Susquehanna fine sandy loam, situated east of Elm Mott, is slightly more broken than that of the greater part of this type. The hills are somewhat steeper and the country is intersected by numerous small streams which have their source in this section of the area.

The rolling topography and sandy character of the soil itself insures excellent drainage, which in the more rolling sections is often too thorough for the best results to be obtained from the crops cultivated.

The fine sand and sandy clays from which this soil is formed are the remains of an old deposit which was laid down over the older geological formations which underlie this part of the area. The rounded, waterworn gravel that occurs in both soil and subsoil indicates that this material was deposited by water. This soil represents the southern extension of the "Lower cross timbers."

A comparatively small proportion of the Susquehanna fine sandy loam is under cultivation, the remainder being at present covered by a heavy growth of post oak. The soil itself is locally known as "post-oak land" and is not considered a very strong soil for general farming purposes. The crops cultivated usually suffer for want of sufficient moisture in a season of average rainfall and are, as a rule, a failure during a dry season. In a wet season, however, very profitable yields are always obtained. The soil warms up early in the spring and can be cultivated sooner after heavy rains than the other upland soils. It is better adapted to crops which mature before the hot, dry months of late summer. Peaches, plums, and pears do well on this type, and it is also well suited to the production of small fruits. Wheat is not grown, and oats to a very limited extent, yielding about 25 bushels per acre in a season of average rainfall, though larger yields are secured in a wet season. Cotton gives an average yield of one-quarter bale per acre, and one-half bale per acre is sometimes produced, but this is considered a large yield. Corn averages about 20 bushels per

acre during an ordinary season, but, as with oats, a much larger yield is secured in a wet year. In dry seasons the crop is usually a failure. Vegetables do fairly well and are grown to a limited extent for the local markets.

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

Mechanical analyses of Susquehanna 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.*	*Per cent.*
12860, 12862	Soil	0.6	4.7	8.1	29.9	22.2	25.0	9.3
12861, 12863	Subsoil	.6	3.5	5.3	18.0	11.9	22.6	38.0

MILLER FINE SANDY LOAM.

The Miller fine sandy loam possesses a mellow, friable, easily tilled surface soil with a depth varying from 12 to 24 inches. It is made up largely of fine to very fine sand and silt of a brown or grayish-brown color, the lighter color being more noticeable when the soil is in a dry condition. The soil grades within a few inches, at the point of contact with the subsoil, into a red, sticky, sandy clay, which usually becomes slightly heavier with increase in depth. The subsoil is composed of nearly equal parts of clay, silt, fine sand, and very fine sand.

Along the edge of some of the terraces erosion has removed the sandy soil covering, leaving exposed the red clayey subsoil. One phase of this type consists of sandy soil, 3 feet or more in depth, the clayey subsoil being either lacking or buried so deep as to have no influence on the surface conditions. This phase occurs near the river and reaches the greatest development in the vicinity of Tehuacan Creek. Other local areas of this phase, situated farther away from the river, can be attributed to wind-blown sand. There are also areas of limited extent where the sand approaches a medium to coarse texture, and still others where the silt content of the soil is greater and the subsoil is heavier and darker in color. These phases are so limited in extent and so intimately associated with the typical soil that it was found impracticable to map and classify them as separate types of soil.

The Miller fine sandy loam is found only along the Brazos River and is the principal bottom type of the area. It occurs on both sides of the river and extends entirely across the area. The main bodies of it are found in the bends of the river, the largest on the east side of the river opposite the city of Waco and on the west side below Patrick.

The surface of the Miller fine sandy loam is terraced and each terrace is nearly level. The terrace nearest the river is but little above the river bed and is quite frequently overflowed. Back from the river

on the big bends there is a succession of terraces, varying in width, each rising to a height of several feet above the last. These higher terraces are never or rarely inundated.

The texture of the surface soil of the Miller fine sandy loam is such that it can be worked much sooner after a rain than any soil of the area except the Miller fine sand. Water falling on the surface is quickly absorbed and removed to the lower depths away from the excessive evaporation at the surface, although the subsoil is heavy enough to prevent its going beyond the reach of capillary attraction. The whole soil is of such a texture and structure that a large percentage of the rainfall is conserved. The surface streams are all small and play no great part in the drainage of the type; yet it is well drained except in a few local low spots which could be easily drained either by open or tile drains extending to the lower terraces.

The Miller fine sandy loam is a deposit laid down by the Brazos River in times of flood and belongs to the present geological time. Along the lower terraces, which are overflowed, it is still in the process of formation. The higher terraces were probably formed when the bed of the river was higher than at present. The red color is due to the fact that the materials deposited are derived from the Permian red beds farther inland.

The Miller fine sandy loam seems to be well adapted to the growing of garden truck, such as radishes, lettuce, cabbage, onions, tomatoes, beets, Irish potatoes, etc. It warms up early in the spring and is easily worked while the clay soils are yet too wet to be handled. These crops grow rapidly, are easily cultivated, and of an excellent quality. Peaches, pears, plums, blackberries, etc., also do especially well on these bottoms. With the shipping facilities afforded, in addition to the good local markets, the acreage of these crops could safely be increased in the vicinity of Waco. Farther up the river the distance from shipping points would be a serious drawback. The advent of the boll weevil has made these bottoms less valuable for cotton, and a further development of the fruit and truck industries, for which this soil is so well adapted, would be in line with the idea of diversification expressed in another part of this report.

Cotton is the chief crop grown at present on the Miller fine sandy loam and yields from one-third to two-thirds bale per acre. The yield has been very materially affected by the boll weevil—more so than on any other soil of the vicinity. Prior to the advent of this troublesome pest the farmer was sure of making from three-fourths bale to 1 bale per acre, but now he may make a good crop or it may be a total failure. Considering the success of the fruit and truck industries already mentioned it would seem to be wise to increase the acreage devoted to these crops and to plant less cotton. Corn does not seem to do as well on this soil as on some others, yet in favorable seasons it

yields from 50 to 60 bushels per acre. The average, however, is very much lower, being about 20 bushels on the poorest tracts and 35 bushels on the best. The corn crop is almost a total failure about one year out of eight, owing to the blasting effects of hot dry winds that sometimes occur just before it matures.

Alfalfa has been successfully grown in the last few years, and the acreage is being gradually increased. It is somewhat difficult to secure a good stand, but when once established three cuttings are obtained each season, each yielding about 1½ tons per acre. The best stand is secured when the seeding is done in October or November.

There are about 500 to 600 acres of peaches and other small fruits in bearing in the vicinity of Waco, the largest part of the orchards being located on the Miller fine sandy loam. These fruits are not often affected by frosts and good crops are usually secured each alternate year. The Mamie Ross peach is earliest, being ready for market about the middle of June, followed about three weeks later by the Elberta. Peach trees are set 18 feet by 20 feet apart and yield from 1½ bushels to 2 bushels per tree. The trees are said to remain in bearing for 10 or 12 years before becoming exhausted. Insect pests are noticeably absent, except the codling moth, which attacks the pear to some extent.

So far the truck crops produced have been grown for the local market and do exceedingly well. Irrigation is used to some extent for the fruits, alfalfa, and truck, the water for this purpose being secured from artesian wells.

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

Mechanical analyses of Miller 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.*	*Per cent.*
12380, 12907.....	Soil	0.2	3.8	7.0	37.1	18.5	24.8	8.4
12381, 12908.....	Subsoil.....	.3	2.4	5.5	27.2	17.4	21.6	25.2

TRAVIS GRAVELLY LOAM.

The surface soil of the Travis gravelly loam, to a depth of about 10 inches, consists of a medium to fine sand or sandy loam, gray or grayish-brown in color, carrying a high percentage of small rounded gravel of various sizes. The subsoil, extending from 10 to 36 inches, is a mass of coarse sand and small rounded gravel, like that in the soil, imbedded in a matrix of heavy, stiff red clay. Sometimes the gravel occurs in such quantity as to form a veritable gravel bed and again the percentage is quite small.

The largest body of this soil lies east of Elm Creek, extending from the northern border of the area to the vicinity of the mouth of Whiterock Creek. Another area of considerable size is found east of

Whiterock Creek at Ross. Between Aquilla and Elm creeks there is also an irregular-shaped area, and a small body occurs on the boundary north of a big bend in Aquilla Creek.

The topography is undulating to quite rolling, but not rough enough to hinder cultivation, except perhaps on a few of the steeper hillsides. This rolling surface gives the greater part of the type excellent natural drainage. There are a few depressed areas in the vicinity of Ross, which are not nearly as well drained. In these surface water collects and has no way to escape except by seepage. The texture of the clay subsoil is such that this process is necessarily slow, and as a result these areas are covered with stagnant water, except in dry times, and are consequently unfit for cultivation. The soil of these wet depressions is more loamy and the gravel content is comparatively small. They could be drained by cutting open ditches through the slight elevations surrounding them and would then make a strong soil for farm purposes.

The gravel present indicates a condition of flood and swift current at the time of the deposition of the material forming this soil. It is derived from an ancient alluvial deposit which covers a considerable proportion of the uplands in this part of the area.

The Travis gravelly loam is adapted to the production of peaches, plums, pears, berries, etc. Vegetables can also be grown to advantage. The fruit trees flourish and yield well. The stiff, impervious character of the subsoil prevents leaching, and the light sandy surface soil warms up early in the spring. Very little of this soil has been cleared and brought under cultivation, the greater part of it being still covered by the original forest growth, mainly post oak.

The Travis gravelly loam produces much better crops than one would naturally expect from its appearance. Cotton has yielded as high as one-half bale or more per acre and will average one-third of a bale from year to year. Corn does fairly well, yielding from 20 to 25 bushels per acre. Oats yield from 35 to 40 bushels and wheat about 10 to 15 bushels. All of these crops do much better in a wet season, and the yields often equal those of the "black land" in a dry season. "Gall spots" occur to a very limited extent, in which cotton, potatoes, and fruit trees die out. These are more noticeable during wet seasons.

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

Mechanical analyses of Travis gravelly 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.*	*Per cent.*
12899, 12903.....	Soil	11.4	18.1	13.0	21.6	15.8	14.4	5.6
12900, 12904.....	Subsoil.....	9.0	14.8	14.8	16.2	6.5	7.9	30.7

HOUSTON CLAY.

The Houston clay is a dark-brown to black clay, with an average depth of about 10 inches. The color varies somewhat with the topographic position. The darker colored areas occupy the shallow depressions and more level areas, while the color of the soil occurring on the slopes is usually of a lighter shade. The surface is friable and easily cultivated, but it becomes baked and sun cracked in areas not under cultivation.

At about 10 inches the soil grades into a stiff clay subsoil, of somewhat lighter color, and containing small fragments of decomposed limestone. At a depth of from 25 to 36 inches the stiff clay becomes considerably lighter in color and passes gradually into a soft white mass of rotten limestone or chalk, which always underlies this soil at no great depth. The upper part of this chalky limestone has decomposed to such an extent that it forms a soft white mass of chalky material easily crumbled between the fingers, and the transition of the overlying clay into this material is so gradual that there is no distinct line of contact.

On many of the steeper slopes extensive erosion has taken place and small fragments of limestone frequently occur scattered over the surface and mixed with the soil. The soil on these areas is shallow and small patches occur where the soft, chalky material of the lower subsoil has been turned up with the plow, causing the surface to have a white or grayish color. In the shallow depressions the soil is deep and black, owing to the washing in of material from the neighboring slopes. Here the underlying limestone is frequently many feet below the surface, and the subsoil is stiffer and of a darker color. Where these areas are of sufficient extent they have been classed with the Houston black clay.

The main body of the Houston clay occurs in a strip extending from the Brazos River, north of Waco, in a southwest direction to the southern boundary of the area. Other patches occur on the east side of the Brazos in the northeastern part of the area, but they are of no great extent.

The topography of the greater part of this type is rolling, but the hills are rounded and the intervening depressions are broad and shallow. Along the smaller streams, however, the topography becomes more broken and the hillsides are steep and eroded. The shallow valleys of the rolling section gradually get narrower as the western boundary of the escarpment occupied by this soil is approached, and the small streams in this section have cut out deep gorges, which extend from the rolling uplands to the valley of the Bosque River.

The Houston clay is well drained, as the rolling character of the topography causes water to find its way rapidly to the small streams.

The steeper slopes and higher elevations are often excessively drained. The water seeping through the heavy subsoil is absorbed by the soft, rotten limestone and crops are often seriously damaged by drought.

The Austin chalk, previously mentioned as forming the escarpment which extends across the area, weathers rapidly to a considerable depth and forms by its disintegration the material which composes this soil. The rock first breaks up into thin, shaly fragments which decompose into the soft, white mass of chalky material which is found in the lower depths of the subsoil. On the eastern side of the Brazos River that portion of the Austin chalk escarpment which lies within the area surveyed is covered to varying depths by the old alluvial deposits, and the Houston clay only occurs in small areas where the overlying deposit has been removed by erosion.

Cotton usually matures considerably earlier on the Houston clay than on the Houston black clay, and the crop is seldom as seriously damaged by the boll weevil as on the other heavy clay soils. The average yield ranges from one-fourth to one-third bale per acre. The better yields of corn are obtained in wet seasons, but the average under ordinary conditions lies between 20 and 25 bushels per acre. With oats a yield of 35 to 40 bushels per acre is continuously obtained. Wheat averages about 10 bushels per acre, but is not extensively grown. Millet and sorghum cane are grown to some extent and profitable yields are always secured. The Houston clay in a wet season often produces yields of these crops which compare very favorably with those obtained from the Houston black clay, but drought affects it to a much greater extent.

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

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12854, 12856.....	Soil	0.3	1.4	1.3	4.3	7.0	39.3	46.4
12855, 12857.....	Subsoil.....	.5	1.6	1.2	4.2	6.2	33.6	52.5

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12854, 25.3 per cent; No. 12855, 47.5 per cent; No. 12856, 33.1 per cent; No. 12857, 49.55 per cent.

HOUSTON GRAVELLY CLAY.

The Houston gravelly clay is a heavy dark-drab or black clay loam containing a large quantity of small rounded gravel, varying in size from coarse sand to pebbles 2 or 3 inches in diameter. The coarse sand present with the gravel seldom makes any material difference in the sticky nature of the soil. At 10 inches below the surface the gravel content is much lower and the subsoil becomes a stiff dark-drab to dark-brown clay, containing a little gravel.

This soil is of very limited extent and occurs in the vicinity of Elm Mott and Ross. There is also a narrow strip on the east side of Tehuacan Creek. It occurs as a rule capping the low swells or elevations in the Houston black clay, and this physiographic position gives it good natural drainage. The origin of the Houston gravelly clay is traced to the remnants of an old gravel formation which once covered this entire region. The material of this deposit has been more or less intermingled with the materials forming the Houston black clay, which it overlies.

Crops on the Houston gravelly clay do not yield as well as those grown on the Houston black clay or "black land." Wheat is seldom sown. Oats are a surer crop than corn, and yield about 30 bushels per acre, always doing best when sown in the fall. Corn will average 20 bushels per acre, but is often a total failure. Cotton will not average more than one-fourth bale per acre. Sorghum cane is grown for feed and does well. The effect of drought is much more marked on this type than it is on the heavier "black land."

The following table gives the results of mechanical analyses of the fine earth of the soil and subsoil of the Houston gravelly clay:

Mechanical analyses of Houston gravelly clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12889	Soil	1.9	5.2	7.7	15.8	16.8	30.8	21.8
12890	Subsoil	1.4	3.9	5.1	10.6	10.8	22.1	45.9

HOUSTON LOAM.

The typical soil of the Houston loam is a gray to light-brown loam, from 10 to 12 inches deep, and containing a large amount of silt. The surface is friable, and when well cultivated the soil has a very desirable tilth. At about 12 inches the soil grades into a drab to slate-colored silty clay, which also contains a considerable amount of fine sand. This subsoil becomes heavier as the depth increases, and at 36 inches it is a stiff, plastic, silty clay, often slightly mottled and still containing a small percentage of fine sand. Small rounded pebbles are sometimes encountered in both the soil and subsoil.

The Houston loam occurs in irregular shaped areas of varying extent in the northeastern part of the area surveyed, and smaller patches are found in other localities where conditions favorable to its formation exist. The topography is gently rolling, and the general appearance of these areas is that of a slightly rolling upland prairie. The drainage of the greater proportion of the type is good, but small poorly drained depressions sometimes occur, where water collects after rains. These areas are usually found in the more level sections of the uplands,

and have a sufficient elevation above the level of the small streams and shallow valleys to permit their being easily drained by means of open ditches.

The Houston loam usually occurs in areas bordering the heavy black clay lands and the lighter alluvial soils, and is composed of the material which forms these two opposite types of soil. The areas bordering the light sandy soils contain the larger quantities of sand, while along the contact with the black clay soil the texture is heavier. A considerable proportion of the sand content of this soil is derived from the fine sand of the Susquehanna fine sandy loam which has been transported by the wind and laid down over the surface of these areas. On some of the small ridges the sand content is greater than that of the typical soil. This is due to the larger amount of material transported by the wind from adjacent areas of fine sandy loam. However, the greater part of the material forming the type consists of a combination of a fine sandy alluvial deposit and the heavier material composing the black prairie soil.

The Houston loam is better adapted to early maturing crops, as the droughts of the late summer months seriously affect the yields. Cotton, up to the present season (1905), has never been seriously damaged by the boll weevil and produces an average yield of one-third to one-half bale per acre. Corn yields about 25 bushels per acre in an ordinary season, oats about 35 bushels per acre, and wheat, rarely grown, from 10 to 12 bushels per acre. Sorghum cane is grown as a forage crop with good results, and alfalfa has also been grown to a limited extent, but great difficulty is usually experienced in getting a stand. In general the crops cultivated on this type are subject to serious damage from droughts, but during a favorable season very fair yields are always obtained.

The following table gives the average results of mechanical analyses of the fine earth of this soil:

Mechanical analyses of Houston 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.*	*Per cent.*
12877, 12879.....	Soil	Tr.	1.4	3.0	14.8	17.1	40.0	23.4
12878, 12880.....	Subsoil.....	0.2	1.4	2.0	10.5	11.8	37.4	36.6

The following sample contains more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12878, 2.01 per cent.

CRAWFORD CLAY.

The Crawford clay is one of the most important types found in the Waco area. The soil averages 8 or 10 inches in depth and consists of a brown, slightly reddish clay, which is stiff and tenacious when wet but friable and granular when in a dry well-cultivated condition.

The subsoil, extending from 10 to 36 inches, is a stiff, tenacious clay of a lighter reddish-brown color, which becomes stiffer and more compact as the depth increases and often contains small fragments of limestone in the lower part of the 3-foot section. The depth to the parent rock ranges from 3 to 6 or 8 feet, the deeper areas occupying slight depressions.

This soil is very uniform in color and texture throughout the whole area embraced by it, the only variation being in the depth to the underlying limestone, and this is largely influenced by topographic position.

The Crawford clay occurs in large unbroken areas occupying almost all the gently rolling and more level sections of the prairie in the western half of the area surveyed. The whole prairie section occupied by the type is a gently rolling upland plateau, which reaches its greatest altitude in the northwest part of the area and has a general slope toward the east. In the western part of the area this plateau has a considerable elevation above the level of the small streams and rivers which traverse it, and the streams flow through deep narrow gorges with almost perpendicular limestone walls. In the eastern part of this prairie section the general elevation is not so great and the stream valleys are not so steep or so narrow. A few of the rounded hills in the northwestern part of the area reach an altitude of more than 700 feet, and the prairies often slope rather abruptly toward the small streams, but where the slopes are steep enough to cause the soil to suffer to any extent from the effect of erosion they are occupied by the Crawford stony clay.

The position of this type on the rolling upland plateau, at a considerable elevation above the level of the small streams, causes it to be excellently drained, yet the stiff character of the subsoil enables it to conserve enough moisture during a season of average rainfall for the successful production of all the crops grown.

The soil owes its origin to the decomposition of the Fort Worth limestone, composed of a series of hard white limestone strata separated by thin layers of marly clay. The harder strata weather more slowly than the marly material, and this, together with the effects of erosion, causes the depth of the soil to vary considerably at short intervals along some of the slightly terraced hillsides.

A large proportion of the grain produced in the area is grown on this soil, and it is considered well adapted to both wheat and oats. The season affects these crops to some extent, but in an ordinary year wheat will produce on an average 15 bushels per acre and oats from 30 to 40 bushels per acre. If there is an unusually large rainfall the wheat crop is often seriously damaged by rust, and, on the other hand, if the season is very dry this causes a decrease in the yield, but as a rule very profitable yields of both wheat and oats are secured. In like manner the yield of corn varies with the rainfall during the grow-

ing season. The crop is seldom a failure and will average from 15 to 20 bushels per acre in a dry year, rising from this to a yield of from 30 to 40 bushels during wet seasons. The boll weevil, up to the present time, has not damaged the cotton crop of this section of the area to any great extent, although a small part of the crop is destroyed annually. Cotton produces on an average a yield of one-third bale per acre, but where well cultivated yields of three-fourths to one bale per acre have often been obtained in favorable seasons. Millet and sorghum cane are grown for feed purposes. Sorghum produces about 2 tons per acre, and two cuttings are frequently secured. The yield from the second cutting is not so large, but the cane produced is of a lighter growth and makes a better feed for stock. Rye is grown to a limited extent and gives an average yield of 20 bushels per acre. A small part of the crop grown is not thrashed, but is used for feed purposes. Peaches and plums are successfully grown, but the trees seldom produce after they are 5 years old.

The following table gives the average results of mechanical analyses of the Crawford clay:

Mechanical analyses of Crawford clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12870, 12872.....	Soil	0.2	1.1	1.1	6.6	9.2	49.6	32.0
12871, 12873.....	Subsoil.....	.1	.8	.9	6.3	9.2	46.3	36.6

The following sample contains more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12873, 5.26 per cent.

CRAWFORD STONY CLAY.

The Crawford stony clay is of little importance both in extent and in agricultural value. It consists of a dark reddish-brown clay, usually carrying a large number of limestone fragments of various sizes embedded in the soil and scattered over the surface. The soil is shallow, the underlying limestone occurring at depths varying from 12 to 20 inches. Many areas have a comparatively small quantity of rock fragments on the surface, but the underlying limestone is encountered at a slight depth and outcrops in small areas where erosion has been greatest. This soil occurs along the slopes adjacent to the small streams and larger draws in the rolling prairies of the western part of the area. It also occurs in the rougher and more broken country north and northeast of Valley Mills. The topography in this section of the area is very rolling, and the hills often have a terraced appearance. The hillsides extending to the small streams or draws are often steep and have only a shallow covering of soil overlying the hard white limestone strata.

The area embraced by the soil is well drained, as many small streams and deep draws occur in the valleys between the rolling hills. The

soil is so shallow and stony that very little moisture is conserved, and this causes it to be of small value agriculturally.

The Crawford stony clay owes its origin to the weathering of the Fort Worth limestone, which underlies it at a slight depth, but owing to the general character of its topography the material forming the soil is rapidly eroded and is washed down to the more level areas, only a shallow stony covering of soil being left above the parent rock.

The areas covered by the type are not suited to cultivation, but they support an exce lent growth of the native grasses and are used almost exclusively as pasture lands. The larger cattle ranches are located in this section of the area; and as it is well watered by many small perennial streams and as the shallow soil produces an abundance of grass, it is well adapted to this industry.

Small areas that are comparatively free from stones are sometimes cultivated; and if there is an abundance of rainfall during the growing season, a fair crop is secured. The average yields on these cultivated areas, when the crops are not destroyed by drought, are as follows: Corn, 15 bushels per acre; wheat, about 6 bushels per acre; oats, 20 bushels per acre, and cotton from one-sixth to one fifth bale per acre. Sorghum is often cultivated, and although no very large yields are obtained, a thin growth well suited for feeding purposes is produced.

CRAWFORD LOAM.

The soil of the Crawford loam, to an average depth of 12 inches, is a brown to reddish-brown loam, containing a relatively large percentage of silt and fine sand. The surface usually contains the largest proportion of sand and often has the general appearance of a fine sandy loam. At about 12 inches below the surface the material becomes noticeably heavier and consists of a heavy brown loam. This grades at 20 to 25 inches into a stiff, compact clay, redder in color, still containing a relatively large quantity of fine sand. The soil occurs mainly in one unbroken area situated north of the Bosque River and southeast of China Spring. A few detached areas occur along the North Fork of Bosque River, but these are very small.

The topography is rolling, but is never of so rough a character as to cause serious erosion of the soil or to interfere with cultivation. This type is well drained by many small intermittent streams which extend from the shallow valleys between the low elevations to the North Fork of the Bosque River. Crops are more apt to suffer from drought than from the lack of sufficient drainage. The light, loamy texture of this soil makes it easy to cultivate, and it can be worked very shortly after heavy rains without impairing its naturally good mechanical condition.

There is a phase of this type on the summits of the low ridges. The sand content of the surface is often higher than is usually found in

the main body of the soil type, but these areas are of very small extent and the texture of the whole 3-foot section is only a slight degree lighter than that of the typical soil.

The Crawford loam is residual and is formed from the weathering of the sandy ferruginous clays, impure limestone, and sandstone which compose the underlying geological formation. A few fragments of sandstone are encountered on the surface of some of the higher ridges, but the heavier subsoil and a large proportion of the soil are probably derived mainly from the reddish sandy clays and from the impure limestone.

This soil is well suited to the cultivation of cotton, corn, and fruits and also produces very fair yields of wheat and oats. Several small orchards of peaches and plums are located on the Crawford loam and annually produce very profitable crops, and fruit growing bids fair to become an important industry in this part of the area. Small fruits also do well. Vegetables are successfully grown for home use and on a small scale for the local markets. With the cultural methods in general use, cotton produces one-third bale per acre, but when more care is taken one-half bale per acre has been secured year after year, and in a favorable season, when the crop is not attacked by the boll weevil, 1 bale per acre has often been produced on this soil. Corn usually yields from 20 to 30 bushels per acre and wheat 10 to 15 bushels per acre. Millet is grown for feed purposes and produces about 1½ tons per acre. Sorghum is sown broadcast and cut for feed and does exceedingly well on this type of soil.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Crawford 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.*	*Per cent.*
12866, 12868.....	Soil	0.1	1.3	2.9	22.2	21.6	31.5	20.1
12867, 12869.....	Subsoil.....	.1	.8	2.4	17.0	16.3	38.3	24.5

MILLER HEAVY CLAY.

The soil of the Miller heavy clay, to a depth of 8 or 10 inches, is a brown or reddish-brown clay, stiff and tenacious when wet and baking and cracking on drying. Hard, bricklike clods are formed if it is plowed when in a wet condition. This surface soil grades into a stiff clay subsoil, lighter and of a more pronounced reddish color. In the lower part of the 3-foot section the subsoil often contains a larger percentage of silt, and from 25 to 36 inches it is usually a stiff, plastic silty clay of a reddish-brown color. Both the soil and subsoil are very heavy clays containing very little sand, but if cultivated properly the surface breaks up into a loose loamy soil, free from hard clods and

having a very desirable tilth. The color of this soil is usually redder along the banks of the streams, and as the distance from the streams increases it grades through a darker brown color into the black Yazoo heavy clay which occurs farther up the valleys.

The Miller heavy clay occurs chiefly in the bottom lands of Tehuacan and Aquilla creeks and extends a short distance up the stream valleys. Other smaller areas occupy low river terraces on the western side of the Brazos River southeast of Waco.

The typography, like that of the upper portion of the valleys, is almost level, but slight elevations and shallow depressions occur at intervals and the surface as a whole has a gentle slope toward the stream. Although these lands are sometimes overflowed they seldom remain in a wet condition for any great length of time. Some of the shallow depressions are poorly drained and would be greatly improved by artificial drainage, but the topography and position of the type in general enables the small streams rapidly to carry off the excess water after floods or heavy rains.

The Miller heavy clay is an alluvial soil and owes its origin to material deposited by the Brazos River, combined with the fine material brought down from the upland prairies by the smaller streams. At times of overflow the flood waters of the Brazos River back up the channels of the smaller streams and spread out over the low, flat valleys. The fine red-colored silt and clay held in suspension by the river water is deposited over these bottoms, and becoming mixed with the darker colored material brought down from the black prairie region by the smaller streams forms a stiff reddish-brown clay.

This soil is well adapted to cotton, corn, and oats, and very profitable yields are usually secured. The yield of cotton, like that obtained from the other lowland types, has been greatly reduced by the ravages of the boll weevil. The average yield is now about one-half bale per acre, although three-fourths bale per acre is often produced. Corn yields from 30 to 35 bushels per acre on the average, and in a favorable season a yield of more than 40 bushels is not uncommon. Forty bushels per acre is about the average yield of oats. No wheat is at present grown on this type. Sorghum cane is grown as a forage crop to a limited extent and does exceedingly well.

The following table gives the average results of mechanical analyses of typical samples of the Miller heavy clay:

Mechanical analyses of Miller heavy clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12895, 12897.....	Soil	0.1	0.8	0.6	1.8	1.2	35.8	59.6
12896, 12898.....	Subsoil.....	.0	.1	.3	1.3	1.6	41.0	55.7

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12895, 13.02 per cent; No. 12896, 21.80 per cent; No. 12897, 8.59 per cent.

MILLER SILT LOAM.

The Miller silt loam consists of a fine-grained silt loam, with a depth of about 15 inches, containing a relatively large percentage of fine and very fine sand. Its color, like that of the other bottom soils associated with it, is brown. The texture becomes slightly heavier as the depth increases, and the material grades into a subsoil somewhat darker in color and heavier, which, however, still carries an appreciable amount of fine and very fine sand. Both soil and subsoil are usually tinged with red. The soil becomes hard and compact, and cracks slightly when dry, but breaks up into a mellow, easily tilled seed bed upon cultivation.

The extent of this type is inconsiderable, there being only a few small, irregular-shaped areas west of the river below Waco. It occupies river terraces and is high enough above the stream level to insure good drainage. The surface is nearly level to slightly undulating.

The origin of the Miller silt loam is similar to that of the Miller heavy clay and Miller fine sandy loam, namely, the deposition of sediments on the flood plain of the Brazos River, the red color being due to the origin of the material brought down.

A considerable part of the Miller silt loam is now used for Johnson grass for pasturage. Cotton, when well cultivated, yields from one-third to one-half bale per acre. Corn, which does well, yields, on the average, from 25 to 30 bushels per acre, oats from 30 to 40 bushels, and wheat from 12 to 15 bushels per acre. Some alfalfa is grown and does well. Crops on this soil stand drought better than those on the more sandy soils, and it is considered a strong soil for general farming.

The following table gives the average results of mechanical analyses of samples of the Miller silt loam:

Mechanical analyses of Miller 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.*	*Per cent.*
12891, 12893.....	Soil	0.0	0.3	0.2	5.4	22.6	53.7	17.4
12892, 12894.....	Subsoil.....	.0	.1	.3	7.2	24.5	50.5	17.1

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 12891, 4.38 per cent; No. 12893, 4.85 per cent.

ROCK OUTCROP.

A few small areas occur along the steeper slopes where the soil has been entirely eroded away and the underlying rock is exposed on the surface. Where these areas are of sufficient extent they have been indicated on the map by means of the rock symbol.

AGRICULTURAL METHODS.

The agricultural practices of the Waco area are extensive rather than intensive. For cotton, on the sandy soils, the surface is usually listed, the plow running about 4 inches deep. Where the field has been in cotton the preceding year, the old row or bed is broken out by the lister. After the listing, the ridges or beds are smoothed, then opened, and the seed planted on the ridge by a single-row horse planter. This brings the rows midway between those of the previous year. The same method is used where cotton follows corn or corn follows cotton. When the cotton plants are well started the cotton is chopped out twice and then cultivated and plowed to keep down the weeds. The methods of handling the heavy soils are very much the same as for the sandy lands, except that the clays are more commonly prepared by using a turning plow, and the rotation of crops is more frequently practiced. These lands are usually plowed to a depth of about 4 inches in the late fall or winter and afterwards listed in preparation for planting. Where wheat or oats follow cotton the seed is drilled in without breaking of any kind, but for any crop the stubble land is usually broken. Some of the farmers in the vicinity of Crawford plant their cotton in the hollow instead of on the ridge, and as the plants grow the soil is thrown around them by cultivation until the surface is level or slightly ridged at the row. A remarkable characteristic of these heavy soils is the excellent tilth secured if they are worked when in proper condition, but if broken when too wet or too dry they break up into large, hard clods, and subsequent cultivation is difficult.

A deeper plowing should be practiced on all the soils and then followed by more thorough preparation for the seed and shallow cultivation to conserve the soil moisture during the growth of the crops. It is conceded by many of the planters that the chief reason for poor yields is, as a rule, poor preparation, cultivation, and management.

On the sandy soils practically no rotation is followed. Cotton is grown year after year, with an occasional crop of corn, but on the heavy soils a good many farmers are planting wheat after cotton and following wheat with corn. This rotation is most common in the western part of the area. It is said that on the sandy soils there are 40 acres of cotton to 10 acres of corn and scarcely any wheat, so that the systematic rotation of crops would not be practicable unless a change in relative acreages be made or some new crop or crops be introduced.

Cotton is generally planted in April and picking commences the last of August. The most of the crop, however, is not ready for picking until September or October. Corn is planted usually during

the last of February and first of March and harvested the latter part of August. Oats and wheat are sown about October, but the former may be sown as late as January. The oats ripen in May and the wheat in June. The grain crops are more generally grown on the heavy limestone clays in the western part of the area.

Commercial fertilizers have not been used extensively, and on the clay soils are practically unknown. During the season of 1904 about 200 pounds per acre of acid phosphate and potash were applied to several plats on the sandy bottoms with excellent results. This season—1905—enough complete fertilizer has been sold for 1,000 acres at 200 pounds per acre, and the results attained from its use are awaited with interest.

Almost every farmer is supplied with the most improved machinery of the day. This consists of wheel plows, listers, planters, cultivators, etc. By means of these the farmer is enabled to plant and care for a large acreage with comparatively little help.

AGRICULTURAL CONDITIONS.

Until comparatively recent times the whole region about Waco was one vast open range and used almost exclusively for grazing purposes, but with the increase in population and the improvement of transportation facilities the cattle ranches gave way to the cotton fields, until now nearly all of the area surveyed is under cultivation and only a few large ranches still exist. These are in the northwestern part of the area, where the soils are too shallow and stony to permit of profitable cultivation.

The farmers of the area are at the present time in a fairly prosperous condition. During the past few years good crops have been obtained and the number of mortgages has greatly decreased. It now rarely happens that the farmer is unable to meet his debts.

The high price obtained for the cotton crop of 1903 has aided materially in enabling the farmers to stand the lower prices of the present season (1904–5), and a majority have been able to hold a large proportion of the crop until it could be marketed at a greater profit.

The farm buildings in the rolling prairie sections are usually neater and more modern than those found on the light, sandy uplands, and the farmer on the heavier soil is, as a rule, in a more prosperous condition. There are few large barns and extensive outbuildings, but the climate is so mild that the stock does not need to be housed during the winter, and as the main crop is cotton, which is usually marketed as soon as it is removed from the gin, there is no necessity for large or expensive buildings of this class. Cattle sometimes need shelter during January and February, but as a rule they can remain out during the entire winter. On the other hand, additional buildings for housing machinery are badly needed.

About 35 per cent of the farms in the area are operated by the owners, a large proportion of the remainder being farmed on shares. Cotton lands are always rented for a share of the crop produced. A profitable yield of this crop is so uncertain and the market price so variable that there is too much risk involved in renting these lands on a cash basis. However, a cash rental is sometimes paid for lands cultivated to grain or used for grazing purposes. When land is farmed on shares the tenant furnishes the seed, farming machinery, work animals, and labor, and receives two-thirds of all the crops produced, with the exception of cotton, of which three-fourths is usually retained. When cash is paid cultivated lands rent for about $5 an acre, but grazing lands are rented at a much lower figure.

The census of 1900 gives the average size of the farms in McLennan County as 109 acres. A few of the ranches in the northwestern part of the area cover more than 640 acres, but in the vicinity of the towns and in the timbered section east of the Brazos River many contain less than 50 acres.

The labor employed in the area consists of whites, negroes, and Mexicans. The proportion of whites and negroes is nearly equal, and there are comparatively few Mexican farm laborers. As a class, the labor employed is of a very efficient character, and is usually plentiful except during the cotton-picking season. If hired by the day, the wages paid average about $1 and board, but for cotton chopping the price is slightly higher—from $1.25 to $1.50 a day. A large proportion of the farm labor is employed by the month or for longer periods, and is usually paid from $20 to $25 a month with board. During the cotton-picking season labor is always scarce, and large numbers of laborers, both white and colored, leave the towns and city for work in the cotton fields. The price paid for this work varies from 60 to 80 cents per 100 pounds, but after a large part of the crop has been picked a higher rate is paid for gathering that remaining on the stalks.

The chief crop raised in the area surveyed, as well as in all parts of the black prairie belt, is cotton. The importance and extent of the production of cotton is emphasized by the fact that in the area under consideration there is a gin for every 20 square miles of territory or less, and that McLennan County produced 85,000 bales in 1904. The idea of diversification of crops has been gaining ground in the last few years. This tendency is of vast importance to the future of agriculture in this community.

The soils, as shown by the soil map, vary from light sandy loams to extremely heavy clays, making the area adapted to a great diversity of crops. Probably the main reason for the adherence to the one-crop idea has been that a large proportion of the farmers were dependent upon the merchant for their supplies, who always bases the amount of his loan on the acreage and probable yield of cotton. In other words,

cotton is cash, and the merchant is practically safe, for every bale is marked and recorded at the gin, and can not be marketed illegally without ultimate detection. However, the financial condition of the farming class has greatly improved, until now a comparatively small proportion of the cotton crop is mortgaged.

Cotton is at present cultivated to some extent on almost every farm in the area and on many it is the only crop grown. Wheat is grown in some sections of the area, and oats and corn are cultivated to some extent on almost every type of soil, though as a rule there is not enough grain produced in the area to supply the demand on the local markets. Enough corn is produced in an average season to feed the stock, but if there is an exceptionally dry season it is often necessary to import it for that purpose. The growing of fruits (peaches, plums, and pears) is rapidly becoming an industry of considerable magnitude in the area. There are several large orchards in the vicinity of Waco, and the number of orchards is rapidly increasing in other sections of the area. The cattle industry is still of some importance, although it is now confined to the rough and more broken section of the area which is least adapted to farming. There are at present a few ranches that have from 400 to 600 head of cattle on them, but the average farmer seldom keeps more than 6 or 8 head.

The heavy limestone soil, mapped as Crawford clay, is recognized as being better adapted to the production of wheat than any of the other soils in the area, and with the exception of a small acreage of Houston black clay devoted to this crop, it produces almost all of the wheat grown in this locality. The average crop of oats on these heavier soils is also large and the results excellent. The Miller fine sandy loam is well adapted to truck, peaches, plums, pears, small fruits, and alfalfa. The truck farm located on this type a few miles southeast of Waco demonstrates that the growing of early truck on a larger scale could be made a very profitable industry. A large proportion of the alfalfa grown in the area is also found on this soil and from 3 to 5 cuttings are annually secured. The peaches, plums, pears, and small fruits are grown almost exclusively on the lighter soils and the Susquehanna fine sandy loam, Miller fine sandy loam, and Crawford loam are all well adapted to their production. A large proportion of the corn produced is grown on the Yazoo heavy clay, Miller heavy clay, and Yazoo clay. These soils produce excellent yields, and the crop is seldom damaged from either drought or overflow. The boll weevil has not damaged the cotton crop on any soil type to such an extent as to make its cultivation unprofitable. That grown on the upland prairies has never been damaged to any great extent, although a small percentage of the crop has annually been destroyed. On all of the lowland types, however, the boll weevil frequently destroys a considerable proportion of the entire crop. The condition in the low, flat valleys

along stream courses seems better suited to the weevil than the rolling prairie sections, and the fact that the cotton cultivated on these bottoms is liable to serious damage by this pest has, in some localities, caused the value of the land to depreciate.

Small spots, seldom more than a fraction of an acre in extent, occur in the heavier types of soils in all sections of the area, on which cotton, potatoes, and fruit trees wilt and die. These small areas are locally known as "alkali spots," but the damage to the crops is not due to the presence of any harmful salts but to a fungous growth which affects the roots of the plants. The greatest injury to the crops affected occurs always during a wet season. The plants come up apparently in a healthy condition, but wilt, turn yellow, and die before the crop can mature. Oats, corn, and sorghum can be successfully grown on these areas.

Excellent transportation facilities are afforded by the seven railroads which traverse the area. Six of these roads, the Houston and Texas Central, International and Great Northern, Missouri, Kansas and Texas, Texas Central, St. Louis Southwestern, and San Antonio and Aransas Pass, extend into Waco, which is the most important shipping point in the area, and the western part of the county is traversed by a line of the Santa Fe system. These roads connect the area surveyed with the important markets both north and south, and every locality is within easy reach of some shipping point. The Brazos River is spanned at Waco by two large bridges, and durable iron bridges have been constructed over most of the smaller streams on all important county roads. During dry weather the county roads are excellent, but they become almost impassable after heavy rains. A few gravel roads have been constructed, which extend from Waco some distance into the black prairie sections. Where this material has been used the roads are always in excellent condition and traffic over them is never impeded even during the worst seasons. Waco is the principal market for all the products of the area. A considerable amount of fruit is now annually shipped to cities both north and south of the area, but there is usually a ready market at Waco for all the fruit and vegetables grown.

Most of the cotton produced is also sold on this market, but a part of this crop is usually sold first to merchants and cotton buyers in the smaller towns and is later bought by the cotton brokers at Waco, whence it is shipped to various parts of the United States or to foreign countries. Fort Worth is the market for most of the cattle raised in the area, but a few are also shipped to Kansas City.

The area as a whole is one of the most prosperous agricultural districts of the State of Texas. The soils are productive and well adapted to a great diversity of crops, the climate is mild and healthful, the transportation facilities are excellent, and the situation is central and in easy reach of the larger markets both in Texas and at a greater distance.

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.