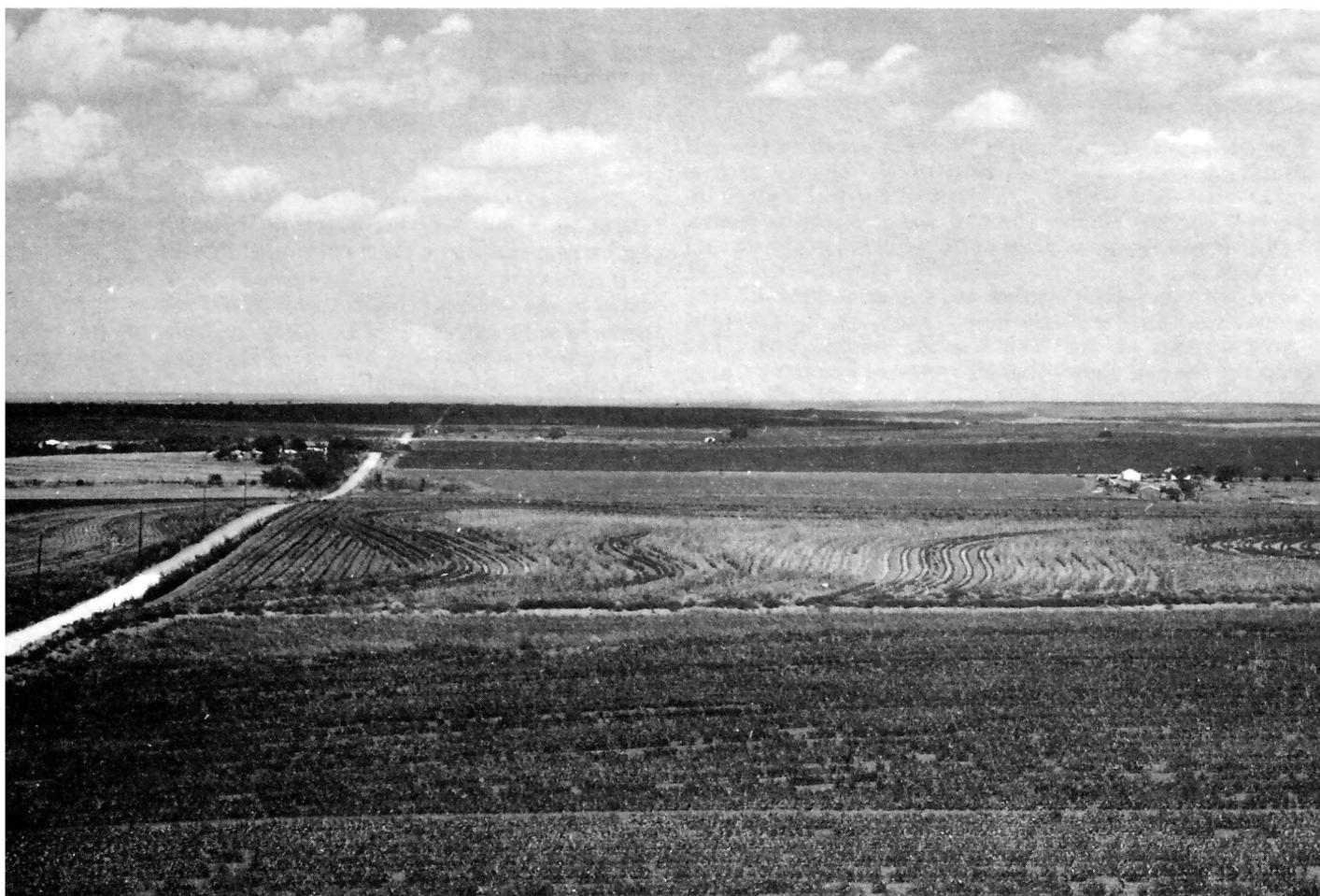


SOIL SURVEY

Fisher County, Texas



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of Fisher County will serve various groups of readers. It will help farmers and ranchers in planning the kind of management that will protect their soils and provide good yields, and it will add to the knowledge of soil scientists.

In making this survey, soil scientists looked at the soils in all parts of the county. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noticed differences in growth of crops, weeds, grasses, and trees; and in fact, recorded all the things about the soils that they believed might affect their suitability for farming, ranching, wildlife, and related uses.

The soil scientists plotted the boundaries of the soils on aerial photographs. Then, cartographers prepared from the photographs the detailed soil map in the back of this report. Fields, roads, streams, and many other landmarks can be seen on the map.

Locating the Soils

Use the index to map sheets to locate areas on the soil map. The index is a small map of the county that is numbered to show where each sheet of the soil map is located. When the correct sheet of the soil map is found, it will be seen that boundaries of the soils are outlined, and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. Suppose, for example, an area located on the map has the symbol C₃B. The legend for the soil shows that this symbol identifies Carey loam, 1 to 3 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

In the "Guide to Mapping Units, Capability Units, and Range Sites" at the back of this report, each soil is listed in the alphabetic order of its map symbol. This guide gives the page where each soil is described, and the page of the capability unit and the range site in which the soil has been placed. It also shows where to find the acreage of each soil, the yields that can be expected, and information about engineering uses of the soils.

Farmers and ranchers can learn about the soils by reading the description of each soil and of the capability unit, range site, and other groupings in which it has been placed. A convenient way of doing this is to turn to the soil map, to list from the map the soil symbols on a farm or ranch, and then to use the "Guide to Mapping Units, Capability Units, and Range Sites" in finding the pages where each soil and its groupings are described.

Game managers, sportsmen, and others concerned with wildlife will find information about the main kinds of wildlife and their food and cover in the subsection "Use of the Soils for Wildlife."

Engineers and builders will find in the subsection "Engineering Uses of the Soils" tables that (1) give engineering descriptions of the soils in the county; (2) name soil features that affect engineering practices and structures; and (3) rate the soils according to their suitability for several kinds of work.

Scientists and others who are interested can read about how the soils were formed and how they were classified in the section "Genesis, Classification, and Morphology of Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Fisher County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information about the county.

* * * * *

Fieldwork for this survey was completed in 1961. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. This survey is part of the technical assistance furnished by the Soil Conservation Service to the Upper Clear Fork Soil Conservation District at Rotan and Sweetwater and the California Creek Soil Conservation District at Stamford. Farmers and ranchers have arranged to receive technical help from the Soil Conservation Service in planning good use and conservation of the soils on their farms and ranches. This survey furnishes some of the facts needed.

Cover picture: Contour farming in Fisher County.

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I

SOIL SURVEY OF FISHER COUNTY, TEXAS

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH
TEXAS AGRICULTURAL EXPERIMENT STATION

FISHER COUNTY, in the northwest-central part of Texas (fig. 1), has a total area of 906 square miles, including about 1,641 acres of riverbeds. The county is approximately 30 miles square. Roby, the county seat, is near the geographic center of the county. Rotan, which is slightly larger, is 10 miles northwest of Roby. The county had a population of 7,865 in 1960.

Physiographically, the county consists chiefly of the drainage area of the Clear Fork of the Brazos River. However, the northern part is drained by the Double Mountain Fork of the Brazos River. Sandhills throughout the northeastern part serve as a divide between these streams. In the northwestern part, deeply entrenched secondary streams have cut back from the Double Mountain Fork of the Brazos River.

Agriculture is the main occupation in the county. About 285,000 acres was cultivated in 1959, and of this, 1,164 acres was irrigated. Cotton, grain sorghum, and wheat are the main cash crops. Cattle are the principal kind of livestock.

Most of the cultivated soils are susceptible to erosion by water and wind. Drought years and periods of drought

are common. Crop yields are generally higher in years of higher rainfall and low in years of drought.

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Fisher County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Carey and Miles, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Miles fine sandy loam and Miles loamy fine sand are two soil types in the Miles series. The difference in texture of their surface layers is apparent from their names.

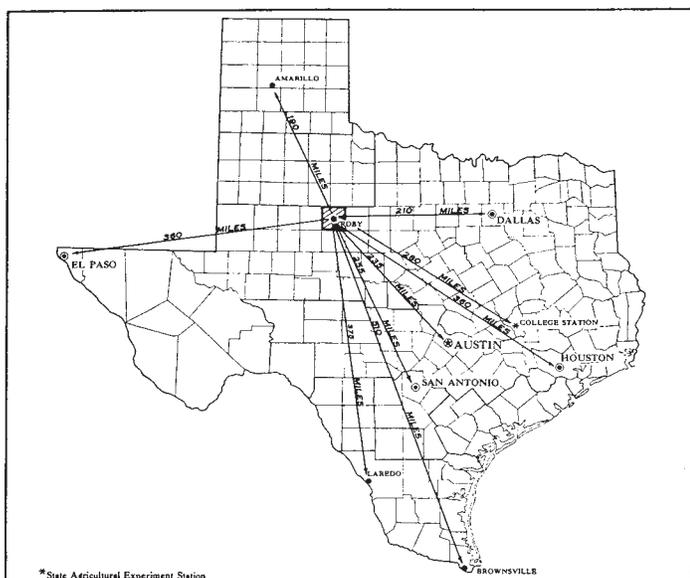


Figure 1.—Location of Fisher County in Texas.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Miles fine sandy loam, 0 to 1 percent slopes, is one of several phases of Miles fine sandy loam, a soil type that ranges from nearly level to strongly sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed soil maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Woodward-Quinlan loams, 1 to 3 percent slopes. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Gravelly land or Badland, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. On basis of the yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored soil map in the back of this report. Each soil association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform.

The soils within any one association are likely to differ greatly among themselves in some properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map shows, not the kind of soil at any particular place, but several distinct patterns of soils.

Each soil association is named for the major soil series in it, but, as already noted, soils of other series may also be present. The major soils of one association may also be present in another association, but in a different pattern.

The general map is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

The nine soil associations in Fisher County are described briefly in this section. More detailed information about the individual soils in each association can be obtained by studying the detailed soil map and by reading the section "Descriptions of the Soils."

1. Carey-Woodward Association

Gently sloping to moderately sloping, deep and moderately deep, loamy soils

This soil association is on uplands cut by many drainageways that are well or moderately well defined. It is mainly in the south-central part of the county, but three areas are in the northern part. The association occupies about 246,500 acres and is the most extensive in the county. It contains more soils and land types than any of the other associations, and the soils lie in an intricate pattern.

The principal soils are those of the Carey and the Woodward series (fig. 2). The Carey soils, which are on nearly level to strongly rolling upland, have a surface layer of reddish-brown loam and a subsoil of reddish-brown, friable sandy clay loam. They occupy about 54 percent of the association, and about two-thirds of their acreage is cultivated.

The surface layer of the Woodward soils is similar to that of the Carey soils, except that it is generally slightly more sandy and is calcareous. Below the surface layer is a layer of loam that is yellowish red in the lower part. The Woodward soils are 24 to 54 inches deep over red-bed material. They occupy about 25 percent of the association, and about half of their acreage is cultivated.

Breaks-Alluvial land complex occupies a small part of the association. It consists of the steep walls of gullies or stream channels and of narrow strips of soils formed in alluvium. Deep, slowly permeable or moderately permeable Wichita and Tipton soils occupy the less sloping areas. They are on benches or flats, above the areas of soils formed in alluvium. Some of the areas along secondary streams are occupied by loamy bottom-land soils that are subject to flooding each time the stream overflows.

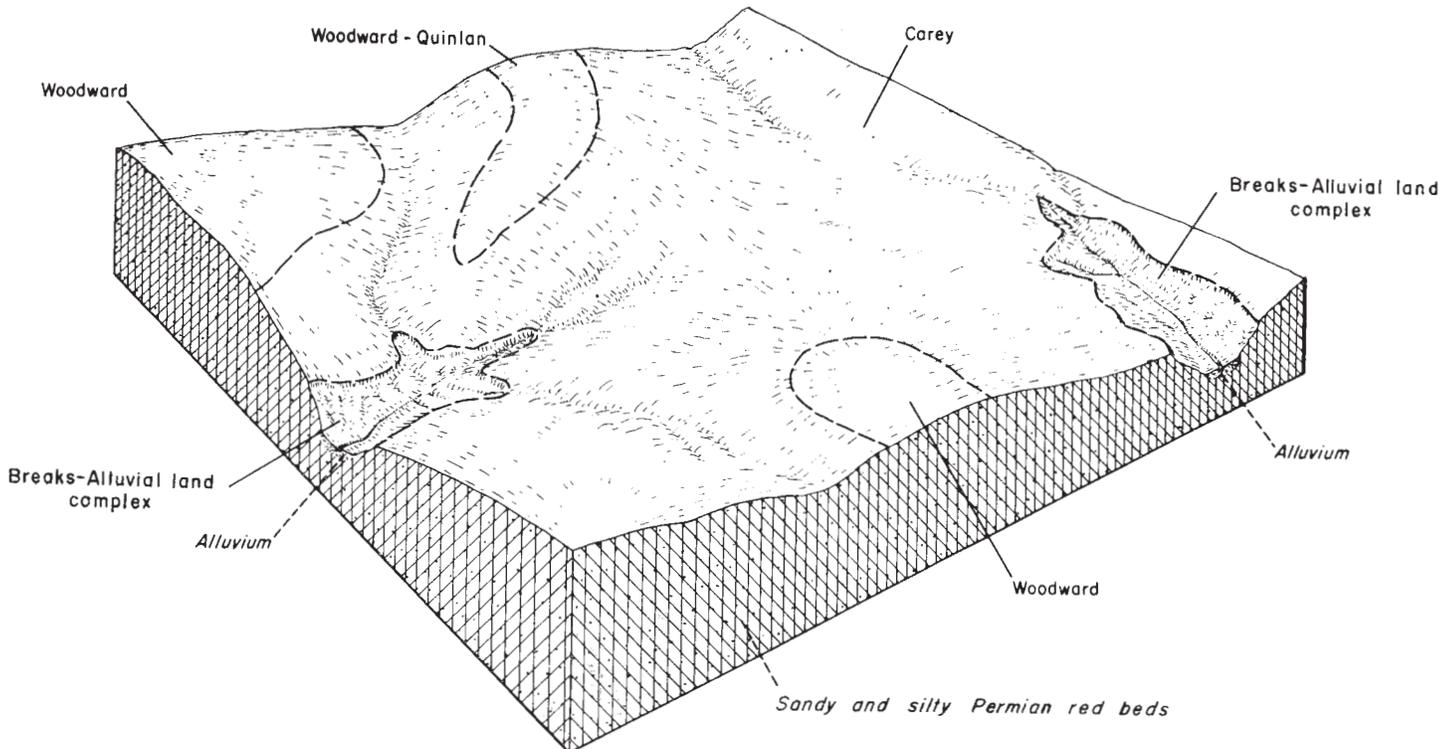


Figure 2.—Cross section of an area in association 1, showing the major soils.

The Spur soils are also along secondary streams, but they are on the higher areas of flood plains and are seldom flooded. They are dark brown, well drained, and calcareous, and they formed in alluvium. The Spur soils are fertile and have a moderately fine textured or medium-textured subsoil.

Areas of the Acme-Cottonwood complex, Cottonwood-Acme complex, Gravelly land, Woodward-Quinlan complexes, and gently sloping and moderately sloping Miles soils make up other small parts of the association. The Acme soils are limy and are underlain by gypsum. The Cottonwood soils consists of a thin layer of grayish-brown, loamy soil material over beds of impure gypsum.

About half of this association is cultivated. Cotton is the main cash crop on the Carey and Woodward soils, but grain sorghum and some wheat are grown. The native vegetation throughout the rest of the association consists of a moderate infestation of mesquite trees, and buffalo-grass, hairy grama, sand dropseed, silver bluestem, some pricklypear, and annual plants.

2. Tillman-Wichita Association

Gently sloping to very strongly sloping, moderately fine textured soils

Soils with a clayey subsoil, in the uplands, make up this association. In most of the areas, the soils are gently sloping, but strongly sloping or steep clayey soils of escarpments and dissected areas make up part of the acreage. The association is mainly in the eastern part of the county. It occupies about 102,000 acres.

A large part of the association consists of Tillman soils,

Wichita soils (fig. 3), and soils of the Tillman-Vernon Complex. The Tillman soils have a surface layer of reddish-brown, noncalcareous clay loam and a subsoil of reddish-brown clay. They make up about 31 percent of the association. The Wichita soils have a surface layer of reddish-brown loam or clay loam. Their subsoil is reddish-brown to dark reddish-brown sandy clay. These soils occupy about 40 percent of the association.

Nearly all of the Tillman-Vernon complex and most areas of Badland and of the Vernon-Badland complex are in this association. In the Vernon soil of both complexes, the solum is thinner than that of the Tillman soil; it consists of calcareous clay over unweathered clay of the red beds. The areas of Badland are rough and have been dissected by stream channels. They include nearly vertical escarpments and the very strongly sloping walls of gullies.

Most of the acreage of Weymouth soils in the county is within this association. The surface layer and the subsoil of the Weymouth soils are reddish-brown clay loam, and below is a layer of accumulated lime. Some areas of the Acme-Cottonwood complex are in this association, and those areas have an irregular shape. Both the Acme and Cottonwood soils consist of grayish-brown clay loam over beds of impure gypsum. In some places there are outcrops of gypsum.

Abilene and Treadway soils occupy a small part of the association. The Abilene soils have a surface layer of dark grayish-brown to brown clay loam and a subsoil of dark-brown, blocky clay underlain by caliche. The Treadway soils have a surface layer of reddish-brown to red clay. They formed in alluvium and are mainly

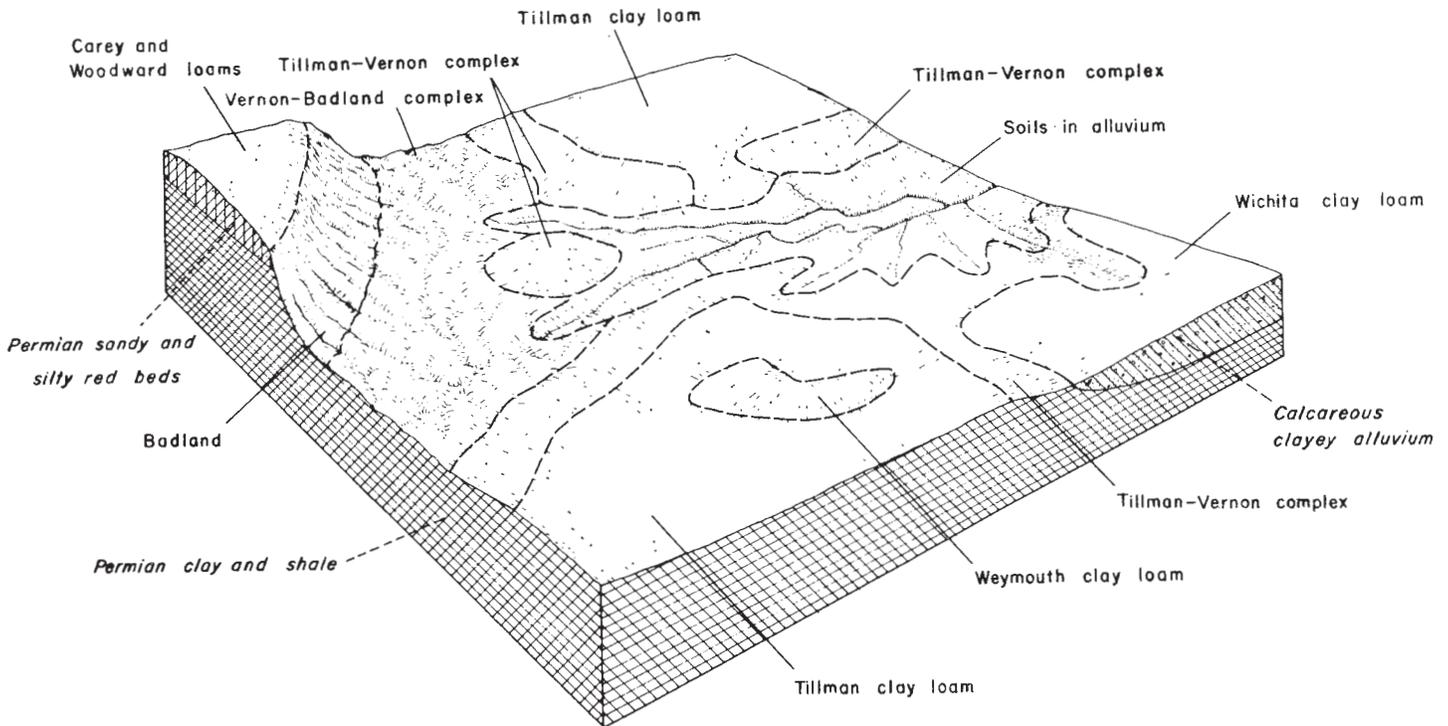


Figure 3.—Cross section of an area of the Tillman-Wichita association, showing the major soils.

on flood plains along small drainageways that originate in areas of Badland. Some of the areas are on foot slopes below areas of Badland.

Other loamy soils on bottom lands occupy a small acreage. They are in narrow bands along the intermittent streams and are flooded after rains.

About 40 percent of the acreage of Tillman soils and about 60 percent of the acreage of Wichita soils is cultivated. Wheat, the chief crop grown on the Tillman soils, is used for winter grazing on most farms. Cotton, wheat, and grain sorghum are grown on the Wichita soils. In most areas of this association that are not cultivated, the soils have a cover of short and mid grasses. The soils of the bottom land support mid and tall grasses.

3. Woodward-Quinlan Association

Moderately sloping to steep, loamy soils

Moderately sloping to steep soils and some gullied areas make up this association. The areas are mostly in the northwestern part of the country, mainly along the Double Mountain Fork of the Brazos River, but also along Rough Creek and Red Creek. In the areas where gullies occur, erosion is active. The association occupies about 30,000 acres.

The Woodward soils of this association are generally too steep for cultivation. They have a surface layer and subsoil of calcareous reddish-brown loam. Their solum is thicker than that of the Quinlan soils; the underlying red-bed material is at a depth of 20 to 50 inches. Woodward soils make up about 42 percent of the association.

The Quinlan soils consist of reddish-brown to red, calcareous, friable loam that is only 4 to 15 inches thick over weakly cemented, sandy material of the red beds. They occupy about 35 percent of the association.

Areas of Breaks occupy a smaller acreage. This land type consists chiefly of the steep sidewalls of deeply incised drainageways, of escarpments, and of the nearly vertical walls that border the channel of the larger streams. Narrow benches where talus has accumulated are on the face of some escarpments. These benches support mid and tall grasses, but many of them are not readily accessible to livestock.

Some areas of strongly sloping Enterprise soils are also within the association. These are deep, friable, reddish-brown soils that have a texture of very fine sandy loam throughout the profile. Areas of Gravelly land make up a fairly large acreage, and areas of soils formed in alluvium, of gypsum outcrops, and of Cottonwood soils make up the rest of the association. In the areas of Gravelly land, from 20 to 30 percent of the surface is covered with quartzite pebbles, the content of gravel in the uppermost layer ranges from 20 to 60 percent, and the beds of gravel beneath range from 3 to 10 feet in thickness.

This association provides an excellent wintering area for livestock, and all of it is in range. In the many vertical-walled canyons, the livestock find comfortable shelter from winter winds. The native vegetation is buffalograss, blue grama, side-oats grama, black grama, little bluestem, sand bluestem, and switchgrass. The sand bluestem grows in areas where talus has accumulated, and the switchgrass grows on the soils formed in alluvium.

4. Miles-Wichita Association

Gently sloping, deep, reddish soils

This association occupies low ridges. It is mainly north of the Clear Fork of the Brazos River, on a ridge that runs northwest to southeast. The association encircles the areas of Brownfield-Tivoli association (fig. 4). The soils are reddish, and they have a sandy surface layer. Their subsoil is sandy clay loam or sandy clay. These soils are mainly gently sloping, but some areas on the lower side of the ridge are nearly level. The soils formed in old alluvium of Quaternary age. The association occupies about 53,200 acres.

The Miles soils have a surface layer of reddish-brown to light-brown fine sandy loam to loamy fine sand. Their subsoil is reddish-brown, friable sandy clay loam. Miles soils are moderately permeable. They occupy about 70 percent of the association.

The Wichita soils, in many places, have a surface layer similar to that of the Miles soils, but it is loam or clay loam in some areas. The subsoil of the Wichita soils is firm, red to reddish-brown sandy clay. Wichita soils are slowly permeable. They occupy about 13 percent of the association.

Some areas of Altus and Portales soils are included in the association. The Altus soils have a surface layer of noncalcareous, brown fine sandy loam and a subsoil of dark-brown, slightly alkaline sandy clay loam. They occupy nearly level or slightly concave areas that resemble

valleys, mainly along the northwestern edge of the association. The Portales soils are moderately deep, dark, moderately alkaline soils of the uplands. They have a surface layer of grayish-brown to dark grayish-brown loam and a subsoil of pale-brown, strongly calcareous light clay loam.

Most of this association is cultivated. The soils generally take in water readily and respond well to improved management. Cotton is the principal crop, but grain sorghum and Austrian winter peas are also grown. In most areas there is a slight to moderate risk of water erosion and a moderate risk of wind erosion. The Miles soils are highly susceptible to wind erosion.

The soils of this association have a higher potential for grass production than the other soils of uplands in this county. When they are properly managed, the soils in range absorb most of the rainfall, which is stored in the subsoil for use over a long period. The potential plant community on the range is mainly mid grasses, but the present cover is largely a moderate stand of mesquite trees, short grasses, and some mid grasses.

5. Miles-Travessilla Association

Gently sloping and strongly sloping to steep rock outcrops, and deep to very shallow, moderately coarse textured soils

Shallow and rocky soils on ridges and knobs that have a somewhat irregular, rounded shape and deeper soils that lie between the ridges and knobs, make up this association.

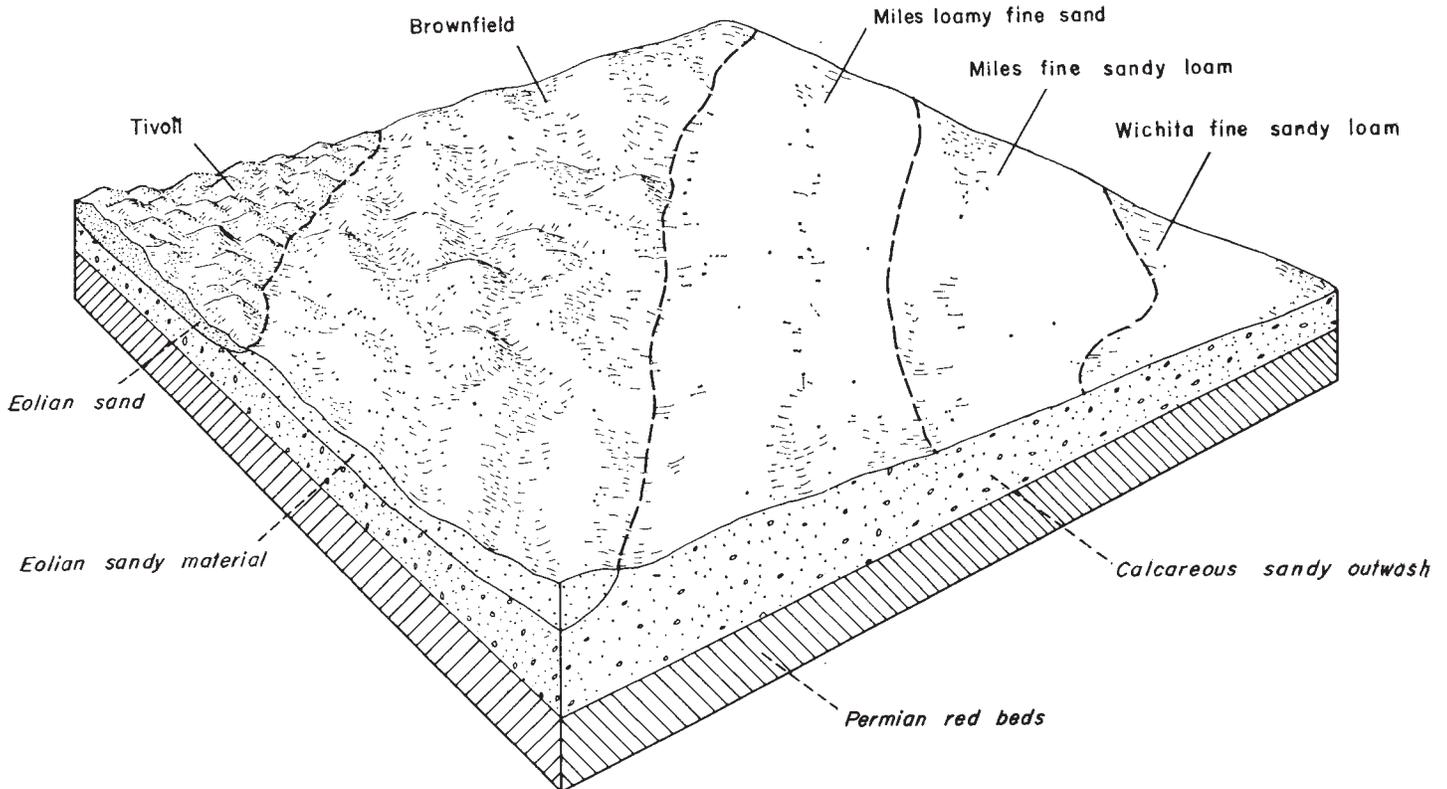


Figure 4.—Cross section of an area of the Miles-Wichita and Brownfield-Tivoli associations.

Several prominent escarpments are below the ridges, and narrow strips of Vernon soils lie at the base of these escarpments. Miles fine sandy loams that are deeper than the Vernon soils and are gently sloping occupy foot slopes between and below these ridges and escarpments. This association is in the southwestern part of the county. It occupies about 37,200 acres.

The principal deep soils are the Miles. The Miles soils have a surface layer of reddish-brown to light brown fine sandy loam and loamy fine sand and a subsoil of reddish-brown, friable sandy clay loam. About 60 percent of the acreage of Miles soils is moderately to highly productive. The rest is less productive, because the sand grains are coarser and the soils contain small quartzite pebbles. Miles soils make up about 45 percent of the association.

The Travessilla soils consist of about 6 inches of gravelly sandy loam that overlies conglomerate rock or sandstone. Travessilla soils and escarpments make up about 25 percent of the association.

Carey, Woodward, Quinlan, and Wichita soils occupy a smaller acreage in the association. A small part of the acreage is occupied mainly by loamy soils formed in alluvium.

About 18 percent of this association is cultivated, but only about 15 percent is well suited to cultivation. The less sloping Miles and Woodward soils that occur in large areas are better suited to cultivation than the other soils.

The present native vegetation is mainly short and mid grasses. The mid grasses are mainly on the Miles soils and in protected spots within areas of escarpments.

6. Abilene-Acme Association

Nearly level, loamy soils

Nearly level, loamy upland soils with a clayey subsoil make up a large part of this association (fig. 5). A complex of soils that overlie beds of impure gypsum also occurs in some parts, but this complex does not occur in the area in the southwestern part of the county. One part of the association is in the northeastern part of the county, another is in the southwestern corner, and a third lies immediately west of Rotan. The association occupies about 36,000 acres.

The Abilene soils have a surface layer of dark-colored clay loam, a subsoil of dark-brown to dark grayish-brown clay, and a substratum of strongly calcareous clay. They occupy about 77 percent of the association.

Nearly level to gently undulating soils of the Acme-Cottonwood and Cottonwood-Acme complexes make up about 11 percent of the association. The Acme soils have a grayish-brown surface layer and subsoil. Their solum is only 12 to 24 inches thick over beds of impure gypsum. The Cottonwood soils in these complexes consist of a thin layer of loam or clay loam over impure beds of gypsum.

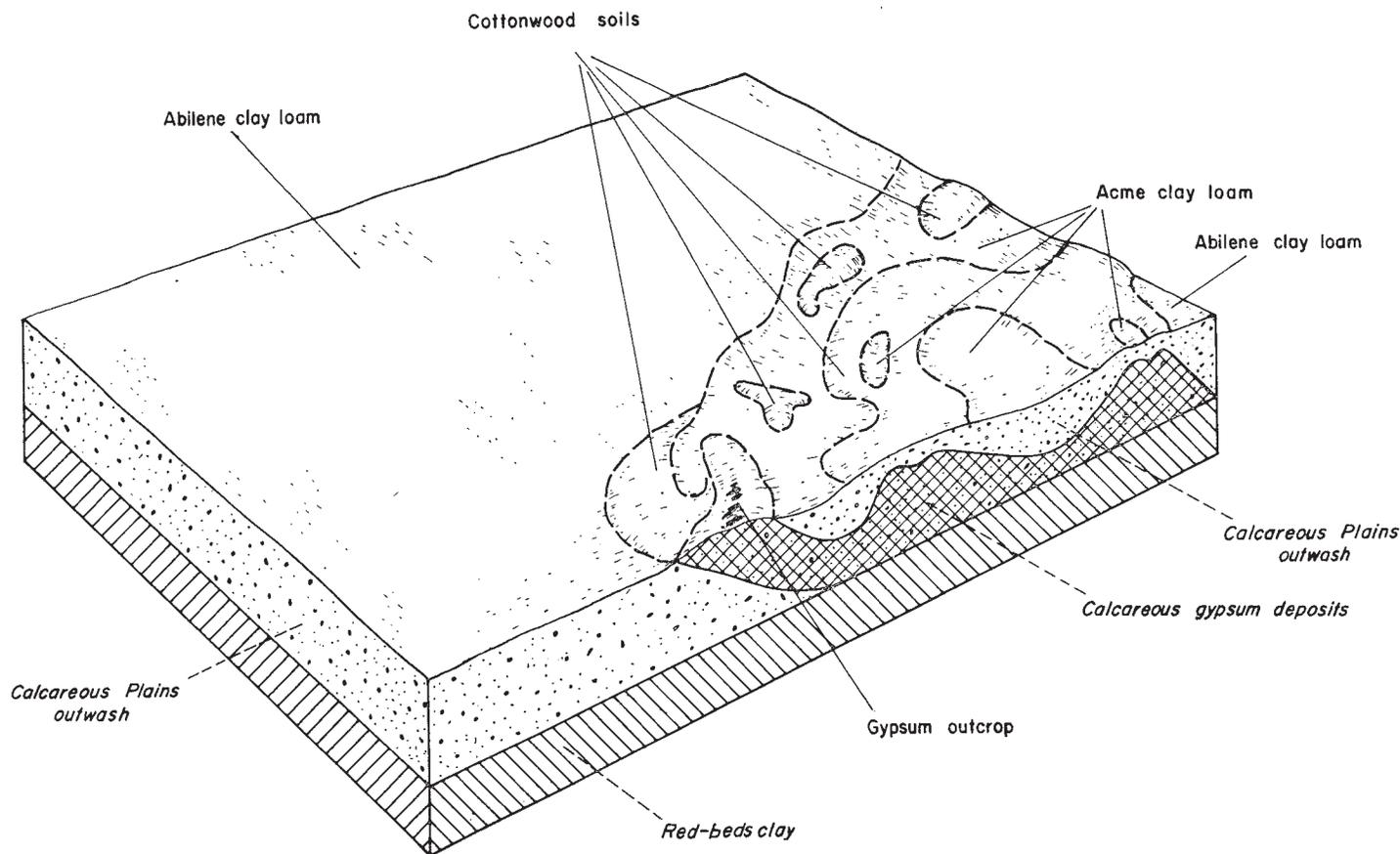


Figure 5.—Cross section of an area of the Abilene-Acme association, showing the major soils.

In the northeastern part of the county, areas of Weymouth soils occupy a small part of this association. The Weymouth soils are on low ridges and are moderately deep over beds of caliche. Another small part of the association is made up of Tipton, Wichita, Mansker, Randall, and Spur soils and of Loamy alluvial land. The Tipton and Wichita soils are nearly level. The surface layer of the Tipton soils is reddish brown to brown, and their subsoil is brown to very dark grayish brown. The Wichita soils have a surface layer of reddish-brown clay loam and a subsoil of dark reddish-brown sandy clay. They and the Tipton soils occur in about equal proportions in this association, but neither the Wichita nor the Tipton soils are in the area in the southwestern part of the county.

Mansker soils, in the southwestern part of the county, occupy a small acreage near the edge of this association. They developed in strongly calcareous sediments. In these soils limy clay loam is only 12 to 22 inches below the surface. Randall soils occupy a small acreage in enclosed depressions or intermittent lakes in the southwestern part of the association. They consist of gray, deep clay and are covered by water during part of each year. Spur soils and Loamy alluvial land are along draws in the northeastern part of this association and are flooded after rains.

Most of this association is cultivated. Yields of cotton, grain sorghum, and wheat are moderate to high, but the higher yields are more common during years when rainfall is higher than average.

7. Mansker-Potter Association

Gently sloping to steep, medium-textured, limy soils

This association occupies the slopes along and below the plateau occupied by Abilene soils in the southwestern part of the county. This area resembles an escarpment and faces east and north. It occupies about 8,000 acres.

The main soils around the slopes in this association are the Mansker, which occupy about half of the association. They are strongly calcareous and have beds of caliche 20 to 25 inches below the surface.

Shallow Potter soils on convex slopes make up about 20 percent of the association. They are gently sloping to moderately steep. A smaller acreage of the association is made up of Miles soils in small areas of irregular shape and by Travessilla gravelly sandy loams that are shallow over conglomerate rock or sandstone. Other soils that occupy a small part of the association are the Vernon and Woodward soils and Loamy alluvial land.

A rather small acreage of Mansker and Miles soils is cultivated. Small grains, chiefly wheat, are grown mainly for supplemental grazing. The native vegetation is mostly short and mid grasses. Water erosion is the greatest hazard on these sloping soils.

8. Spur-Yahola Association

Nearly level, deep, moderately fine textured and medium-textured, moderately permeable soils of the bottom land

This association lies mainly along the Clear Fork of the Brazos River, Cottonwood Creek, and the Double Mountain Fork of the Brazos River. Most of the areas are nearly level, but those along the Double Mountain Fork of the Brazos River are undulating. The soils are deep

and moderately fine textured or medium textured. The association occupies a total area of about 44,300 acres, of which about 1,600 acres is riverbeds.

The Spur soils have a surface layer of dark-brown clay loam and silt and a dark-brown to dark reddish-brown subsoil. Their subsoil is friable clay loam and silty clay loam. These soils are moderately permeable and well drained. They occupy about 65 percent of this association, and nearly two-thirds of the acreage is cultivated. Cotton is the main crop, but grain sorghum, wheat, and some alfalfa are grown. Yields are moderate to high.

The Yahola soils have a surface layer of reddish-brown, calcareous, friable very fine sandy loam. The texture, structure, and consistence of their subsoil is similar to those of the surface layer, but the very fine sandy loam is stratified with thin layers of loamy fine sand in many places. The substratum in many places is an old buried soil. Yahola soils make up about 12 percent of the association, and about 40 percent of their acreage is cultivated. Moderate to high yields of cotton and grain sorghum are obtained.

Loamy alluvial land, on streambanks and on the low adjacent areas above the channels of the larger streams, occupies a small acreage in this association. It is flooded frequently. Because of the flooding and the irregular shape of the areas, this land type is unsuitable for cultivation.

Small areas of Sandy alluvial land, along the Double Mountain Fork of the Brazos River, also occur in this association. This land type consists of stratified layers of fine sand, loamy sand, and sandy loam. It lies immediately above and adjacent to the channels of meandering streams. Sandy alluvial land is unsuitable for cultivation, because of the hazard of overflow and the danger of wind erosion.

Approximately 2,200 acres of the Spur and Yahola soils in this association is irrigated. Water for irrigation is taken from wells that are 30 to 50 feet deep and produce from 50 to 400 gallons of water per minute. Until recently the chief irrigated crop was cotton. After insects seriously damaged the cotton crop, however, many farmers started to grow grass instead of cotton, and Coastal bermudagrass is now the dominant irrigated crop.

The soils of this association, especially Loamy alluvial land, have high potential for producing good yields of native vegetation. They are the best soils in the county for this purpose. Indiangrass, switchgrass, and sand bluestem are among the tall grasses that grow on the association.

9. Brownfield-Tivoli Association

Gently undulating, deep, sandy soils

In this association are soils on long, oval ridges, about 3 miles north of the Clear Fork of the Brazos River. The soils are gently undulating and sandy, and they developed in deposits of Quaternary age. The association occupies about 21,500 acres.

The Brownfield soils have a surface layer of loose fine sand about 30 inches thick. Their subsoil is red, friable, noncalcareous sandy clay loam. The Brownfield soils make up about 79 percent of the association, and about 18 percent of their acreage is cultivated. The principal crop is grain sorghum, and moderate yields are obtained.

The Tivoli soils are deep, light-colored, loose sands. They are gently undulating, and in a few places they occupy low stabilized dunes. The Tivoli soils are rapidly permeable, and their surface layer absorbs rain as it falls. They make up about 20 percent of the association, and Miles soils occupy a small acreage. The hazard of wind erosion is high on the Tivoli soils. Therefore only a small acreage is cultivated, and the rest is in range.

The native vegetation on the soils of this association consists mainly of moderately thick stands of shin (shin-ery) oak and scattered plants of little bluestem, sand bluestem, and giant dropseed. Good range management and control of the shin oak are needed to improve the native grasses.

Descriptions of the Soils

This section is provided for those who want detailed information about the soils in the county. It describes the series and single soils, or mapping units; that is, the areas on the detailed soil map that are bounded by a line and identified by a symbol. For more general information about the soils, the reader can refer to the section "General Soil Map," in which the broad patterns of soils in the county are described. The acreage and proportionate extent of each soil mapped in the county are given in table 1. The location of the soils is shown on the soil map at the back of the report.

In the descriptions that follow, the soils in a series are first discussed as a group by describing important features that apply to all the soils in the series. The location of the soils in the county is generally given, as well as the position of the soils on the landscape. Some of the nearby or similar soils are named and compared with the soils in the series described. After the general description of the series, a broad statement is given that tells how the soils are used.

Following the description of each series are descriptions of each soil in the series. Generally these descriptions tell how the profile of the soil described differs from the one described as representative of the series. They also tell about the use and suitability of the soil described and something about the management it needs.

Detailed, layer by layer descriptions of soil profiles are not given in this section. A detailed, representative profile is described for each soil series in the section "Genesis, Classification, and Morphology of Soils." Some of the terms scientists use in describing soils are defined in the section "How This Soil Survey Was Made." Other terms are described in the Glossary at the back of this report.

Abilene Series

In the Abilene series are deep, moderately dark colored soils that formed in old alluvium of the uplands. These soils are nearly level or gently sloping.

In most places the surface layer is noncalcareous, dark-brown clay loam that has weak granular to weak subangular blocky structure. It is about 8 inches thick. The surface layer is easily worked. In cultivated areas, all of it normally is in the plow layer.

The upper part of the subsoil is generally dark-brown clay loam that has moderate, medium, subangular blocky

structure. The lower part is brown light clay to clay that has medium, blocky structure. The subsoil is generally about 42 inches thick. It becomes more calcareous with increasing depth and ranges from noncalcareous in the upper part to strongly calcareous in the lower part.

Below the subsoil is old alluvium consisting of very strongly calcareous light clay. The uppermost 16 inches contains some soft, segregated lime.

The surface layer ranges from 5 to 10 inches in thickness. The subsoil ranges from 20 to 60 inches in thickness and from brown to dark grayish brown in color. The gently sloping areas and the areas that are closely associated with the Acme soils are shallower than the nearly level areas.

The Abilene soils have good water-holding capacity. Their natural fertility is high.

The Abilene soils are browner and have a more clayey subsoil than the Miles soils. They are browner than the Wichita soils. The profile of the Abilene soils is less clayey than that of the associated Randall soils, and the horizons are more clearly defined.

The Abilene soils are suited to wheat, cotton, and sorghum, and also to native grass. Most areas are cultivated.

Abilene clay loam, 0 to 1 percent slopes (AbA).—This soil makes up about 95 percent of the acreage of Abilene soils in this county. The areas are generally several hundred acres in size.

The surface layer is brown to dark grayish brown and is about 8 inches thick. Where this soil occurs with Acme soils, the surface layer is calcareous.

The mapped areas include small areas of Acme clay loam, shallow, 0 to 1 percent slopes, and small, finger-shaped ridges of Abilene clay loam, 1 to 3 percent slopes. The shallow Acme soil is not mapped separately in Fisher County.

This Abilene soil is easily tilled. It makes a good seedbed for cotton, grain sorghum, and wheat, and the seedbed is easily prepared. The main management problems are conserving moisture and maintaining tilth. If the supply of moisture is adequate, yields are moderate to high. (Capability unit IIc-4; Deep Hardland range site)

Abilene clay loam, 1 to 3 percent slopes (AbB).—This soil occurs with Abilene clay loam, 0 to 1 percent slopes, and some areas are completely encircled by that soil. The slopes are 400 to 500 feet long. The areas rarely exceed 100 acres in size.

The surface layer is about 5 to 6 inches thick, and the subsoil is 30 to 40 inches thick. Depth to the parent material is about 50 inches.

Small spots of Mansker loam, 1 to 3 percent slopes, are included in the mapped areas of this soil.

This Abilene soil is fertile. The main problems in managing it are controlling erosion, conserving moisture, and maintaining good tilth so that intake of water does not become lower. Yields of cotton, grain sorghum, and wheat are moderate to high when the supply of soil moisture is adequate during the growing season. (Capability unit IIIe-2; Deep Hardland range site)

Acme Series

The Acme series consists of dark soils that are nearly level or gently sloping. These soils are only 10 to 20 inches thick over beds of gypsum. They are in low areas that

TABLE 1.—Approximate acreage and proportionate extent of the soils

Soil	Acres			Percent	Soil	Acres			Percent
	Cultivated	Range	Total			Cultivated	Range	Total	
Abilene clay loam, 0 to 1 percent slopes	24,666	3,432	28,098	4.8	Randall clay	157	76	233	(¹)
Abilene clay loam, 1 to 3 percent slopes	2,029	750	2,779	.5	Sandy alluvial land	70	1,888	1,958	0.3
Acme-Cottonwood complex	2,223	6,614	8,837	1.5	Spur clay loam	7,854	5,908	13,762	2.4
Altus fine sandy loam	1,509	16	1,525	.3	Spur silt loam	11,453	5,620	17,073	2.9
Badland	3	3,643	3,646	.6	Tillman clay loam, 0 to 1 percent slopes	8,081	8,403	16,484	2.8
Breaks-Alluvial land complex	56	17,098	17,154	3.0	Tillman clay loam, 1 to 3 percent slopes	5,020	11,082	16,102	2.8
Brownfield fine sand	3,099	14,044	17,143	2.9	Tillman-Vernon complex	538	1,493	2,031	.3
Carey loam, 0 to 1 percent slopes	2,123	360	2,483	.4	Tipton silt loam, 0 to 1 percent slopes	2,149	524	2,673	.5
Carey loam, 1 to 3 percent slopes	57,664	19,895	77,559	13.3	Tipton silt loam, 1 to 2 percent slopes	674	235	909	.2
Carey loam, 3 to 5 percent slopes	33,274	16,865	50,139	8.6	Tivoli fine sand	20	4,508	4,528	.8
Cottonwood-Acme complex	483	3,588	4,071	.7	Travessilla-Vernon complex	29	8,355	8,384	1.4
Enterprise very fine sandy loam, 0 to 1 percent slopes	232	40	272	(¹)	Treadway clay	16	1,294	1,310	.2
Enterprise very fine sandy loam, 1 to 3 percent slopes	552	615	1,167	.2	Vernon-Badland complex	90	8,307	8,397	1.4
Enterprise very fine sandy loam, 3 to 5 percent slopes	299	1,046	1,345	.2	Weymouth clay loam, 1 to 3 percent slopes	2,646	2,295	4,941	.9
Enterprise very fine sandy loam, 5 to 12 percent slopes		911	911	.2	Weymouth clay loam, 3 to 5 percent slopes	262	417	679	.1
Gravelly land	640	6,547	7,187	1.2	Wichita clay loam, 0 to 1 percent slopes	13,117	6,394	19,511	3.4
Loamy alluvial land	741	24,623	25,364	4.4	Wichita clay loam, 1 to 3 percent slopes	8,570	9,317	17,887	3.1
Mansker loam, 1 to 3 percent slopes	543	756	1,299	.2	Wichita fine sandy loam, 0 to 1 percent slopes	1,099	68	1,167	.2
Mansker loam, 3 to 5 percent slopes	736	2,426	3,162	.5	Wichita fine sandy loam, 1 to 3 percent slopes	5,791	395	6,186	1.1
Mansker loam, 5 to 8 percent slopes	381	935	1,316	.2	Wichita fine sandy loam, 3 to 5 percent slopes, eroded	753	33	786	.1
Miles fine sandy loam, 0 to 1 percent slopes	3,750	153	3,903	.7	Wichita loam, 0 to 1 percent slopes	3,368	1,455	4,823	.8
Miles fine sandy loam, 1 to 3 percent slopes	18,274	6,806	25,080	4.3	Wichita loam, 1 to 3 percent slopes	5,675	2,879	8,554	1.5
Miles fine sandy loam, 3 to 5 percent slopes	6,526	10,815	17,341	3.0	Woodward loam, 1 to 3 percent slopes	3,116	1,843	4,959	.8
Miles fine sandy loam, 3 to 5 percent slopes, eroded	505	105	610	.1	Woodward loam, 3 to 5 percent slopes	9,281	13,140	22,421	3.9
Miles loamy fine sand, 0 to 3 percent slopes	9,327	1,215	10,542	1.8	Woodward-Quinlan loams, 1 to 3 percent slopes	2,490	2,802	5,292	.9
Portales loam, 0 to 1 percent slopes	1,696	119	1,815	.3	Woodward-Quinlan loams, 3 to 5 percent slopes	15,361	14,192	29,553	5.1
Potter soils	8	1,581	1,589	.3	Woodward-Quinlan loams, 5 to 8 percent slopes	2,292	12,076	14,368	2.5
Quinlan-Woodward complex	4	21,188	21,192	3.7	Yahola very fine sandy loam	2,380	2,959	5,339	.9
					Riverbed			1,641	.3
					Total	285,383	293,456	580,480	100.0

¹ Less than 0.05 percent.

resemble valleys. Many of the areas lie between areas of higher lying soils and the small, intermittent streams.

In most places the surface layer is dark, calcareous light clay loam to loam about 6 inches thick. It has moderate, fine, subangular blocky and granular structure.

The subsoil is generally dark grayish-brown clay loam that has moderate, fine, subangular blocky and granular structure. The subsoil is about 9 inches thick. It is strongly calcareous and contains small masses of soft lime. Below the subsoil are thick beds of weakly cemented, mixed, soft gypsum and lime. The material in these beds is white and chalky.

The surface layer and subsoil range from brown to very dark grayish brown in color. The surface layer ranges from 5 to 12 inches in thickness.

These soils are well drained. They have moderate permeability, but their water-holding capacity is limited because they are shallow over gypsum.

The Acme soils are deeper than the associated Cottonwood soils. They are deeper and more permeable than the Abilene soils, and they have a more limy surface layer than those soils.

The Acme soils generally occur in small areas and are managed like the surrounding soils. These soils are well suited to native grass, but about 25 percent of the acreage is cultivated. In this county the Acme soils are mapped only in complexes with the Cottonwood soils.

Acme-Cottonwood complex (0 to 3 percent slopes) (Ac).—The soils of this complex are so intermingled that it was not practical to map them separately. Acme soils make up approximately 70 percent of the acreage, and Cottonwood soils make up the rest.

Small, concave pockets of a soil deeper than the Acme, and small areas of gypsum outcrops, are in the mapped areas of this complex. The pockets are 15 to 20 feet across and are 4 to 6 inches below the level of the surrounding soils.

The Acme soils are easily tilled. They have moderately high natural fertility, but their root zone is shallow. The Cottonwood soils are low in natural fertility. The Acme soils and the included soils support a cover of native grass, but the Cottonwood soils support only a low growth of pricklypear and other cactus. Proper management of plant residue is needed to maintain the content of organic matter and to reduce wind erosion on the soils of this complex. (Acme soil, capability unit IIIe-6 and Deep Hardland range site; Cottonwood soil, capability unit VIIs-1 and Gypland range site)

Altus Series

In the Altus series are deep, dark-colored soils formed in old alluvium of the uplands. These soils are in nearly level or slightly concave areas that resemble valleys.

In most places the surface layer is about 18 inches thick. The upper part is brown fine sandy loam that has weak granular structure; the lower part is dark-brown light sandy clay loam that has weak subangular blocky structure.

Generally the subsoil is dark-brown sandy clay loam that has weak subangular blocky structure and is about 14 inches thick. It is calcareous and has a few pockets of lime in the lower part.

The substratum is strongly calcareous, grayish-brown sandy clay loam. It contains many pockets or masses of soft lime.

The thickness of the surface layer ranges from 8 to 20 inches. The subsoil ranges from sandy clay loam to clay loam in texture and from dark brown to light gray in color.

These soils have good surface drainage. Their capacity to hold water and plant nutrients is also good. Permeability is moderate, but at times these soils have a high water table caused by a very slowly permeable layer of red-bed material a few feet below the surface.

The Altus soils are less reddish than the Miles and Carey soils. They are more friable and less clayey than the Abilene soils.

Nearly all of the acreage of the Altus soils is cultivated. Yields of cotton and grain sorghum are good.

Altus fine sandy loam (0 to 1 percent slopes) (Am).—This is the only Altus soil mapped in the county. It is in nearly level or slightly concave areas that resemble valleys.

Mapped with this soil are small areas of soils that are underlain by gypsum. The included soils occur in areas of irregular shape and in no well-defined pattern.

This Altus soil is easily tilled and takes in water readily. The risk of wind erosion is moderate, but there is a slight hazard of water erosion in the slightly concave areas. Fertility is moderate. Crops grown on this soil respond well if organic matter and fertilizer are added. (Capability unit IIIe-4; Sandy Loam range site)

Badland (Ba)

In this land type are almost bare areas of red, clayey material of Permian age. The areas are rough and broken and consist of narrow ridges between moderately entrenched gullies. The walls of the gullies have slopes that range from 20 to 50 percent, but the overall slope is generally between 5 and 40 percent. In some places there are escarpments where the slopes are very steep. Thin strata of sandstone or of dolomitic limestone form small plateaus in some areas. The small plateaus have an irregular shape and occur in a discontinuous sequence at varying elevations.

Some of the soil material from the higher areas is removed by water erosion during each measurable rain. The bottoms of the gullies are covered by a layer of partly weathered red clay that varies in thickness.

This land type is productive only where it occurs on the floors of drainageways and in a few areas where soil material has lodged. (Capability unit VIIIs-1; not placed in a range site)

Breaks-Alluvial Land Complex (Bk)

About 60 percent of this complex is nearly level Alluvial land, and about 40 percent is eroded, sandy and silty red-bed material. In a few areas, however, the acreage of the Breaks, or red-bed material, exceeds that of Alluvial land. This complex is in shallow, narrow intermittent drainageways that range from 100 to 400 feet in width. In most places the drainageways do not exceed 15 feet in depth. They drain soils developed in sandy or silty material of the red beds. The bottoms of the drainageways are covered with loamy alluvial material that has been de-

posited recently. These alluvial deposits are generally calcareous and are highly stratified. The drainageways have steep sides, where sandy or silty red-bed material is exposed. In places along their sides, the steep slopes have eroded to short, vertical drops.

Small areas of Quinlan soils are included in the mapped areas of this complex. The included areas are steep and are on the sides of the drainageways.

The Breaks part of the complex is more sandy and more productive of vegetation than Badland. The Alluvial land part is too much cut by channels, too steep, and too frequently flooded for cultivation. Because the areas of Alluvial land are on the bottoms of the drainageways and receive extra moisture, they support a good growth of native grasses. (Breaks, capability unit VII_s-2 and Rough Broken range site; Alluvial land, capability unit Vw-1 and Loamy Bottom Land range site)

Brownfield Series

In the Brownfield series are soils that are loose and sandy. These soils are mainly north of the Clear Fork of the Brazos River and east of Rotan.

In most places the surface layer is about 30 inches thick. The upper 10 inches is brown fine sand, and the lower part is reddish-yellow fine sand.

Generally, the subsoil is noncalcareous, red sandy clay loam about 14 inches thick. It is friable and has moderate, medium, subangular blocky structure.

The substratum is noncalcareous, red, heavy fine sandy loam. This material was deposited by wind.

The surface layer ranges from 21 to 35 inches in thickness. The color is consistent throughout the surface layer in some places. The subsoil ranges from 12 to 28 inches in thickness, from light sandy clay loam to loamy fine sand in texture, and from yellowish red through reddish brown to red in color.

The capacity to hold water and plant nutrients is poor in these soils. The soils are well drained and have moderate permeability.

Brownfield soils have a thicker, more sandy surface layer than the Miles soils. Unlike the Tivoli soils, they have a well-defined subsoil.

The Brownfield soils are highly susceptible to wind erosion. Where they have been cultivated, erosion has removed much of the surface layer and the eroded areas are reverting to native vegetation. Because they are susceptible to wind erosion, these soils are unsuitable for dry-land farming and are used mainly for range.

Brownfield fine sand (2 to 7 percent slopes) (Br).—This is the only Brownfield soil mapped in the county. It is in areas several hundred acres in size.

Small areas of Miles loamy fine sand, 0 to 3 percent slopes, are included in the areas mapped as this soil. Also included are areas of Tivoli fine sand.

This Brownfield soil is susceptible to wind erosion and cannot be cultivated safely. It is suitable only for range. The present vegetation on the range consists of a moderate to thick cover of shin oak, a few scattered mesquite trees, and a thin cover of coarse grasses. The value of this soil for range can be increased by using a chemical spray to reduce the growth of woody plants and by seeding adapted grasses. (Capability unit VI_e-7; Deep Sand range site)

Carey Series

The Carey series consists of deep, reddish-brown, moderately permeable soils formed in calcareous sandy and silty material of the red beds. These soils are nearly level to strongly rolling. They are mainly in the central part of the county in areas that extend from north to south.

In most places the surface layer is reddish-brown loam that has weak subangular blocky and granular structure. It is about 10 inches thick and is free of lime.

Generally the subsoil is sandy clay loam that has compound weak, coarse, prismatic structure and moderate, medium and fine, subangular blocky structure. The subsoil is about 48 inches thick. The upper part is reddish brown, and the lower part is yellowish red. This layer is free of lime.

The upper 10 inches of the substratum contains soft lime leached from the material above. Below is red, weakly calcareous, light very fine sandy loam material of the red beds.

The surface layer ranges from loam to very fine sandy loam in texture and from 4 to 12 inches in thickness. The subsoil ranges from 20 to 62 inches in thickness; the texture in the lower part ranges from sandy clay loam to loam. The substratum ranges from calcareous, sandy and silty material of the red beds to noncalcareous, soft to weakly cemented sandstone or pack sand.

The Carey soils are deeper than the Woodward soils, and their profile is not limy throughout. Their subsoil is less brownish than that of the Tipton soils. They have a less sandy surface layer and a less reddish subsoil than the Miles soils.

Carey soils are well suited to cultivated crops and native grasses. The chief cultivated crops are cotton, sorghum, and wheat.

Carey loam, 0 to 1 percent slopes (CaA).—This soil is in slightly concave areas and is about 60 to 70 inches deep. It is nearly level. Erosion is slight on this soil, but there is a slight hazard of further wind erosion. Some water erosion results when runoff accumulates from higher lying Carey soils.

Included in some areas mapped as this soil are areas of Tipton silt loam that total about 10 percent of the mapping unit. Also included are small areas of Acme soils along intermittent drainageways.

About 90 percent of the acreage of this Carey soil is cultivated, and cotton, sorghum, and wheat are well suited. The soil is easily tilled, and a good seedbed is easily prepared. Lack of moisture is the chief limitation. (Capability unit II_ce-2; Mixed Land range site)

Carey loam, 1 to 3 percent slopes (CaB).—This soil is about 50 to 60 inches deep over red-bed material. Only slight erosion has occurred.

The mapped areas include areas of Woodward, Tipton, and Acme soils. The Tipton and Acme soils are along drainageways.

About 70 percent of the acreage of this Carey soil is cultivated, and cotton and sorghum are well-suited crops. The risk of wind erosion is slight, but the hazard of water erosion is slight to moderate. A system of terraces helps to control water erosion. Stubble mulching also helps to control erosion by reducing surface crusting. After the crusting is reduced, more rainfall is absorbed and less runs off. (Capability unit II_e-1; Mixed Land range site)

Carey loam, 3 to 5 percent slopes (CcC).—In some places water erosion has removed about 30 percent of the original surface layer of this soil. The present surface layer is only about 6 inches thick.

Mapped with this soil are areas of Woodward soils and small areas of Quinlan soils. The included soils make up about 10 percent of the acreage in the mapping unit.

This Carey soil is suited to sorghum, cotton, and wheat. Of these, cotton is the most profitable crop and causes the least erosion if it is grown where the slopes are less than 4 percent. Where the slopes are more than 4 percent, grain sorghum and small grains, such as wheat, help to control erosion. Erosion can also be controlled by constructing terraces and using a cropping system in which crops that produce a large amount of residue are grown. (Capability unit IIIe-3; Mixed Land range site)

Cottonwood Series

The Cottonwood soils are very shallow over thick beds of gypsum. They are nearly level or gently sloping, and they have both concave and convex slopes. They are generally in low-lying areas along intermittent streams.

In most places the surface layer is strongly calcareous light clay loam to loam that has moderate, very fine, subangular blocky to granular structure. This layer is generally about 5 inches thick.

The layer immediately below the surface layer consists of a thick bed of white, chalky material. This layer is weakly cemented, soft gypsum and lime.

The surface layer of these soils ranges from dark brown to grayish brown in color, and it ranges from 4 to 10 inches in thickness over gypsum and lime.

These soils are well drained. Their water-holding capacity is low because weakly cemented material is near the surface. These soils are not suitable for cultivation.

The Cottonwood soils are shallower than the Acme and Abilene soils with which they are associated. In this county the Cottonwood soils are mapped only in complexes with the Acme soils.

Cottonwood-Acme complex (1 to 3 percent slopes (Cc).—The soils of this complex are so intermingled that it was not practical to map them separately. The Cottonwood soils make up approximately 70 percent of the acreage, and the Acme soils make up the rest. In most places the Cottonwood soils are at an elevation a few inches higher than that where the Acme soils occur. The Acme soils generally occupy circular areas. They probably formed in slightly depressed sink areas in the beds of gypsum.

Small, concave areas of a deep soil are mapped with the soils of this complex. Also included are small areas where the beds of gypsum outcrop. (Cottonwood soil, capability unit VIIs-1 and Gypland range site; Acme soil, capability unit IIIe-6 and Deep Hardland range site)

Enterprise Series

The Enterprise series consists of deep, very friable loamy soils formed in limy windblown deposits. This material has blown from the channels of streams that drain the area.

In most places the surface layer is reddish-brown very fine sandy loam that has weak granular structure. It is about 14 inches thick.

Generally the soil material below the surface layer is yellowish-red very fine sandy loam. The upper part is limy and has weak subangular blocky and granular structure. The lower part is structureless.

The surface layer ranges from 5 to 20 inches in thickness, and it ranges from noncalcareous to calcareous. Below the surface layer, the texture ranges from very fine sandy loam to heavy very fine sandy loam.

Surface drainage and internal drainage are good to excessive. The capacity to hold water and plant nutrients is good. The steeper slopes are very susceptible to water erosion.

Enterprise soils have a finer textured surface layer than Miles soils. Also, their subsoil is the same texture as their surface layer.

About 28 percent of the acreage of these soils is cultivated. In the areas where the slopes are less than 5 percent, these soils are well suited to cultivation, and cotton, sorghum, and small grains are grown. All of these soils are well suited to native grasses.

Enterprise very fine sandy loam, 0 to 1 percent slopes (EnA).—This soil occurs in small areas, chiefly on a flat north of the Double Mountain Fork of the Brazos River. The surface layer ranges from 8 to 20 inches in thickness. Little or no erosion has occurred.

Areas of Enterprise very fine sandy loam, 1 to 3 percent slopes, on short slopes are included in the mapped areas of this soil. Also included are a few small areas of a soil that has a weakly developed textural profile.

This Enterprise soil is fairly good for agriculture. It takes in water readily and releases it easily to plants. It is easily tilled, but there is a slight risk of wind erosion. Stubble mulching effectively controls wind erosion. Austrian peas or other winter legumes are crops that can be grown to improve the soil. (Capability unit IIc-2; Mixed Land range site)

Enterprise very fine sandy loam, 1 to 3 percent slopes (EnB).—The surface layer of this soil is 8 to 20 inches thick. Water erosion has occurred in some places. Small areas of Enterprise very fine sandy loam, 0 to 1 percent slopes, are included in the areas mapped as this soil.

Fertility is moderate, and this soil is easily tilled. It is suited to the crops commonly grown in the county. The chief management problem is the slight to moderate hazard of water erosion. Terracing, contour farming, and stubble mulching are needed to control washing and to conserve moisture. (Capability unit IIe-1; Mixed Land range site)

Enterprise very fine sandy loam, 3 to 5 percent slopes (EnC).—This soil is moderately sloping and is highly susceptible to water erosion. The surface layer ranges from 5 to 20 inches in thickness. It is thinnest in the cultivated areas where erosion has removed part of the surface layer.

Small areas of Enterprise very fine sandy loam, 1 to 3 percent slopes, and a few small areas that have slopes greater than 5 percent are included in the mapped areas of this soil. Also included are a few areas of soils that are similar to the Enterprise soils but that are shallow over gravel.

This Enterprise soil is fairly productive and is easily tilled. Approximately 25 percent of the acreage is cultivated. The chief limitations are the moderate to severe hazard of water erosion and the slight risk of wind erosion. Terraces that have grassed outlets help reduce water erosion. Contour farming, stubble mulching, and growing

crops that produce a large amount of residue are practices needed to control erosion and to maintain the content of organic matter. (Capability unit IIIe-3; Mixed Land range site)

Enterprise very fine sandy loam, 5 to 12 percent slopes (EnD).—The profile of this soil is similar to that of Enterprise very fine sandy loam, 3 to 5 percent slopes. In places on the steeper slopes, however, shallow gullies have developed. In other places some gravel is on the surface. This soil occupies a minor acreage and occurs as narrow bands between the Double Mountain Fork of the Brazos River and other soils of the upland.

Small areas of soils that have a profile similar to that of the Enterprise soils are mapped with this soil. The included soils are shallow over gravel.

Because of the steep slopes, this Enterprise soil is highly susceptible to water erosion and is not suited to cultivation. It is well suited to perennial grasses, and all of the acreage is in range. Mid grasses, such as side-oats grama and plains bristlegrass, are potential climax plants in the plant community on the range areas. (Capability unit VIe-4; Mixed Land range site)

Gravelly Land (Gr)

This miscellaneous land type is made up of gently sloping to hilly areas where the soils are shallow over deep beds of loamy gravel. Quartzite pebbles that vary in size cover 20 to 30 percent of the surface. Pebbles make up 20 to 60 percent, by volume, of the upper part of the soil material, and the rest is loam or loamy sand. The underlying gravel beds are 3 to 10 feet thick. The slopes range from 5 to 25 percent.

As a result of erosion, a gravel pavement has formed on the surface. This pavement extends down the slopes from the crest of the rounded knobs. Red-bed clay is exposed in the gullies between the gravelly knobs.

All of this land type is in range, and yields of forage are low. The vegetation generally consists of black grama, buffalograss, catclaw, scattered, small mesquite bushes, and pricklypear. In the northwestern part of the county, where the largest acreage of this land type occurs, cedar is also common. (Capability unit VIIs-1; Gravelly range site)

Loamy Alluvial Land (La)

This land type consists of recent water-laid deposits of reddish-brown, calcareous loamy material. It occupies the channels of streams that frequently overflow onto adjacent soils. The surface layer is highly stratified and ranges from clay loam to loamy fine sand in texture. The areas are strongly sloping to nearly level and range from 100 feet to 1,000 feet in width, depending on the size of the flood plain. The slopes range from 1 to 15 percent.

This land type is too frequently overflowed to be cultivated safely. Because it receives extra moisture, however, it is the most productive range site in the county. (Capability unit Vw-1; Loamy Bottom Land range site)

Mansker Series

In the Mansker series are brown, gently sloping to strongly sloping, limy soils. These soils formed in very strongly calcareous loam to light clay.

In most places the surface layer is brown loam about 6 inches thick. It is strongly calcareous and has very weak granular structure.

Generally the subsoil is strongly calcareous clay loam that has compound weak subangular blocky and granular structure. It is about 9 inches thick.

The upper 23 inches of the underlying material is pinkish-white clay loam in which free lime has accumulated as a result of leaching. About 30 percent, by volume, of this material is soft lime. Below is light-brown, strongly calcareous, light clay.

The surface layer ranges from 6 to 10 inches in thickness, from brown to dark grayish brown in color, and from light loam to light clay loam in texture. The subsoil ranges from 5 to 16 inches in thickness and from light brown to yellowish brown in color.

Surface drainage is good to excessive on the steeper slopes. These soils are moderately permeable and have good internal drainage. The water-holding capacity is limited because the solum is rather thin. The high content of lime tends to make some plant nutrients unavailable to plants. These soils are well suited to native grasses.

The Mansker soils are deeper than the Potter soils and are shallower, more loamy, and more permeable than the Abilene soils. They are shallower and less reddish than the Miles soils.

Mansker loam, 1 to 3 percent slopes (MaB).—This soil has a few caliche pebbles on the surface and throughout the profile. It has gentle slopes.

Small areas of Mansker loam, 0 to 1 percent slopes, not mapped separately in this county, are included in the areas mapped as this soil. Also included are small areas of Mansker loam, 3 to 5 percent slopes.

About 30 to 35 percent of the acreage is cultivated. Some cotton is grown, but this soil is better suited to small grains than to cotton. The rather shallow root zone and the moderate water-holding capacity limit the choice of crops that can be grown and the yields that are obtained. (Capability unit IIIe-7; Deep Hardland range site)

Mansker loam, 3 to 5 percent slopes (MaC).—This soil is on convex slopes. It is slightly less deep than Mansker loam, 1 to 3 percent slopes. In most places depth to caliche is about 13 to 14 inches.

Small areas of Mansker loam, 1 to 3 percent slopes, are included in the areas mapped as this soil.

About 85 percent of the acreage is still in native grasses. If this soil is cultivated, small grains are better suited than cotton or other clean-tilled crops, which do not provide enough cover to control erosion. (Capability unit IVe-2; Deep Hardland range site)

Mansker loam, 5 to 8 percent slopes (MaD).—The profile of this Mansker soil is similar to the one described for the series, but the surface layer is light loam and the subsoil is loam. Mapped with this soil are small areas of Potter soils.

A good cover of grass is needed on this Mansker soil to maintain a water-intake rate high enough that maximum yields of forage will be produced. The grass also reduces the hazard of erosion. Yields of forage are moderate. (Capability unit VIe-2; Deep Hardland range site)

Miles Series

In the Miles series are deep, reddish-brown, moderately sandy soils formed in sandy loam outwash of the uplands. These soils are nearly level to strongly sloping.

The surface layer is fine sandy loam to loamy fine sand about 9 inches thick. It has very weak granular structure and is free of lime.

The subsoil is sandy clay loam about 40 inches thick. It is reddish brown in the upper part and red in the lower part.

The substratum is generally fine sandy loam, but its texture ranges to sandy clay loam. In places it contains free lime.

These soils are well drained and moderately permeable. Their capacity to hold water and plant nutrients is good.

The Miles soils have a less sandy surface layer than the Brownfield soils. They are more reddish and more sandy than the Abilene soils, and they are more sandy than the Carey soils.

Miles soils that have a surface layer of loamy fine sand are highly susceptible to wind erosion. They are well suited, however, to crops that are managed so as to leave a large amount of residue on the surface. All of the Miles soils are well suited to native grasses. If these soils are used for range, they are the most productive of any of the soils of uplands in the county.

Miles fine sandy loam, 0 to 1 percent slopes (MfA).—The surface layer of this soil is reddish-brown fine sandy loam about 10 inches thick. The uppermost 18 inches of the subsoil is reddish-brown sandy clay loam, and the lower 25 inches is reddish light sandy clay loam. The thickness of the profile ranges from 50 to 72 inches.

Included in some areas mapped as this soil are areas of soils in small drainageways where silt has accumulated. In these included soils no textural profile has developed.

Most of the acreage is cultivated. The surface layer takes in water readily, and the water stored in the subsoil is released readily to plants. The hazard of wind erosion is moderate. Therefore, this soil should be protected by a cover of crop residue in winter. This soil responds well if organic matter and fertilizer are added and other good management is used. (Capability unit IIIe-4; Sandy Loam range site)

Miles fine sandy loam, 1 to 3 percent slopes (MfB).—This soil has a surface layer about 9 inches thick. Its profile is similar to that of Miles fine sandy loam, 0 to 1 percent slopes, but it ranges from 36 to 72 inches in thickness.

Small areas of Miles fine sandy loam, 0 to 1 percent slopes, are included in the mapped areas of this soil. Also included, in the southwestern part of the county, are small areas of a soil that is similar to the Miles soil but shallow over beds of lime-coated gravel.

Limitations to the use of this soil are similar to those of the less sloping Miles soil, and in addition, there is a moderate risk of water erosion. This soil responds well to good management. (Capability unit IIIe-4; Sandy Loam range site)

Miles fine sandy loam, 3 to 5 percent slopes (MfC).—This soil has a thinner surface layer than Miles fine sandy loam, 1 to 3 percent slopes. The surface layer is reddish-brown fine sandy loam about 6 inches thick. Depth from the surface to the underlying material ranges from 30 to 50 inches.

Included in the areas mapped as this soil are areas of a soil that is similar but is shallow over lime-coated gravel. This included soil is on small knolls or narrow ridges. Also included are small areas of Miles fine sandy loam, 1 to 3 percent slopes.

Natural fertility is moderate, and the principal management problem is the control of erosion by water and wind. Keeping organic residue on the surface by using stubble-mulch tillage helps to control wind erosion. Terraces and contour farming reduce water erosion. (Capability unit IVe-4; Sandy Loam range site)

Miles fine sandy loam, 3 to 5 percent slopes, eroded (MfC2).—This soil is similar to Miles fine sandy loam, 3 to 5 percent slopes; however, much of the surface layer has been removed by water erosion, and gullies have formed. In places the gullies are 30 to 40 feet apart, and some have cut into the underlying material. In areas without gullies, the surface layer is thin and the plow layer is sandy clay loam. A few small areas of eroded Miles fine sandy loam, 1 to 3 percent slopes, that are adjacent are included in the areas mapped as this soil.

The main problem in managing this soil is the control of water erosion. Growing crops that produce a large amount of residue and keeping all residue on the surface are the most effective practices for reducing erosion. Terraces and contour farming also help to reduce water erosion. (Capability unit IVe-3; Sandy Loam range site)

Miles loamy fine sand, 0 to 3 percent slopes (MmB).—In most places this soil has a surface layer of brown loamy fine sand about 8 inches thick, but the surface layer is as much as 20 inches thick in some places. The color of the surface layer ranges from light brown to reddish brown. The subsoil is generally reddish-brown to red sandy clay loam that ranges from 20 to 60 inches in thickness. In places, however, the upper part of the subsoil is light fine sandy loam. Included in the areas mapped as this soil are spots of Miles loamy fine sand that have slopes of 3 to 5 percent.

Wind erosion is a greater hazard than on the Miles fine sandy loams, and it limits the use of this soil for tilled crops. Sorghum and small grains, such as rye, are well suited and give protection from erosion. Native grasses are also well suited.

This soil absorbs most of the rainfall. Yields of summer crops are moderate to good if adequate fertilizer is applied and wind erosion is controlled. (Capability unit IVe-6; Sandy Land range site)

Portales Series

The Portales series consists of dark, calcareous soils formed over beds of soft caliche in the uplands. These soils are in nearly level areas and in places on slightly concave slopes.

In most places the upper part of the surface layer is dark grayish-brown, calcareous loam, and the lower part is light clay loam. The surface layer has weak, fine, granular structure and is about 18 inches thick.

Generally the subsoil is very strongly calcareous, pale-brown light clay loam that has moderate, fine, subangular blocky and granular structure. It contains films of segregated lime and is about 16 inches thick.

The substratum is light-gray sandy clay loam. About 20 to 30 percent, by volume, is soft lime.

The surface layer ranges from heavy fine sandy loam to light clay loam in texture and from brown to dark grayish brown in color. The color of the subsoil ranges from pale brown to dark grayish brown.

These soils have good internal drainage. The capacity to hold water and plant nutrients is good.

The Portales soils have a thicker surface layer and subsoil than the Mansker soils, and they are less sloping. Their profile is similar to that of the Altus soils, but their surface layer is calcareous. The Portales soils are more calcareous and less clayey than the Abilene soils, and their profile is less deep.

Most of the acreage of Portales soils is cultivated, and crops grown in this county are well suited. The areas where the surface layer is heavy fine sandy loam need protection from wind erosion.

Portales loam, 0 to 1 percent slopes (PoA).—This is the only Portales soil mapped in the county. Included in the areas mapped as this soil are small convex areas of Portales loam that have slopes of 1 to 2 percent.

This soil is easily tilled and is readily penetrated by moisture and roots. Grain sorghum grown on this soil is susceptible to chlorosis, or yellowing of the leaves, because of the moderately high content of lime. As a result, yields may be lowered. Adding a moderately large amount of crop residue regularly helps to offset the effect of the lime. The residue also helps to control wind erosion. (Capability unit IIc-5; Mixed Land range site)

Potter Series

The Potter series consists of limy soils that are shallow over caliche. These soils are gently sloping to moderately steep and are on convex slopes.

In most places the surface layer is limy, grayish-brown clay loam that has very fine granular structure and is about 6 inches thick. It contains some fragments of hard lime.

Below the surface layer is white caliche mixed with a small amount of soil material. The upper part of this material is weakly cemented and contains some large fragments of hard caliche.

These soils range from 4 to 10 inches in thickness and from clay loam to fine sandy loam in texture. The underlying material ranges from soft to hard caliche.

Runoff is rapid or very rapid. As a result of the caliche near the surface, the capacity to hold water and plant nutrients is low.

Potter soils are shallower and are generally steeper than Mansker soils. They are much shallower than the Abilene and Miles soils with which they are associated. The Potter soils are used only for range.

Potter soils (Pt).—These are the only Potter soils mapped in the county. They are well drained. The dominant slopes range from 8 to 20 percent, but in about one-fourth of the acreage these soils have slopes of 1 to 8 percent.

Included in some areas mapped as this soil are small areas of Mansker loam that have slopes of 3 to 5 percent. Also included are small areas of Mansker loam that have slopes of 5 to 8 percent.

The Potter soils can be safely used only for range. Even under the best management, the yields of usable forage are moderately low. (Capability units VII-1; Very Shallow range site)

Quinlan Series

In the Quinlan series are medium-textured, calcareous soils that are shallow over sandy or silty red beds. These soils are closely associated with Woodward and Carey soils.

In most places the surface layer is reddish-brown, calcareous very fine sandy loam that has weak granular and subangular blocky structure. It is very friable and about 11 inches thick. Below the surface layer is calcareous sandy or silty material of the red beds.

These soils range from 4 to 15 inches in thickness and from reddish brown to yellowish red in color. As a rule, they are weakly calcareous to strongly calcareous, but a few areas are noncalcareous.

These soils are well drained. Their capacity to hold water and plant nutrients is low.

The Quinlan soils are not mapped separately in this county but are mapped in complexes with the Woodward soils. They are less deep than the Woodward and Carey soils and are less clayey than the Vernon soils.

Quinlan soils are poorly suited to cultivation and are in native range. They will support black grama, blue grama, and other annual plants.

Quinlan-Woodward complex (Qw).—This complex consists mainly of areas of Quinlan and Woodward soils, but it includes areas of Breaks and of soils formed in alluvium in narrow strips, on long oval interridges, and in elliptical bands. The areas are too intermixed for the soils to be mapped separately. They are dissected by incised drainageways and by many secondary and tertiary side channels that form a dendritic pattern. The soils on the bottoms of the drainageways have been stabilized by vegetation, but erosion is active in the headwater areas and on the short escarpments.

The Quinlan soils of this complex are generally adjacent to the drainageways on long, oval interridges and on benches above the escarpments. Quinlan soils that have slopes of 5 to 12 percent make up 25 to 40 percent of the acreage in the complex. Steep Quinlan soils on the sides of the larger drainageways make up 20 to 30 percent.

Woodward soils generally are along the outer edges of areas of this complex, and make up 20 to 30 percent of the acreage. Included in the areas mapped as Woodward soils are some areas of Quinlan soils that have slopes of 5 to 10 percent.

The areas of Breaks are on the nearly vertical walls of gullies. They are not extensive in the northwestern part of the county but are striking along the outer elbows of Rough Creek, Red Creek, and other streams in that area. In places, chiefly near the Double Mountain Fork of the Brazos River, the escarpments occupied by Breaks have short, nearly vertical sides, but moderately sloping interbenches are within these areas. In other small areas strata of gypsum 2 to 3 feet thick and separated by 20 to 30 feet of soft sandstone outcrop on the face of the escarpments. The escarpments occupied by Breaks make up less than 5 percent of the acreage in the complex.

The soils formed in alluvium make up about 3 percent of the complex. They are mainly on the bottoms of the drainageways.

Soils of the Woodward-Quinlan complexes, Carey loams, and Gravelly land occur near the areas of this complex. The associated soils are less sloping than those of the Quinlan-Woodward complex and are in higher lying areas.

The soils of Quinlan-Woodward complex are suitable only for range or for providing food and cover for wildlife. Proper control of grazing is needed to maintain the cover of grass and to control erosion. The present vegetation consists mostly of bluestem, Indiangrass, switchgrass, side-oats grama, buffalograss, black grama, yucca, and juniper and mesquite trees. Bermudagrass is the chief kind of grass on the soils that receive frequent deposits of alluvial material. Switchgrass and Canada wildrye are the main kinds on the less frequently flooded, but well-watered, areas of soils formed in alluvium. On the Quinlan soils are some shrubs, cactus, buffalograss, and common black grama. On the Woodward soils are a moderate overstory of mesquite trees and a cover of mid and tall grasses. Little bluestem and some sand bluestem grow on the more weathered material and on talus slopes between the beds of gypsum. Redberry juniper grows mainly in the areas where the most escarpments occur. (Quinlan and Woodward soils, capability unit VIe-4 and Mixed Land range site; Breaks, capability unit VIIs-2 and Rough Broken range site)

Randall Series

The Randall series consists of deep, gray to dark-gray clayey soils that occupy the floors of enclosed depressions or intermittent lakes. These soils are covered by water for short periods after rainy seasons. Most areas are in the southwestern part of the county.

The surface layer is gray to dark-gray clay about 14 to 20 inches thick. It is generally noncalcareous. The material below is more clayey and more compact than that in the surface layer, and it contains larger, firmer structural blocks. Depth to the layer of lime accumulation ranges from 38 to 62 inches.

These soils have poor surface drainage and very slow permeability. In the depressions where they occur, runoff water from the surrounding nearly level or gently sloping areas of Abilene soils accumulates to a depth of a few inches to a foot or more.

About two-thirds of the acreage is used for cultivated crops, chiefly cotton, grain sorghum, and wheat. The small areas in range have a dense cover of grasses, mainly buffalograss, tobosa, and vine-mesquite. Mesquite trees grow on the outer edges of these areas.

Randall clay (0 to 1 percent slopes) (Ra).—This is the only Randall soil mapped in the county. It is deep, noncalcareous, and clayey, and occupies the floors of depressions and intermittent lakes.

This soil is fertile, but periods of wetness limit its use in some years. Water on the surface often delays planting and sometimes prevents harvesting the mature crop. In most places farmers have constructed terraces on the areas of surrounding soils to protect this soil from runoff. Although planting is delayed, grain sorghum is planted and harvested in most years. In dry periods the moisture stored in the soil aids crops.

This soil is not susceptible to wind or water erosion, but the surface layer puddles if the soil is tilled when wet. Returning crop residue to the soil helps to maintain desirable tilth. (Capability unit IVw-1; Deep Hardland range site)

Sandy Alluvial Land (Sa)

This miscellaneous land type is made up of stratified sand, loamy sand, and sandy loam. The areas have slopes of 0 to 1 percent. They are in the northwestern part of the county, along the Double Mountain Fork of the Brazos River and along Rough Creek. Areas of this land type are the first above the stream channel to be flooded when streams overflow. The hazard of wind erosion and the hazard of overflow make them unsuitable for cultivation. (Capability unit Vw-2; Loamy Bottom Land range site)

Spur Series

In the Spur series are well-drained, friable, calcareous, dark-brown to brown soils formed in alluvium. These soils are nearly level and occupy the bottom lands of the larger streams. In some places they are in broad areas up to 250 acres in size. In other places, however, they are in smaller, more irregularly shaped areas, slightly below the associated Yahola soils.

The surface layer is very fine sandy loam to clay loam about 16 inches thick. It is calcareous and has weak granular structure.

The subsoil is strongly calcareous clay loam to silty clay loam about 36 inches thick. This layer is moderately permeable.

The underlying material is strongly calcareous clay loam to silty clay loam. This material, in places, contains thin layers of fine sandy loam.

These soils are moderately permeable and have a good water-holding capacity. They are naturally fertile and productive. Erosion is not a hazard, because the soils are nearly level and enough clods form in the surface layer to limit blowing. Damage to crops from flooding occurs occasionally, as in the floods of 1932 and 1955.

The Spur soils have a less sandy surface layer than the Yahola soils. Also they are darker and contain more organic matter than the Yahola soils.

Cotton is the principal crop, and yields are high if moisture is adequate. Wheat and grain sorghum are also grown; a large part of the acreage in wheat is grazed by livestock in winter.

Spur clay loam (0 to 1 percent slopes) (Sc).—This soil is generally on smooth bottom lands that are back from the main channels of the larger streams, but in some places it is in slightly lower areas. The largest areas are on the smooth bottom lands. Many of them are more than 200 acres in size, and in a few places along the Clear Fork of the Brazos River the areas are more than 500 acres in size. The size of the areas that are slightly lower ranges from 25 to 50 acres.

The surface layer is about 15 inches thick, and its color ranges from brown to dark brown. This soil ranges from weakly calcareous to strongly calcareous.

Included in the areas mapped as this soil are small areas of Spur silt loam. This included soil occupies small circular or oval areas that resemble mounds.

The chief management problem is maintaining good tilth in the plow layer. Plant residue, kept on or near the surface by stubble mulching, helps to keep the content of organic matter at a desirable level and maintains good tilth in the plow layer. (Capability unit IIce-1; Loamy Bottom Land range site)

Spur silt loam (0 to 1 percent slopes) (Sp).—This is a deep, calcareous soil of the bottom lands. It is along the larger streams in the county. The surface layer is brown to dark-brown silt loam that ranges from 12 to 18 inches in thickness. The subsurface layer is dark brown to reddish brown and is strongly calcareous.

Included in some areas mapped as this soil are small areas of Yahola very fine sandy loam in narrow bands adjacent to the streambank and in other long, narrow bands. Also included are small areas of Spur clay loam in slight depressions. The included soils make up less than 5 percent of the acreage of this mapping unit.

This soil is fertile, and cotton and grain sorghum are the main crops grown. If the cropping system includes a cover crop and if the crop residue is returned to the soil, yields are moderate to high. (Capability unit IIc-3; Loamy Bottom Land range site)

Tillman Series

In the Tillman series are deep, reddish-brown soils formed in calcareous, clayey red-bed material. These soils are nearly level and are on uplands in the eastern part of the county.

In most places the surface layer is reddish-brown heavy clay loam about 5 inches thick. It is noncalcareous.

Generally the subsoil is reddish-brown light clay to clay about 50 inches thick. The upper part is noncalcareous and has moderate, fine, subangular blocky structure; the lower part is weakly calcareous and has moderate to strong, medium, irregular or wedge-shaped, blocky structure.

The substratum is very strongly calcareous, dark-red clay. It has a layer of lime accumulation, about 10 inches thick, in the upper part.

The surface layer ranges from 5 to 12 inches in thickness and from reddish brown to brown in color. The subsoil ranges from dark reddish brown through reddish brown to dark red. The substratum in places has a distinct layer of lime accumulation. The topmost 18 inches of the profile ranges from noncalcareous to weakly calcareous.

Surface runoff is slow to medium, and internal drainage and permeability are very slow. The capacity to hold water and plant nutrients is good.

The Tillman soils are more clayey than the Wichita soils and more reddish than the Abilene soils. They are deeper than the Vernon and Weymouth soils and more clayey and more slowly permeable than the Weymouth soils.

About 40 percent of the acreage is cultivated. The rest is in range and supports a cover of short grasses. These soils are droughty and are best suited to small grains or other crops grown in cool seasons; however, cotton and sorghum are grown.

Tillman clay loam, 0 to 1 percent slopes (TcA).—About half of the acreage of this soil is cultivated. In some places where water has accumulated along roads through fields and in turn rows, this soil is slightly eroded.

Included in the areas mapped as this soil are small, concave areas of a darker soil. Also included are a few small areas of Tillman clay loam, 1 to 3 percent slopes.

Permeability is very slow in the subsoil; the movement of water, air, and roots is restricted. Also the surface layer tends to crust after heavy rains. This crusting

and the slow movement of water into the subsoil make the soil somewhat droughty. Keeping plant residue on the surface as a stubble mulch reduces crusting and increases the rate at which water enters the soil. Growing crops that have fibrous roots also helps to make the subsoil more porous so that more water will enter. (Capability unit IIIs-1; Deep Hardland range site)

Tillman clay loam, 1 to 3 percent slopes (TcB).—About 30 percent of the acreage of this soil is cultivated. Surface drainage is medium, and sheet erosion is noticeable in some areas. Included in the areas mapped as this soil are small areas of Weymouth clay loam, 1 to 3 percent slopes.

Conserving moisture and controlling erosion are the main problems in managing this soil. Stubble mulching of such crops as wheat, which produces a large amount of residue, helps to control erosion and conserve moisture. (Capability unit IIIe-1; Deep Hardland range site)

Tillman-Vernon complex (1 to 3 percent slopes) (Tm).—In this complex are small areas of gently sloping Tillman clay loam intermingled with slightly more sloping areas of Vernon clay loam. The Tillman soil makes up about 55 percent of the acreage, and the Vernon soil makes up the rest. Included in the mapping are small areas in which the slopes are 3 to 5 percent.

The profile of the Tillman soil is more shallow than that described for the Tillman series. The surface layer is about 5 inches thick, and the subsoil is about 26 inches thick.

The surface layer of the Vernon soil is also about 5 inches thick. The subsoil is about 14 inches thick. It is more friable than the clayey red-bed material in the substratum.

This complex is used mainly for range. Some areas are cultivated, however, and wheat is the main crop. The shallow to moderately deep root zone limits the kinds of crops that can be grown, and crops, such as wheat, that grow in the cool seasons are best suited.

The control of erosion is important because the loss of a few inches of soil material would further reduce the depth of the root zone. Keeping crop residue on the surface as a mulch or adding a mulch of cotton burs, installing terraces, and farming on the contour will help control erosion and improve the soil. (Tillman soil, capability unit IIIe-1 and Deep Hardland range site; Vernon soil, capability unit IVe-7 and Shallow Redland range site)

Tipton Series

In the Tipton series are deep, dark loamy soils formed in loamy and silty alluvium. These soils are nearly level to very gently sloping and are in concave areas.

The surface layer is 15 to 26 inches thick, depending on the thickness of the recently deposited material. The upper part is reddish brown, and the lower part, which is the original surface layer, is dark-brown silt loam.

The subsoil is brown to dark grayish-brown silty clay loam that has moderate, medium, subangular blocky structure. It is about 20 inches thick and is weakly calcareous to moderately calcareous.

Below the subsoil is pale-brown, strongly calcareous silty clay loam. In places there is a horizon of lime accumulation. These soils generally become more calcareous with increasing depth.

Surface drainage ranges from slow to medium, and internal drainage is medium. The capacity to hold moisture and plant nutrients is good.

The Tipton soils are darker, smoother, and less sloping than the surrounding Carey and Woodward soils. They are less clayey and have a more permeable subsoil than the Abilene soils.

The Tipton soils are well suited to cotton, grain sorghum, and wheat, and nearly all of the acreage is cultivated. When moisture is adequate, yields are moderate to high.

Tipton silt loam, 0 to 1 percent slopes (TpA).—This soil is nearly level and is in the lower part of broad, shallow draws. In places it has 10 to 20 inches of reddish-brown silt loam overwash on the surface. Included in the areas mapped as this soil are small adjacent areas of Carey loam, 0 to 1 percent slopes.

This Tipton soil is naturally fertile and easily tilled. The main problems in managing it are conserving moisture, maintaining good tilth, and controlling wind erosion. (Capability unit IIc-2; Mixed Land range site)

Tipton silt loam, 1 to 2 percent slopes (TpB).—This soil is gently sloping and is near the head of shallow draws. It is generally 35 to 40 inches deep. In some places the reddish-brown deposit on the surface is thinner than that on Tipton silt loam, 0 to 1 percent slopes. In other places there is no deposit. Included in the areas mapped as this soil are small areas of Carey loam, 1 to 3 percent slopes.

The risk of erosion by wind and water is slight on this Tipton soil. Keeping plant residue on the surface as a stubble mulch is an effective way of controlling erosion. Terraces and contour farming also help reduce water erosion. (Capability unit IIe-1; Mixed Land range site)

Tivoli Series

In the Tivoli series are deep, light-colored, loose sands that were deposited by wind. The soils are undulating to rolling and consist partly of stabilized dunes. They are gently sloping to moderately steep.

In most places the surface layer is brown, loose fine sand about 10 inches thick. Below the surface layer is reddish-yellow, loose fine sand. The uppermost 2 feet is slightly lighter colored than the material below.

The color of the surface layer ranges from brown to grayish brown. The color of the underlying material ranges from light yellowish brown to reddish yellow.

These sandy soils absorb the water from rain as it falls. Their internal drainage is very rapid. Natural fertility and the water-holding capacity are very low.

The Tivoli soils are more undulating than the Brownfield soils, and they lack a subsoil of sandy clay loam. They are more sandy than the associated Miles soils, and they are more undulating or rolling than those soils.

The Tivoli soils are too susceptible to wind erosion to be used for anything other than range. The main vegetation is shin oak, but these soils are capable of supporting tall grasses.

Tivoli fine sand (5 to 20 percent slopes) (Ts).—This is the only Tivoli soil mapped in the county. Mapped with it are small, irregularly shaped areas of Brownfield fine sand and a few small areas of soils in concave depressions between the dunes. The soils in the depressions have a

layer of light sandy clay loam, 2 to 6 inches thick, below a depth of 42 inches.

Yields of native mid and tall grasses are fair to good on this Tivoli soil. If maximum yields of forage are to be obtained, however, the shin oak must be controlled. (Capability unit VIIe-1; Deep Sand range site)

Travessilla Series

The Travessilla series consists of gravelly sandy loams that are shallow over conglomerate rock or sandstone. These soils are on prominent ridges in the western part of the county. The soils on the tops of the ridges are gently sloping to strongly sloping, and those on the sides are moderately steep to steep. Large areas of conglomerate rock and sandstone outcrop on the steeper slopes.

In most places the surface layer is about 6 inches thick. It is brown gravelly sandy loam that is about 15 to 20 percent, by volume, angular quartzitic pebbles.

These soils range from 2 to 10 inches in thickness and from loam to gravelly sandy loam in texture. Their color ranges from reddish gray to dark brown.

Surface drainage is rapid. The capacity to hold water and plant nutrients is low. The Travessilla soils are similar to the associated areas of Gravelly land. They are shallow, however, over conglomerate rock or sandstone.

These soils are used only for range. Side-oats grama and black grama are common grasses, and catclaw is a common brushy plant. In this county Travessilla soils are mapped only in a complex with the Vernon soils.

Travessilla-Vernon complex (5 to 50 percent slopes) (Tv).—Travessilla soils make up about half of this complex, and Vernon soils make up the rest. The soils are on ridges or escarpments above gently sloping, deeper soils in the western and southwestern parts of the county.

The Travessilla soils are on the tops and upper sides of the ridges, and the Vernon soils are at the foot of the ridges or escarpments. The Vernon soils vary in depth and are gullied in places.

Where these soils are used for range, yields of forage are low. Careful management is needed to maintain a good cover of grass and to obtain maximum yields. (Travessilla soil, capability unit VIIs-1 and Very Shallow range site; Vernon soil, capability unit VIe-1 and Shallow Redland range site)

Treadway Series

In the Treadway series are soils that are generally calcareous, red, and clayey. These soils formed in alluvium and are on alluvial fans or flood plains below outcrops of clayey red beds.

The surface layer of these soils is clay that ranges from reddish brown to red in color and from clay through silty clay to clay loam in texture. The soils range from strongly calcareous to noncalcareous and have platy structure from the surface on down. They are 35 to 100 inches deep over undisturbed red-bed material.

These soils are well drained; however, the surface seals over quickly and as a result, little moisture enters the soils. Permeability is very slow. The soils are seldom wet to a depth of more than 10 inches.

The Treadway soils formed in alluvium rather than in clayey red-bed material like the Vernon and Tillman

soils. Also the Treadway soils are stratified, and the Tillman and Vernon soils are not.

These soils are not suitable for cultivation. In some places where they are in range, the surface has sealed over and is bare.

Treadway clay (0 to 1 percent slopes) (Tw).—This is the only Treadway soil mapped in the county, and it occupies only a small acreage in the eastern part of the county. This soil is on flood plains and foot slopes below outcrops of clayey material. It occurs only in areas of soils formed in clayey red-bed material.

Small areas of adjacent eroded soils, formed in clayey red-bed material, are included in the areas mapped as this soil. Also included are small areas of less clayey soils formed in alluvium.

If this Treadway soil is protected so that clayey material will not be deposited on it, the cover of grass can be improved. Using management that controls erosion on the higher lying, clayey soils from which the clayey material is derived will protect this Treadway soil. Also, diversion terraces may be used to divert the clayey deposits, and grazing should be deferred for a lengthy period. If livestock are not allowed to graze, the growth of the native grasses will improve, and the amount of plant litter on the surface and the water intake rate will increase. (Capability unit VIc-2; Deep Hardland range site)

Vernon Series

The Vernon series consists of reddish-brown, calcareous clayey soils that are shallow over clayey red beds. These soils are gently sloping to strongly sloping and are in convex areas.

In most places the surface layer is reddish-brown clay loam about 5 to 6 inches thick. Generally the subsoil is reddish-brown to red clay about 10 to 15 inches thick. The substratum is compact red clay and contains thin strata of blue shaly clay.

The profile of these soils ranges from 6 to 25 inches in thickness. In most places these soils are calcareous to the surface, but in a few spots they are noncalcareous.

Surface drainage is good, but permeability is slow. The capacity to hold water and plant nutrients is limited.

In this county the Vernon soils are mapped only in complexes with the Tillman and Travessilla soils and with areas of Badland. They are shallower than the Tillman soils, and they lack the thick zone of lime accumulation that is typical in the Weymouth soils. The Vernon soils are more clayey than the Quinlan soils, and they developed over more clayey red beds.

The Tillman soils are used mainly for range. In areas where they are the thickest, however, such crops as small grains are grown.

Vernon-Badland complex (5 to 50 percent slopes) (Vb).—About 80 percent of this complex consists of Vernon soils that have slopes of more than 5 percent, 15 percent is Badland, and 5 percent is clayey material and islands of less sloping Vernon clays and Vernon clay loams. The areas of Badland consist of clayey material of the red beds. They contain little or no soil material and occur as escarpments on the higher rims within this complex.

The Vernon soils are the most productive part of the complex and are used for range. Little or no vegetation

grows on the areas of Badland. (Vernon soil, capability unit VIc-1 and Shallow Redland range site; Badland, capability unit VIIIc-1 and not placed in a range site)

Weymouth Series

The Weymouth series consists of reddish-brown, calcareous clay loams that are gently sloping to strongly sloping. The slopes are convex. These soils are on ridges in the uplands, surrounded by large areas of deep soils formed in red-bed material and by deep soils formed in old alluvium.

In most places the surface layer is reddish-brown light clay loam about 6 inches thick. It is strongly calcareous and has weak, fine, granular structure.

Generally the subsoil is reddish-brown light clay loam that has weak, coarse, prismatic structure and weak to moderate, fine, subangular blocky structure. It is strongly calcareous and is about 9 inches thick.

The uppermost 20 inches of the substratum is reddish-brown light clay loam; 15 to 20 percent, by volume, is soft lime. The lower part of the substratum is red clay in which the content of segregated lime decreases with increasing depth.

The surface layer ranges from 5 to 11 inches in thickness and from reddish brown to brown in color. It ranges from weakly calcareous to strongly calcareous. The thickness of the subsoil ranges from 6 to 18 inches. In places the layer of lime accumulation in the substratum is 12 to 24 inches thick. The profile ranges from 11 to 29 inches in thickness.

These soils are well drained and moderately permeable. Their capacity to hold water and plant nutrients is limited, however, by the clayey material near the surface.

The Weymouth soils have a more granular structure and are less clayey than the Vernon soils. Also, they have a distinct layer of lime accumulation that is lacking in the Vernon soils. The Weymouth soils are less deep and more permeable than the associated Tillman and Wichita soils.

About half of the acreage is cultivated. Small grains are grown more extensively than row crops, but some cotton and sorghum are grown. The soils are well suited to range plants, and about half of the acreage is in range.

Weymouth clay loam, 1 to 3 percent slopes (WcB).—This soil is on convex ridges. It lies between the soils formed in red beds and the less sloping soils formed in old alluvium and is encircled by those soils in some places.

Included in the areas mapped as this soil are small areas of soils that have a slightly more clayey subsoil. These included soils are transitional from Weymouth to Tillman soils.

The water intake rate is moderate, and this soil is easily tilled. Water erosion is a moderate hazard. About 55 percent of the acreage is cultivated, but the shallow root zone and the moderate water-holding capacity limit crop production. Wheat and other crops that grow in cool seasons are better suited than crops that mature in summer. If moisture is adequate, however, crops that mature in summer make fair to good yields. (Capability unit IIIc-7; Shallow Redland range site)

Weymouth clay loam, 3 to 5 percent slopes (WcC).—In cultivated areas this soil has been thinned by water erosion. The profile is generally 2 to 3 inches thinner than

that of Weymouth clay loam, 1 to 3 percent slopes. Common, fine to coarse caliche pebbles are on the surface.

About 38 percent of the acreage is cultivated. Limitations are about the same as those on the less sloping Weymouth soils, but the hazard of water erosion is greater. Such practices as terracing and contour farming are needed to control erosion. In addition, a mulch of small-grain stubble or cotton burs is desirable. (Capability unit IVe-2; Shallow Redland range site)

Wichita Series

In the Wichita series are deep, reddish-brown soils of the uplands. These soils are nearly level to moderately sloping.

In most places the surface layer is reddish brown and is about 6 inches thick. It has weak granular structure. In cultivated areas the entire surface layer is in the plow layer.

Generally the subsoil is about 30 inches thick and has medium blocky structure. The upper part is reddish brown; above a depth of about 24 inches, it contains more clay than the lower part. The lower part is weakly calcareous, reddish-brown to red light clay to sandy clay loam.

The substratum is calcareous clay loam alluvium. The upper part contains soft masses of lime.

The surface layer ranges from 5 to 15 inches in thickness and from clay loam to fine sandy loam in texture. The subsoil ranges from 20 to 50 inches in thickness, depending on the depth of the alluvium over red-bed material. In the areas where the surface layer is fine sandy loam, the subsoil is sandy clay.

Surface drainage is good, but these soils have moderately slow permeability in the subsoil. Their water-holding capacity is good.

The Wichita soils are more reddish than the Abilene soils and are less clayey than the Tillman soils. They formed in old alluvial material, rather than in red-bed material like that in which the Tillman soils formed. The Wichita soils are more clayey and have a more slowly permeable subsoil than the Miles soils, and they are deeper and more slowly permeable than the Weymouth soils.

Most of the acreage of Wichita soils is cultivated. These soils are suited to grain sorghum, forage sorghum, small grains, and cotton.

Wichita clay loam, 0 to 1 percent slopes (WmA).—This is a deep, fertile soil of the uplands. It is nearly level. In most places there is little danger of water erosion, but there is a slight hazard on long slopes of about 1 percent. Included in the areas mapped as this soil are small areas of Abilene clay loam, 0 to 1 percent slopes.

This soil is well suited to cotton, sorghum, and small grains. Conserving moisture is the main problem in managing it. Such practices as stubble mulching, terracing, and contour farming help to conserve moisture. Also, keeping plant residue on the surface reduces crusting and helps to maintain the content of organic matter. (Capability unit IIc-4; Deep Hardland range site)

Wichita clay loam, 1 to 3 percent slopes (WmB).—This soil is deep and generally has slopes of about 2 percent. Small areas are moderately eroded. Mapped with this soil are small areas of Weymouth clay loam, 1 to 3 percent slopes, on narrow ridges.

This Wichita soil is well suited to small grains, cotton, and sorghum; however, water erosion is a moderate hazard. The chief management problems are controlling erosion, conserving moisture, and maintaining good tilth. Good tilth is necessary to insure the maximum intake of rainfall and to prevent crusting. Terraces and contour farming reduce erosion; a surface mulch of crop residue helps to increase the water intake rate, and crop residue on the surface reduces crusting and helps to maintain good tilth. (Capability unit IIIe-2; Deep Hardland range site)

Wichita fine sandy loam, 0 to 1 percent slopes (WfA).—This soil is in nearly level, convex or slightly concave areas in the uplands. Its surface layer is fine sandy loam about 12 inches thick. Wind erosion is a moderate hazard. Included in the areas mapped as this soil are small areas of Miles fine sandy loam, 0 to 1 percent slopes.

Most of the acreage is cultivated. This soil is well suited to cotton, small grains, and sorghum, but cotton is the main crop. (Capability unit IIIe-4; Sandy Loam range site)

Wichita fine sandy loam, 1 to 3 percent slopes (WfB).—This soil is gently sloping and occupies convex areas. The surface layer is generally about 6 inches thick. In a few small areas, however, about half of the surface layer has been removed by wind or water erosion.

This soil takes in water readily, but it is moderately susceptible to further erosion by wind and water. Unless an adequate cover of growing plants or plant residue is kept on the surface in winter and early in spring, wind erosion may cause serious damage. Terraces and contour farming help control water erosion in the more sloping areas.

This soil is suited to cotton, small grains, and sorghum, but cotton is the main crop. (Capability unit IIIe-4; Sandy Loam range site)

Wichita fine sandy loam, 3 to 5 percent slopes, eroded (WfC2).—This soil is on strongly sloping, convex uplands. It is less deep than the less sloping Wichita fine sandy loams. In most places erosion has removed about half of the surface layer. In the steeper areas all of the surface layer has been removed.

This soil is moderately susceptible to further wind erosion and highly susceptible to further water erosion. It is suited to sorghum and to small grains, such as wheat and rye. The residue from these crops, if kept on the surface by using stubble-mulch tillage, will help to control further erosion. Terracing and contour farming also are needed to control erosion. (Capability unit IVe-3; Sandy Loam range site)

Wichita loam, 0 to 1 percent slopes (WhA).—This soil of the uplands has a surface layer that is about 7 inches thick. The hazard of erosion is slight. Included in the areas mapped as this soil are small areas of a slightly more sloping Miles fine sandy loam.

This Wichita soil is suited to cotton, small grains, and sorghum. Conserving rainfall and maintaining good tilth are the chief aims in managing it. Crop residue kept on the surface adds organic matter and helps to maintain tilth. Also it generally increases the water intake rate. Such practices as terraces and contour farming conserve moisture. (Capability unit IIc-2; Deep Hardland range site)

Wichita loam, 1 to 3 percent slopes (WhB).—This soil is gently sloping and is in convex areas. Runoff has caused moderate erosion in small areas. Included in the areas mapped as this soil are small areas of Miles fine sandy loam, 1 to 3 percent slopes.

This Wichita soil is well suited to small grains, sorghum, and cotton. It is easily tilled and has moderate to high natural fertility. The risk of wind erosion is slight. The risk of water erosion is slight to moderate. (Capability unit IIe-1; Deep Hardland range site)

Woodward Series

The Woodward series consists of moderately deep, reddish-brown soils formed in calcareous, sandy or silty material of the red beds. These soils are gently sloping to strongly sloping and are on rolling uplands in the central part of the county.

In most places the surface layer is about 20 inches thick. It is reddish-brown, strongly calcareous loam.

Generally the subsoil is yellowish-red, strongly calcareous loam. It has very weak subangular blocky and granular structure. Below the subsoil is calcareous, sandy and silty material of the red beds.

The surface layer ranges from 8 to 26 inches in thickness, from reddish brown to yellowish red in color, and from very fine sandy loam to loam in texture. The subsoil generally ranges from 10 to 20 inches in thickness, but in areas where the subsoil consists of two layers, it is as much as 40 inches thick. The subsoil ranges from reddish brown to yellowish red in color and from loam to very fine sandy loam in texture. The profile ranges from 24 to 54 inches in thickness.

The Woodward soils are well drained. Their capacity to hold water and plant nutrients is fair, but it is limited by the small amount of clay in the surface layer.

The Woodward soils are deeper than the Quinlan soils, and they are less clayey than the Weymouth soils. Woodward soils are shallower and more calcareous than the Carey soils, and their subsoil contains less clay.

Woodward soils are well suited to range. In cultivated areas cotton and sorghum are the main crops.

Woodward loam, 1 to 3 percent slopes (WoB).—This soil is gently sloping and is in convex areas. Its subsoil contains slightly more clay than that of Woodward loam, 3 to 5 percent slopes.

Included in the area mapped as this soil are small areas of Woodward-Quinlan loams, 1 to 3 percent slopes, along the crests of ridges.

Most of the acreage is cultivated, and cotton and sorghum are the main crops. This soil is also productive of native grass.

Erosion by wind and water is a slight hazard, and terraces and contour farming are practices that help to control erosion. In addition, keeping crop residue on the surface controls wind erosion and helps to conserve moisture. (Capability unit IIe-1; Mixed Land range site)

Woodward loam, 3 to 5 percent slopes (WoC).—This soil is in convex areas in the central part of the county. It is moderately sloping, has a more sandy profile, and is slightly shallower than the Woodward loam that has slopes of 1 to 3 percent. Included in the areas mapped as this soil are small areas of shallow soils.

This Woodward soil is easily tilled and has moderate natural fertility. It is readily penetrated by plant roots, air, and moisture. The hazard of wind erosion is slight, but that of water erosion is moderate to high. More than half of the acreage is still in native grass. (Capability unit IIIe-3; Mixed Land range site)

Woodward-Quinlan loams, 1 to 3 percent slopes (WwB).—This complex occupies convex areas within areas of Carey and Woodward loams. The soils are so intermingled that it was not practical to map them separately. Woodward soils make up about half of the acreage, and Quinlan soils make up the rest.

The subsoil of these soils contains slightly more clay than that of the more sloping Woodward and Quinlan loams. The average depth of the soils is about 18 to 20 inches, but the depth ranges from 4 inches in the shallowest part of the Quinlan soil to 30 inches in the deepest part of the Woodward soil.

About half of the acreage is cultivated, and in the cultivated areas thin fragments of weakly cemented sandstone have been turned up by plowing. The main cash crops are cotton and sorghum. These soils are slightly susceptible to water erosion, but most areas are protected by terraces. Growing crops that produce a large amount of residue help to reduce erosion. The soils are well suited to range. (Capability unit IIIe-3; Mixed Land range site)

Woodward-Quinlan loams, 3 to 5 percent slopes (WwC).—The soils of this complex are on ridges and points of ridges in the central part of the county. They are closely associated with Carey and other Woodward soils. Woodward loam makes up 50 to 75 percent of the acreage, and Quinlan loam makes up the rest. The profile of the Woodward soil ranges from 20 to 30 inches in thickness. The soils of this complex are more eroded than those in Woodward-Quinlan loams, 1 to 3 percent slopes.

About half of the acreage is cultivated, and sorghum and cotton are the main cash crops. These soils are moderately susceptible to water erosion and are better suited to perennial grasses than to tilled crops. Production is low in a few areas where erosion has thinned the surface layer so that the weakly cemented sandstone below the Quinlan soil is exposed.

Such practices as terracing and contour farming are needed to control erosion on these soils. Crops should be grown that produce a large amount of residue. (Capability unit IVe-3; Mixed Land range site)

Woodward-Quinlan loams, 5 to 8 percent slopes (WwD).—The soils of this complex are on narrow, curving ridges, mainly on the side slopes below the tops of the ridges. Generally Quinlan soils make up only 25 to 35 percent of the acreage, but in places they make up 50 percent or more. The rest of the acreage is Woodward loam.

The areas that have been cultivated are moderately to severely eroded. Sandy red-bed material is exposed in many places in the Quinlan soils.

More than 80 percent of the acreage is in range. Many areas that were cultivated have been abandoned, and native grasses now cover part of those areas. The risk of erosion is too high for these soils to be safely cultivated. Terraces can be constructed, but the steep slopes require closely spaced terraces, which are difficult to maintain. Erosion can be controlled by keeping these soils in perennial vegetation. (Capability unit VIe-4; Mixed Land range site)

Yahola Series

In the Yahola series are reddish-brown, calcareous, moderately coarse textured soils. These soils formed in alluvium on the flood plains of streams that drain the county. They are highly stratified soils of the bottom land.

In most places the surface layer is reddish-brown, strongly calcareous very fine sandy loam about 18 inches thick.

Generally the subsoil is reddish-brown, strongly calcareous very fine sandy loam about 40 inches thick. It contains many thin layers of light-brown loamy fine sand.

In many places the underlying material is much like the material in the subsoil. It contains strata of loamy fine sand that are thicker and more numerous than those in the subsoil. In most places the Yahola soils in this county are underlain by a buried soil at a depth of about 5 feet.

The surface layer ranges from dark reddish brown to brown in color and from 15 to 24 inches in thickness. The thickness of the subsoil ranges from 15 to 50 inches. The subsoil contains strata of various textures.

These soils are subject to occasional overflow. Internal drainage is good, but the subsoil of loamy fine sand lowers the capacity to hold moisture and plant nutrients.

Yahola soils are more sandy and are more stratified than the Spur soils. They are less stratified and less frequently flooded than the areas of Loamy alluvial land in this county.

About 45 percent of the acreage is cultivated, and the main cash crops are cotton and sorghum. These soils are also well suited to range.

Yahola very fine sandy loam (0 to 1 percent slopes) (Yc).—This is the only Yahola soil mapped in the county. Generally it has slopes of 1 percent or less, but areas that have short, steeper slopes are included. Also included in the areas mapped as this soil are small areas of Spur silt loam.

Wind erosion is a slight hazard on this Yahola soil, but water erosion is negligible. This soil is suited to sprinkler irrigation. (Capability unit IIc-3; Loamy Bottom Land range site)

Use and Management of the Soils

This section first describes basic management practices for soils in cultivated crops and pasture. Then the system of capability grouping is defined; the use and management of the soils in each capability unit are discussed; and predicted average acre yields of dryland wheat, grain sorghum, and cotton are given. Finally, the use and management of the soils for range, wildlife, and engineering purposes are discussed.

The suggestions for use and management must be interpreted with judgment, for a soil cannot always be used and managed by itself. Generally, several soils occur together in one field, and all the soils in the field, though they have different characteristics, are farmed together. A steep or shallow soil, for example, is generally unsuitable for cultivation. It may be farmed, however, because it occupies only a small area in a field made up mainly of soils that are suitable for cultivation. The use of the soils, the kinds of crops that are grown, and the practices used to

control erosion must be adjusted to each individual farm or ranch. Factors that affect the use and management are the way the soils have been cropped in the past, the amount of erosion that has occurred, and the response of the soils to management.

Management of Soils in Crops and Pasture

The soils used for crops and pasture in Fisher County are generally dry farmed or in range, and less than 1 percent of the cultivated land is irrigated. Most of the cultivated acreage that is irrigated is along the north side of the Clear Fork of the Brazos River. In that area many farmers grow irrigated crops on tracts 15 to 20 acres in size, and recently several farmers have established irrigated pastures of Coastal bermudagrass. The county had a total of 23 irrigated farms in 1959, and in that year irrigated crops were harvested on a total of 1,163 acres. There were 80 irrigation wells in the county at the time the soil survey was made, and the yield of water from these wells ranges from about 50 to 700 gallons per minute. The wells southeast of Rotan generally yield about 400 gallons per minute.

The amount of irrigated acreage so far has been small because water is not available in many areas, even though the soils are suitable for irrigation. In some areas the available water is of poor quality and would harm the soils. The main harmful salts in the water are sodium chloride (table salt), sodium sulfate (glauber salt), magnesium sulfate (epsom salts), and sodium bicarbonate (baking soda). Other salts that are present in large quantities, but that are not harmful, are calcium sulfate, calcium carbonate, and magnesium carbonate. Water that is used for irrigation should be analyzed before it is used.

Row and sprinkler irrigation are the two types of irrigation used in this county. Row irrigation requires fairly level land, and land leveling is generally necessary before that system can be used. Sprinkler irrigation works satisfactorily on gently sloping areas and is generally the only type suitable for the more sandy soils.

Although the irrigated acreage is small, yields under irrigation are generally at least two or three times as high as those obtained under dryland farming. The common yield of cotton is normally 1 to 1½ bales under irrigation, but sometimes it is higher. More information on irrigation can be obtained from technicians of the Soil Conservation Service who serve the Upper Clear Fork Soil Conservation District.

No matter whether the soils are irrigated or dry farmed, the problems caused by climatic limitations and the limitations of low fertility and poor tilth are interrelated. Water erosion, for example, starts whenever rain falls faster than it can enter the soil; the rate of entry is determined by the texture and structure of the soil and by the amount of vegetation or plant residue on the soil surface. The permeability of the subsoil generally controls the movement of water from the surface layer down through the profile. When this movement is slow, the excess water remains on the surface and begins to move downhill. As it moves, it causes sheet or gully erosion.

Sheet erosion occurs, to a certain extent, any time there is runoff, but it is less noticeable than rill and gully erosion. Rill and gully erosion are easily observed. They occur when the water concentrates as it moves downhill.

The steeper the slope, the greater the hazard of erosion. The hazard of water erosion is greatest late in spring and early in summer. Water erosion is a continuous threat, however, through the month of October.

Each time the soil is plowed or there is any compaction, the normal structural arrangement of the soil particles is damaged. Also, the exposure and reexposure of the soil material to high temperatures reduces the content of organic matter, which was high when the soils were still under grass. When the content of organic matter is reduced, the tilth of the soil deteriorates. Then, if the surface layer is left bare, the impact of raindrops damages the structure and a crust is likely to form. The soil material in this crust is so tightly packed that water is no longer taken into the soil. As a result, runoff is increased and water erosion takes place.

Wind erosion is likely to occur whenever the surface layer is not protected by a cover of growing plants or plant residue. The coarse-textured soils have only a moderate natural supply of plant nutrients. A relatively short period of cropping may reduce this supply materially, especially if all of the plant cover is removed. As the supply of plant nutrients dwindles, less residue is produced by growing crops, and erosion becomes a more serious threat.

Wind erosion also occurs when the surface soil is broken into individual small particles, as is likely to happen in sandy, structureless soils or in the more clayey soils that have been tilled for a number of years. The hazard of wind erosion is slight on the medium-textured and fine-textured soils. It is moderate on the moderately coarse textured soils and high on the coarse-textured soils. Wind erosion is most critical late in fall, in winter, and early in spring.

Control of erosion

Among the practices needed for controlling erosion are management of crop residue, tillage for control of wind erosion, terracing and contour farming, use of a suitable cropping system, and use of fertilizer. The application of these practices to specific soils or groups of soils is discussed under the capability units in the section "Management of Soils by Capability Units."

MANAGEMENT OF CROP RESIDUE

Proper management of crop residue helps to conserve moisture, to maintain the content of organic matter, and to improve tilth. The main objective, however, is the control of wind erosion. There are three methods of managing residue to achieve these ends. These are stubble mulching, use of crop residue, and mulching.

Stubble mulching consists of tilling, planting, and harvesting crops in such a way that most of the crop residue remains on the surface throughout the year. This residue reduces erosion by wind and water and loss of moisture through evaporation. In Fisher County the principal crops that are stubble mulched are wheat, grain sorghum, and sudangrass.

Mulching consists of applying cotton burs or other residue in amounts large enough to control erosion. This material also conserves moisture.

Use of crop residue, the third method of residue management, is similar to stubble mulching in that crop residue is left on the surface of the soil throughout the critical erosion period. The crop residue is managed so that it

protects the soils when the surface is not protected by a growing crop. The residue of any of the crops commonly grown in the county may be left, but the residue of the crops that produce the most top growth is the most suitable.

TILLAGE AND THE CONTROL OF EROSION

Keeping tillage to a minimum and tilling when the soils contain the proper amount of moisture are important in the control of erosion. Frequent tillage destroys the granular structure of the plow layer. It causes the content of organic matter to decrease unless adequate crop residue is returned to the soils. As a result, the numerous natural pores and channels through which water and air move into the soil are closed. When rain falls on such a soil, the surface soil runs together and forms a crust that reduces the amount of water that enters the soil. Then, the crop is damaged by the lack of moisture and the lack of aeration. Also, the soil is more susceptible to water erosion.

If a soil is tilled when it is too wet, a compact layer is likely to form just below the plow layer. This layer is called a plowpan or tillage pan. In some soils it reduces the rate at which water moves through the soil by as much as 90 percent, and the roots of plants may not be able to penetrate it. As a result, the plant is unable to fully utilize the plant nutrients and moisture that are stored in the soil. Less top growth is produced, and erosion is likely to increase.

Soils in good tilth are easily worked because they have granular structure, are crumbly and porous, and retain their desirable structure when wet. Air and the water from rainfall move readily into such soils, and a large part of the moisture is stored below the zone of evaporation. This storage of moisture in the soil is a desirable and efficient way of reducing erosion.

The tilth can be improved or desirable tilth can be maintained and erosion controlled by the continuous use of crop residue. The residue is most effective when it is left as a mulch on the surface. In this climatic zone, however, it is sometimes not feasible to keep a cover of crops or crop residue on the surface at all times. Deep plowing and emergency tillage are supplemental measures that can be used to provide temporary control of wind erosion.

Deep plowing is a method of increasing the clay content of the surface layer of some coarse-textured soils enough so that clods will form. It is adapted to the highly erodible loamy fine sands that have a subsoil of sandy clay loam. By plowing to a depth of about 16 to 24 inches, from 4 to 8 inches of the sandy clay loam is brought to the surface. Tillage mixes the more clayey material with that in the surface layer, but enough clods are left to provide resistance to wind erosion. The benefits from deep plowing last only a few years.

Deep plowing should be practiced only on soils that have slopes of less than 2 percent. Where the soils have stronger slopes, water erosion occurs if deep plowing is done. In areas where deep plowing is practiced, it is necessary to grow soil-improving crops and crops that produce a large amount of residue.

Emergency tillage should be resorted to only when there is immediate danger of damage by wind erosion. Its purpose is to roughen and clod the surface so that the soils will resist blowing. The effect is temporary. Rain, snow, or wind may destroy many of the clods and make it necessary to repeat the tillage operation. Listers, chisels, or stalk

cutters are among the kinds of farm machinery used for emergency tillage. Tillage should be done on the contour, or it should be done at right angles to the direction of prevailing winds where the soils are sandy.

TERRACING AND CONTOUR FARMING

Terracing and contour farming help to conserve moisture and to control water erosion. Conserving moisture is extremely important in this area of low rainfall, and control of water erosion is important on the sloping soils. The terrace system needs to be designed so that it fits the specific soils and topography. The cost must be considered in relation to the returns (fig. 6).

Contour farming consists of plowing, planting, and tilling across the slope. It is frequently used in areas where there is a gentle slope. Commonly, the areas between terraces are farmed on the contour, and the rows are run parallel to the terraces.

CROPPING SYSTEMS AND ROTATIONS

A good cropping system provides enough high-residue crops and other protective crops to control erosion. It also includes soil-improving crops that help to keep the soil in good tilth and reasonably fertile. The farmers and ranchers of this county have a somewhat limited choice among crops that can be used in a beneficial rotation. Because of the low rainfall, only a few crops are suited to this area. The crops that are grown must be able to withstand drought. Many of the crops that are suitable for this area, however, are not profitable enough to justify growing them extensively.

Cotton is the main cash crop in this county, and it is grown particularly on the areas of mixed soils. The amount of residue produced by cotton is comparatively low, and as a result, this crop does not provide much protection from erosion. Because of the lack of residue and the tillage required for producing each crop of cotton, the soil tilth deteriorates and losses from erosion increase when that crop is grown. Therefore, a crop that improves the soils, preferably one that will produce a large amount of residue, should be grown in rotation with cotton.

Small grains, forage sorghum, grain sorghum, and

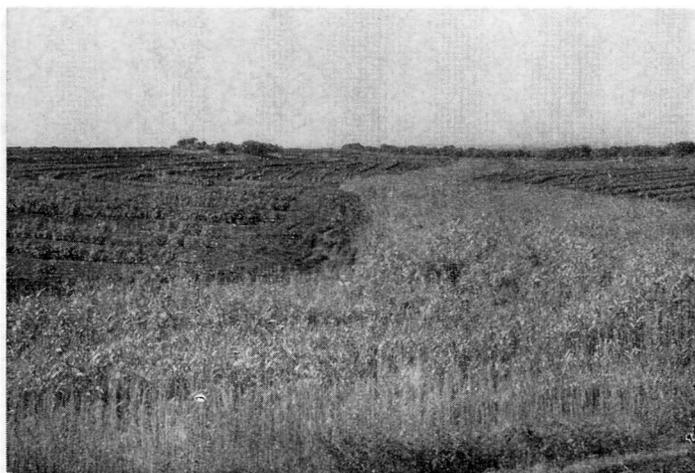


Figure 6.—A terrace system and a grassed waterway that safely remove excess water.

sudangrass are soil-improving crops if they are properly managed. Good management consists of fertilizing the crop and returning the residue to the soil; applying fertilizer to the residue and returning the residue to the soil; and mixing the residue with the soil as a green-manure crop.

The cropping system should include enough high-residue crops and other protective crops to control erosion effectively and to maintain desirable soil tilth. To be effective, the crops should be grown with the proper spacing, in the proper season, and with the proper frequency. Legumes may be grown when there is enough moisture for moderate to high yields. Soils that are sloping, shallow, coarse textured, or low in fertility require more frequent use of high-residue and soil-improving crops in the cropping system than other soils.

Stripcropping, a practice used with rotation of crops, consists of alternating strips of crops that provide enough cover to control erosion with strips of crops that do not. The crop that provides control of erosion may be either a tall crop or a close-growing crop. These barriers of vegetation are most effective in reducing erosion by wind. For best control of soil blowing, the strips should be run at right angles to the direction of prevailing winds. For protection against water erosion, the strips should be on the contour.

Cover crops are close-growing crops planted mainly for the purpose of improving the soils and protecting them against wind and water erosion. Such crops are sudangrass, legumes, small grains, and forage sorghum. Ordinarily, cover crops are grown for 1 year or less, or for one season. Then they may be plowed under as a green-manure crop. Frequently, they are fertilized so that they will produce the optimum amount of top growth. The residue is left on or near the surface during the next critical erosion period. Fertilizer is sometimes added to the residue to aid decomposition when the residue is returned to the soil. Many of the farmers in Fisher County have learned that a larger amount of residue can be obtained from nonleguminous crops than from legumes.

USE OF FERTILIZER

Except for the sandy soils, the soils of this county have fairly high natural fertility. Leaching of the soil minerals has been slight. The results of laboratory testing indicate that the plant nutrients most lacking are nitrogen and phosphorus.

On many of the soils, the use of commercial fertilizer for all cash crops may not be profitable, because the low rainfall may limit the benefits that would normally be expected. Furthermore, before it can be learned whether fertilizing dryland crops is practical, it will be necessary to observe for a longer period the results obtained by farmers when they apply commercial fertilizer to dryland crops.

On the fine-textured and medium-textured soils of the county, the main return from applying fertilizer to small grains is an increase in the amount of top growth available for winter grazing. Good response to commercial fertilizer has also been obtained on the moderately coarse textured and coarse textured soils. During some of the wetter years, crops that grow in summer have responded well to fertilizer.

All of the crops grown under irrigation respond well to fertilizer. Before any commercial fertilizer is applied, however, the kind and amount of fertilizer required for the specific soil and for the crop to be grown should be determined at a soil-testing laboratory. Up-to-date information about the kinds of fertilizer to use and the rates of application can be obtained from the county agricultural extension agent, or from a local representative of the Soil Conservation Service who provides technical assistance for the Upper Clear Fork Soil Conservation District.

Seeding grass in cultivated areas

Because of shifting sand, steep slopes, or shallow soil material, this county has a larger acreage of cultivated soils that are best suited to permanent grass. Such soils are highly susceptible to erosion. Further erosion will greatly reduce their potential for growing plants, and establishing native grass is the most feasible means of control. Also, grass may be more profitable than cash crops, for many of these soils produce only low yields of cash crops. Following are the names of the grasses best suited to different types of soils in the county:

Moderately fine textured soils—	Plains bristlegrass.
Blue grama.	Side-oats grama.
Buffalograss.	Western wheatgrass.
Side-oats grama.	Coarse-textured soils—
Western wheatgrass.	Indiangrass.
Medium-textured soils—	Sand bluestem.
Blue grama.	Sand lovegrass.
Buffalograss.	Switchgrass.
Canada wildrye.	Weeping lovegrass.
King Ranch bluestem.	

Care is needed in establishing native grasses on many of the soils because of the risk of erosion. The year before the seeding is done, a high-residue crop should be grown to provide a cover of litter in which to seed. Red-top cane is an example of a crop that will provide litter (fig. 7). It is an annual, and therefore will not take moisture from the grass seedlings. The stubble of sudan-grass or of a small grain will also provide litter and a cover.

New strains of grass are constantly being developed. For the latest information on suitable varieties and



Figure 7.—Seeding grass in little redtop cane.

methods of establishing grass, consult a technician of the Soil Conservation Service or the local county agent.

Management of soils by capability units

In this section the system of capability grouping is explained, the soils of the county are placed in capability units, and use and management is suggested for the soils of each unit. In planning management of the soils, the basic practices of management described in the preceding section are to be considered.

Capability groups of soils

The capability classification is a grouping that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, II*e*. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony, and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, II*e*-1 or III*e*-2. The capability units are not numbered consecutively in Fisher County, because not all of the capability units used in Texas are in this county.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and

without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use. (None in Fisher County)

Class II. Soils that have some limitations that reduce the choice of plants or that require moderate conservation practices.

Subclass IIe. Soils subject to moderate erosion if they are not protected.

Unit IIe-1. Deep, medium-textured, gently sloping soils that have moderate to moderately slow permeability.

Subclass IIc. Soils that have a moderate climatic hazard of low rainfall and are subject to moderate erosion if they are not protected.

Unit IIc-1. Deep, dark, moderately fine textured soils that are nearly level and have moderate permeability.

Unit IIc-2. Deep, medium-textured, nearly level soils of the uplands.

Unit IIc-3. Deep, medium-textured, nearly level soils on bottom lands.

Unit IIc-4. Deep, dark, moderately fine textured, nearly level soils that have moderately slow to slow permeability.

Unit IIc-5. Deep, moderately permeable, nearly level, loamy soils.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

Unit IIIe-1. Deep, reddish-brown, moderately fine textured, gently sloping soils that have slow permeability.

Unit IIIe-2. Deep, dark, moderately fine textured, gently sloping soils that have moderately slow permeability.

Unit IIIe-3. Deep to moderately deep, reddish-brown soils that are gently sloping and have moderate to moderately rapid permeability.

Unit IIIe-4. Deep, moderately coarse textured, moderately to slowly permeable, nearly level or gently sloping soils.

Unit IIIe-6. Shallow, medium-textured, nearly level soils that have moderate permeability.

Unit IIIe-7. Moderately deep, medium-textured, gently sloping soils that are moderately permeable.

Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.

Unit IIIs-1. Deep, reddish-brown, moderately fine textured, nearly level soils that are slowly permeable.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.

Unit IVe-2. Strongly calcareous, moderately permeable, gently sloping soils.

Unit IVe-3. Deep and moderately deep, reddish-brown, medium-textured to moderately coarse textured soils that are moderately sloping and have moderate to slow permeability.

Unit IVe-4. Deep, reddish-brown, moderately coarse textured soils that are moderately permeable and gently sloping.

Unit IVe-6. Deep, moderately permeable, nearly level to gently sloping soils that have a sandy surface layer.

Unit IVe-7. Shallow, gently sloping soils that have a surface layer of clay loam and moderately slow permeability.

Subclass IVw. Soils that have very severe limitations for cultivation because of excess water.

Unit IVw-1. Deep, clayey, very slowly permeable soils in depressed areas.

Class V. Soils not likely to erode that have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.

Unit Vw-1. Deep, loamy land types on first bottoms along streams.

Unit Vw-2. Deep, sandy soil material on the flood plains of rivers.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIe-1. Shallow, moderately fine textured, moderately sloping soils.

Unit VIe-2. Medium-textured, moderately permeable, moderately sloping soils.

Unit VIe-4. Deep and moderately deep, medium-textured, moderately sloping soils.

Unit VIe-7. Deep, sandy, undulating soils.

Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by moisture capacity, stones, or other features.

Unit VIs-1. Shallow, gravelly, moderately sloping land.

Unit VIs-2. Clayey soils formed in alluvium.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIIe-1. Deep, coarse-textured, undulating soils.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.

Unit VIIs-1. Very shallow, rough, stony soils.

Unit VIIs-2. Steep, loamy land.

Class VIII. Soils and landforms that, without major reclamation, have limitations that preclude their use for commercial production of plants and restrict their use

to recreation, wildlife, water supply, or esthetic purposes.

Subclass VIII. Rock or soil material that has little potential for production of vegetation.

Unit VIII-1. Rough and broken, shallow land.

CAPABILITY UNIT He-1

This unit consists of deep, medium-textured, gently sloping soils that have moderate to moderately slow permeability. These soils are—

- Carey loam, 1 to 3 percent slopes (CoB).
- Enterprise very fine sandy loam, 1 to 3 percent slopes (EnB).
- Tipton silt loam, 1 to 2 percent slopes (TpB)
- Wichita loam, 1 to 3 percent slopes (WhB).
- Woodward loam, 1 to 3 percent slopes (WoB).

These soils are easily tilled and are readily penetrated by moisture, air, and roots. Their natural fertility is moderate to high. The risk of wind erosion is slight, and the risk of water erosion is slight to moderate.

Cotton is the chief cash crop, but these soils are well suited to grain sorghum and to most of the other crops grown in this area. They are also well suited to native grasses.

The main problems in managing these soils are controlling erosion and conserving moisture. The best way to increase yields is to maintain good tilth, which conserves the moisture from rainfall.

The cropping system for these soils should include a crop that produces a large amount of residue, or a cover crop grown in rotation with clean-tilled crops. Crop residue kept on the surface conserves moisture and controls wind and water erosion. Terraces and contour farming can be used to reduce runoff. Where the amount of crop residue is not adequate to control erosion, use emergency tillage to roughen the surface.

CAPABILITY UNIT Hce-1

Only one soil, Spur clay loam (Sc), is in this capability unit. It is a deep, dark, smooth, nearly level, moderately fine textured soil of the bottom lands and is moderately permeable to water and roots.

This is a fertile soil. Its capacity for storing water and plant nutrients is high, and the hazard of erosion by wind and water is slight. Conserving the water from rainfall and maintaining desirable tilth in the plow layer are essential for high yields. Hence, it is most desirable to maintain a good supply of organic matter in this soil and to keep a cover of plants on its surface as much of the time as feasible. The plant cover increases the intake of water from rainfall.

Yields of general crops are moderately high on this soil. Cotton, grain sorghum, and wheat are the principal cash crops. A crop rotation that consists of these crops and of a legume will help to maintain yields. Peas or guar are suitable legumes to grow in summer, and Austrian winter peas may be grown in winter. Plant residue left on or near the surface helps to add organic matter. It also increases the water intake and reduces evaporation of soil moisture. Potential yields of native grass are high if good management is used.

CAPABILITY UNIT Hce-2

This unit consists of deep, dark, medium-textured, nearly level soil of the uplands. These soils are—

- Carey loam, 0 to 1 percent slopes (CoA).
- Enterprise very fine sandy loam, 0 to 1 percent slopes (EnA).
- Tipton silt loam, 0 to 1 percent slopes (TpA).
- Wichita loam, 0 to 1 percent slopes (WhA).

These are the most desirable general-purpose soils in the county. They are easily tilled, and their capacity for holding water and plant nutrients is high. The moisture they store is readily available to plants. Water erosion is negligible, and the risk of wind erosion is slight in cultivated areas.

Most crops suited to the climate can be grown successfully on these soils. Cotton and grain sorghum are the main crops, and some wheat is grown. Native grasses also do well if they are properly managed.

Farmers have learned that the main problems in managing these soils under dryland farming are conserving moisture from rainfall, maintaining good soil tilth, and controlling erosion. Maintaining the fertility of the soils is generally not a problem in most areas. Where these soils are dry farmed, a cropping system that includes a cover crop or a crop that produces a large amount of residue may be followed; or a mulch, such as cotton burs, should be applied. Residue from small grains and sorghum is most beneficial if it is kept as a stubble mulch. This residue conserves moisture by increasing the intake of water and reducing runoff; it also helps to control wind erosion. In some areas where there is runoff, terraces and contour farming will conserve moisture and control erosion. If enough residue is not available for controlling erosion, use emergency tillage to roughen the surface.

Where water is available, these soils are well suited to row irrigation. If the soils are irrigated, the management practices are similar to those suggested for dryland farming, except that legumes should be included in the rotation. Fertilizer is needed for continuous high yields. The kind and amount should be determined by soil tests. Proper use of irrigation water is needed for maximum production.

CAPABILITY UNIT Hce-3

This unit consists of deep, medium-textured, nearly level soils of bottom lands that are flooded occasionally. These soils are—

- Spur silt loam (Sp).
- Yahola very fine sandy loam (Ya).

These soils are relatively fertile and are permeable to water, air, and roots. They are slightly susceptible to wind erosion. To control wind erosion, maintain a good supply of organic matter in the surface layer, and keep an adequate cover of plants or plant residue on the surface in winter.

Cotton and grain sorghum are the main crops grown on these soils, and yields are moderate to high. Native grasses also produce well.

A cropping system that includes a cover crop, or crops that produce a large amount of residue used as mulch, helps to maintain yields. Farmers have found that growing summer legumes, such as peas and guar, improves the yields of crops that follow. Fertilizer applied according to the results of soil tests generally increases yields of field crops and forage crops, except in dry years.

CAPABILITY UNIT IIc-4

In this unit are deep, dark, moderately fine textured, nearly level soils. These soils are—

Abilene clay loam, 0 to 1 percent slopes (AbA).
Wichita clay loam, 0 to 1 percent slopes (WmA).

The natural fertility and water-holding capacity of these soils are high, but the slow to moderately slow permeability of the subsoil tends to restrict the movement of water, air, and roots. Lack of moisture is the chief limitation to the high production of cultivating crops and native grasses. In years of low rainfall, these soils are somewhat droughty.

Cotton, grain sorghum, and wheat are the main crops. More wheat is grown on the Wichita soil than on the Abilene soil.

Under dryland farming the main problems in managing these soils are conserving moisture, maintaining good tilth, and controlling erosion. Farmers in the county have learned that stubble mulching of crop residue, terracing, and contour farming help to conserve the moisture from rainfall and to control erosion satisfactorily. When these practices are used, yields are generally increased. Using a surface mulch of organic residue also reduces surface crusting and maintains the content of organic matter in the soils.

CAPABILITY UNIT IIc-5

Only one soil, Portales loam, 0 to 1 percent slopes (PoA), is in this capability unit. It is a deep, moderately permeable, nearly level, loamy soil that is strongly calcareous.

This soil is easily tilled and is readily permeable to moisture, air, and roots. The moderately high content of lime helps to keep the plow layer in good tilth, but lime-induced chlorosis may lower yields, especially of grain sorghum. Hence, regular applications of a moderately large amount of organic residue are needed to offset the effects of lime. In addition, organic residue is needed to control wind erosion because the soil particles are limy and are readily transported by wind. Crop residue, used as a mulch on or near the surface, is more effective for controlling wind erosion than deep plowing. Terracing and contour farming may also be needed to conserve moisture in some areas. The moderately high water-intake rate helps to produce good yields of native grasses.

CAPABILITY UNIT IIIe-1

In this unit are deep, reddish-brown, moderately fine textured, gently sloping soils that are slowly permeable. These soils are—

Tillman clay loam, 1 to 3 percent slopes (TcB).
Tillman-Vernon complex (Tillman soil only) (Tm).

These soils are naturally fertile, but their thin surface layer, the dense, blocky clay in the subsoil, and the poor soil-moisture relationship make them droughty. The risk of water erosion is moderate, but the risk of wind erosion is slight.

Cool-season crops are best suited to these soils. Wheat is the main cash crop, but grain sorghum, planted early in spring, is fairly successful. The native grasses are fairly productive if they are managed so that the maximum intake of rainfall is maintained.

The main problems in managing these soils are controlling erosion, improving tilth, and conserving moisture. A good cropping system includes crops that produce a

large amount of residue or that provide a mulch. Farmers in this area have learned that stubble mulching increases yields. Residue kept on the surface also reduces surface crusting and permits more rainfall to enter the soil. As a result, less water runs off and less soil material is lost through water erosion. Terraces and contour farming are also needed to control water erosion.

CAPABILITY UNIT IIIe-2

The soils of this unit are deep, dark, moderately fine textured, and gently sloping. These soils are—

Abilene clay loam, 1 to 3 percent slopes (AbB).
Wichita clay loam, 1 to 3 percent slopes (WmB).

These are fertile soils that have a high capacity to store moisture and plant nutrients. The moderately slow permeability of their subsoil limits the movement of moisture, air, and roots. Consequently, in years of lower than average rainfall, these soils are somewhat droughty. The hazard of wind erosion is slight, and the hazard of water erosion is moderate.

Most crops grown in the area are suited to these soils, but cotton, grain sorghum, and wheat are the main cash crops.

The main problems in managing these soils are controlling erosion, conserving moisture, and maintaining good tilth. Maintaining good tilth is essential for the maximum intake of rainfall.

The cropping system should include crops that yield a large amount of residue or that provide a mulch, such as cotton burs. Cotton or other clean-tilled crops can be grown without excessive losses of soil material from water erosion. It is best, however, not to grow cotton more than 2 years in succession. Farmers in the area have learned that keeping crop residue on the surface helps to increase yields on these soils by increasing the intake of water. This practice also helps to keep the plow layer in good tilth. Terraces and contour farming also help to control water erosion.

CAPABILITY UNIT IIIe-3

This unit consists of deep to moderately deep, reddish-brown, gently sloping soils that have moderate to moderately rapid permeability. These soils are—

Carey loam, 3 to 5 percent slopes (CoC).
Enterprise very fine sandy loam, 3 to 5 percent slopes (EnC).
Woodward loam, 3 to 5 percent slopes (WoC).
Woodward-Quinlan loams, 1 to 3 percent slopes (WwB).

These soils are easily tilled. They have moderate natural fertility and are readily penetrated by roots, moisture, and air. The risk of wind erosion is slight, and the risk of water erosion is moderate to high.

Most crops suited to this area are grown on these soils, but cotton, grain sorghum, and wheat are the main crops. Native grasses also grow well if they are properly managed. A larger acreage of Woodward soils than of Carey soils is in range.

The chief problem in managing these soils is controlling water erosion. Using a rotation that includes a cover crop, or a crop that produces a large amount of residue, generally helps to control water erosion. Using crop residue as a mulch or adding a mulch of cotton burs helps to conserve moisture and to control erosion. In addition, terracing and farming on the contour reduce runoff and erosion.

CAPABILITY UNIT IIIe-4

This unit consists of deep, moderately coarse textured, moderately permeable to slowly permeable, nearly level or gently sloping soils. These soils are—

- Altus fine sandy loam (Am).
- Miles fine sandy loam, 0 to 1 percent slopes (MfA).
- Miles fine sandy loam, 1 to 3 percent slopes (MfB).
- Wichita fine sandy loam, 0 to 1 percent slopes (WfA).
- Wichita fine sandy loam, 1 to 3 percent slopes (WfB).

These soils are easily tilled, and they readily take in moisture from rainfall. Consequently, they are more suitable for crops grown in summer than the other soils of the county. They also produce a large amount of forage when used for range. Their natural fertility is moderate, but these soils respond readily to commercial fertilizer in most years. The danger of wind erosion is moderate. There is a slight hazard of water erosion in the gently sloping areas.

Most of the locally grown crops are suited to these soils. Because the yields of cotton and other crops grown in summer are relatively high, however, not much wheat is grown. Rye is well adapted as a winter cover crop.

A cropping system should be used that will maintain the level of fertility and that will keep an adequate cover of plants or plant residue on the surface. The plants or plant residue control wind erosion in winter and early in spring. In the gently sloping areas, terraces and contour farming help to control water erosion.

A suitable cropping system for these soils is one in which a cover crop or a crop that produces a large amount of residue is grown part of the time, and a clean-tilled crop that produces only a small amount of residue is grown the rest of the time. Austrian winter peas or other soil-improving winter legumes help to maintain the level of fertility in these soils. Cotton burs, added as a surface mulch control wind erosion and add organic matter to the soils. Leave most of the crop residue on the surface, especially during the winter months. Emergency tillage, which roughens the surface, effectively controls wind erosion when plant residue is scarce. Row or sprinkler irrigation can be used on these soils, and a small amount of water is available on some farms. Commercial fertilizer should be applied according to the results of soil tests and the kind of crop to be grown.

CAPABILITY UNIT IIIe-6

This unit consists of complexes of medium-textured, moderately permeable, nearly level soils that are shallow over gypsum. These soils are—

- Acme-Cottonwood complex (Acme soil only) (Ac).
- Cottonwood-Acme complex (Acme soil only) (Cc).

The Acme soils are easily tilled and are moderately high in fertility. Only about one-third of the acreage is cultivated. Native grasses make good growth on these soils.

In most places these soils make up only a relatively small part of a cultivated field. Therefore, they are usually cropped and managed like the other soils in the field.

The hazard of wind erosion is slight, and these soils need a protective cover on the surface during the dry winter months. Crops that produce a large amount of residue help to maintain the content of organic matter, and they tend to offset the effect of the moderately high content of lime.

CAPABILITY UNIT IIIe-7

The soils in this unit are moderately deep, medium-textured, moderately permeable, and gently sloping. These soils are—

- Mansker loam, 1 to 3 percent slopes (MdB).
- Weymouth clay loam, 1 to 3 percent slopes (WcB).

These soils are easily tilled. They have a shallow root zone, moderate water-holding capacity, and moderate to high natural fertility. The moderately high content of lime, however, makes part of the plant nutrients unavailable to plants. The hazard of wind erosion is slight, and that of water erosion is slight to moderate.

Wheat or other cool-season crops are better suited to these soils than crops grown in summer. Because these soils are well drained, however, rapidly maturing varieties of grain sorghum, planted early in spring, make fairly good yields. Also, crops planted late in summer frequently make good yields. In years when there are frequent showers in summer, yields of cotton are fair. Native grasses do well if they are properly managed.

The main problems in managing these soils are controlling erosion, conserving moisture, and maintaining the content of organic matter. The cropping system in most years should include a cover crop or a crop that produces a large amount of residue. A mulch, such as cotton burs, adds needed organic matter and tends to offset the effect of lime in these soils. Terracing and farming on the contour help to reduce erosion. If fertilizer is used, soil tests should be made to determine the kinds and amounts to apply.

CAPABILITY UNIT IIIe-1

Tillman clay loam, 0 to 1 percent slopes (TcA), is the only soil in this capability unit. It is deep, reddish brown, moderately fine textured, and nearly level.

This soil is easily tilled. Its capacity to hold moisture and plant nutrients is high. The subsoil is clayey and slowly permeable, and as a result, the movement of air, water, and roots is restricted. This limitation tends to make the soil somewhat droughty. The risk of erosion is slight, except on long slopes where runoff may carry away part of the surface layer.

Most crops grown in the area are suited to this soil. Wheat is the main crop, however, and is used for winter grazing.

Conserving moisture by increasing the intake of water is the chief aim in managing this soil. Improving and maintaining the soil are also necessary.

The cropping system in most years should include a cover crop or a crop that produces a large amount of residue. Residue kept on or near the surface reduces crusting, increases the water intake rate, and helps to maintain the content of organic matter. Where water erosion is a hazard, terraces and contour farming may be needed.

CAPABILITY UNIT IVe-2

This unit consists of strongly calcareous, moderately permeable, gently sloping soils. These soils are—

- Mansker loam, 3 to 5 percent slopes (McC).
- Weymouth clay loam, 3 to 5 percent slopes (WcC).

These soils are easily tilled. They have a moderate capacity for holding plant nutrients and water. The fairly high content of lime may cause lime-induced chlorosis, particularly in grain sorghum. The hazard of wind

erosion is slight, and the hazard of water erosion is moderate.

Most crops grown in this area are suited to these soils, but yields are only moderate. Cotton or other clean-tilled crops do not provide enough cover to control wind and water erosion.

The limited capacity of these soils for storing moisture narrows their use for cultivated crops. As a result, cool-season crops, such as wheat, are the best suited cash crops. It is probably more economical to grow native grasses than cultivated crops, and the native grasses provide the best protection against erosion. If cultivated crops are grown, keep residue on or near the surface to control erosion and to increase the content of organic matter. Terracing and contour farming also help to control water erosion. A mulch of cotton burs helps to offset the effects of the lime in these soils.

CAPABILITY UNIT IVe-3

In this unit are deep and moderately deep, reddish-brown, medium-textured to moderately coarse textured soils that are moderately sloping and have moderate to slow permeability. These soils are—

- Miles fine sandy loam, 3 to 5 percent slopes, eroded (MfC2).
- Wichita fine sandy loam, 3 to 5 percent slopes, eroded (WfC2).
- Woodward-Quinlan loams, 3 to 5 percent slopes (WwC).

These soils are only moderately fertile because much of their original surface layer has been removed by erosion. The thin surface layer and the moderate slopes have reduced the water-holding capacity. Controlling erosion is the main problem in managing these soils.

The limited water-holding capacity makes cool-season crops, such as wheat or rye, more productive than other crops grown on these soils. These crops help to control erosion because they grow at a time when rainfall is most intense. The residue of small grain, kept on the surface by stubble mulching, provides year-round control of erosion. Terraces and contour farming are additional practices that prevent runoff from concentrating and causing washes and gullies. Fertilizer used according to the results of soil tests generally increases yields and provides more forage for winter grazing. If yields are increased, more straw cover is generally available for the control of erosion.

CAPABILITY UNIT IVe-4

Only one soil, Miles fine sandy loam, 3 to 5 percent slopes (MfC), is in this capability unit. It is a deep, reddish-brown, moderately coarse textured, gently sloping soil that is moderately permeable.

This soil is moderately fertile, easily tilled, and permeable to water, air, and roots. The risk of erosion by wind and water is moderate.

The main problem in managing this soil is controlling erosion by water and wind. One of the best ways of controlling erosion is to grow only crops that produce a large amount of residue. Native grasses produce well on this soil and are the most effective means of controlling erosion.

If cultivated crops are grown, leave most of the straw and stalks on the surface. In years of above-average rainfall, commercial fertilizer will increase the growth of plants. The increased amount of top growth, in turn, provides more residue to protect the soil. Terraces and contour farming are needed to control water erosion.

CAPABILITY UNIT IVe-6

Miles loamy fine sand, 0 to 3 percent slopes (MmB), is the only soil in this unit. It is a deep, moderately permeable, nearly level to gently sloping soil that has a sandy surface layer.

This soil is easily tilled, readily absorbs rainfall, and is permeable to roots, moisture, and air. Its capacity to hold plant nutrients in the root zone is rather low. The surface layer holds only a small amount of moisture, but a fairly large amount is stored in the subsoil. Therefore, this soil is fairly drought free, except in summers when dry periods of 6 to 8 weeks occur.

The main problems in managing this soil are the high susceptibility to wind erosion and the low fertility of the surface layer. Yields are frequently reduced because the shifting sand covers up or cuts off some of the young plants and only a partial stand is obtained.

Where this soil is dry farmed, the cropping system should include a cover crop or a crop that produces a large amount of residue. Crop residue left standing or used as a mulch on the surface helps to protect the soil against blowing. A mulch of cotton burs, applied in winter and early in spring, also controls blowing. The addition of residue increases the content of organic matter and materially increases the capacity of the surface layer to hold plant nutrients. Commercial fertilizer is needed to obtain the highest yields of crops and of plant residue.

Deep plowing is also effective in controlling soil blowing. It brings to the surface from the subsoil a 3- to 4-inch furrow slice of sandy clay loam. The finer textured material brought up from below is soon mixed with the sandy material in the original surface layer. Therefore, deep plowing should be used principally as an emergency measure. A large amount of standing residue from a crop such as grain sorghum is probably most effective in controlling wind erosion. Planting a crop that will cover this soil in winter also controls wind erosion, but the cold surface layer limits the amount of growth a crop will make in winter. Farmers in the area have learned that rye or barley furnishes the best winter cover on this soil.

Water for irrigation is available for some areas of this soil. In those areas a sprinkler system can be used most efficiently. Proper, timely application of water is needed for best results.

Because plant nutrients are readily leached out of this soil during irrigation, a large amount of commercial fertilizer is needed to maintain high yields. The kind and amount of fertilizer should be determined by soil tests. A soil-improving crop, such as guar, alfalfa, or summer peas, grown about half the time, helps to maintain fertility. Using crop residue, standing or as a mulch, prior to the critical "winter-blow" period is the best way of reducing wind erosion.

CAPABILITY UNIT IVe-7

Only the Vernon soil of the Tillman-Vernon complex (Tm) is in this capability unit. It is a reddish-brown, gently sloping soil that has a surface layer of clay loam and is shallow over clayey red beds.

This soil has a shallow root zone and moderate capacity for storing moisture and plant nutrients. Permeability is moderately slow. The risk of water erosion is slight to moderate.

The main problems in managing this soil are controlling

water erosion, conserving moisture, and maintaining or improving tilth. Most of the time, the cropping system should include a cover crop or a crop that produces a large amount of residue. Wheat or some other small grain that grows during the cool season is best suited. Stubble mulching of crop residue helps to conserve moisture, improve tilth, and increase the water intake rate. A mulch of cotton burs or similar material can be substituted for growing a crop that produces a large amount of residue. Terraces and contour farming are also needed to control erosion and conserve moisture on this soil.

CAPABILITY UNIT IVw-1

Only one soil, Randall clay (Rc), is in this capability unit. This deep, dark, clayey soil is in depressions and is very slowly permeable.

This is a very fertile soil, but it has a slow or very slow water intake rate. Most of the areas receive runoff from the surrounding soils, and water stands intermittently on the surface. Therefore, a flexible cropping system is required. Wheat, cotton, and grain sorghum are well-suited crops.

The main problems in managing this soil are maintaining desirable tilth and reducing the amount of runoff that accumulates. Surface drainage is not practical in most areas. Growing crops that produce a large amount of residue and keeping the residue on the surface as a stubble mulch are the best ways of improving soil tilth. Mulching with cotton burs is also effective. These practices help prevent surface crusting and increase the water intake rate. A good water intake rate may shorten the periods of ponding enough that damage to a growing crop can be prevented or a mature crop can be harvested.

CAPABILITY UNIT Vw-1

This unit consists of deep, loamy land types on first bottoms along rivers, creeks, and the smaller drainageways. These land types are—

- Breaks-Alluvial land complex (Alluvial land only) (Bk).
- Loamy alluvial land (Lc).

These land types are subject to recurrent flooding. They occur in narrow strips and are suitable only for pasture and for supplying food and shelter for wildlife. The soils are high in natural fertility and generally receive enough extra water from runoff so that the production of native grasses is good.

Under good range management the hazard of erosion is only slight on these land types. The erosion consists chiefly of downcutting of stream channels. Control of grazing is necessary or the more palatable grasses will be overgrazed.

The land types of this unit make up the highest producing sites for native grasses in the county. Some of the better grasses are Canada wildrye, switchgrass, western wheatgrass, Texas wintergrass, vine-mesquite, and side-oats grama. Hackberry, chinaberry, and willow trees are also native on these land types. Bermudagrass grows in the lower areas along stream channels.

Sites for farm ponds are generally located near the upper part of the drainageways in this unit. Wells to supply water can usually be developed in the lower, broader areas. For additional information on the use and man-

agement of these land types, see the Loamy Bottom Land range site in the section "Use of the Soils for Range."

CAPABILITY UNIT Vw-2

Only Sandy alluvial land (Sc) is in this capability unit. This land type consists of deep, sandy soil material on the flood plains of the Double Mountain Fork of the Brazos River. The areas are subject to recurrent damaging floods. They consist of stratified coarse sand, fine sand, and loamy fine sand deposited when streams overflow.

All of this land type is used for range. Grasses that tolerate salt are the main plants on the lower areas, and switchgrass, Indiangrass, and sand bluestem are well suited on the low sandy mounds.

Grazing needs to be controlled to protect the areas from wind erosion. Some areas are benefited by controlling brush, principally saltcedar. Wells for livestock can be developed on this land type. More information about the potential of this land for range is given in the section "Use of the Soils for Range," under the Loamy Bottom Land range site.

CAPABILITY UNIT VIe-1

In this unit are moderately fine textured, moderately sloping soils that are shallow over clayey red beds. These soils are—

- Travessilla-Vernon complex (Vernon soil only) (Tv).
- Vernon-Badland complex (Vernon soil only) (Vb).

These soils are in the southern, eastern, and western parts of the county. They generally are in areas on the lower side of the escarpments in the Travessilla-Vernon complex and are below the areas of Badland in the Vernon-Badland complex. They also are in convex gently sloping areas.

These soils are too shallow, too steep, and generally too dissected for cultivation. The hazard of water erosion is moderately high. The vegetation consists of buffalograss, curly mesquite, tobosagrass, and scattered mesquite trees. Careful management of grazing is needed to control erosion.

Suitable sites for the construction of farm ponds for livestock are available on these soils, but a site should be selected in areas where there is the least danger of silting. More information about the use of these soils for range is given in the section "Use of the Soils for Range," under the Shallow Redland range site.

CAPABILITY UNIT VIe-2

Only one soil, Mansker loam, 5 to 8 percent slopes (MaD), is in this capability unit. It is medium textured, moderately permeable, and moderately sloping.

This soil is strongly calcareous. It is highly susceptible to water erosion, and therefore cannot be cultivated safely.

The vegetation consists of scattered mesquite in the deeper soil areas; catclaw on the shallower areas; and buffalograss, needlegrass, and sand dropseed on the more sandy areas. Careful management of range is needed to control erosion. More information on management of this soil for range is given in the section "Use of the Soils for Range," under the Deep Hardland range site.

CAPABILITY UNIT VIe-4

This unit consists of deep and moderately deep, medium-textured, moderately sloping soils. These soils are—

Enterprise very fine sandy loam, 5 to 12 percent slopes (EnD).
 Quinlan-Woodward complex (Quinlan and Woodward soils only) (Qw).
 Woodward-Quinlan loams, 5 to 8 percent slopes (WwD).

These soils have moderately rapid to moderate permeability. The risk of wind erosion is slight, but the risk of water erosion is high. Deep gullies form readily in areas of range that are overgrazed.

Nearly all of this unit is in range. The native vegetation is mainly hooded windmillgrass, buffalograss, sand dropseed, black grama, and blue grama, but it includes mesquite trees, yucca, and pricklypear.

Potentially, these are among the better soils for upland range in the county. Careful grazing management is needed, however, to increase the water intake rate. If more water is taken in, the growth of grass will improve and the improved cover of grass will help to control erosion.

Of the soils of this unit, the Enterprise soils offer the best possibilities for locating wells for livestock. Sites for farm ponds are somewhat limited on the other soils, and satisfactory areas for spillways are difficult to locate in the steeper areas. Also beds of gypsum may cause seepage in some places. More information about the use of these soils for range is given in the section "Use of the Soils for Range," under the Mixed Land range site.

CAPABILITY UNIT VIe-7

Only Brownfield fine sand (Br) is in this capability unit. It is a deep, sandy, moderately permeable, undulating soil.

This soil has a sandy surface layer that is structureless. It is highly susceptible to wind erosion. In the upper part of the root zone the capacity for storing water and plant nutrients is low, but the subsoil, at a depth of about 20 inches, stores a moderate amount of water.

Nearly all of the acreage is in range. The native vegetation consists chiefly of shin oak, tall dropseed, and some little bluestem. Reseeding with mid and tall grasses is needed to control erosion on cultivated fields. Wells that will provide water for livestock can be developed in this soil. Information about the management of this soil for range is given in the section "Use of the Soils for Range," under the Deep Sand range site.

CAPABILITY UNIT VI s-1

Only one land type, Gravelly land (Gr) is in this capability unit. It consists of gravelly knobs that are moderately sloping and are shallow over deep beds of loamy gravel. This land is unsuitable for cultivation.

The mantle of gravelly soil material that makes up this land type consists of fine sandy loam to loamy fine sand. It overlies beds of quartzite gravel. In the areas in the eastern part of the county, the gravel beds are underlain by red-bed clay of Permian age. The areas in the northwestern part are underlain by red-bed sands.

In the eastern part of the county, the vegetation on this land type is buffalograss, sixweeks grama, some tobosagrass, catchlaw, and a few small mesquite trees. In the western part, redberry juniper is common and there are small mesquite trees.

This land type does not have suitable sites for farm ponds. For more information about this site, see the Gravelly range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VI s-2

Only one soil, Treadway clay (Tw), is in this capability unit. It is a clayey soil formed in alluvium. This soil occupies smooth, nearly level areas that resemble valleys. It is on flood plains adjacent to well-defined drainageways that originate in areas of the Vernon-Badland complex or Badland, and on foot slopes immediately below those areas. This soil is subject to flooding and receives deposits of silty and clayey material from the headwater areas.

This soil is not suitable for cultivation, for in addition to the hazard of flooding, the surface seals over so completely that little moisture enters the soil. The soil can be used for range, but grazing should be deferred for a lengthy period. This will increase the amount of plant litter and the amount of moisture that enters the soil, and it gradually improves the production of grass. Controlling erosion by careful grazing in the areas of Vernon-Badland complex and Badland, and using terraces to divert the silty material, will also improve the cover of grass.

Sites for farm ponds are available on this soil, but the amount of silty material needs to be reduced, or the pond will be useful for only a short period. More information about the use of this soil for range is given in the section "Use of the Soils for Range," under the Deep Hardland range site.

CAPABILITY UNIT VIIe-1

Tivoli fine sand (Ts) is the only soil in this unit. It is deep, coarse textured, and undulating.

This soil has rapid permeability, low fertility, and low water-holding capacity. The hazard of wind erosion is severe; therefore this soil is not suited to cultivation.

This soil is fairly well suited to range because rainfall is readily absorbed and most of this moisture is available to plants. Brush, such as shin oak, should be controlled to reduce competition for moisture and to eliminate shading. Water for livestock can be obtained from wells. More information about the management of this soil for range is given in the section "Use of the Soils for Range," under the Deep Sand range site.

CAPABILITY UNIT VII s-1

In this unit are very shallow, rough, stony soils that are moderately sloping to strongly sloping. These soils are—

Acme-Cottonwood complex (Cottonwood soils only) (Ac).
 Cottonwood-Acme complex (Cottonwood soils only) (Cc).
 Potter soils (P).
 Travessilla-Vernon complex (Travessilla soil only) (Tv).

These soils are too shallow or rocky and too sloping for cultivation. Also the production of native grasses is fairly low.

Information about the management of these soils for range is given in the section "Use of the Soils for Range," in the Very Shallow and Gypland range sites.

CAPABILITY UNIT VII s-2

This unit consists of steep, reddish-brown, loamy land called breaks. These breaks are in—

Breaks-Alluvial land complex (Breaks part only) (Bk).
 Quinlan-Woodward complex (Breaks part only) (Qw).

Breaks in the Quinlan-Woodward complex consist of sandy material of the red beds and occupy strongly sloping

ing banks or sides of intermittent drainageways. These banks are above the U-shaped channels of the drainageways. They have nearly vertical walls or consist of short escarpments with narrow benches. Breaks in the Breaks-Alluvial land complex are mainly used as range.

The thin solum and steep slopes make these areas unsuitable for cultivation. They support little native vegetation. Therefore, careful management is needed to control erosion. If the surrounding areas in the Mixed Land range site are managed to control runoff into these areas, bank cutting and down cutting at the head of the drainageways will be reduced.

Farm ponds for livestock can be built on the Breaks that are in the Breaks-Alluvial land complex, but the number that can be built on the Breaks in the Quinlan-Woodward complex is limited because satisfactory spillways for ponds are difficult to locate.

More information on the management of this land for range is given in the section "Use of the Soils for Range," under the Rough Broken range site.

CAPABILITY UNIT VIII-1

The land types in this unit are rough and broken, nearly bare, and shallow over clayey red beds. They are—

Badland (Ba).

Vernon-Badland complex (Badland part only) (Vb).

These areas are suitable only for wildlife food and cover. Runoff is very rapid, and geologic erosion by water is active after each rain. Small areas of alluvial material and pockets of deeper soil material produce cover for wildlife if they are protected from grazing.

Predicted Yields

Table 2 gives the predicted average yields per acre under dryland farming for the three principal crops grown in the county—cotton, grain sorghum, and wheat. The yields shown are for two levels of management and are based on the experience of farmers and on the observations of agricultural workers in the county.

Yields under dryland farming depend largely on the supply of moisture that is available in the soils at planting time and during the growing season. Generally, the higher the rainfall during the growing season, the higher the yields. Farmers have found, however, that a good crop of wheat can be produced on the deep, moderately fine textured soils if the subsoil is wet to a depth of 36 to 40 inches in fall at planting time. Water stored in the subsoil is removed largely by plants, and little is lost through evaporation. Yields on some of the more sandy soils may also be limited by low fertility.

Consistently high yields depend on good soil management, as well as on moisture and high fertility. The soil that is used within its capabilities and managed according to its needs will produce the best average yields. The required management consists of using terraces and contour farming, where needed, as well as soil-improving crops, cover crops, and high-residue crops. Fertilizer is also applied where needed, and crops are grown that are adapted to the soils.

If all of these conservation practices are not used, crop

yields can be expected to decrease gradually. Growing crops unsuited to the soil also results in low yields.

For many years in Fisher County, the farmers have attempted to conserve moisture and control erosion by using terraces and contour farming. On most farms the system of terraces has been redesigned and rebuilt so that as much moisture as possible is conserved by mechanical means.

Some farmers rotate crops to improve soil tilth and maintain a desirable content of organic matter in the soils. Few farmers, however, continuously meet all the requirements for maintaining maximum production. Lack of rainfall may prevent the timely application of some of the most important practices, but in most years there is enough moisture to grow some soil-improving crops if a systematic plan is followed.

The yields shown for columns A in table 2 were obtained under the average management used by most of the farmers in the county, and those in columns B reflect a high level of management. The predicted yields are an average of yields obtained over a period of 10 to 20 years and cannot be expected every year. In some years they will be higher than the average; in others they will be lower. No predictions were made for crops grown under irrigation, but yields of irrigated crops are considerably higher than those obtained under dryland farming.

The following are practices used under the average level of management:

1. Some, but not all, of the rainfall is conserved and used. For example, terraces have been built but are not maintained.
2. Crop residue is not effectively managed; the seedbed is prepared too early; and tillage, rather than crop residue, is used to control erosion.
3. Fertilizer and soil-improving crops are used haphazardly or not at all.
4. The soils are tilled more than necessary; tillage and harvesting are done when the soils are too wet; and the cropping sequence used does not maintain the supply of organic matter in the surface layer.

Under a high level of management, all of the best available methods of farming are used. Following are some of these practices:

1. Rainfall is conserved by using all necessary conservation measures, including a properly maintained system of terraces, contour farming, and stubble-mulch tillage.
2. Crop residue is managed for effective control of erosion.
3. The fertility of the soils is maintained by timely application of fertilizer, based on soil tests and the needs of the crop to be grown, and by growing and managing adapted soil-improving crops.
4. Soil tilth is adequately maintained by using a cropping sequence that insures an adequate supply of organic matter in the surface layer; avoiding tillage and harvesting operations when the soils are wet; and by tilling only when it is necessary to prepare the seedbed or to control weeds.
5. Using suitable methods of controlling insects, diseases, and weeds.

TABLE 2.—Predicted average yields per acre of the principal crops grown under two levels of management on the soils suitable for cultivation

[Yields in columns A are those obtained over a period of years under average management; yields in columns B are those to be expected under improved management. Absence of a yield figure indicates that the soil is not suited to the crop specified or that the crop is not commonly grown under the type of management indicated]

Soil	Cotton (lint)		Grain sorghum		Wheat	
	A	B	A	B	A	B
	<i>Lb.</i>	<i>Lb.</i>	<i>Lb.</i>	<i>Lb.</i>	<i>Bu.</i>	<i>Bu.</i>
Abilene clay loam, 0 to 1 percent slopes	170	225	1,000	1,500	12	18
Abilene clay loam, 1 to 3 percent slopes	140	200	800	1,300	10	16
Acme-Cottonwood complex (Acme soil)	90	125	600	800	8	10
Altus fine sandy loam	200	275	900	1,100		
Brownfield fine sand	75		600			
Carey loam, 0 to 1 percent slopes	250	325	1,200	1,500	12	16
Carey loam, 1 to 3 percent slopes	175	300	1,100	1,400	10	14
Carey loam, 3 to 5 percent slopes	160	225	800	1,100	9	12
Enterprise very fine sandy loam, 0 to 1 percent slopes	200	300	900	1,200	12	15
Enterprise very fine sandy loam, 1 to 3 percent slopes	175	250	850	1,000	11	13
Enterprise very fine sandy loam, 3 to 5 percent slopes	150	200	750	900	10	12
Mansker loam, 1 to 3 percent slopes	85	110	550	700	8	10
Mansker loam, 3 to 5 percent slopes	75		500	650	7	9
Miles fine sandy loam, 0 to 1 percent slopes	250	350	1,200	1,800	11	15
Miles fine sandy loam, 1 to 3 percent slopes	200	300	1,100	1,500	10	14
Miles fine sandy loam, 3 to 5 percent slopes	175	225	800	1,200	7	10
Miles fine sandy loam, 3 to 5 percent slopes, eroded	110	150	700	900	6	9
Miles loamy fine sand, 0 to 3 percent slopes	200	250	900	1,200	8	10
Portales loam, 0 to 1 percent slopes	170	200	800	1,000	10	14
Randall clay	150	175	1,200	1,400	13	15
Spur clay loam	175	250	1,200	1,500	18	25
Spur silt loam	200	300	1,300	1,800	14	18
Tillman clay loam, 0 to 1 percent slopes	125	175	800	1,000	11	14
Tillman clay loam, 1 to 3 percent slopes	110	140	700	900	9	12
Tillman-Vernon complex:						
Tillman soil	95	105	600	850	8	11
Vernon soil	75	85	500	700	7	10
Tipton silt loam, 0 to 1 percent slopes	200	275	1,000	1,200	12	16
Tipton silt loam, 1 to 2 percent slopes	175	250	900	1,100	10	14
Weymouth clay loam, 1 to 3 percent slopes	85	100	600	900	8	10
Weymouth clay loam, 3 to 5 percent slopes	60		450		6	
Wichita clay loam, 0 to 1 percent slopes	170	225	1,000	1,500	12	18
Wichita clay loam, 1 to 3 percent slopes	140	200	800	1,200	10	14
Wichita loam, 0 to 1 percent slopes	175	225	900	1,300	12	16
Wichita loam, 1 to 3 percent slopes	155	200	800	1,000	10	14
Wichita fine sandy loam, 0 to 1 percent slopes	190	250	900	1,100	11	14
Wichita fine sandy loam, 1 to 3 percent slopes	175	225	800	1,000	10	13
Wichita fine sandy loam, 3 to 5 percent slopes, eroded	100		600	900	7	10
Woodward loam, 1 to 3 percent slopes	150	200	900	1,200	9	12
Woodward loam, 3 to 5 percent slopes	140	180	800	1,000	8	11
Woodward-Quinlan loams, 1 to 3 percent slopes:						
Woodward soil	130	150	700	900	8	11
Quinlan soil	70	100	500	700	6	9
Woodward-Quinlan loams, 3 to 5 percent slopes:						
Woodward soil	125		700	850	7	10
Quinlan soil	25		500	550	5	7
Yahola very fine sandy loam	200	275	900	1,200	11	13

Use of the Soils for Range¹

Ranching is second only to farming as the leading enterprise in this county. About half of the land used for agriculture is in range. At the time this survey was made, 23 ranching units were in the county and ranches occupied about 200,000 acres. Almost all of the ranches are of the cow-calf type, but stocker steers are run on a few.

Much of the acreage used for agriculture is not suitable for cultivation but is well suited to the production of grass

for grazing. Some areas that are grazed are on clayey uplands, others are on loamy bottom lands, and still others are in between. Because of this variation in location, the vegetation ranges from short to tall grasses, but short and mid grasses are the most widely distributed.

Deterioration in the original cover of forage, caused by continuous heavy grazing, has taken place over the past several decades. Inferior types of vegetation have invaded the plant community as a result of this deterioration. On the more clayey soils—the loams and sandy loams—a moderate to heavy stand of mesquite trees covers approximately 140,000 acres. On the sandy soils shin oak has replaced the tall and mid grasses on about 16,000 acres.

¹By JOE B. NORRIS, range conservationist, Soil Conservation Service, Lubbock, Tex.

There is a moderate infestation of redberry juniper on about 30,000 acres, mainly on the Rough Broken, Gravelly, Shallow Redland, and Very Shallow range sites.

Range sites and condition classes

Range sites are distinctive kinds of rangeland that have a different potential for producing native plants. Within a given climate, the sites differ only in the kind or amount of vegetation they will produce. These differences are the result of varying soil characteristics, such as depth, texture, structure, position, and to a lesser extent, exposure and elevation.

The kind and the amount of vegetation a site will produce depend on the level of fertility, on the amount of air that enters the soil, and on the amount of water that is taken in and retained in the root zone. A deep, fertile bottom-land range site that receives water by flooding, in addition to that received through normal rainfall, produces taller kinds and greater amounts of grass than an upland site or a shallow site that receives less water.

Grass, like all other green plants, manufactures its food in the leaves and stems; therefore, the growth and reproduction of range plants is directly affected by the amount of grazing the plant receives. Under heavy grazing or overuse, the leaves and stems are reduced or destroyed. The result is a corresponding reduction in the amount of food received to maintain the plant and allow it to grow. If heavy grazing is continued over a period of years, many of the plants die.

Livestock tend to graze the most palatable and nutritious plants first; consequently, those plants are destroyed or damaged first. Plants that generally decrease under close grazing are called *decreasers*. The stand is thinned as the decreasers are eliminated. Then, less palatable plants, known as increasers and invaders, move in. *Increasers* tend to increase at first under heavy grazing but are the next plants to be reduced or eliminated. As the decreasers and increasers are eliminated, the condition of the range continues to decline and successively less desirable plants dominate the site. Finally, plants from other sites or distant areas invade the plant community. These plants are known as *invaders*.

By this process the plant composition of the range site, or the range condition, changes from excellent to poor. A range is in *excellent condition* if more than 75 percent of the present vegetation consists of the original, or climax, plants; in *good condition* if 50 to 75 percent consists of climax plants; in *fair condition* if 25 to 50 percent consists of climax plants; and in *poor condition* if less than 25 percent consists of climax plants.

Descriptions and interpretive uses of range sites

Range sites are easily recognized. Therefore, they are the most significant basis for planning treatment and management of the range. Each site responds to differences in the climate and to the degree of grazing received. The grazing habits of the various types of livestock and the palatability of the plants growing on the site influence this response. Therefore, good range management requires that the range operator know how well his range site will respond to grazing and that he manage the livestock so that the site will not be overgrazed.

Generally there are several range sites in a pasture, but one site is normally preferred for grazing. This site can

be used as a basis for managing and evaluating the grazing use of the entire pasture. If this key site is properly grazed, the entire pasture will improve.

In Fisher County there are 11 distinct range sites. A brief description of these sites follows.

DEEP HARDLAND SITE

In this range site are nearly level to gently sloping soils of the uplands. These soils are—

- Abilene clay loam, 0 to 1 percent slopes (AbA).
- Abilene clay loam, 1 to 3 percent slopes (AbB).
- Acme-Cottonwood complex (Acme soil only) (Ac).
- Cottonwood-Acme complex (Acme soil only) (Cc).
- Mansker loam, 1 to 3 percent slopes (MaB).
- Mansker loam, 3 to 5 percent slopes (MaC).
- Mansker loam, 5 to 8 percent slopes (MaD).
- Randall clay (Rc).
- Tillman clay loam, 0 to 1 percent slopes (TcA).
- Tillman clay loam, 1 to 3 percent slopes (TcB).
- Tillman-Vernon complex (Tillman soil only) (Tm).
- Treadway clay (Tw).
- Wichita clay loam, 0 to 1 percent slopes (WmA).
- Wichita clay loam, 1 to 3 percent slopes (WmB).
- Wichita loam, 0 to 1 percent slopes (WhA).
- Wichita loam, 1 to 3 percent slopes (WhB).

Randall clay and Treadway clay are normally not part of the Deep Hardland range. They were included, however, because of their small acreage.

In this site the capacity of the soils to hold water and plant nutrients is high, but water is absorbed slowly. As a result, the soils are somewhat droughty and produce short to mid grasses.

Pitting or chiseling is often used to temporarily open up the soil so that water can enter rapidly. This extra water stimulates the growth of plants and enhances the chance that the plants will survive. Sustained improvement is best obtained by maintaining a healthy stand of grass at all times.

Blue grama, side-oats grama, vine-mesquite, Arizona cottontop, and western wheatgrass are the main decreasers on this site. Increasers include buffalograss, tobosagrass, and Texas wintergrass. Invaders are hairy tridens, Texas grama, mesquite, pricklypear, condalia, and annual weeds.

The annual yield of air-dry herbage, excluding that from woody species, ranges from 2,300 pounds per acre in favorable years to 1,500 pounds per acre in unfavorable years.

LOAMY BOTTOM LAND SITE

This range site is made up of nearly level to gently sloping soils adjacent to rivers and intermittent streams. These soils are—

- Breaks-Alluvial land complex (Alluvial land part only) (Bk).
- Loamy alluvial land (Lo).
- Sandy alluvial land (So).
- Spur clay loam (Sc).
- Spur silt loam (Sp).
- Yahola very fine sandy loam (Yo).

Sandy alluvial land is normally not a part of this range site. It is included, however, because of its small acreage.

This site has the highest potential for the production of grass of any in the county. Because the site receives extra moisture from stream overflow and runoff from adjacent uplands, it produces tall grasses. The dominant tall grasses in the potential plant community are Indian-

grass, switchgrass, little bluestem, Canada wildrye, sand bluestem, and side-oats grama. Increasers are vine-mesquite, meadow dropseed, Texas wintergrass, white tridens, blue grama, and western wheatgrass. Invaders are buffalograss, three-awns, western ragweed, mesquite, pricklypear, and annual weeds. A few tall trees, such as pecan, elm, and cottonwood, also grow on this site.

The annual yield of air-dry herbage, excluding that from the woody species, ranges from 3,400 pounds per acre in favorable years to 2,000 pounds per acre in unfavorable years.

GYPLAND SITE

In this range site are nearly level to gently sloping soils that occupy small areas in the Carey-Woodward association. These soils are—

- Acme-Cottonwood complex (Cottonwood soil only) (Ac).
- Cottonwood-Acme complex (Cottonwood soils only) (Cc).

The amount of gypsum in the soils directly affects the kind and amount of vegetation the site is capable of producing. Normally, mid and tall grasses, such as little bluestem, side-oats grama, and blue grama, grow on this site as decreasers. Other decreasers that are less extensive are sand bluestem, Indiangrass, and switchgrass.

Where the content of gypsum is high, the dominant decreaser plants vary from true climax plants and include side-oats grama, hairy grama, and lesser amounts of little bluestem. Increasers are buffalograss, fall witchgrass, reverchoni panicum, black grama, and silver bluestem. Invaders include hairy tridens, Texas grama, mesquite, redberry juniper, catclaw, and annual weeds.

Where the content of gypsum is not extremely high in these soils, the annual yield of air-dry herbage, excluding that from woody species, ranges from 1,100 pounds per acre in favorable years to 500 pounds per acre in unfavorable years. Where the content of gypsum is extremely high, the total annual production of air-dry herbage ranges from 1,000 pounds per acre in favorable years to 300 pounds per acre in less favorable years.

ROUGH BROKEN SITE

This site has a distinct drainage pattern characterized by steep slopes and bluffs. Geologic erosion has occurred in the more dissected areas. These soils are—

- Breaks-Alluvial complex (Breaks parts only) (Bk).
- Quinlan-Woodward complex (Breaks part only) (Qw).

The risk of erosion is high on this site; therefore, good range management is essential, for a cover of grass must be maintained to control runoff.

If this range site is overgrazed and allowed to deteriorate, generally the result is serious overuse of the entire pasture.

The decreasers of the potential plant community on this site are side-oats grama, blue grama, and little bluestem. Increaser grasses that blend into the original composition are hairy grama, black grama, buffalograss, and silver bluestem. Invading plants are numerous, but Texas grama, hairy tridens, mesquite, redberry juniper, pricklypear, and catclaw are dominant.

The annual yield of air-dry herbage on this site, excluding that from woody species, ranges from 900 pounds per acre in favorable years to 500 pounds per acre in unfavorable years.

SANDY LOAM SITE

This range site is made up of gently sloping to moderately sloping soils that occupy ridges or rolling areas in the uplands. These soils are—

- Altus fine sandy loam (Am).
- Miles fine sandy loam, 0 to 1 percent slopes (MfA).
- Miles fine sandy loam, 1 to 3 percent slopes (MfB).
- Miles fine sandy loam, 3 to 5 percent slopes (MfC).
- Miles fine sandy loam, 3 to 5 percent slopes, eroded (MfC2).
- Wichita fine sandy loam, 0 to 1 percent slopes (WfA).
- Wichita fine sandy loam, 1 to 3 percent slopes (WfB).
- Wichita fine sandy loam, 3 to 5 percent slopes, eroded (WfC2).

Many kinds of plants grow on this site. The soils absorb light rainfall effectively but contain enough clay to hold moisture for a long period. The site is highly desirable for range.

The decreasers in the potential plant community on this site are side-oats grama, little bluestem, Arizona cottontop, plains bristlegrass, and vine-mesquite. Buffalograss, blue grama, hairy grama, and silver bluestem are among the increasers. Invaders are fall witchgrass, mesquite, pricklypear, yucca, and all annuals.

The annual yield of air-dry herbage on this site, excluding the yield of woody species, ranges from 2,550 pounds per acre in favorable years to 1,800 pounds per acre in unfavorable years.

DEEP SAND SITE

In this range site are undulating to hummocky sandy soils. These soils are—

- Brownfield fine sand (Br).
- Tivoli fine sand (Ts).

The potential plant community on this site consists of such decreasers as Indiangrass, switchgrass, little bluestem, and sand bluestem. The increasers in this community are side-oats grama, hairy grama, silver bluestem, and giant dropseed. Invaders are gummy lovegrass, red lovegrass, tumble lovegrass, and numerous annuals. Shin oak at one time made up only a small part of the plant community on this site. Now, because the better forage plants have been overgrazed, shin oak has increased throughout the site and is the dominant vegetation in some areas.

The annual yield of air-dry herbage, excluding the yield from woody species, ranges from 3,400 pounds per acre in favorable years to 1,400 pounds per acre in unfavorable years.

SANDY LAND SITE

Only Miles loamy fine sand, 0 to 3 percent slopes (MmB), is in this range site. This soil is fairly smooth for the most part, but it ranges from undulating to gently hummocky.

A number of different kinds of range plants can be produced on this site, but Indiangrass, sand bluestem, switchgrass, sand lovegrass, and little bluestem are the principal decreasers. Increasers include side-oats grama, hairy grama, silver bluestem, giant dropseed, plains bristlegrass, blue grama, and Arizona cottontop. Invaders are gummy lovegrass, tumblegrass, red lovegrass, yucca, and mesquite. Shin oak and sand sagebrush made up a minor part of the original plant composition. Prolonged heavy grazing has destroyed their natural competition, however, and shin oak and sand sagebrush now make up a large part of the total vegetation.

The annual yield of air-dry herbage, excluding the yield from woody species, ranges from 3,000 pounds per

acre in favorable years to 1,300 pounds per acre in unfavorable years.

MIXED LAND SITE

This range site is made up of gently sloping to steep soils of the uplands in areas of rolling hills and well-defined drainageways. The drainageways generally have a good cover of grass. These soils are—

- Carey loam, 0 to 1 percent slopes (CaA).
- Carey loam, 1 to 3 percent slopes (CaB).
- Carey loam, 3 to 5 percent slopes (CaC).
- Enterprise very fine sandy loam, 0 to 1 percent slopes (EnA).
- Enterprise very fine sandy loam, 1 to 3 percent slopes (EnB).
- Enterprise very fine sandy loam, 3 to 5 percent slopes (EnC).
- Enterprise very fine sandy loam, 5 to 12 percent slopes (EnD).
- Portales loam, 0 to 1 percent slopes (PoA).
- Quinlan-Woodward complex (Quinlan-Woodward soils only) (Qw).
- Tipton silt loam, 0 to 1 percent slopes (TpA).
- Tipton silt loam, 1 to 2 percent slopes (TpB).
- Woodward loam, 1 to 3 percent slopes (WoB).
- Woodward loam, 3 to 5 percent slopes (WoC).
- Woodward-Quinlan loams, 1 to 3 percent slopes (WwB).
- Woodward-Quinlan loams, 3 to 5 percent slopes (WwC).
- Woodward-Quinlan loams, 5 to 8 percent slopes (WwD).

The potential plant community on this site includes such decreaseers as side-oats grama, Arizona cottontop, plains bristlegrass, blue grama, western wheatgrass, and vine-mesquite. The main increaseers are buffalograss, hairy grama, black grama, tall dropseed, and silver bluestem. Invaders are Texas grama, sand muhly, red grama, hairy tridens, mesquite, condalia, tasajillo, pricklypear, and annuals. Deterioration of the original stand of grass results in an increase of buffalograss. Mesquite also invades readily if overgrazing is prolonged.

The annual yield of air-dry herbage, excluding the yield from woody species, ranges from 2,400 pounds per acre in favorable years to 1,600 pounds per acre in unfavorable years.

GRAVELLY SITE

Only Gravelly land (Gr) is in this range site. It occupies gently rolling to steep, gravelly hills. Pavements of gravel extend down the slopes.

This site produces many kinds of vegetation. Decreaseers in the potential plant community include side-oats grama, blue grama, little bluestem, black grama, and Arizona cottontop. Smaller amounts of sand bluestem, Indiangrass, and switchgrass grow in the more favored spots. The increaseers include hairy grama, buffalograss, silver bluestem, Texas wintergrass, and small amounts of shin oak. Invaders are Texas grama, sand muhly, hairy tridens, fall witchgrass, mesquite, redberry juniper, cat-claw, pricklypear, and numerous annuals.

The annual yield of air-dry herbage, excluding the yield from woody species, ranges from 1,800 pounds per acre in favorable years to 1,100 pounds per acre in unfavorable years.

VERY SHALLOW SITE

This range site is made up of rolling to hilly soils of the uplands. In places the soils are on knolls or on fairly steep escarpments. These soils are—

- Potter soils (Pi).
- Travessilla-Vernon complex (Travessilla soil only) (Tv).

The depth of the soil material greatly influences the kind of vegetation produced on this site. Tall grasses grow on the slopes where the soils are fairly deep and where runoff is received from higher areas. This site,

however, generally produces mid grasses, including such decreaseers as side-oats grama, little bluestem, and blue grama. The main increaseers are buffalograss, hairy grama, silver bluestem, slim tridens, and black grama. The invaders are numerous and include hairy tridens, sand dropseed, Texas grama, red grama, sand muhly, mesquite, pricklypear, condalia, yucca, redberry juniper, and annuals.

The annual yield of air-dry herbage, excluding the yield from woody species, ranges from 850 pounds per acre in favorable years to 400 pounds per acre in unfavorable years.

SHALLOW REDLAND SITE

This range site consists of soils of the uplands in gently sloping areas, on rolling hills, and on ridges. These soils are—

- Tillman-Vernon complex (Vernon soil only) (Tm).
- Travessilla-Vernon complex (Vernon soil only) (Tv).
- Vernon-Badland complex (Vernon soil only) (Vb).
- Weymouth clay loam, 1 to 3 percent slopes (WcB).
- Weymouth clay loam, 3 to 5 percent slopes (WcC).

The overall conditions on this site favor short grasses, but some mid grasses grow in areas where moisture is more favorable (fig. 8). Decreaseers are blue grama, side-oats grama, and vine-mesquite. Increaseers are buffalograss, tobosagrass, hairy grama, and silver bluestem. Invaders are hairy tridens, sand muhly, Texas grama, red grama, mesquite, pricklypear, redberry juniper, and annuals.

The annual yield of air-dry herbage, excluding the yield from woody species, ranges from 1,600 pounds per acre in favorable years to 900 pounds per acre in unfavorable years.

General management of range

All of the range in this county responds to proper grazing use and other basic practices of good management. Most of the sites in good to excellent condition can be grazed during any season of the year. They can be grazed continuously, but this practice may lead to overuse and deterioration of the range.

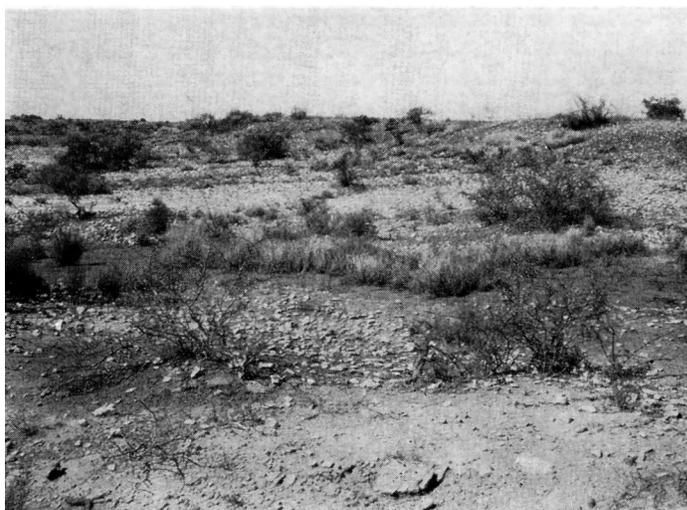


Figure 8.—An area of the Shallow Redland range site. Mid grasses grow in some of the low areas.

Other practices of good range management include stocking the kind of livestock best suited to the range; making necessary adjustments in grazing management so as to best use the plants that are palatable in different seasons; preventing overuse of any part of the range; and distributing livestock over the range so that all parts of the range will be grazed properly and uniformly. As an example, the Sandy Land and Deep Sand range sites are producing tall grasses, so they are best suited to grazing in spring and summer because the tall grasses are less palatable and less nutritious in winter. Also, these sandy sites are highly susceptible to wind erosion if the cover of plants is removed. They should be managed so that they are not overgrazed and the plant cover is maintained at all times.

As the condition of the range deteriorates, it may be necessary to practice deferred grazing, range seeding, and control of brush. Proper distribution of water and proper fencing are also necessary.

Deferred grazing.—Resting a pasture, or deferring grazing, for a definite period in summer or early in fall is a good way to hasten the recovery of range that is in fair or poor condition. This allows the desirable plants to grow vigorously, to spread vegetatively, and to produce seed. In addition, this practice builds up a reserve of forage for later use. A schedule of deferred grazing can be worked out by rotating grazing on different parts of the range, but fencing generally is required. The rest seasons should be adjusted to the growing and seeding habits of the key plants.

Range seeding.—Seeding to perennial or improved grasses is needed on range that is in poor condition, on most range that has been root-plowed to control mesquite, and on range where chemicals have been used to control shin oak. Also, converting cropland to range by seeding suitable perennial grasses is the best way to control erosion in difficult areas.

Brush control.—If brush makes up more than 10 percent of the vegetation on a site, grass is suppressed and does not protect the soil from erosion. Mesquite, shin oak, and redberry juniper are the most troublesome kinds of brush in this county. In some areas measures are needed to control brush before the range can be improved. Where the areas are heavily infested with mesquite, root plowing is generally used. Tree dozing is a common practice in areas that have lighter infestations of mesquite and cedar. Chemicals are commonly used to control shin oak and, in some areas, to control mesquite.

Distribution of water.—Water for livestock should be located so that animals do not have to travel more than about 1 mile in sandy or rolling areas and 2 miles in smoother areas. Strategically located wells and stock ponds help in obtaining even distribution of grazing. Most of the sandy areas in the county have adequate wells for livestock, but on much of the Deep Hardland site and particularly on the Tillman and Vernon soils, ponds for watering livestock are needed.

Fencing.—Most of the range in this county is adequately fenced to allow control of livestock and regulation of grazing. Additional cross-fences, however, could be built within some fenced areas to permit deferred and seasonal grazing.

Use of the Soils for Wildlife

This section briefly describes historical trends in the kinds of wildlife in the county. It also discusses the general management and the potential for producing wildlife. The management is presented mainly by soil associations, the broad areas described in the section beginning on page 2 and shown on the general soil map at the back of this report.

Kinds of wildlife in the county.—Some species of wildlife have survived in this county, but most have not. When white settlers came to the area, bison, deer, and antelope were plentiful, and coyotes, wolves, and bobcats were the main predators. One species of mountain lion was in the county, and there were possibly a few bear. Prairie dogs were numerous in many places, and many raccoons, skunks, and other fur bearers inhabited the area. The predators, particularly wolves, which traveled in packs, caused considerable damage to livestock.

Most of the damaging predators and nearly all of the prairie dogs have been exterminated, but coyotes and bobcats still roam the larger ranches in the county. Foxes, skunks, jackrabbits, cottontail rabbits, raccoons, and squirrels are still numerous. There are also many quail, doves, and songbirds. Deer have been stocked in some areas, and fish have been stocked in some ponds.

Settlement of the county and cultivation of large tracts of land have brought about the need for sites that can be improved for wildlife habitats. Many farmers and ranchers have sites that are potentially good for wildlife. Many of these can be improved by carefully managing the native vegetation and by fencing off odd areas, such as drainage channels, gullies, and spots of nonarable soils within fields, to provide additional habitats for wildlife. Generally, a plan for developing or improving a site for wildlife includes practices such as protecting the site from overgrazing and fire, controlling erosion, providing cover and food by planting or maintaining low trees or shrubs in some areas, planting some type of good seed-producing plants if such plants are not already available, and providing a year-round source of food for wildlife.

Ponds and the areas around ponds provide good habitats for wildlife. The larger ponds in the county are on ranches in the Tillman-Wichita and Miles-Travessilla associations and in the northern part of the Carey-Woodward association. Several of these ponds are at least a quarter of an acre in size and have a supply of water all year. Therefore, they are suitable for stocking with fish. Fish well suited to pond culture in this county are bass, bluegill, redeared sunfish, and channel catfish. Rough fish, such as carp, should be seined out (5).²

Livestock should be excluded from the areas around the pond. If water from the pond is needed for livestock, it can be piped to a trough below the dam. Cattails, moss, and other undesirable weeds should be controlled, and most ponds need fertilizer for maximum production. Regular fishing, beginning after the stocked fish have spawned, is also necessary for maintaining a desirable balance of species and for obtaining the best growth and reproduction of the fish (5).

Fish for stocking the ponds are available from the U.S. Fish and Wildlife Service and from the Texas Parks and

² Italic numbers in parentheses refer to Literature Cited, p. 75.

Wildlife Department. Information on developing wildlife habitats and farm fish ponds can be obtained from technicians of the Soil Conservation Service or from the local county agricultural agent.

Management of wildlife by soil associations.—Most of the Carey-Woodward association, the largest association of the county, has been cultivated for more than 50 years. In this association, until about the beginning of World War II, many farms 160 acres in size and several farms 80 acres in size were cultivated intensively. The small plots of native grass were heavily grazed by horses, mules, and other livestock, and the grazing destroyed most of the cover for wildlife.

More recently, many of the farm units within this association have been consolidated, and as a result, there are large connected areas along drainageways. These areas can be protected and improved as habitats for wildlife. Planting grain sorghum in the fields adjacent to the drainageways has provided feed for game birds late in summer and early in fall. As a result, game birds have increased in number and are hunted by many persons who come into the area during the hunting season.

The Tillman-Wichita association has more range than the Carey-Woodward association. In recent years a large acreage of range in that association has been root-plowed to control mesquite. During the first summer after the range is plowed, and sometimes during the second summer, sunflowers provide an abundant supply of feed for doves. Fields of grain also provide feed for doves and quail, and the numerous farm ponds in this association provide a good supply of water. Some of the larger and better ponds are suitable for stocking with game fish.

The areas of Badland in this association are suitable only for providing food and cover for wildlife. Careful management of the vegetation is necessary in those areas to increase the amount of cover for wildlife. Many sites for additional farm ponds are available in the areas of Badland, but the high rate of silting must be considered when a site for a pond is chosen.

Bobcats inhabit the areas of Vernon-Badland complex within the larger ranches of this association, and raccoon are numerous along the secondary streams, such as China, Dry, and Raven Creeks. "Coon" hunters come into the county from towns to the south and east to hunt this animal. The association also harbors coyotes and skunks, and the number of armadillos has increased considerably in recent years.

The Woodward-Quinlan association, in the northwestern part of the county, contains a variety of habitats for wildlife. Among these are cedar canyons, areas of bottom lands, and ledges not readily accessible to cattle. The variety of vegetation and the year-round supply of water in waterholes along Red Creek and Rough Creek give the association a high potential for wildlife. Careful management of grazing and protection from fire are needed, however, to improve this association for wildlife and to increase the number of birds and animals.

Hackberry and other trees on the bottom lands furnish food for birds such as cedar waxwing. Other birds in this association include bobwhite quail and blue quail. Coyotes and fox also inhabit the area, and recently, some deer have been stocked.

The Miles-Wichita association is largely cultivated, and cotton is the chief crop, although some grain sorghum is

grown. Small plots of native grass produce a number of different kinds of grasses, weeds, and woody plants, which provide food and cover for wildlife. Water from wells is also available in watering troughs. Protection from fire and careful management of grazing are needed to improve and maintain this association as a favorable habitat for birds.

Quail, chiefly bobwhite quail, and mourning doves are the principal species of birds in this association.

In the Miles-Travessilla association, the numerous bluffs, ridges of sandstone and conglomerate rock, and large areas of range afford good cover for wildlife. Also the many different kinds of grasses, forbs, and shrubs provide nearly a year-round supply of food. These wildlife areas must be protected from fire.

Recently, deer have been stocked on the larger ranches in the association, and game fish have been stocked in some of the larger ponds. In dry years adjustments in the stocking rate may be necessary so that enough food will be available for deer.

Much of the Abilene-Acme association is cultivated. The small plots of range in this association have stock ponds, which provide water in fall for doves that feed on grain sorghum. Many of the small areas of native grass have been overgrazed. Careful management is needed to increase the kinds and amounts of grass, which is essential for cover.

In the Mansker-Potter association the cover of plants suitable as habitats for wildlife is limited. Jackrabbits, cottontail rabbits, and some quail, however, do inhabit this association. Doves come into the area in fall and are hunted in areas near farm ponds.

The Spur-Yahola association provides considerable protective cover for wildlife, particularly along streambanks. In addition to the luxuriant growth of native grasses, the vegetation includes cottonwood, pecan, hackberry, and elm trees. Hackberry trees furnish food for many species of birds early in spring, and the grasses and weeds provide cover and food for quail, doves, and songbirds. In fall, doves also feed on grain sorghum grown on the adjacent cropland.

Pecan trees furnish food for squirrels, particularly along Sweetwater Creek and in the eastern part of this association. Water is available throughout the year in waterholes, and this makes the area a suitable habitat for raccoons. Good habitats could be developed where several of the smaller streams enter the main channels of larger streams, if these areas were fenced and protected from grazing.

In this county the Brownfield-Tivoli association has the best potential for providing habitats for wildlife, particularly for birds. Only a small part of this association is cultivated, but all of the surrounding acreage is cultivated. The present vegetation, consisting of shinnery oak, oak motts, or small clumps of oak, mid grasses, annual weeds, and wild plum bushes, provides cover and a variety of food for wildlife. Water from wells is also available in watering troughs.

Quail, particularly bobwhite quail, are the principal species of birds on this association. Coyotes and foxes are numerous, but hunters keep them under control; also the snake population is smaller in this association than in the other associations.

Proper management of grazing will increase the amount of cover to some extent and will increase the amount of native legumes, which provide an additional source of food for quail. The areas must also be protected from fire.

Engineering Uses of the Soils³

Some soil properties are of special interest to engineers because they affect the planning, construction, and maintenance of roads, airports, pipelines, foundations for buildings, facilities for water storage, erosion control structures, drainage systems, irrigation systems, and sewage disposal systems. The properties most important to the engineer are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Depth to the water table, and to bedrock, the topography, and the hydrologic characteristics are also important.

The interpretations given in this section will be helpful to readers who are interested in the general characteristics of the soils. Engineers, and those in related work will be interested in the tabular data.

The engineering interpretations reported here can be used for many purposes. It should be emphasized, however, that these interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of the layers here reported. Even in those situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

The information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
2. Make preliminary estimates of the engineering properties of soil in the planning of agricultural drainage systems, farm ponds, irrigation systems, waterways, diversion terraces, and other similar structures.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables and in planning detailed investigations at the selected locations.
4. Locate probable sources of sand, gravel, topsoil, and other material suitable for construction.
5. Correlate performance of engineering structures with soil mapping units to develop information for overall planning that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of soil mapping units for cross-country movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps and reports and aerial photographs to make maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

³ By CAVE M. WANN, engineer, and RALPH L. SCHWARTZ, soil scientist, Soil Conservation Service.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words, such as *soil*, *clay*, *silt*, *sand*, and *aggregate* may have special meanings in soil science. These terms, as well as other special terms that are used in the soil survey report, are defined in the Glossary at the back of this report.

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure (8). This system is useful only as the initial step in making engineering classifications of soils. The engineering properties of a soil must be determined or estimated after the initial classifications have been made. Two systems are used by engineers for classifying soils. These are the systems used by the American Association of State Highway Officials (AASHTO) and the Unified system. These systems are explained briefly in the following paragraphs. The explanations are taken largely from the PCA Soil Primer (6).

AASHTO Classification System.—Most highway engineers classify soil material according to the system approved by the American Association of State Highway Officials (AASHTO) (1). In this system soil material is classified in seven principal groups. The groups range from A-1, in which are gravelly soils of high bearing capacity, to A-7, which consists of clay soils having low strength when wet. Within each group, the relative load-carrying capacity of the soil material is indicated by a group index number. These numbers range from 0 for the best material to 20 for the poorest. The group index numbers are determined by the gradation, liquid limit, and plasticity index. For the soils tested, the group index number is shown in parentheses in table 5 following the soil group symbol.

Unified Classification System.—Some engineers prefer to use the Unified Soil Classification System. In this system soil material is divided into 15 classes (9). Eight classes are for coarse-grained material (GW, GP, GM, GC, SW, SP, SM, and SC); six are for fine-grained material (ML, CL, OL, MH, CH, and OH); and one (Pt) is for highly organic material. Mechanical analyses is used to determine the GW, GP, SW, and SP classes of material; mechanical analyses and tests for liquid limit and plasticity index are used to determine GM, GC, SM, SC, and fine-grained soils. The soils of this county have been classified in the GM, SM, SC, ML, CL, and CH classes.

Engineering interpretations of soils

Most of the engineering information in this section is given in tables 3, 4, and 5. These tables are discussed in the following paragraphs.

Table 3 gives a brief description of the soils in Fisher County and estimates of the properties significant to engineering. Some of the descriptions of the soil layers and of depth from the surface differ slightly from the description of the typical profile given in the section "Descriptions of the Soils." The purpose of the descriptions given in table 3 is to show the horizons that have significantly different engineering features.

The AASHTO designations given in table 3 for the Abilene, Carey, Tillman, Wichita, and Woodward soils are based on test data furnished by the Texas Highway

Department from samples taken in Fisher County. The classifications for the other soils are based on the results of field tests and on interpretations of test data from similar soils in nearby counties.

The estimates given for permeability are for the soil in place. They were based on soil structure and porosity and were compared with the results obtained by testing undisturbed cores of similar soil material.

The estimates of available water capacity, in inches per inch of soil, show the capacity of the soil to hold water in a form available to plants. It is the amount of moisture held in the soil between field capacity and the wilting point of plants. For more reliable estimates, field measurements must be taken or samples must be taken from representative soils that are undisturbed.

The column that shows reaction gives the estimated degree of acidity or alkalinity of the soils. In this system of notation, pH 7.0 is neutral; lower values indicate acidity; and higher values show alkalinity.

The shrink-swell potential indicates the volume change of the soil material that can be expected with changes in moisture content. In general, soils classified as A-7 and CH have high shrink-swell potential. Sand and gravel, containing a small amount of slightly plastic fines, as well as most other nonplastic to slightly plastic soil material, have a low shrink-swell potential. The subsoil of the Tillman clay loams, for example, has a high shrink-swell potential, for it is high in montmorillonite clay, which is very sticky when wet and contains numerous shrinkage cracks when dry. In contrast, the subsoil of Tivoli fine sand has low shrink-swell potential, for it is structureless (single grain) and nonplastic.

Table 3 gives the estimated content of gypsum that occurs naturally in the soils. Gypsum causes the soil particles to flocculate into small granules. Where the content of gypsum is shown as "low," the soils show little evidence of flocculation. The soils rated as "high," however, contain enough gypsum to produce extensive flocculation, and as a result, water can move freely through the profile.

Table 4 indicates the suitability of the soils for various engineering uses. In this table soil features are named that affect the suitability of the soils for highway construction and for agricultural engineering.

The soils are rated as a source of topsoil for use primarily on the sides of embankments, on the shoulders of roads, and as a lining for ditches. The surface layer was used as the basis for the ratings.

The suitability for road fill depends largely on the compaction characteristics, plasticity, internal drainage, and susceptibility to erosion of the undisturbed soil. Soils such as Randall clay are given a rating of "poor" as a source of material for road fill, because they are highly plastic, difficult to compact and handle, and have very poor internal drainage. In contrast, the Carey loams have desirable compaction characteristics, moderate to low plasticity, and good internal drainage. Therefore, they are given a rating of "good" as a source of material for road fill.

Soil features that make a site undesirable for the location of highways are a high water table, a flooding hazard, high plasticity, gypsum, bedrock on or near the surface, and unsuitable topography. Examples of soils that have some of these undesirable features are highly

plastic soils, such as the Abilene and Treadway, which have low bearing capacity when wet. Soils such as the Cottonwood have a high content of gypsum and thus have low bearing strength. The Travessilla soils have massive, hard rock near the surface. Grade control is difficult, and establishing a highway is expensive in areas where the Travessilla soils occur. Gravelly land is an example of a land type that has topography unsuitable for the location of highways. In this land type are deep valleys between narrow, high ridges; the topography varies greatly within short distances.

Soil features that influence the suitability of soils for dikes, levees, and embankments for farm ponds are plasticity, stability, susceptibility to seepage, and the erodibility of the slopes. Soils made up predominantly of highly plastic clay and loam, such as the Tillman clay loams, Treadway clay, and Abilene clay loams, have low strength and stability, and they crack badly when dry. Material from such soils may be used for impervious cores and blankets, but it should not be used in embankments unless more suitable material is mixed with it. Brown-field fine sand and Tivoli fine sand are examples of soils that do not contain enough soil-binding agents to produce a stable embankment or to hold seepage losses to an acceptable rate. The Miles fine sandy loams, Spur silt loam, and the Portales soil, on the other hand, have fair strength and stability and desirable compaction characteristics.

The main characteristics considered in choosing a site to be used as a reservoir for a farm pond are the rate of seepage, the presence of permeable material, and the depth to the underlying bedrock. The Tillman clay loams and soils of the Tillman-Vernon complex are excellent for reservoirs, for they have a low seepage rate and adequate depth over bedrock.

The suitability of a soil for agricultural drainage is affected by the rate at which water moves through the part of the profile where the development of roots takes place. In such soils as the Woodward loams, the movement of water is restricted by soft sandstone at a depth of 30 to 40 inches. Other soils, such as Treadway clay, have a slowly permeable surface layer and therefore are seldom saturated to a depth of more than 3 feet.

The features given for irrigation help to determine the suitability of the soils for certain kinds of crops, the best method of applying water, and the rate of application. If sprinkler irrigation is used, the Yahola soil, for example may offer good possibilities for the production of fruit, cotton, or bermudagrass. The Acme and Cottonwood soils, on the other hand, are too shallow for deep-rooted crops such as alfalfa to be grown economically; they have low water-holding capacity and are therefore not well suited to irrigation. Only a sprinkler system can be used for irrigating the Miles loamy fine sand, for that soil has moderate permeability and low water-holding capacity. Some soils are so porous that they require frequent light applications of water.

Soil features significant in the construction of terraces and diversions are the degree of slope, the content of stones, the depth of the soil, and the susceptibility of the soil material to blowouts. Other features are the hazard of flooding, the permeability of the soil material, as related to the drainage needs, and the erodibility of the soils.

TABLE 3.—*Brief description of the soils and*

Map symbol	Soil	Description	Depth from surface	Classification
				USDA texture
AbA	Abilene clay loam, 0 to 1 percent slopes.	About 16 inches of clay loam over 3 to 4 feet of light clay to clay; underlain by outwash material of calcareous clay and sandy clay.	<i>Inches</i> 0-16 16-50	Clay loam.....
AbB				Light clay to clay...
Ac	Acme-Cottonwood complex.	Acme soil: 10 to 20 inches of calcareous clay loam over thick beds of white calcium sulfate and calcium carbonate. For a description of the Cottonwood soil, see Cottonwood-Acme complex.	0-6 6-15 15-18+	Light clay loam....
				Clay loam.....
				Sandy clay loam....
Am	Altus fine sandy loam.	8 to 18 inches of fine sandy loam over 14 to 24 inches of moderately permeable, weakly calcareous sandy clay loam; formed in strongly calcareous alluvium.	0-8 8-32 32-62+	Fine sandy loam....
				Sandy clay loam....
				Sandy clay loam....
Ba	Badland.	2 to 4 inches of slightly weathered clay over unweathered clayey material of the red beds.	0-15+	Clay.....
Bk	Breaks-Alluvial land complex.	Breaks: A miscellaneous land type in shallow drains that extend through areas of Carey and Woodward soils. The side slopes of the drains are occupied by Quinlan soils or consist of outcrops of sandy and silty material of the red beds. For a description of Alluvial land, see Loamy alluvial land.	0-15	Fine sandy loam to loam.
Br	Brownfield fine sand.	20 to 30 inches of fine sand over 10 to 20 inches of moderately permeable sandy clay loam; underlain by windblown fine sandy loam.	0-30 30-44 44-62+	Fine sand..... Sandy clay loam..... Heavy fine sandy loam.
CaA	Carey loam, 0 to 1 percent slopes.	4 to 12 inches of loam over 24 to 50 inches of moderately permeable sandy clay loam; the underlying material is calcareous sandy and silty material of the red beds.	0-10 10-58 58-75+	Loam.....
CaB				Sandy clay loam....
CaC				Light very fine sandy loam.
Cc	Cottonwood-Acme complex.	Cottonwood soil: 4 to 10 inches of moderately permeable, calcareous loam over thick beds of white calcium sulfate and calcium carbonate. For a description of the Acme soil, see Acme-Cottonwood complex.	0-10 10-30+	Loam.....
				Gypsum.....
EnA	Enterprise very fine sandy loam, 0 to 1 percent slopes.	4 to 6 feet of calcareous very fine sandy loam that has moderate permeability; formed in calcareous windblown material.	0-14 14-54	Very fine sandy loam.
EnB				Very fine sandy loam.
EnC				Enterprise very fine sandy loam, 3 to 5 percent slopes.
EnD				Enterprise very fine sandy loam, 5 to 12 percent slopes.
Gr	Gravelly land.	10 to 20 inches of gravelly loam over thick beds of gravel; consists of quartzitic material ranging from fine sand to cobbles.	0-15 15-20+	Gravelly loam..... Gravel.....
La	Loamy alluvial land.	3 to 5 feet of stratified fine sandy loam to clay loam that is frequently overflowed; formed in alluvium.	0-60+	Stratified fine sandy loam to clay loam.
MaB	Mansker loam, 1 to 3 percent slopes.	12 to 22 inches of well-drained, strongly calcareous loam to clay loam; formed in strongly calcareous, medium-textured to fine-textured sediments.	0-6 6-15 15-50+	Loam.....
MaC				Clay loam.....
MaD				Clay loam.....

See footnotes, at end of table.

their estimated physical and chemical properties

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Content of gypsum
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
CL ¹ -----	A-6 ¹ -----	¹ 100	¹ 100	¹ 75-85	<i>Inches per hour</i> 0.2-0.6	<i>Inches per inch of soil</i> 0.16-0.18	<i>pH</i> 7.0-7.5	Moderate-----	Low.
CL, CH ¹ ---	A-6, A-7 ¹ ---	¹ 100	¹ 95-100	¹ 80-85	0.2-0.6	0.18-0.20	7.0-8.0	Moderate to high.	Low.
CL, CH ¹ ---	A-6, A-7 ¹ ---	¹ 95-100	¹ 90-100	¹ 70-85	0.2-0.6	0.14-0.16	7.0-8.0	Moderate-----	Low.
CL-----	A-6-----	100	80-100	70-80	0.8-1.5	0.14-0.16	7.5-8.0	Low to moderate.	Medium to high.
CL-----	A-6-----	100	85-100	75-85	1.0-1.5	0.16-0.18	7.5-8.0	Low to moderate.	High.
ML, CL---	A-4, A-6---	100	85-95	50-65	1.5+	0.12-0.16	7.5-8.0	Low to moderate.	Very high.
SM, SC---	A-4-----	100	80-95	35-50	0.2-2.0	0.12-0.15	6.5-7.0	Low-----	Low.
ML-----	A-4-----	100	85-95	45-60	1.0-1.5	0.14-0.18	7.0-7.5	Low to moderate.	Low.
SM, SC---	A-4-----	100	85-100	40-55	1.0-1.5	0.14-0.18	7.5-8.5	Low to moderate.	Low.
CL, CH---	A-6, A-7---	100	85-100	75-90	0.05-0.1	0.14-0.16	7.5-8.5	High-----	Low.
SM, SC---	A-4-----	90-100	80-95	35-50	1.0-1.5	0.13-0.15	7.0-7.5	Low-----	Low.
SM-----	A-2-----	95-100	90-100	10-15	1.5-3.0	0.07-0.09	6.0-6.5	Low-----	None.
SM, SC---	A-6-----	100	95-100	35-45	1.0-2.0	0.14-0.18	6.0-6.5	Low to moderate.	None.
SM-----	A-2-----	100	100	25-35	1.0-2.0	0.12-0.15	6.5-7.0	Low-----	None.
ML, CL ¹ ---	A-4 ¹ -----	¹ 100	¹ 100	55-60	0.8-1.5	0.12-0.15	6.5-7.5	Low-----	Low.
CL ¹ -----	A-6 ¹ -----	¹ 100	¹ 100	55-70	0.7-1.2	0.14-0.18	6.5-7.5	Low to moderate.	Low.
ML, CL ¹ ---	A-4 ¹ -----	¹ 100	¹ 100	50-65	1.0-1.5	0.12-0.15	7.5-8.0	Low-----	Low to moderate.
CL-----	A-4, A-6---	100	80-100	55-70	1.0-1.5	0.12-0.15	7.5-8.5	Low to moderate.	High.
(?)-----	(?)-----	(?)	(?)	(?)	(?)	(?)	(?)	(?)-----	(?).
SM, SC---	A-4-----	100	90-100	40-60	1.5-2.5	0.14-0.16	7.5-8.0	Low-----	Low.
SM, SC---	A-4-----	100	95-100	50-65	1.0-2.0	0.14-0.16	7.5-8.5	Low-----	Low.
GM, SM---	A-2-----	40-70	25-40	10-25	2.5+	0.10-0.12	7.0-7.5	Low-----	None.
(?)-----	(?)-----	(?)	(?)	(?)	(?)	(?)	(?)	(?)-----	(?).
SM, SC---	A-4-----	70-100	60-85	45-55	0.8-2.5	0.16-0.18	7.5-8.5	Low to moderate.	Low.
CL-----	A-4, A-6---	100	95-100	50-65	1.0-1.2	0.14-0.16	8.0-8.5	Low-----	None.
CL-----	A-6-----	100	95-100	65-80	0.8-1.2	0.16-0.18	8.0-8.5	Low to moderate.	None.
CL-----	A-6-----	100	95-100	65-80	0.8-1.2	0.16-0.18	8.0-8.5	Moderate-----	None.

TABLE 3.—*Brief description of the soils and*

Map symbol	Soil	Description	Depth from surface	Classification
				USDA texture
MfA	Miles fine sandy loam, 0 to 1 percent slopes.	9 inches of fine sandy loam over 40 to 50 inches of moderately permeable sandy clay loam; formed in calcareous outwash material.	<i>Inches</i> 0-9 9-50 50-60+	Fine sandy loam----
MfB	Miles fine sandy loam, 1 to 3 percent slopes.			Sandy clay loam----
MfC	Miles fine sandy loam, 3 to 5 percent slopes.			Sandy clay loam to fine sandy loam.
MfC2	Miles fine sandy loam, 3 to 5 percent slopes, eroded.			
MmB	Miles loamy fine sand, 0 to 3 percent slopes.	8 inches of loamy fine sand over 40 to 50 inches of moderately permeable sandy clay loam; formed in fine sandy loam outwash.	0-8 8-50 50-60+	Loamy fine sand----
				Sandy clay loam----
				Fine sandy loam----
PoA	Portales loam, 0 to 1 percent slopes.	26 to 36 inches of calcareous, moderately permeable loam to light clay loam; underlain by soft calcium carbonate.	0-18 18-34 34-72+	Loam-----
				Light clay loam----
				Sandy clay loam----
Pt	Potter soils.	4 to 10 inches of strongly calcareous clay loam over a thick bed of soft caliche.	0-6 6-24+	Clay loam-----
				Soft and hard caliche.
Qw	Quinlan-Woodward complex.	For a description of the Quinlan soil, see the Woodward-Quinlan loams; for a description of the Woodward soil, see the Woodward loams; and for a description of Breaks, see Breaks-Alluvial land complex.		-----
Ra	Randall clay.	3 to 5 feet of poorly drained clay in enclosed depressions.	0-40 40-72+	Clay-----
				Clay-----
Sa	Sandy alluvial land.	Frequently overflowed, stratified sand, loamy sand, and fine sandy loam; on alluvial terraces along the larger streams.	0-66+	Sands, loamy sands, and fine sandy loams.
Sc	Spur clay loam.	5 feet or more of calcareous clay loam to silty clay loam that has moderately slow permeability; formed in outwash material from Permian red beds.	0-6 6-60+	Clay loam-----
				Silty clay loam to clay loam.
Sp	Spur silt loam.	7 inches of silt loam over 4 feet or more of stratified clay loam and silt loam outwash material from Permian red beds.	0-7 7-62+	Silt loam-----
				Clay loam-----
TcA	Tillman clay loam, 0 to 1 percent slopes.	5 to 12 inches of clay loam over 4 feet of calcareous clay that has moderately slow permeability; formed in calcareous, clayey material of the red beds.	0-5 5-55 55-75+	Heavy clay loam----
TcB	Tillman clay loam, 1 to 3 percent slopes.			Clay ¹ -----
				Clay ¹ -----
Tm	Tillman-Vernon complex.	Vernon soil: 12 to 20 inches of calcareous clay loam to clay that has moderately slow permeability; overlies clayey red beds. For a description of the Tillman soil, see the Tillman clay loams.	0-9 9-18 18-20+	Clay loam-----
				Clay-----
				Clay-----
TpA	Tipton silt loam, 0 to 1 percent slopes.	15 to 26 inches of silt loam over 20 to 30 inches of calcareous silty clay loam that has moderately slow to moderate permeability; formed in old alluvium washed from the surrounding soils that were derived from red-bed material.	0-26 26-46 46-58+	Silt loam-----
TpB	Tipton silt loam, 1 to 2 percent slopes.			Silty clay loam----
				Silty clay loam----
Ts	Tivoli fine sand.	5 to 7 feet of fine sand that has moderately rapid permeability; formed in windblown deposits.	0-10 10-62+	Fine sand----- Fine sand-----

See footnotes at end of table.

their estimated physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Content of gypsum
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
SM	A-2, A-4	100	100	25-50	<i>Inches per hour</i> 1.0-2.0	<i>Inches per inch of soil</i> 0.12-0.15	<i>pH</i> 6.5-7.0	Low	None.
ML	A-6	100	95-100	45-60	0.8-1.2	0.15-0.18	7.0-7.5	Moderate	None.
SM, SC	A-4, A-6	100	95-100	35-50	0.8-1.2	0.14-0.16	7.5-8.0	Moderate	None.
SM	A-2, A-4	95-100	80-95	25-40	1.5-2.0	0.08-0.10	6.5-7.0	Low	None.
ML	A-4	100	95-100	45-60	0.8-1.5	0.15-0.18	7.0-7.5	Low to moderate.	None.
SM, SC	A-4	100	95-100	35-50	0.8-1.5	0.12-0.15	7.5-8.0	Low	None.
SM, SC	A-4	100	80-95	40-55	0.8-1.4	0.16-0.18	7.5-8.0	Low to moderate.	Low.
ML, CL	A-6	100	85-100	55-70	0.8-1.2	0.14-0.16	8.0-8.5	Moderate	Low
SM, SC	A-2, A-4	100	85-95	50-65	0.8-1.0	0.14-0.16	8.0-8.5	Low to moderate.	Low.
CL	A-6	100	85-95	65-85	0.8-1.5	0.16-0.18	8.0-8.5	Moderate to high.	None.
ML, CL	A-4	100	80-95	55-65	0.8-2.0	0.06-0.07	8.0-8.5	Low to moderate.	None.
CL, CH	A-6, A-7	100	100	80-95	0-0.05	0.18-0.20	6.5-7.5	High	None.
CL, CH	A-6, A-7	100	100	75-90	0-0.25	0.18-0.20	7.5-8.0	High	None.
SM, SC	A-2, A-4	100	80-95	25-50	5.0+	0.08-0.10	7.5-8.0	Low	Low.
ML, CL	A-6	100	95-100	60-80	0.8-1.2	0.16-0.18	7.5-8.0	Moderate	Low.
CL, CH	A-6, A-7	100	100	60-80	0.8-1.0	0.16-0.18	7.5-8.0	Moderate to high.	Low.
ML	A-4	100	100	50-65	0.8-1.0	0.16-0.18	7.5-8.0	Moderate	Low.
ML, CL	A-6	100	100	60-75	0.8-1.2	0.16-0.18	7.5-8.0	Moderate	Low.
CL	A-6	100	90-100	80-90	0.05-0.20	0.16-0.18	7.0-8.0	Moderate	Low.
CL ¹	A-7 ¹	100	95-100	85-95	0.05-0.10	0.16-0.18	7.5-8.0	High	Low.
CL ¹	A-7-6 ¹	100	95-100	60-80	0.05-0.10	0.14-0.16	7.5-8.5	High	Low.
CL	A-7	100	95-100	65-90	0.05-0.20	0.16-0.18	7.5-8.0	High	Low.
CL, CH	A-7	100	95-100	85-95	0.05-0.20	0.16-0.18	7.5-8.5	High	Low.
CL, CH	A-7	100	90-100	75-95	0.05-0.10	0.14-0.16	7.5-8.5	High	Low.
ML	A-4	100	90-100	55-70	0.8-1.2	0.14-0.16	7.0-7.5	Moderate	None.
ML, CL	A-4, A-6	100	95-100	70-85	0.8-1.0	0.16-0.18	7.0-8.0	Moderate to high.	None.
ML, CL	A-4, A-6	100	95-100	70-80	0.8-1.0	0.14-0.16	7.0-8.0	Moderate to high.	None.
SP, SM	A-2	100	85-100	10-25	5.0+	0.07-0.09	6.5-7.0	Low	None.
SM	A-2	100	85-100	20-35	5.0+	0.06-0.08	6.5-7.0	Low	None.

TABLE 3.—*Brief description of the soils and*

Map symbol	Soil	Description	Depth from surface	Classification
				USDA texture
Tv	Travessilla-Vernon complex.	Travessilla soil: 2 to 10 inches of gravelly sandy loam over conglomerate rock or sandstone; has steep outcrops of conglomerate rock and sandstone around the sides. For properties of the Vernon soil, see Vernon-Badland complex.	<i>Inches</i> 0-6 6-7+	Gravelly sandy loam. Rock-----
Tw	Treadway clay.	3 to 6 feet of stratified, calcareous clay; formed in eroded, clayey material of the red beds.	0-72 72-90+	Stratified clays----- Clay-----
Vb	Vernon-Badland complex.	Vernon soil: 4 to 10 inches of clayey soil material over clayey material of the red beds. For a description of Badland, see the mapping unit Badland.	0-8 8-14+	Clay loam----- Clay-----
WcB	Weymouth clay loam, 1 to 3 percent slopes.	12 to 20 inches of calcareous clay loam that has moderately slow permeability; formed in strongly calcareous material of the red beds.	0-6	Clay loam-----
WcC	Weymouth clay loam, 3 to 5 percent slopes.		6-15	Clay loam-----
			15-24+	Sandy clay loam-----
WfA	Wichita fine sandy loam, 0 to 1 percent slopes.	5 to 15 inches of fine sandy loam over 2 to 5 feet of sandy clay loam to light sandy clay; has moderately slow permeability; formed in old alluvium of light sandy clay loam.	0-6	Fine sandy loam-----
WfB	Wichita fine sandy loam, 1 to 3 percent slopes.		6-58	Sandy clay loam to sandy clay.
WfC2	Wichita fine sandy loam, 3 to 5 percent slopes, eroded.		58-64+	Sandy clay loam-----
WhA	Wichita loam, 0 to 1 percent slopes.	5 to 8 inches of loam over 2 to 3 feet of clay loam to light clay; has moderately slow permeability; formed in strongly calcareous old alluvium.	0-8	Loam-----
WhB	Wichita loam, 1 to 3 percent slopes.		8-42	Clay loam-----
			42-60+	Clay loam-----
WmA	Wichita clay loam, 0 to 1 percent slopes.	5 to 8 inches of clay loam over 2 to 3 feet of clay loam to light clay; has moderately slow permeability; formed in strongly calcareous old alluvium.	0-5	Light clay loam-----
WmB	Wichita clay loam, 1 to 3 percent slopes.		5-34	Clay loam-----
			34-84+	Sandy clay loam-----
WoB	Woodward loam, 1 to 3 percent slopes.	2 to 4 feet of calcareous loam that has moderate permeability; formed in calcareous very fine sandy loam of the red beds.	0-20	Loam-----
WoC	Woodward loam, 3 to 5 percent slopes.		20-36 36-40+	Loam----- Sandy red beds-----
WwB	Woodward-Quinlan loams, 1 to 3 percent slopes.	Quinlan soil: 4 to 15 inches of loam or very fine sandy loam over calcareous, sandy material of the red beds. For a description of the Woodward soils, see the Woodward loams.	0-6	Loam or very fine sandy loam.
WwC	Woodward-Quinlan loams, 3 to 5 percent slopes.		6-18	Loam or very fine sandy loam.
WwD	Woodward-Quinlan loams, 5 to 8 percent slopes.		18-30+	Sandy red beds-----
Ya	Yahola very fine sandy loam.	4 to 5 feet of stratified very fine sandy loam, loam, and loamy fine sand; strongly calcareous; flooded occasionally.	0-58 58-72+	Very fine sandy loam to loam to loamy fine sand. Silty clay loam-----

¹ Based on test data shown in table 5.

their estimated physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Content of gypsum
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
GM, SM (²)	A-2, A-4 (²)	40-80 (²)	25-40 (²)	0-5 (²)	<i>Inches per hour</i> 1.0-2.5 0-0.1	<i>Inches per inch of soil</i> 0.10-0.12 0-0.05	<i>pH</i> 6.5-7.0 6.5-7.0	Low (²)	None. None.
CL, CH	A-6, A-7	100	95-100	75-95	0-0.05	0.14-0.16	7.5-8.5	High	Low.
CL, CH	A-6, A-7	100	80-95	70-90	0-0.05	0.16-0.18	7.5-8.5	High	Low.
CL	A-6	100	95-100	80-90	0.1-0.2	0.16-0.18	7.5-8.5	High	Low.
CL, CH	A-6, A-7	100	85-100	75-90	0.1-0.2	0.14-0.16	7.5-8.5	High	Low.
CL	A-4, A-6	100	80-95	60-75	0.8-1.2	0.16-0.18	7.5-8.0	Moderate to high.	None.
CL	A-4, A-6	100	85-100	70-85	0.8-1.0	0.16-0.18	7.5-8.5	Moderate to high.	None.
ML, CL	A-6	100	80-95	60-80	0.8-1.2	0.12-0.16	8.0-8.5	Moderate	None.
SM, SC	A-4	80-95	70-90	40-55	0.4-0.75	0.12-0.15	6.5-7.0	Low	None.
CL	A-6, A-7	100	95-100	75-90	0.2-0.6	0.16-0.18	7.0-7.5	Moderate to high.	None.
CL	A-6	95-100	90-100	75-90	0.3-0.6	0.14-0.16	7.5-8.0	Moderate	None.
CL	A-6	100	85-95	70-90	0.3-0.6	0.16-0.18	7.0-7.5	Moderate	None.
CL	A-6, A-7	100	95-100	75-90	0.2-0.4	0.16-0.18	7.0-7.5	Moderate to high.	None.
CL	A-6, A-7	100	95-100	75-90	0.2-0.4	0.16-0.18	7.5-8.5	Moderate to high.	None.
CL	A-7-6	95-100	80-95	70-85	0.25-0.7	0.16-0.18	7.0-7.5	Moderate to high.	None.
CL ¹	A-7-6 ¹	¹ 100	¹ 95-100	¹ 75-90	0.2-0.5	0.16-0.18	7.5-8.0	Moderate to high.	None.
CL ¹	A-6 ¹	¹ 97-100	¹ 90-100	¹ 75-90	0.2-0.6	0.14-0.16	8.0-8.5	Moderate to high.	None.
ML, CL ¹	A-4 ¹	¹ 95-100	¹ 90-95	¹ 70-75	2.0-3.0	0.12-0.15	7.5-8.0	Low	Low to none.
ML, CL ¹	A-4 ¹	¹ 85-100	¹ 85-100	¹ 65-85	2.0-2.5	0.14-0.16	7.5-8.0	Low	Low to none.
ML, CL ¹	A-4 ¹	¹ 90-100	¹ 90-98	¹ 80-90	2.0-2.5	0.06-0.08	7.5-8.5	Moderate	Low to none.
ML, CL	A-4	90-100	85-95	55-75	0.8-2.0	0.12-0.15	7.5-8.0	Moderate	Low.
ML, CL	A-4	85-100	85-100	60-85	0.8-2.0	0.12-0.15	7.5-8.5	Moderate	Low.
ML, CL	A-4	80-100	70-90	45-60	0.8-1.5	0.06-0.08	7.5-8.5	Moderate	High.
SM, SC	A-4	85-100	75-95	45-65	0.8-2.5	0.14-0.16	7.5-8.0	Low	Low.
ML, CL	A-4	95-100	85-100	60-80	0.8-2.0	0.16-0.18	7.5-8.5	Moderate	Low.

² Properties not estimated.

TABLE 4.—*Interpretations of*

Soil type and map symbol	Suitability as a source of—			Soil features affecting engineering practices	
	Topsoil	Sand and gravel	Road fill	Highway location	Dikes or levees
Abilene clay loam (AbA, AbB)-----	Fair-----	Not suitable-----	Poor; high plasticity.	High plasticity in substratum.	High plasticity; cracks when dry; poor stability.
Acme-Cottonwood complex (Ac): (Acme soil only; for interpretations for Cottonwood soils, see Cottonwood-Acme complex)	Fair to good--	Not suitable-----	Very poor; will not compact properly.	Shallow over beds of gypsum.	Poor stability; piping hazard in strata of gypsum.
Altus fine sandy loam (Am)-----	Good-----	Not suitable-----	Fair to a depth of 36 inches; stable where side slopes are gentle.	Fair to good stability; occasional high water table.	Fair to good stability where side slopes are gentle; moderate seepage.
Badland (Ba)-----	Poor-----	Not suitable-----	Not suitable-----	High plasticity-----	High plasticity; cracks when dry.
Breaks-Alluvial land complex (Bk): (Breaks only; for interpretations for Alluvial land, see Loamy alluvial land)	Poor to good--	Not suitable-----	Fair to good-----	Flooding because of low position; fair stability.	Fair stability where side slopes are gentle; moderate seepage.
Brownfield fine sand (Br)-----	Fair to poor--	Poor to fair; significant percentage of fines.	Fair; low content of soil binder.	Poor stability; compaction difficult because soil material is poorly graded.	Moderate permeability; poor stability.
Carey loam (CaA, CaB, CaC)-----	Good-----	Not suitable-----	Good; erodible on steep slopes.	Erodible on steep slopes.	Moderate permeability; fair to good stability.
Cottonwood-Acme complex (Cc): (Cottonwood soil only; for interpretations for Acme soil, see Acme-Cottonwood complex).	Poor; very shallow.	Not suitable-----	Poor; will not compact properly.	High content of gypsum; does not compact properly.	Poor stability; piping hazard as a result of the underlying gypsum.
Enterprise very fine sandy loam (EnA, EnB, EnC, EnD).	Good-----	Not suitable-----	Fair to good; moderately erodible on steep side slopes.	Fair to good stability; moderately erodible on steep side slopes.	Fair to good stability; moderately erodible on steep side slopes.
Gravelly land (Gr)-----	Poor-----	Good; well-mixed fine sand to pebbles the size of cobbles.	Fair to good; highly erodible on steep slopes.	Extremely undulating topography.	High seepage; not suitable.

engineering properties of the soils

Soil features affecting engineering practices—Continued

Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment				
Permeable strata at a depth of 4 to 6 feet.	Low strength and poor stability.	Moderately slow permeability; subsurface drainage difficult.	Moderately slow intake rate.	No limitations-----	Vegetation difficult to establish on deep cuts.
Rapid permeability because gypsum is below a depth of 20 inches.	Excessive gypsum; not suitable for embankments.	Good internal drainage as a result of the underlying gypsum.	Shallow and has low water-holding capacity; not suitable.	The underlying gypsum causes piping.	Gypsum near the surface limits shaping; some piping channels because of the gypsum; low fertility.
Moderate permeability; moderate seepage.	Fair to good stability where side slopes are gentle.	Moderate permeability; limited by impervious material in a few places below the surface layers.	Moderate permeability; occasional high water table.	Subsurface drainage restricted in some areas; no other limitations.	High erodibility; impervious substratum in some areas.
Slow seepage; depth not limited in most places.	Low strength and poor stability; high shrink-swell potential.	Very slow permeability; subsurface drainage difficult.	Not suitable-----	Poor position; not suitable.	Not suitable.
Moderate permeability; moderate seepage.	Fair stability; moderate seepage.	Moderate permeability; drainage not needed.	Not suitable; rough topography.	Poor position; not suitable.	Easily eroded where slopes are steep; low water-holding capacity.
Moderate permeability; excessive seepage.	Moderate permeability; excessive seepage.	Moderate permeability; drainage not needed.	Moderate permeability; low water-holding capacity; low capacity for holding plant nutrients.	Poor stability; not suitable for terraces.	High erodibility; low fertility; low water-holding capacity.
Moderate permeability; moderate to high seepage.	Fair to good stability on flat slopes; moderate to high seepage.	Moderate permeability; drainage not needed.	Moderate permeability and water-holding capacity; hazard of erosion on slopes of more than 3 percent.	Moderate erodibility; no other limitations.	Moderate erodibility.
High seepage in gypsum strata below a depth of 10 inches.	Excessive gypsum; unsuitable for embankments.	Good internal drainage because of the underlying gypsum.	Poor agricultural soil; very shallow; not suitable.	Very shallow; piping as a result of the underlying gypsum; not suitable.	Gypsum near the surface limits shaping; some piping channels caused by the gypsum; low fertility.
Moderate to high seepage.	Fair to good stability; moderate to high seepage.	Moderate to moderately rapid permeability; drainage not needed.	Moderate to high water-holding capacity; moderate to moderately rapid permeability.	Moderately erodible; no other limitations.	Moderately erodible.
Moderately rapid permeability to a depth of several feet; not suitable, because of position on ridgetops.	Moderately rapid permeability; sand and gravel; not suitable for embankments without additional soil binder.	Moderately rapid permeability; drainage not needed.	Poor agricultural soil; not suitable for irrigation.	Not suitable-----	Low fertility and low water-holding capacity; normally not suitable, because of position.

TABLE 4.—*Interpretations of*

Soil type and map symbol	Suitability as a source of—			Soil features affecting engineering practices	
	Topsoil	Sand and gravel	Road fill	Highway location	Dikes or levees
Loamy alluvial land (La)-----	Good to fair--	Not suitable-----	Fair to good if side slopes are gentle.	Frequent flooding; stratified material.	Moderate seepage; fair to good stability on gentle side slopes; possible seepage in substratum.
Mansker loam (MaB, MaC, MaD)--	Fair in upper 10 inches.	Not suitable; fair source of caliche.	Fair; moderate to high plasticity.	Moderate to high plasticity.	Moderate to high plasticity; fair stability.
Miles fine sandy loam (MfA, MfB, MfC, MfC2).	Good-----	Not suitable-----	Good; low percentage of fines in surface layer.	Erodible on steep slopes.	Good stability; moderate erosion on steep slopes.
Miles loamy fine sand (MmB)-----	Fair to good--	Not suitable-----	Good; low percentage of fines in surface layer.	Erodible on steep slopes.	Moderate permeability; fair stability; erodible on steep slopes.
Portales loam (PoA)-----	Poor to fair in upper 10 inches.	Not suitable; contains some caliche.	Fair; moderate plasticity.	Moderate plasticity.	Moderate plasticity; fair stability; high seepage in substratum.
Potter soils (Pt)-----	Poor; shallow soil.	Fair; good source of caliche.	Fair below surface layer.	Moderate to high plasticity; soft and hard caliche below a depth of 10 inches.	Moderate to high plasticity; poor stability; high seepage below a depth of 10 inches
Quinlan-Woodward complex (Qw): (Breaks only; for interpretations for Quinlan soil, see Woodward-Quinlan loams, and for those for Woodward soil, see Woodward loam).	Poor; very shallow.	Not suitable-----	Fair to good if side slopes are gentle; erodes easily.	Moderate plasticity; erodes easily.	Moderate permeability; moderate seepage; erodible on steep slopes.
Randall clay (Ra)-----	Poor-----	Not suitable-----	Poor; high plasticity.	High plasticity; flooding in enclosed, concave areas.	High plasticity; cracks when dry.
Sandy alluvial land (Sa)-----	Poor-----	Poor to fair; poorly graded material.	Good where side slopes are gentle; erodes easily.	Low position; flooding and depositing of sediment.	Poor stability; low content of soil binder in some strata; high seepage.
Spur clay loam (Sc)-----	Fair to good--	Surface layer not suitable; water-bearing sand and gravel below a depth of 10 feet in places.	Poor; moderate to high plasticity; water table at a depth of 10 to 15 feet.	Moderate to high plasticity; slight hazard of flooding; water table at a depth of 10 to 15 feet.	Moderate permeability; fair stability; cracks when dry.

engineering properties of the soils—Continued

Soil features affecting engineering practices—Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment				
Moderate seepage; stratified material.	Moderate seepage; fair to good stability when mixed.	Stratified material with variations in permeability.	Frequently flooded; suitability for irrigation questionable.	Frequent flooding---	Susceptible to high sedimentation from flooding.
Slow seepage; depth generally not limited.	Low strength and fair stability.	Moderate permeability; subsurface drainage difficult.	Shallow soil; low water-holding capacity.	Soil properties favorable; minor limitations because of shallowness.	Shallowness limits shaping.
Moderate permeability in substratum.	Fair strength and good stability.	Moderate permeability; subsurface drainage satisfactory.	High intake rate requires frequent light applications of water.	Soil conditions favorable; no limitations.	Surface erodible; low fertility.
High seepage-----	Moderate permeability; erodible on steep slopes.	Soil material moderately permeable; drainage not needed.	Moderate permeability; complex slopes; limited to sprinkler irrigation.	Not suitable; surface soil unstable in terraces.	Erodible; low fertility.
High seepage below a depth of 36 inches.	Fair strength and stability; low seepage above a depth of 36 inches.	Moderate permeability; drainage below a depth of 36 inches is satisfactory.	Moderately fertile; some tendency to produce chlorosis.	Soil properties favorable; no limitations.	Vegetation difficult to establish on cuts.
High seepage below a depth of 10 inches.	Low strength and poor stability.	Moderate permeability; subsurface drainage not needed.	Poor agricultural soil; too shallow for irrigation.	Shallow; soft and hard caliche below a depth of 10 inches.	Caliche near the surface limits shaping; soft and hard caliche below a depth of 10 inches; vegetation difficult to establish and maintain.
Moderate seepage; depth not limited in most places.	Medium strength and stability; erodible on steep slopes.	Moderate permeability; subsurface drainage difficult.	Poor agricultural soil; sloping and highly erodible.	Not suitable; contains very shallow spots.	Shallowness limits shaping; erodible on steep slopes.
Slow seepage; depth generally not limited.	Low strength and poor stability.	Very slow permeability; needs surface drainage; subsurface drainage difficult.	Very slow permeability; frequent flooding; not suitable unless drained.	Very slow permeability; no limitations.	Vegetation difficult to establish and maintain.
High seepage into understream water table.	Low strength and poor stability; rapidly permeable.	Soil material rapidly permeable; drainage not needed.	Rapid permeability; low water-holding capacity; frequent flooding; suitability for irrigation questionable.	Frequently flooded; not suitable.	Low water-holding capacity; erodible on steep slopes.
Low seepage; depth limited.	Fair strength and stability; low seepage.	Moderate permeability; subsurface drainage difficult.	Soil properties favorable; some chance of flooding.	Soil properties favorable; some chance of flooding.	Vegetation difficult to establish in cuts; occasional sediments deposited from flooding.

TABLE 4.—*Interpretations of*

Soil type and map symbol	Suitability as a source of—			Soil features affecting engineering practices	
	Topsoil	Sand and gravel	Road fill	Highway location	Dikes or levees
Spur silt loam (Sp)-----	Fair-----	Surface layer not suitable; water-bearing sand and gravel at a depth of 10 to 15 feet.	Poor; moderate to high plasticity; water table at a depth of 10 to 15 feet.	Moderate to high plasticity; slight hazard of flooding; water table at a depth of 10 to 15 feet.	Moderate permeability; fair stability; cracks when dry.
Tillman clay loam (TcA, TcB)-----	Fair-----	Not suitable-----	Poor; high plasticity.	High plasticity-----	High plasticity; cracks when dry.
Tillman-Vernon complex (Tm): (Vernon soil only; for interpretations for Tillman soil, see Tillman clay loam.)	Poor-----	Not suitable-----	Not suitable to poor; high plasticity.	High plasticity-----	High plasticity; cracks when dry.
Tipton silt loam (TpA, TpB)-----	Good-----	Not suitable-----	Poor to fair; moderate to high plasticity.	Moderate to high plasticity.	Moderate to high plasticity; cracks when dry.
Tivoli fine sand (Ts)-----	Poor-----	Poor to fair; material poorly graded.	Poor to fair; low percentage of fines; erodes easily.	Monotextured material; compaction difficult; highly erodible.	Moderately rapid permeability; low percentage of fines; erodes easily.
Travessilla-Vernon complex (Tv): (Travessilla soil only; for interpretations for Vernon soils, see Tillman-Vernon complex)	Poor-----	Not suitable; massive conglomerate quartzitic rock; very hard below a depth of 10 inches.	Poor to fair; low percentage of fines in surface layer; soft to very hard below a depth of 10 inches.	Soft and very hard rock below a depth of 10 inches.	Moderate permeability; in surface layer; soft and very hard rock below a depth of 10 inches.
Treadway clay (Tw)-----	Poor-----	Not suitable-----	Not suitable; very high plasticity.	Very high plasticity.	Very high plasticity; cracks when dry.
Vernon-Badland complex (Vb): (Vernon soil only; for interpretations for Badland, see Badland)	Poor-----	Not suitable-----	Not suitable to poor; high plasticity.	High plasticity-----	High plasticity; cracks when dry.
Weymouth clay loam (WcB, WcC)-----	Fair-----	Not suitable; some caliche below a depth of 20 inches.	Poor; high plasticity.	High plasticity-----	High plasticity; cracks when dry.

engineering properties of the soils—Continued

Soil features affecting engineering practices—Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment				
Low seepage; depth limited.	Fair strength and stability; low seepage.	Moderate permeability; subsurface drainage difficult.	Soil properties favorable; some chance of flooding.	Soil properties favorable; some chance of flooding.	Vegetation difficult to establish in cuts; occasional sediments deposited from flooding.
Slow seepage; depth generally not limited.	Low strength and poor stability.	Slow permeability; subsurface drainage difficult.	Slow permeability	Soil properties favorable; no limitations.	Vegetation difficult to establish.
Slow seepage; depth generally not limited.	Low strength and poor stability; high shrink-swell potential.	Slow permeability; subsurface drainage difficult.	Slow permeability; shallow; low water-holding capacity.	Slow permeability; no other limitations.	Vegetation difficult to establish; soil cracks badly.
Moderate seepage in substratum; depth generally not limited.	Low strength and poor stability.	Moderate permeability; subsurface drainage difficult.	Moderate permeability.	Soil properties favorable; no limitations.	Vegetation difficult to establish.
Rapid seepage to a depth of several feet.	Low strength and poor stability; moderately rapid permeability.	Moderately rapid permeability; drainage not needed.	Poor agricultural soil; suitability for irrigation questionable.	Not suitable; very high erodibility; material not stable in terraces.	Low water-holding capacity; moderately rapid permeability; low fertility.
Slow seepage; massive rock requiring blasting below a depth of 10 inches.	Predominantly massive rock; not suited to embankments.	Moderately permeable surface layer over impervious rock at a depth of about 10 inches; drainage satisfactory.	Shallow; very steep; poor agricultural soil; not suitable.	Shallow; stony below a depth of 2 to 10 inches; not suitable.	Shaping limited by rock below a depth of 10 inches; normally not suitable for shaping.
Slow seepage; depth generally not limited.	Low strength and poor stability; high shrink-swell potential.	Very slow permeability; subsurface drainage difficult.	Very slow permeability; suitability for irrigation questionable.	Very slow permeability and very shallow; not suitable.	Vegetation difficult to establish; soil cracks badly.
Slow seepage; depth generally not limited.	Low strength and poor stability; high shrink-swell potential.	Moderately slow permeability; subsurface drainage difficult.	Moderately slow permeability; gullied and steep; not suitable.	Moderately slow permeability; very shallow, and limestone outcrops in some areas; not suitable.	Bedrock near the surface limits shaping; vegetation difficult to establish; soil cracks badly.
Slow seepage; depth generally not limited.	Low strength and poor stability; high shrink-swell potential.	Moderate permeability; subsurface drainage satisfactory.	Shallow; hazard of erosion in the steeper areas.	Soil properties favorable; no limitations.	Vegetation difficult to establish.

TABLE 4.—*Interpretations of*

Soil type and map symbol	Suitability as a source of—			Soil features affecting engineering practices	
	Topsoil	Sand and gravel	Road fill	Highway location	Dikes or levees
Wichita fine sandy loam (WfA, WfB, WfC2).	Good-----	Not suitable-----	Poor to fair; moderate to high plasticity.	Moderate to high plasticity; moderately erodible on steep slopes.	Moderate to high plasticity; cracks when dry; moderately erodible on steep slopes.
Wichita loam (WhA, WhB)-----	Good-----	Not suitable-----	Poor to fair; moderate to high plasticity.	Moderate to high plasticity.	Moderate to high plasticity; cracks when dry.
Wichita clay loam (WmA, WmB)---	Fair-----	Not suitable-----	Poor; high plasticity.	High plasticity---	High plasticity; cracks when dry.
Woodward loam (WoB, WoC)-----	Fair-----	Not suitable in places; source of soft sandstone for crushing below a depth of 30 to 40 inches.	Fair; moderate plasticity.	Erodible on steep slopes; soft sandstone in places below a depth of 30 to 40 inches.	Moderate to moderately rapid permeability; moderate seepage; erodible on steep slopes.
Woodward-Quinlan loams (WwB, WwC, WwD): (Quinlan soil only; for interpretations for Woodward soils, see Woodward loam)	Fair to poor in upper 8 inches.	Not suitable in places; soft sandstone for crushing below a depth of 20 inches.	Fair; moderate plasticity.	Erodible on steep slopes; soft sandstone below a depth of 20 inches.	Moderate permeability; moderate to high seepage.
Yahola very fine sandy loam (Ya) --	Poor; variable with depth.	Surface not suitable; good below a depth of 10 feet in places.	Fair to good if layers are mixed.	Frequently overflowed; stratified material.	Moderate permeability; poor stability; high seepage.

The suitability of soils for waterways is determined by the amount of shaping that can be done, the velocity that can be attained without losing stability, and the difficulty of establishing and maintaining an adequate cover of plants. Also in some soils, cracks develop or below-grade channel erosion develops. In other soils, such as the Tillman and Wichita clay loams, a surface crust forms. The crust prevents young seedlings from emerging, and a cover is therefore hard to establish. In such soils deep cracks develop when the soils are dry; the soil profile becomes air dry below root depth, which results in the loss of plant

cover. Some horizons of other soils have similar characteristics.

Table 5 gives engineering test data for samples from soils of the Abilene, Carey, Tillman, Wichita, and Woodward series. The data were furnished by the Bureau of Public Roads and the Texas Highway Department. They give facts about the shrinkage limit, shrinkage ratio, lineal shrinkage, liquid limit, and plasticity index.

As moisture is removed, the volume of a soil decreases in direct proportion to the loss of moisture, until equilibrium, called the *shrinkage limit*, is reached. Beyond the

engineering properties of the soils—Continued

Soil features affecting engineering practices—Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment				
Moderate seepage; depth generally not limited.	Moderate strength and stability; moderately erodible on steep slopes.	Moderately slow permeability; subsurface drainage difficult.	Moderately slow permeability; eroded phase not suitable.	Soil properties favorable; no limitations.	Soil properties favorable for establishing and maintaining vegetation.
Slow to moderate seepage; depth generally not limited.	Moderate strength and stability; moderate shrink-swell potential.	Moderately slow permeability; subsurface drainage difficult.	Moderately slow permeability.	Soil properties favorable; no limitations.	Vegetation difficult to establish.
Slow seepage; depth generally not limited.	Low strength and poor stability; high shrink-swell potential.	Moderately slow permeability; subsurface drainage difficult.	Moderately slow permeability.	Soil properties favorable; no limitations.	Vegetation difficult to establish.
Moderate seepage; depth generally not limited.	Moderate strength and stability; erodible on steep slopes.	Surface layer well drained; subsurface drainage impeded by soft sandstone below a depth of 30 to 40 inches.	Soil depth limits leveling in places; hazard of erosion in the steeper areas.	Soil properties generally favorable, but a few areas are too shallow.	Minor limitations for shaping because soil is shallow; moderately erodible.
Moderate to high seepage; soft sandstone in a few places below a depth of 20 inches.	Moderate strength and stability; erodible on steep slopes.	Surface layer well drained; subsurface drainage impeded by soft sandstone at a depth of 20 inches.	Shallow to very shallow soil; steeper areas not suitable.	Soil properties favorable; soft sandstone below a depth of 20 inches in places.	Depth limits shaping and makes vegetation difficult to establish; soft sandstone below a depth of 20 inches.
High seepage; sand and gravel below a depth of 10 feet in places.	Low strength and poor stability.	Frequent flooding; surface and subsurface drainage satisfactory.	Moderate permeability; frequent flooding.	Not suitable; frequently flooded.	Soil condition favorable for shaping and establishing vegetation; occasional sediments from flooding.

shrinkage limit, more moisture may be removed, but the volume of the soil does not change. In general, the lower the number indicated for the shrinkage limit, the higher the content of clay.

The *shrinkage ratio* is the volume change, expressed as a percentage of the volume of dry soil material, divided by the loss of moisture caused by drying. This ratio is expressed numerically.

Lineal shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the

soil mass when the moisture content is reduced from the stipulated percentage to the shrinkage limit.

The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

TABLE 5—Engineering

Soil name and location	Parent material	Texas report No.	Depth	Horizon
Abilene clay loam:			<i>Inches</i>	
1.4 mile NE. of Wastella and 50 feet E. of road. (Modal profile)	Clayey Plains outwash-----	61-300-R----- 61-301-R----- 61-302-R-----	6-12 12-30 40-80	B1 B2 Ccal
2.5 miles NE. of Wastella. (Deeper than modal profile)	Clayey Plains outwash-----	61-303-R----- 61-304-R----- 61-305-R-----	6-12 12-40 64-108	B1 B2 Ccal
Carey loam:				
3 miles S. of Rotan, and 0.9 mile W. and 300 feet N. of county road. (Modal profile)	Sandy and silty material of the red beds.	61-309-R----- 61-310-R----- 61-311-R-----	0-10 10-34 34-56	A1 B2 B3
4.2 miles SW. of Roby and 100 feet S. of farm road 419. (Contains a thin zone of calcium carbonate)	Sandy and silty material of the red beds.	61-315-R----- 61-316-R----- 61-317-R-----	0-8 8-32 32-62	Ap B2 B3
2.3 miles N. of Palava and 200 feet E. of county road. (Noncalcareous and more sandy than modal profile)	Sandy and silty material of the red beds.	61-336-R----- 61-337-R----- 61-338-R-----	0-5 12-36 36-42	Ap B2 B3
Tillman clay loam:				
2.2 miles SW. and 100 feet E. of Sylvester. (Modal profile)	Clayey material of the red beds-----	61-324-R----- 61-325-R----- 61-326-R-----	5-11 11-30 44-60	B1 B2 Cca
1.25 mile E. and 6 miles S. of Sylvester, and 400 feet W. and 0.15 mile S. on county road. (More clayey than normal profile)	Clayey material of the red beds-----	61-327-R----- 61-328-R----- 61-329-R-----	4-9 9-34 66-72	B1 B2 Cca
4.1 miles NE. of Eskota and 100 feet E. (Noncalcareous)	Clayey material of the red beds, and material weathered from blue shale.	61-297-R----- 61-298-R----- 61-299-R-----	6-12 12-36 60-66	B1 B2 Cca
Wichita clay loam:				
7.75 miles S. of Sylvester, and 0.35 mile N. and 1.8 mile E. on county road. (Modal profile)	Clayey outwash-----	61-330-R----- 61-331-R----- 61-332-R-----	12-26 26-34 34-72	B2 B3 Cca
8.5 miles S. of Sylvester and 200 feet W., 0.4 mile S., and 1.5 mile W. on county road. (Calcareous B2 horizon)	Clayey outwash-----	61-333-R----- 61-334-R----- 61-335-R-----	12-30 30-45 45-84	B2 B3 Cca
6 miles SE. of Sylvester. (Surface layer of sandy clay loam)	Clayey outwash-----	61-321-R----- 61-322-R----- 61-323-R-----	5-25 25-57 57-72	B2 B3 Cca
Woodward loam:				
0.25 mile S. and 8 miles E. of Rotan on State Highway 92. (Modal profile)	Sandy and silty material of the red beds.	61-312-R----- 61-313-R----- 61-314-R-----	0-8 8-24 24-58	A1 AC1 AC2
5.3 miles SE. of Roby. (Finer textured than modal profile)	Sandy and silty material of the red beds.	61-318-R----- 61-319-R----- 61-320-R-----	0-7 7-24 24-54	Ap AC1 AC2
2 miles W. and 0.8 mile N. of Capitola. (Noncalcareous)	Sandy and silty material of the red beds.	61-306-R----- 61-307-R----- 61-308-R-----	0-6 6-24 24-40	Ap AC1 AC2

¹ Tests performed by the Texas Highway Department in accordance with standard procedures of the American Association of State Highway Officials (AASHO).

² Mechanical analysis according to AASHO Designation T 88-57 (1). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis

of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis used in this table are not suitable for use in naming textural classes for soil.

³ 100 percent of the soil material passed a ¼-inch sieve.

⁴ 100 percent of the soil material passed a ⅜-inch sieve.

test data¹

Shrinkage			Mechanical analysis ²							Liquid limit	Plasticity index	Classification	
Limit	Ratio	Lineal	Percentage passing sieve—				Percentage smaller than—					AASHO	Unified
			No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.				
12	1.94	16.4	-----	100	99	82	75	45	39	49	30	A-7-6(18)---	CL.
11	1.98	16.5	-----	100	97	82	78	48	40	47	28	A-7-6(17)---	CL.
12	1.98	13.1	³ 98	94	90	74	69	49	37	38	23	A-6(13)---	CL.
12	1.96	17.7	-----	100	97	80	77	49	40	53	34	A-7-6(19)---	CH.
10	2.02	19.5	-----	100	99	83	78	54	46	56	38	A-7-6(19)---	CH.
10	2.05	17.8	-----	100	97	83	80	55	39	49	33	A-7-6(18)---	CL.
18	1.71	2.8	-----	-----	100	57	39	13	10	22	4	A-4(4)---	ML-CL.
16	1.81	7.1	-----	100	99	63	51	25	24	29	13	A-6(7)---	CL.
18	1.74	3.6	-----	-----	100	55	39	16	15	26	6	A-4(4)---	ML-CL.
17	1.73	3.0	-----	-----	100	60	54	13	11	22	4	A-4(5)---	ML-CL.
14	1.87	10.8	-----	-----	100	70	56	35	33	36	20	A-6(11)---	CL.
18	1.73	3.3	-----	-----	100	56	43	16	15	24	5	A-4(4)---	ML-CL.
16	1.75	2.8	-----	-----	100	34	24	11	9	22	4	A-2-4(0)---	SM-SC.
15	1.82	7.4	-----	-----	100	50	41	26	23	30	15	A-6(5)---	SC.
17	1.76	4.3	⁴ 95	92	91	37	34	19	17	25	6	A-4(0)---	SM-SC.
11	1.99	15.7	100	98	94	84	80	55	46	45	25	A-7-6(15)---	CL.
11	2.00	16.1	100	97	92	84	80	55	48	48	28	A-7-6(17)---	CL.
11	2.01	⁵ 13.7	⁵ 100	98	82	62	59	43	20	39	⁵ 23	A-6(11)---	CL.
13	1.92	15.5	-----	100	96	93	91	60	48	48	25	A-7-6(16)---	CL.
13	1.99	16.3	100	99	92	88	85	60	51	47	26	A-7-6(16)---	CL.
13	1.92	12.7	100	98	89	77	74	52	25	47	26	A-7-6(16)---	CL.
10	2.03	17.0	100	99	95	91	88	56	48	47	29	A-7-6(17)---	CL.
10	2.05	16.7	-----	100	96	91	88	57	49	46	29	A-7-6(17)---	CL.
10	1.97	⁵ 10.5	⁵ 100	98	86	65	64	35	18	30	⁵ 18	A-6(9)---	CL.
12	1.96	15.6	100	99	96	83	79	46	41	46	26	A-7-6(16)---	CL.
11	2.02	14.8	100	97	90	79	78	48	39	42	26	A-7-6(15)---	CL.
10	2.05	13.0	³ 97	92	86	76	70	46	34	36	22	A-6(13)---	CL.
12	1.96	15.2	100	99	95	86	76	46	39	45	27	A-7-6(16)---	CL.
11	2.00	15.3	100	98	95	87	81	48	40	44	28	A-7-6(16)---	CL.
11	2.01	11.5	100	97	90	85	84	50	35	33	18	A-6(11)---	CL.
11	1.99	15.5	100	99	97	77	72	47	42	45	28	A-7-6(16)---	CL.
12	1.97	17.0	³ 98	98	96	71	67	45	40	50	32	A-7-6(17)---	CL.
10	2.04	16.2	⁴ 99	94	87	74	68	47	39	45	29	A-7-6(16)---	CL.
18	1.73	3.7	⁴ 98	96	94	76	56	13	10	24	5	A-4(8)---	ML-CL.
18	1.75	4.8	³ 96	92	89	74	55	16	13	27	6	A-4(8)---	ML-CL.
21	1.65	2.9	⁴ 99	98	97	85	66	11	9	26	5	A-4(8)---	ML-CL.
19	1.84	4.5	⁴ 99	97	96	62	50	18	14	23	7	A-4(5)---	ML-CL.
14	1.89	7.6	⁶ 93	90	87	73	51	25	20	28	13	A-6(9)---	CL.
15	1.83	6.5	⁶ 62	59	56	44	40	15	11	27	11	A-6(2)---	SC.
18	1.71	2.9	³ 97	95	94	53	38	13	10	23	4	A-4(4)---	ML-CL.
19	1.70	3.3	³ 97	96	95	54	38	13	11	24	5	A-4(4)---	ML-CL.
20	1.65	2.6	³ 98	96	94	67	49	11	9	25	5	A-4(6)---	ML-CL.

⁵ Based on Test No. 104-E (Modified), of the Texas Highway Department, Materials and Testing Division, in "Manual of Testing Procedures; Determination of Moisture Content of Soils Containing Gypsum," June 1962. [Unpublished] The laboratory test data for report No. 61-326-R has been corrected for 30 percent

gypsum. The laboratory test data for report No. 61-299-R has been corrected for 50 percent gypsum.

⁶ For report No. 61-319-R, 100 percent of the soil material passed a 1-inch sieve, and for report No. 61-320-R, 100 percent passed a 2-inch sieve.

Genesis, Classification, and Morphology of Soils

The purpose of this section is to present the outstanding morphologic characteristics of the soils of Fisher County and to relate the characteristics to the factors of soil formation. The first part deals with the environment of the soils; the second, with the classification of the soils; and the third, with the morphology of the soils. Physical and chemical data are limited for these soils, and the discussion of soil genesis and morphology is correspondingly incomplete.

Factors of Soil Formation

Soil is the product of the forces of environment, acting on soil materials deposited or accumulated by geologic processes. The characteristics of the soil at any given point on the earth are determined by the interaction of five major factors. These are (1) parent material, (2) climate, (3) relief, (4) plant and animal life, and (5) time. All five of these factors influence the present characteristics of every soil, but the significance of each factor varies from one place to another. In one area one factor may dominate the formation of a soil, and in another area a different factor may be more important.

The interrelationship among these five factors is complex, and the effects of any one factor cannot be isolated and completely evaluated. It is convenient to discuss each factor separately, however, and to indicate the probable effects of each. The five factors are discussed as they are related to the soils of Fisher County.

Parent material

Parent material is the unconsolidated material from which soil develops. It is formed as the result of the weathering of rocks through the processes of freezing and thawing, as the result of wind erosion, and as the result of the grinding away of rocks by rivers and glaciers. It is also formed as the result of chemical processes.

The parent material of the soils of this county is of five principal kinds. These are (1) clay of Permian age mixed with material weathered from soft sandstone and gypsum; (2) sandy alluvium and clayey outwash material; (3) windblown deposits along streams and above the level of the streams; (4) material weathered from moderately coarse textured sandstone and basal conglomerate; and (5) recent alluvial material on the flood plains of streams. The following paragraphs give some facts about the geology of the county and about the various kinds of parent material.

GEOLOGY.—Rocks of Permian age outcrop over much of Fisher County (4). These rocks, which comprise a stratified sequence about 4,000 feet thick, are primarily chemical precipitates (limestone, dolomite, anhydrite, and gypsum) of marine origin. The rocks that outcrop belong to the El Reno and overlying Whitehorse groups. They strike generally north-northeast and dip toward the west.

San Angelo sandstone is the lowest member of the El Reno group. It outcrops along the eastern edge of the county, near the southeastern corner. San Angelo sandstone is not extensive in this county. It is made up mainly of crossbedded, chert-bearing, conglomeratic, medium-

grained sandstone. In places, however, it contains intercalated shale, clay, and conglomerate. The San Angelo formation reaches a maximum thickness of about 150 feet in this county.

Overlying the San Angelo formation are other rocks of the El Reno group. In general, the sequence consists predominantly of red shale in the lower part; massive anhydrite and beds of dolomite in the middle part; and alternating fine-grained sandstone, anhydrite, and dolomite near the top.

Rocks of the Whitehorse group conformably overlie those of the El Reno group. The lower part of the Whitehorse group in this county consists of about 700 feet of gypsiferous red shale. Above the shale, the material grades through alternating layers of fine- to medium-grained sandstone, other shale, and anhydrite to predominantly sandstone in the upper part.

Rocks of Late Triassic age are represented in this county by the Dockum group. In the southwestern part of the county, the rocks of the Dockum group overlie uneven erosional material of Permian age. They consist of sandy clay, of medium-textured to coarse-textured, crossbedded sandstone, and of a basal conglomerate. The basal conglomerate was named Camp Springs conglomerate after the community of Camp Springs, which lies immediately to the west in Scurry County. Rocks of the Dockum group form a prominent escarpment in some areas west of Claytonville, and it is believed that they reach a maximum thickness of 170 feet.

Alluvial deposits of unconsolidated clay, sand, and silt of Quaternary age overlie parts of the Permian and Triassic rocks in this county. The clayey alluvium, or Plains outwash, is mainly in the southwestern corner of the county and overlies rocks of Triassic age. Most of the sediments in the outwash were deposited by streams, but some were blown in by wind. In the area north and east-southeast of Rotan, some of the deposits of Quaternary age are of eolian origin; sediments in the belt of sand, called shinnery sand, have been reworked by wind. This reworking occurred after the sediments were deposited by the waters of the Clear Fork of the Brazos River and after the channel of the river had migrated gradually southward. The maximum thickness of the alluvium in this county is approximately 85 feet in the area of shinnery sand east of Rotan. In most places the alluvium is less than 35 feet thick.

PARENT MATERIAL OF THE PRINCIPAL SOILS.—Most of the soils in the county have developed in material of Permian age. Clay beds of the El Reno group and material weathered from rocks of the Whitehorse group are the parent material of the Tillman soils, which are gently sloping. They also are the parent material of the Vernon soils, which are more sloping. Badland and Vernon-Badland complex overlie the rocks of the El Reno and Whitehorse groups, but they are too susceptible to erosion for much profile development to have taken place. Soils of the Acme, Carey, Woodward, and Quinlan series also developed in material weathered from the varying strata of gypsiferous red shale, fine- to medium-grained sandstone, and other shale of the Whitehorse group.

The thick beds of sandy alluvium of Quaternary age were deposited by fast-moving streams. After the sediments were deposited, they were probably reworked by wind, which made the topography undulating and hum-

mocky. The Altus, Miles, and Brownfield soils developed in this sandy parent material.

South of the Double Mountain Fork of the Brazos River is an area covered by a mantle of wind-laid sand, probably blown from the old channel of the river. The area is covered by low dunes that resulted when the wind reworked the river sand. The Enterprise and Tivoli soils developed in this reworked sand. They are deep soils, but they lack a B horizon.

The Abilene, Wichita, and Mansker soils developed in clayey Plains outwash, deposited by slow-moving water on smooth plains. The Travessilla soils developed in material weathered from moderately coarse grained sandstone and conglomerate of the Dockum group. The Travessilla soils are along escarpments and are shallow over sandstone or conglomerate. Sandstone or conglomerate outcrop in many of the areas.

Soils such as the Spur developed in recent alluvial material along rivers and secondary streams. Their profile is immature; it lacks distinct horization. Some of the soils developed in alluvium are sandy, but others are silty or clayey. The texture depends upon the rate of streamflow and on the texture of the soils of the watershed. A characteristic common to all soils formed in alluvium is the stratification of material of different textures throughout the profile.

Climate

Climate has had a definite effect on the development of soils in this county. Precipitation, temperature, and wind are the main climatic factors that have had their effect on soil development.

In the past the climate was wetter than it is now and more water was available to transport the material from which the present sedimentary rocks are formed. More recently, the climate has been subhumid. Rainfall has been too limited to leach the finer minerals from the soils. Consequently, except in the most sandy soils, the level of fertility is high. Because the soils are seldom moistened to a depth of 6 feet, many of them have a horizon of calcium carbonate a few feet below the surface. Most of the young soils and some strongly sloping soils, such as the Woodward, have lime throughout the profile.

Temperature has had some effect on the development of the soils. The temperature is high in summer and mild in winter. The rate of evaporation is high. The high temperature and low rainfall have limited the amount of organic matter that has accumulated in the soils.

Wind has had some effect on the development of the soils. After sediments were deposited by water, the sandy material was reworked by wind, which caused the areas to be undulating. Tivoli fine sand is an example of a soil developed in material reworked by wind.

Relief

Relief, or the lay of the land, influences the development of soils through its effect on drainage and runoff. The total effect of relief can be seen in other small, dissected areas of the landscape throughout this county.

Relief influences the amount of soil material that accumulates, the drainage, the amount of organic matter that accumulates, the thickness of the solum, the degree of horization, and the amount of lime in the profile. The

Randall soils, for example, developed in low, concave or nearly level areas, and they are dark, deep, and generally more clayey than soils that developed in more sloping areas. This is because the Randall soils receive more water or have less runoff than the soils in more sloping areas. As a result, more plant residue is produced on the Randall soils than on soils that receive less water, and the Randall soils support more biological activity.

Conversely, in a large part of the county, soils have developed in areas that are gently sloping to steep. The soils in these sloping areas are lighter colored than those developed in nearly level areas, and their profile has not developed to so great a depth. In the steep areas, normal erosion removes the soil material almost as fast as it is deposited. As a result, the soils in steep areas are shallow over the underlying material.

Plant and Animal Life

Living organisms, consisting of grasses, shrubs, micro-organisms, and other forms of life, have significantly affected the development of the soils. Because of the semi-arid climate, the vegetation consists of different grasses in all except the very sandy areas. The kind of parent material has largely determined the kinds of grasses. Tall grasses grow mainly on the moderately sandy soils, mid grasses on the medium-textured soils, and short grasses on the clayey soils.

The decaying leaves and stems of these grasses distribute the organic matter on the surface. Decaying roots distribute some organic matter in the solum. The network of tubes left by the decaying roots and by the activity of earthworms greatly aids in the movement of water and air through the soil. In this county the environment below the surface of the soil has been favorable for the maximum activity of worms and other forms of animal life. In other areas, however, where precipitation has been less effective because of the steep slope or the fine texture of the surface layer, the activity of living organisms has had less influence. In some places overgrazing of the range or excessive tillage has lowered the content of organic matter in the soils and has thus reduced the activity of soil organisms.

Time

The length of time the soil-forming factors have acted upon a soil determines, to a large degree, the characteristics of that soil. Some soils that have been subject to soil-forming processes for only a relatively short time do not have well-defined and genetically related horizons. Bottom-land soils are examples of the effect of time in the development of a profile. In those soils the soil material has been in place only a short time. As a result, a well-developed profile has not had time to develop.

Soils that have been in place for a long period and that are nearly level or gently sloping normally show marked horizon differentiation. In Fisher County examples of such soils are those of the Abilene, Miles, and Wichita series. Those soils have approached equilibrium with their environment and are mature.

Where the slopes are steeper, the soils have a less well-developed profile, even though the process of development has gone on for a long time. In such areas relief is dominant over time as a soil-forming factor. The Vernon,

Weymouth, and Quinlan soils are examples of soils in the steeper areas.

Classification of Soils

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broad classes for study and comparison of large areas, such as continents. In the comprehensive system of soil classification followed in the United States (2), the soils are placed in six categories, one above the other. Beginning at the top, the six categories are order, suborder, great soil group, family, series, and type.

In the highest category, the soils of the whole country are grouped into three orders, whereas thousands of soil types are recognized in the lowest category. The suborder and family categories have never been fully developed and thus have been little used. Attention has been given largely to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders. Soil series, type, and phase are defined in the section "How This Soil Survey Was Made." Subdivisions of soil types into phases provide finer distinctions significant to soil use and management.

Classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (7). The zonal order comprises soils with evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. In the intrazonal order are soils with evident, genetically related horizons that reflect the dominant influence of a local factor of topography or parent material over the effects of climate and living organisms. In the azonal order are soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography.

The following list shows the classification of the soil series in Fisher County by great soil groups and orders. Each series recognized in the county has been classified on the basis of current knowledge of the soils and their formation.

Order and great soil group	<i>Series</i>
Zonal—	
Reddish Chestnut	Carey, Miles, Tillman, Tipton, Wichita.
Chestnut	Abilene, Altus.
Reddish Brown	Brownfield.
Intrazonal—	
Grumusol	Randall.
Calcisol	Acme, Mansker, Portales, Weymouth, Woodward.
Azonal—	
Regosol	Enterprise, Quinlan, Tivoli.
Lithosol	Cottonwood, Potter, Travessilla, Vernon.
Alluvial	Spur, Treadway, Yahola.

The relationship of the distinguishing morphological characteristics of the soils of this county to the factors of soil formation is discussed briefly in the following paragraphs.

Three great soil groups are in the zonal order. These are the Reddish Chestnut, the Chestnut, and the Reddish Brown.

The soils of the Reddish Chestnut great group make up about 47 percent of the acreage in the county. They developed under grass and some shrubs, and they have a distinct sequence of A, B, and C horizons. Their surface layer is typically reddish brown to dark reddish brown and is friable. Their subsoil is reddish brown to red and is more clayey than the surface layer. The lower part of the subsoil is lighter colored than the upper part and is strongly calcareous. Although the soils in this group have relatively high natural fertility, the low rainfall and the high rate of evaporation in this climatic zone limit their potential for crops. In this county the soils in this great group are those of the Carey, Miles, Tillman, Tipton, and Wichita series.

The Chestnut soils have a dark-brown surface layer that grades to lighter colored horizons. These soils generally have a layer of accumulated calcium carbonate at a depth of 3 to 4 feet. Their sequence of horizons is similar to that in the profile of the Reddish Chestnut soils, but they are darker colored than the Reddish Chestnut soils. The Chestnut soils have high natural fertility, but crop yields are frequently low because of the low rainfall. In Fisher County the soils in this great group are those of the Abilene and Altus series. These soils formed under mixed tall and short grasses in a subhumid to semiarid, temperate to cool-temperate climate.

Reddish Brown soils have a light reddish-brown or reddish-brown surface layer; dull reddish-brown or red, slightly finer textured material beneath the surface layer; and a grayish or pinkish accumulation of lime. These soils formed under shrubs and short grasses in a semiarid, warm-temperate, or tropical climate. They have low natural fertility. Because of their high susceptibility to wind erosion, they are not suitable for cultivation. In this county the only soils in the Reddish Brown great soil group are those of the Brownfield series.

In the intrazonal order in this county are soils that generally do not have a B horizon. The horizon sequence is A, AC, Cca, C, and R. In this county the Grumusol and Calcisol great soil groups are in the intrazonal order.

Grumusols have a relatively uniform texture and are high in montmorillonite clay. They shrink and crack when dry and swell when wet. As a result, the soils are continually churned. Randall soils are the only Grumusols in this county.

Calcisols are a group of soils having an A horizon, variable in thickness and color, a prominent deeper horizon of lime accumulation, and parent material that contains a large amount of lime. The soils of this group in Fisher County are those of the Acme, Mansker, Portales, Weymouth, and Woodward series.

The azonal soils in this county are those of the Regosol, Lithosol, and alluvial great soil groups. These soils generally have only weak horizonation and have A, AC, and C horizons.

Regosols lack definite genetic horizons, because they are young or because geologic erosion has occurred on the steep

slopes. They have developed mostly in deposits of wind-blown sand, in soft, limy loam, or in material weathered from soft sandstone. The Regosols in this county are those of the Enterprise, Tivoli, and Quinlan series.

The Lithosol great soil group consists of shallow soils that show little profile development. The texture of these soils varies, depending on the underlying material. In this county the underlying material is mostly lime, gypsum, or shale. Except where the Lithosols are underlain by gypsum and lack soil-forming materials, they are generally strongly sloping. In this county the soils in this group are those of the Vernon, Potter, Cottonwood, and Travessilla series.

Alluvial soils are developing in material transported and recently deposited by water. In these soils there has been little or no alteration of the original material by soil-forming processes. Alluvial soils of this county are relatively dark colored, and they have high natural fertility. Generally, they are the most productive of the dryland soils, except where they are too clayey for high yields. They are on flood plains along streams throughout the county. The soils in this group are those of the Spur, Yahola, and Treadway series.

Descriptions of Soil Series

This section was prepared for those who need more technical information about the soils in the county than is given elsewhere in the report. Described in alphabetic order are the soil series in the county. The procedure is to name characteristics common to the soils of the series and to describe, by horizons, a profile at a stated location. The profile is representative of the series. After the profile is described, variations from this profile are given.

Soil descriptions that are probably easier for the general reader to understand are given in the section "Descriptions of the Soils." They contain some interpretations and other information that is not in this section.

ABILENE SERIES

The soils of Abilene series are on uplands, where they developed in calcareous alluvial clay and sandy clay. These soils are mainly nearly level, but the slopes range from 0 to 3 percent.

The Abilene soils are more clayey and are browner and less reddish than the Miles and Wichita soils. They are more mature and less clayey than the Randall soils.

The following describes a typical profile of Abilene clay loam (fig 9) in a cultivated field west of Rotan, 150 feet south of Farm Road 611 and 0.6 mile west of Texas Highway No. 70:

- Ap—0 to 8 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; weak granular and weak subangular blocky structure; slightly hard when dry, friable when moist; noncalcareous; abrupt boundary.
- B1—8 to 16 inches, dark-brown (7.5YR 4/2) clay loam; dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky when wet; noncalcareous; clear boundary.
- B21t—16 to 30 inches, brown (7.5YR 4/2) light clay; dark brown (7.5YR 3/2) when moist; moderate, medium, blocky structure; extremely hard when dry, firm when moist, sticky and plastic when wet; weakly calcareous; continuous thin clay films; gradual boundary.

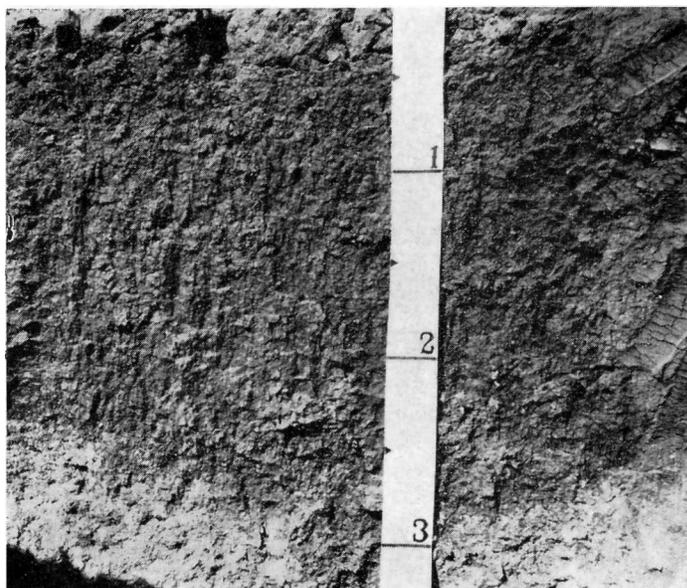


Figure 9.—Typical profile of Abilene clay loam.

- B22t—30 to 50 inches, brown (7.5YR 5/2) clay; dark brown (7.5YR 4/2) when moist; moderate to weak, medium, blocky structure; extremely hard when dry, firm when moist, sticky when wet; strongly calcareous; clear boundary.
- Cca—50 to 66 inches, reddish-yellow (7.5YR 6/6) light clay; strong brown (7.5YR 5/6) when moist; about 3 percent, by volume, soft, segregated calcium carbonate; clear boundary.
- C—66 to 75 inches, reddish-yellow (5YR 6/6) light clay; strong brown (7.5YR 5/6) when moist; very strongly calcareous.

The A horizon ranges from 5 to 10 inches in thickness, and the B horizon, from 20 to 60 inches. Depth to the Cca horizon ranges from 30 to 60 inches. The color of both the A and B horizons ranges from dark brown or brown to dark grayish brown.

ACME SERIES

The Acme series consists of dark-colored soils that are shallow over material weathered from shale or sandstone. In most places these soils are in narrow bands adjacent to intermittent drains. They have slopes of 0 to 3 percent.

Acme soils occur with the Cottonwood soils, but they are less shallow than the Cottonwood soils. They are calcareous to the surface and are more permeable than the Abilene soils.

The following describes a typical profile of Acme clay loam in a pasture about 1 mile west of Farm Road 1085 and 3.6 miles south of Sylvester:

- A—0 to 6 inches, dark grayish-brown (10YR 4/2) light clay loam; very dark grayish brown (10YR 3/2) when moist; compound, moderate, fine, subangular blocky and granular structure; slightly hard when dry, friable when moist; calcareous; gradual boundary.
- AC—6 to 15 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) when moist; compound, moderate, fine, subangular blocky and granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; common specks and threads of calcium carbonate or calcium sulfate; abrupt boundary.

Ccs—15 to 18 inches +, a thick bed of weakly cemented, white, chalky material consisting of calcium sulfate and calcium carbonate.

The texture of the surface layer ranges from clay loam to loam. Depth of the solum over weakly cemented chalky material ranges from 10 to 24 inches. The color of the solum ranges from dark brown to very dark grayish brown.

ALTUS SERIES

In the Altus series are soils of the uplands. These soils developed in alluvium in areas that resemble valleys.

The Altus soils occur with Miles and Carey soils, but they are browner than those soils. They are less clayey and more friable than the Abilene soils.

The following describes a typical profile of a cultivated Altus fine sandy loam 4.6 miles east of Rotan, 500 feet west of a county road, and 0.5 mile south of the point where the county road intersects Texas Highway No. 92:

Ap—0 to 8 inches, brown (10YR 5/3) fine sandy loam; dark brown (10YR 3/3) when moist; very weak, granular structure; slightly hard when dry, very friable when moist; noncalcareous; abrupt boundary.

A1—8 to 18 inches, dark-brown (7.5YR 3/2) light sandy clay loam; very dark brown (7.5YR 2/2) when moist; weak, subangular blocky structure; hard when dry, friable when moist; noncalcareous; clear boundary.

B2t—18 to 32 inches, dark-brown (7.5YR 4/2) sandy clay loam; dark brown (7.5YR 3/2) when moist; weak, subangular blocky structure; hard when dry, friable when moist; calcareous; has a few fine soft concretions of calcium carbonate in the lower part; gradual boundary.

C1ca—32 to 46 inches, grayish-brown (10YR 5/2) sandy clay loam; dark grayish brown (10YR 4/2) when moist; strongly calcareous; about 5 percent, by volume, soft calcium carbonate; gradual boundary.

C2ca—46 to 62 inches +, light brownish-gray (10YR 6/2) sandy clay loam; grayish brown (10YR 5/2) when moist; strongly calcareous; about 30 percent, by volume, concretions of soft calcium carbonate.

The A horizon ranges from 8 to 20 inches in thickness. The B2t horizon ranges from sandy clay loam to clay loam in texture and from dark brown to light gray in color. Depth to calcareous material ranges from 18 to 36 inches.

BROWNFIELD SERIES

In the Brownfield series are loose, sandy soils that overlie red sandy clay loam. These soils developed in sandy windblown material. Their slopes range from 1 to 8 percent, but they are mainly between 1 and 5 percent.

The Brownfield soils have a thicker, more sandy A horizon than the Miles soils. They have a more clearly defined B horizon of sandy clay loam than the Tivoli soils.

The following describes a typical profile of Brownfield fine sand in a pasture 75 feet east of a county road, and 1.25 miles south of the intersection of the county road with Texas Highway No. 92, 3 miles east of Rotan:

A1—0 to 10 inches, brown (10YR 5/3) fine sand; dark brown (10YR 4/3) when moist; structureless; loose when dry or moist; noncalcareous; clear boundary.

A2—10 to 30 inches, reddish-yellow (7.5YR 6/6) fine sand; strong brown (7.5YR 5/6) when moist; structureless; loose when dry or moist; noncalcareous; abrupt boundary.

B2t—30 to 50 inches, red (2.5YR 4/6) sandy clay loam; dark red (2.5YR 3/6) when moist; weak to moderate, medium, subangular blocky structure; very hard when

dry, friable when moist; noncalcareous; clear boundary.

C—50 to 62 inches +, red (2.5YR 4/6) heavy fine sandy loam; dark red (2.5YR 3/6) when moist; slightly hard when dry, friable when moist; noncalcareous.

The A horizon ranges from 20 to 35 inches in thickness. In places well-defined A1 and A2 horizons are absent. The B horizon ranges from red through reddish brown to yellowish red in color and from 12 to 28 inches in thickness. The texture of the B horizon ranges from a light sandy clay loam to light clay loam.

CAREY SERIES

The soils of the Carey series are on uplands. They are deep, well-drained, reddish-brown very fine sandy loams. Their subsoil is moderately permeable. In most places these soils developed in calcareous sandy and silty material of the red beds, but in some places they developed in weathered, noncalcareous to weakly calcareous, soft to weakly cemented sandstone or pack sand. In most of the areas where the soils developed over sandstone or pack sand, they lack a zone of carbonate accumulation.

The Carey soils are deeper than the Woodward soils, and they have a more mature profile. They have a less brownish B horizon than the Tipton soils.

The following describes a typical profile of Carey loam, 1 to 3 percent slopes (fig. 10) in a cultivated field west

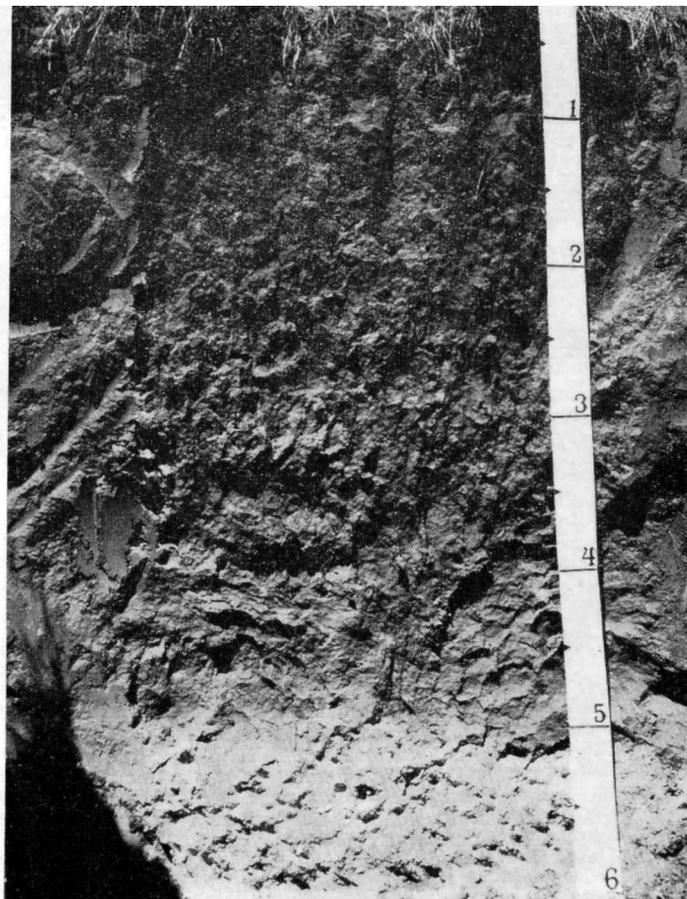


Figure 10.—A typical profile of Carey loam. In this profile the zone of carbonate accumulation is at a depth of 62 inches.

of a county road and 0.1 mile north of the junction of the county road with Farm Road 419, 3.8 miles southwest of Roby:

- Ap—0 to 6 inches, reddish-brown (5YR 4/4) light loam; dark reddish brown (5YR 3/4) when moist; very weak, granular structure; slightly hard when dry, friable when moist; noncalcareous; smooth, abrupt boundary.
- A1—6 to 10 inches, reddish-brown (5YR 4/4) light loam; dark reddish brown (5YR 3/4) when moist; weak, subangular blocky and granular structure; hard when dry, friable when moist; noncalcareous; gradual boundary.
- B2t—10 to 34 inches, reddish-brown (5YR 4/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist; compound weak, coarse, prismatic and moderate, medium and fine, subangular blocky structure; very hard when dry, friable when moist; noncalcareous; many very fine and common fine pores; gradual boundary.
- B3—34 to 58 inches, yellowish-red (5YR 5/6) light sandy clay loam; yellowish red (5YR 4/6) when moist; weak, subangular blocky structure; hard when dry, friable when moist; noncalcareous; many very fine pores; clear boundary.
- Cca—58 to 68 inches, yellowish-red (5YR 5/6) light sandy clay loam; yellowish red (5YR 4/6) when moist; strongly calcareous and contains common soft masses and a few hard concretions of calcium carbonate (2 to 5 percent by volume); gradual boundary.
- C—68 to 75 inches +, red (2.5YR 5/6) light very fine sandy loam; dark red (2.5YR 3/6) when moist; weakly calcareous sandy material of the red beds.

The A horizon ranges from 4 to 12 inches in thickness and from light loam to very fine sandy loam in texture. In the more sloping and eroded areas, the A horizon is thinner than in the less sloping, less eroded areas. The B2t horizon ranges from 15 to 30 inches in thickness and from sandy clay loam to silty clay loam in texture. The B3 horizon ranges from light sandy clay loam to loam in texture and from yellowish red to red in color. The reaction of the B3 horizon ranges from neutral to mildly alkaline. The solum ranges from 36 to 70 inches in thickness.

COTTONWOOD SERIES

In the Cottonwood series are calcareous, gypseous soils that have a surface layer of light clay loam to loam. These soils are dark colored and calcareous. They are underlain by deep beds of calcium sulfate and calcium carbonate. The Cottonwood soils are shallower than the associated Acme soils.

The following describes a typical profile of Cottonwood clay loam in a pasture reached by going 3 miles south of Sylvester on Farm Road 1085, west 1 mile and south 1.5 miles on a county road, and then east 150 yards:

- A—0 to 5 inches, dark grayish-brown (10YR 4/2) light clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, very fine, subangular blocky to granular structure; slightly hard when dry, very friable when moist, slightly sticky when wet; strongly calcareous; abrupt boundary.
- R—5 to 30 inches +, a bed of white calcium sulfate and calcium carbonate with the uppermost few inches weakly cemented; strongly calcareous.

The A horizon ranges from 4 to 10 inches in thickness and from dark brown to grayish brown in color. The texture of the A horizon ranges from light clay loam to loam.

ENTERPRISE SERIES

The Enterprise series consists of deep, reddish-brown, young soils developed in recent calcareous material blown

from the channels of streams that drain the area. In most places these soils have slopes between 1 and 5 percent, but their slopes range from 0 to 12 percent.

The Enterprise soils have a finer textured surface layer than the Miles soils. They also lack a textural B2 horizon.

The following describes a typical profile of Enterprise very fine sandy loam, 1 to 3 percent slopes, in a cultivated field 1,800 feet west of Texas Highway No. 70 and 5.1 miles north of Rotan:

- Ap—0 to 6 inches, reddish-brown (5YR 5/4) very fine sandy loam; reddish brown (5YR 4/4) when moist; very weak, granular structure; soft when dry; very friable when moist; noncalcareous; clear, smooth boundary.
- A1—6 to 14 inches, reddish-brown (5YR 4/4) very fine sandy loam; reddish brown (5YR 3/4) when moist; weak, granular structure; soft when dry, very friable when moist; noncalcareous; common worm casts; gradual boundary.
- AC—14 to 54 inches +, yellowish-red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) when moist; weak, subangular blocky and granular structure; soft when dry, very friable when moist; strongly calcareous; contains threads and films of soft, white calcium carbonate and a few small concretions below a depth of 30 inches; few worm casts.

The A horizon ranges from 8 to 20 inches in thickness and from noncalcareous to calcareous. The texture of the AC horizon ranges from very fine sandy loam to heavy very fine sandy loam.

MANSKER SERIES

In the Mansker series are brown soils that are gently sloping to strongly sloping. These soils developed in very strongly calcareous, medium-textured to fine-textured sediments.

The Mansker soils are deeper than the Potter soils. They are shallower over clay and are more permeable and less clayey than the Abilene soils.

The following describes a typical profile of Mansker loam, 1 to 3 percent slopes, in a cultivated field east of a county road, 0.5 mile northeast and 3.4 miles north of Wastella:

- Ap—0 to 6 inches, brown (10YR 5/3) loam; dark brown (10YR 3/3) when moist; very weak, granular structure; hard when dry, very friable when moist; strongly calcareous; has a few hard concretions of calcium carbonate on the surface and throughout the horizon; abrupt, smooth boundary.
- AC—6 to 15 inches, brown (7.5YR 5/4) clay loam; dark brown (7.5YR 3/4) when moist; compound, weak, subangular blocky and granular structure; hard when dry, very friable when moist; strongly calcareous; contains a few fine and medium soft masses and hard concretions of calcium carbonate; common worm casts; gradual, wavy boundary.
- Cca—15 to 38 inches, pinkish-white (7.5YR 8/2 both dry and moist) clay loam; friable when moist; 30 percent or more soft concretions of calcium carbonate and hard concretions; gradual boundary.
- C—38 to 50 inches +, light-brown (7.5YR 6/4) light clay; brown (7.5YR 5/4) when moist; strongly calcareous; contains much less segregated calcium carbonate than the Cca horizon.

The Ap or A1 horizon ranges from 6 to 8 inches in thickness and from brown or dark brown to dark grayish brown in color. The AC horizon ranges from 6 to 16 inches in thickness and from brown or light brown to yellowish brown. The thickness of the solum ranges from 12 to 24 inches.

MILES SERIES

In the Miles series are deep, noncalcareous soils that have a well-developed profile. The B horizon is reddish, friable sandy clay loam. These soils developed mainly in old alluvium of Quaternary age. In some places, however, they developed in material similar to the old alluvium, except for differences in age or in mode of deposition. These soils are gently sloping to undulating. They developed under bunch and mid grasses.

The Miles soils occur with Wichita, Brownfield, and Altus soils. Of these soils, they most nearly resemble the Wichita fine sandy loams. They developed in slightly less clayey deposits and have a less blocky and more permeable B2 horizon, however, than the Wichita soils. Their A horizon is darker, less sandy, and less thick than that of the Brownfield soils. The Miles soils have a lighter colored surface layer and a less calcareous substratum than the Altus soils.

The following describes a typical profile of Miles fine sandy loam in a cultivated field reached by going 1 mile north of Rotan on Texas Highway No. 70, then 0.7 mile east and 0.2 mile north on county road:

- Ap—0 to 10 inches, reddish-brown (5YR 4/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; very weak, granular structure; slightly hard when dry, very friable when moist; noncalcareous; pH 7.0; (This field has been deep plowed, and the B1 horizon has been mixed into the plow layer); abrupt, smooth boundary.
- B21t—10 to 30 inches, reddish-brown (5YR 4/4) sandy clay loam; dark reddish brown (5YR 3/4) when moist; compound weak, coarse, prismatic; weak, fine, subangular blocky; and very fine, granular structure; very hard when dry, friable when moist; noncalcareous; (pH 6.8); common fine and very fine pores; gradual boundary.
- B22t—30 to 50 inches, yellowish-red (5YR 5/6) light sandy clay loam; yellowish red (5YR 4/6) when moist; compound moderate, very coarse, prismatic; weak, fine, subangular blocky; and very fine granular structure; hard when dry, friable to very friable when moist; noncalcareous (pH 7.5); many fine and very fine pores; diffuse boundary.
- B3—50 to 70 inches, yellowish-red (5YR 5/8) heavy fine sandy loam; yellowish red (5YR 4/8) when moist; hard when dry, very friable when moist; noncalcareous (pH 7.5); gradual boundary.
- Cca—70 to 80 inches +, red (2.5YR 4/6) light sandy clay loam; dark red (2.5YR 3/6) when moist; strongly calcareous; common very fine hard concretions of calcium carbonate.

The texture of the surface layer ranges from fine sandy loam to light fine sandy loam. In these soils in the southwestern part of the county, the surface layer is dominantly light fine sandy loam that contains a few quartzite pebbles. The surface layer ranges from 6 to 12 inches in thickness; it is thickest where these soils are near the head of shallow draws.

The dry color of the A horizon ranges from reddish brown to yellowish red with values of 4 to 5 and chromas of 3 to 6 in hues of 5YR. In many places the plow layer is yellowish red. The color of the B21t horizon varies only slightly from reddish brown, ranging from a value of 4 and chroma of 4, chiefly in hues of 2.5YR. The B22t and B3 horizons range from reddish brown to yellowish red in color with values of 4 to 5 and chromas of 4 to 8 in hues of 2.5YR to 5YR.

The thickness of the B horizons ranges from 30 to 60 inches. The Cca horizon ranges from 10 to 14 inches in

thickness. In some places the Cca horizon is barely evident, but in other places it is well defined.

The following describes a typical profile of Miles loamy fine sand, 0 to 3 percent slopes, west of a road in a cultivated field, 3.6 miles south of U.S. Highway No. 180 along Farm Road 1812:

- Ap—0 to 8 inches, brown (7.5YR 5/4) loamy fine sand; dark brown (7.5YR 3/4) when moist; weak, granular structure to structureless; soft when dry, very friable to loose when moist; noncalcareous; abrupt boundary.
- A1—8 to 14 inches, reddish-brown (5YR 4/4) heavy loamy fine sand; dark reddish brown (5YR 3/4) when moist; weak, granular structure; soft when dry, very friable when moist; noncalcareous; clear boundary.
- B2t—14 to 36 inches, reddish-brown (2.5YR 4/4) sandy clay loam; dark reddish brown (2.5YR 3/4) when moist; compound weak, very coarse, prismatic and moderate, medium, subangular blocky structure; very hard when dry, friable when moist; noncalcareous; many fine and very fine pores; clear boundary.
- B3—36 to 50 inches, red (2.5YR 5/6) light sandy clay loam; red (2.5YR 4/6) when moist; friable when moist; noncalcareous; clear boundary.
- C—50 to 60 inches +, yellowish-red (5YR 5/6) fine sandy loam; yellowish red (5YR 4/6) when moist; noncalcareous.

The A horizon ranges from 8 to 20 inches in thickness and from brown or light brown to reddish brown in color. Combined the B horizons range from 20 to 60 inches in thickness. Their texture ranges from fine sandy loam in the upper part of the B2t horizon to sandy clay loam in the lower part of that horizon. Some profiles contain a horizon where calcium carbonate has accumulated.

PORTALES SERIES

The soils of the Portales series developed in limy sediments. They are dark colored, nearly level, and moderately permeable.

The Portales soils are somewhat similar to the Altus and Abilene soils, but they are calcareous to the surface. They are also less clayey and less deep than the Abilene soils.

The following describes a typical profile of Portales loam, 0 to 1 percent slopes, in a field reached by going 5.4 miles north of Roby on Texas Highway No. 70, 0.7 mile east on a county road, and then 200 feet south in the field:

- Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, very friable when moist; calcareous; few fine quartz pebbles; abrupt boundary.
- A1—7 to 18 inches, dark grayish-brown (10YR 4/2) light clay loam; very dark grayish brown (10YR 3/2) when moist; compound weak, fine, subangular blocky and moderate, fine and very fine, granular structure; very hard when dry, friable when moist; slightly sticky when wet; strongly calcareous; common worm casts; few fine and common very fine pores; clear boundary.
- AC—18 to 34 inches, pale-brown (10YR 6/3) light clay loam; brown (10YR 4/3) when moist; moderate, fine, subangular blocky and granular structure; very hard when dry, friable when moist; very strongly calcareous; common threads and films of soft calcium carbonate, few worm casts; few very fine and fine pores; diffuse boundary.
- Cca—34 to 72 inches +, light-gray (10YR 7/2) sandy clay loam; pale brown (10YR 6/3) when moist; very strongly calcareous; 20 to 30 percent by volume, soft, white calcium carbonate with common fine and few medium-sized hard concretions.

The A horizon ranges from heavy fine sandy loam to light clay loam in texture and from brown to dark grayish

brown in color. It ranges from strongly calcareous to weakly calcareous. The color of the AC horizon ranges from pale brown or brown to dark grayish brown.

POTTER SERIES

In the Potter series are grayish-brown soils that are shallow over beds of weakly cemented caliche. These soils are gently sloping to moderately steep and are on the uplands.

The Potter soils are generally more sloping and are shallower over caliche than the Mansker soils. They are shallower than the associated Abilene and Miles soils.

The following describes a typical profile of Potter clay loam, 8 to 20 percent, in a pasture reached by going 3.5 miles north and 1 mile east of Wastella on a county road and then 1 mile north:

A—0 to 6 inches, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) when moist; contains common pebbles consisting mostly of subangular fragments and concretions of calcium carbonate and some quartzite pebbles; moderate, very fine, granular structure; friable when moist; very strongly calcareous; abrupt boundary.

C—6 to 24 inches +, white caliche containing a small amount of soil material.

The A horizon ranges from 4 to 10 inches in thickness and from dominantly clay loam through loam or gravelly loam to fine sandy loam. The caliche ranges from soft to indurated.

QUINLAN SERIES

The Quinlan series consists of reddish-brown, medium-textured, calcareous soils that are shallow over material of the red beds. The soils developed in sandy or silty material of the red beds.

The Quinlan soils occur with the Woodward and Carey soils. They are less deep than those soils and lack the well-defined B horizon that is typical in the profile of the Carey soils.

The following describes a typical profile of Quinlan very fine sandy loam in an area of Woodward-Quinlan loams, 1 to 3 percent slopes, 1.8 miles north of the Nolan and Fisher County line, along Texas Highway No. 70 and 100 feet east in a field:

A—0 to 11 inches, reddish-brown (5YR 4/4) very fine sandy loam; dark reddish brown (5YR 3/4) when moist; weak, granular to weak, subangular blocky structure; slightly hard when dry, very friable when moist; weakly calcareous; lower 5 to 6 inches contains small fragments of sandy material from the red beds; abrupt boundary.

C—11 to 18 inches +, a mixture of red and light-gray, calcareous, sandy material of the red beds.

The solum ranges from 4 to 15 inches in thickness and from reddish brown to yellowish red in color. This soil is generally weakly to strongly calcareous, but some small areas are noncalcareous.

RANDALL SERIES

In the Randall series are deep, very dark gray to gray soils on the floors of enclosed depressions or intermittent lakes. The soils lie 3 to 10 feet below the level of the surrounding nearly level or gently sloping soils of the uplands. Surface drainage is slow or lacking, and these soils have slow internal drainage.

The following describes a typical profile of Randall clay one-half mile northeast, 2.2 miles north, and 1 mile east of Wastella:

A—0 to 16 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, fine, blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; noncalcareous and nearly neutral; gradual boundary.

AC—16 to 40 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; weak to moderate, coarse, blocky structure in upper part, becoming moderate, coarse, irregular blocky in lower part, extremely hard when dry, very firm when moist, very sticky and plastic when wet; weakly calcareous; few very fine pores; gradual boundary.

Cca—40 to 72 inches +, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) when moist; massive; firm when moist, sticky when wet; strongly calcareous and moderately alkaline; few hard concretions of calcium carbonate and 2 to 5 percent, by volume, of soft calcium carbonate.

The thickness of the A horizon ranges from 14 to 20 inches, and the color of that horizon ranges from gray to dark gray. In some areas 2 to 3 inches of the surface layer consists of recent deposits that are neutral to weakly calcareous. Depth to the Cca horizon ranges from 38 to 62 inches.

SPUR SERIES

The Spur series is made up of dark-brown, well-drained, friable, calcareous soils that have a moderately fine textured to medium-textured subsoil. These soils developed in slightly reddish, loamy, calcareous alluvium washed from such soils as the Miles, Abilene, Tillman, Carey, and Vernon.

The Spur soils are darker and less sandy than the Yahola soils. They have slightly more clayey lower horizons than the Yahola soils, and lime threads and soft nodules of segregated calcium carbonate are more common in their profile than in the profile of the Yahola soils.

The following describes a typical profile of Spur clay loam reached by going 2.6 miles north of Roby on U.S. Highway No. 70 and 5.5 miles northwest on a county road:

A11—0 to 4 inches, brown (7.5YR 5/4) clay loam; dark brown (7.5YR 4/2) when moist; weak, thick, platy structure; hard when dry, friable when moist; weakly calcareous; abrupt boundary.

A12—4 to 34 inches, dark-brown (7.5YR 4/2) clay loam; dark brown (7.5YR 3/2) when moist; compound moderate, fine, subangular blocky and fine, granular structure; hard when dry, friable when moist; strongly calcareous; common threads and films of soft lime; many very fine and few fine and medium pores; common worm casts; gradual boundary.

AC—34 to 52 inches, reddish-brown (5YR 4/3) silty clay loam; dark reddish brown (5YR 3/3) when moist; fine, moderate, subangular blocky structure and fine, blocky peds; very hard when dry, firm when moist, and slightly sticky and plastic when wet; very strongly calcareous; few soft nodules of calcium carbonate; gradual boundary.

C—52 to 72 inches +, brown (7.5YR 5/3) clay loam; dark brown (7.5YR 3/3) when moist; weak to moderate, fine, subangular blocky structure; very hard when dry, friable when moist; very strongly calcareous and few threads and small nodules of calcium carbonate; thin layers of loam and sandy clay loam in lower 6 inches.

The A11 and A12 horizons range from clay loam to heavy loam in texture and from brown to dark brown in color, with dry values of 4 to 5 in hues of 7.5YR. The AC horizon ranges from fine sandy clay loam to silty clay loam in texture. The dry color of that horizon ranges from brown to reddish brown, with values of 4 to 5 in hues of 5YR to 7.5YR. The AC horizon ranges from strongly calcareous to very strongly calcareous. The C horizon

ranges from sandy clay loam to silty clay loam in texture. Its dry color ranges from reddish yellow to brown, with values of 5 to 6 in hues of 5YR to 7.5YR.

The following describes a typical profile of cultivated Spur silt loam 400 feet east of Texas Highway No. 70 and 0.8 mile south from the intersection of Texas Highway No. 70 and U.S. Highway No. 180.

- Ap—0 to 6 inches, brown (7.5YR 5/4) silt loam; dark brown (7.5YR 3/4) when moist; weak, very fine, granular structure; hard when dry, friable when moist; strongly calcareous; abrupt boundary.
- A1—6 to 16 inches, brown (7.5YR 5/4) silt loam; dark brown (7.5YR 3/4) when moist; weak to moderate, fine, granular structure; slightly hard when dry, friable when moist; strongly calcareous; common fine pores and worm casts; gradual boundary.
- AC—16 to 56 inches, dark-brown (7.5YR 4/2) clay loam; dark brown (7.5YR 3/2) when moist; compound weak, subangular blocky and moderate, fine, granular structure; hard when dry, friable when moist; strongly calcareous; films of soft calcium carbonate; few thin layers of very fine sandy loam; clear boundary.
- C—56 to 72 inches +, reddish-brown (5YR 5/4) clay loam; reddish brown (5YR 4/4) when moist; weak to moderate, fine, subangular blocky structure; very hard when dry, firm when moist, and slightly sticky when wet; strongly calcareous; few spots of soft calcium carbonate.

The dry color of the A horizon ranges from brown to dark brown, with values of 4 and 5 in hues of 7.5YR to 10YR. The dry color of the AC horizon ranges from dark brown to brown, with values of 4 to 5 in hues of 7.5YR. The texture of the AC horizon ranges from light sandy clay loam to silty clay loam. The C horizon ranges in texture from fine sandy clay loam to silty clay loam. The dry color of that horizon ranges from reddish brown to brown, with values of 4 to 5 in hues of 5YR to 7.5YR.

TILLMAN SERIES

In the Tillman series are soils developed in calcareous, clayey material of the red beds. The slopes range from 0 to 3 percent, but in most places they are between $\frac{1}{2}$ and $1\frac{1}{2}$ percent.

The Tillman soils are more clayey than the Wichita soils, redder than the Abilene soils, and deeper than the Vernon soils. They are deeper, more clayey, and more slowly permeable than the associated Weymouth soils.

The following describes a typical profile of Tillman clay loam in an area of range reached by going $4\frac{3}{4}$ miles south of Sylvester on Farm Road 1085, and then 200 feet west of that road:

- A1—0 to 5 inches, reddish-brown (5YR 4/4) heavy clay loam; dark reddish brown (5YR 3/4) when moist; weak, subangular blocky structure; hard when dry, friable when moist, and slightly sticky when wet; noncalcareous; clear boundary.
- B1—5 to 10 inches, reddish-brown (5YR 4/4) light clay; dark reddish brown (5YR 3/4) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist, and slightly sticky when wet; noncalcareous; thin clay films; clear boundary.
- B21t—10 to 21 inches, reddish-brown (5YR 4/3) clay; dark reddish brown (5YR 3/3) when moist; moderate, medium and fine, blocky structure; very hard when dry, firm when moist, and slightly sticky and plastic when wet; weakly calcareous; thin continuous clay films; few very fine pores; gradual boundary.
- B22t—21 to 55 inches, reddish-brown (5YR 4/3) clay; dark reddish brown (5YR 3/3) when moist; moderate to strong, medium, irregular or wedge-shaped blocky structure; extremely hard when dry, firm when moist,

and slightly sticky and plastic when wet; weakly calcareous; thin, continuous clay films; few very fine, angular pebbles; few very fine pores; gradual boundary.

Cca—55 to 65 inches, red (2.5YR 4/6) silty clay; dark red (2.5YR 3/6) when moist; very strongly calcareous; 2 to 3 percent, by volume, soft, segregated calcium carbonate; clear boundary.

C—65 to 75 inches +, dark-red (2.5YR 3/6) clay; same color when moist; very strongly calcareous; calcium carbonate less segregated than in the Cca horizon.

The A1 horizon ranges from 5 to 12 inches in thickness and from reddish brown to dark brown in color. In places the B1 horizon is absent. The color of the B21t horizon ranges from dark reddish brown through reddish brown to dark red. The degree of development of the Cca horizon ranges from faint to distinct. The lower part of the Cca horizon also contains gypsum crystals in some places. The uppermost 18 inches of the soil profile ranges from noncalcareous to weakly calcareous.

TIPTON SERIES

In the Tipton series are deep, nearly level or gently sloping soils developed in calcareous loamy and silty alluvium. These soils are in open concave areas.

The Tipton soils occur near the Carey and Woodward soils, but they are at a lower elevation than those soils and they have a darker color. The Tipton soils are less clayey and have a more permeable B horizon than the Abilene soils, and they are less reddish and more silty than the Miles and Wichita soils.

The following describes a typical profile of Tipton silt loam, 0 to 1 percent slopes, approximately 3 miles west and north of Longworth:

- A11—0 to 15 inches, reddish-brown (5YR 4/4) silt loam (appears to be recently deposited material washed from the surrounding more sloping Carey soils); dark reddish brown (5YR 3/4) when moist; very weak, granular structure; slightly hard when dry, very friable when moist; noncalcareous; abrupt boundary.
- A12—15 to 26 inches, dark-brown (7.5YR 4/2) silt loam; dark brown (7.5YR 3/2) when moist; weak, granular structure; very friable when moist; noncalcareous to weakly calcareous below a depth of 22 inches; contains many fine and medium pores; many worm casts; gradual boundary.
- B2t—26 to 46 inches, dark-brown (7.5YR 4/3) silty clay loam; dark brown (7.5YR 3/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, friable when moist; strongly calcareous; contains films and threads of calcium carbonate in the lower part; many fine pores; gradual boundary.
- Cca—46 to 58 inches +, pale-brown (10YR 6/3) silty clay loam; brown (10YR 5/3) when moist; strongly calcareous and contains common soft masses of calcium carbonate.

Where the A11 horizon is present, it ranges from 10 to 20 inches in thickness, but in some places it is absent. The B2t horizon ranges from brown or dark brown to very dark grayish brown in color and from moderate, medium, subangular blocky to weak, medium, blocky in structure. The B2t horizon ranges from calcareous to noncalcareous. The degree of development of the Cca horizon ranges from distinct to faint.

TIVOLI SERIES

The Tivoli series consists of soils that have a profile of loose fine sand. The soils developed in windblown sand.

They are undulating to rolling. In some places they are on stabilized dunes.

The Tivoli soils are more undulating than the Brownfield soils, and they lack a B horizon of sandy clay loam. They are more undulating and more sandy than the Miles soils, and they do not have a well-developed profile like that of the Miles soils. The following describes a typical profile of Tivoli fine sand in an area of range reached by going 5.4 miles east of Roby on U.S. Highway No. 180, 0.7 mile north on a county road, and east 1 mile:

- A—0 to 10 inches, brown (10YR 5/3) fine sand; dark brown (10YR 4/3) when moist; structureless; loose when dry or when moist; noncalcareous; clear boundary.
- C1—10 to 34 inches, reddish-yellow (7.5YR 8/6) fine sand; reddish yellow (7.5YR 7/6) when moist; structureless; loose when dry or moist; noncalcareous; gradual boundary.
- C2—34 to 62 inches +, reddish-yellow (7.5YR 6/6) fine sand; strong brown (7.5YR 5/6) when moist; structureless; loose when dry or moist; noncalcareous.

The color of the A horizon ranges from brown or dark brown to grayish brown. The color of the C horizon ranges from reddish yellow to light yellowish brown.

TRAVESSILLA SERIES

The Travessilla series consists of gravelly soils that overlie conglomerate rock or sandstone. The areas are gently sloping to steep or are rough and broken. This soil is shallow over conglomerate rock or sandstone.

The following describes a typical profile of Travessilla gravelly sandy loam one-fourth mile east of the northwest corner of section 8, block 22 of the Texas and Pacific Railroad survey:

- A1—0 to 6 inches, brown (7.5YR 4/3) gravelly sandy loam; dark brown (7.5YR 3/3) when moist; moderate, very fine, granular structure; noncalcareous; about 15 to 20 percent, by volume, consists of pebbles one-eighth of an inch to 2 inches in diameter; the pebbles are mostly angular and are quartzitic; abrupt boundary.
- R—6 to 7 inches, hard conglomerate rock.

The solum ranges from 2 to 10 inches in thickness. It ranges from loam to gravelly sandy loam in texture and from reddish gray to dark brown in color.

TREADWAY SERIES

In the Treadway series are red soils made up of raw clay. These soils consist of compact, platy layers of red-bed materials. This material was eroded from the surrounding outcrops of red beds and deposited in alluvial fans.

The Treadway soils occur with the Vernon and Tillman soils. Unlike those soils, their profile lacks distant horizons. The following describes a typical profile of Treadway clay reached by going 5 miles north and east of Eskota on the county road and 50 yards east on Raven Creek:

- C1—0 to 6 inches, red (2.5YR 4/6) clay; dark red (2.5YR 3/6) when moist; weak, medium and thin, platy structure; hard when dry, very friable when moist, and slightly sticky when wet; weakly to strongly calcareous; few very fine pores; continuous thin surface crust; clear boundary.
- C2—6 to 40 inches, red (2.5YR 5/6) clay, coarser than that in the C1 horizon; dark red (2.5YR 3/6) when moist; weak, thin and very thin, platy structure; hard when dry, friable when moist, and slightly sticky when wet; strongly calcareous; few very fine layers of silt;

material has been only slightly altered since deposition; clear boundary.

- C3—40 to 58 inches, red (2.5YR 4/6) gravelly clay, and unweathered clay fragments of the red beds; dark red (2.5YR 3/6) when moist, very hard when dry; clear boundary.
- C4—58 to 72 inches, red (2.5YR 5/6) light clay; red (2.5YR-4/6) when moist; compound weak, coarse, prismatic; weak to moderate, fine, blocky; and very fine, irregular blocky structure; very hard when dry, friable when moist, and slightly sticky when wet; weakly calcareous; few very fine pores; few very thin strata of very fine sand; clear boundary.
- C5—72 to 90 inches +, red (10YR 4/6) partly weathered shale of the red beds; dark red (10YR 3/6) when moist; contains thin strata of a blue shale that is slightly more sandy than the red shale.

The color of the different horizons ranges from reddish brown to red. The number of horizons ranges from two to five, and the texture ranges from clay through silty clay to clay loam. The material ranges from strongly calcareous to noncalcareous and from 35 to 100 inches in thickness over undisturbed red-bed material.

VERNON SERIES

The Vernon series consists of soils developed in clayey material of the red beds. The soils are reddish brown and are gently sloping to strongly sloping. They are in convex areas. Many quartzitic pebbles are on the surface.

Vernon soils are shallower over red-bed material than the associated Tillman soils. They are more clayey than the associated Weymouth soils, and they lack a strongly developed zone of calcium carbonate accumulation. They are more clayey than the Quinlan soils.

The following describes a typical profile of Vernon clay loam, 1 to 3 percent slopes, in an area of range reached by going 1 mile east of the overpass on U.S. Highway No. 180 and Farm Road 57; then six-tenths of a mile north on a county road, and 500 feet west:

- A—0 to 9 inches, reddish-brown (2.5YR 4/4) clay loam; dark reddish brown (2.5YR 3/4) when moist; weak, very fine, subangular blocky and granular structure; hard when dry, friable when moist and slightly sticky when wet; weakly calcareous; clear boundary.
- AC—9 to 18 inches, reddish-brown (2.5YR 4/4) clay; dark reddish brown (2.5YR 3/4) when moist; moderate, medium and fine, blocky structure; very hard when dry, friable when moist, and slightly sticky when wet; weakly to strongly calcareous; nearly continuous clay films; common very fine pores; few worm casts; clear boundary.
- R—18 to 20 inches +, red (2.5YR 4/6), calcareous, clayey red beds; dark red (2.5YR 3/6) when moist.

The A horizon ranges from 6 to 16 inches in thickness and from reddish brown to dark reddish brown in color. The color of the AC horizon ranges from reddish brown to dark red. In most places these soils are calcareous, but in places they are noncalcareous to a depth of 10 inches.

WEYMOUTH SERIES

In the Weymouth series are reddish-brown, gently sloping to strongly sloping soils developed in strongly calcareous material of the red beds. These soils are shallow over the red-bed material.

The Weymouth soils are less clayey than the Vernon soils. They also have more granular structure and a distinct Cca horizon. They are less deep, and they do not have the profile development typical of the associated Tillman and Wichita soils.

The following describes a typical profile of Weymouth clay loam, 1 to 3 percent slopes, in a pasture reached by going 1 mile west of the Newman cemetery on a county road, then 0.65 mile west and 600 feet north:

- A—0 to 6 inches, reddish-brown (5YR 4/4) light clay loam; dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist, and slightly sticky when wet; strongly calcareous; few fine concretions of calcium carbonate; clear boundary.
- AC—6 to 15 inches, reddish-brown (5YR 5/4) light clay loam; reddish brown (5YR 4/4) when moist; weak, coarse, prismatic and weak to moderate, fine, subangular blocky structure; hard when dry, friable when moist, and slightly sticky when wet; strongly calcareous; common fine concretions of calcium carbonate; many fine pores; gradual, irregular boundary.
- Cca—15 to 30 inches, reddish-brown (5YR 5/4) light clay loam; red (2.5YR 4/6) when moist; weak, subangular blocky structure; hard when dry, friable when moist, and slightly sticky when wet; strongly calcareous; 15 to 20 percent, by volume, soft calcium carbonate; few fine concretions of calcium carbonate; clear boundary.
- C—30 to 50 inches +, yellowish-red (5YR 5/6) clay loam; yellowish red (5YR 4/6) when moist; strongly calcareous; few soft and hard lumps of calcium carbonate.

The A horizon ranges from 5 to 11 inches in thickness and from reddish brown to brown in color. It ranges from weakly to strongly calcareous. The AC horizon ranges from 6 to 18 inches in thickness. The Cca horizon ranges from 12 to 24 inches in thickness and from red through reddish brown to yellowish red. The thickness of the solum ranges from 13 to 24 inches.

WICHITA SERIES

The Wichita series consists of well-drained soils developed in calcareous alluvial material. These soils are in broad, shallow valleys and in high areas that resemble terraces. The slopes range from 0 to 5 percent, but they are mainly between 0 and 3 percent.

The Wichita soils are redder than the Abilene soils. They are less clayey than the Tillman soils and developed in alluvial material, rather than in material from the red beds. The Wichita soils have a more clayey subsoil than the Miles soils, and the permeability of their subsoil is moderately slow.

The following describes a typical profile of Wichita clay loam in a cultivated field reached by going 10.3 miles east of Roby on U.S. Highway No. 180, then 5.6 miles south and east on Farm Road 1812, and 0.2 mile north:

- Ap—0 to 5 inches, reddish-brown (5YR 4/3) clay loam; dark reddish brown (5YR 3/3) when moist; very weak subangular blocky and granular structure; hard when dry, friable when moist, and slightly sticky when wet; noncalcareous; abrupt, smooth boundary.
- B1—5 to 10 inches, dark reddish-brown (5YR 3/2) light clay; dark reddish brown (5YR 2/2) when moist; weak, medium and fine, subangular blocky structure; hard when dry, friable when moist, and slightly sticky when wet; noncalcareous; many very fine, common fine, and few medium pores; thin clay films on the surfaces of peds; few worm casts; clear boundary.
- B21t—10 to 24 inches, dark reddish-brown (2.5YR 3/2) sandy clay; dusky red (2.5YR 2/2) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist, and slightly sticky when wet; noncalcareous; common very fine and few fine pores; continuous thin clay films on the surfaces of peds; clear boundary.

B22t—24 to 36 inches, reddish-brown (2.5YR 4/4) sandy clay, lighter than that in the B21t horizon; dark reddish brown (2.5YR 3/4) when moist; weak to moderate, medium, blocky structure; very hard when dry, friable when moist, and slightly sticky when wet; noncalcareous to weakly calcareous in the lower 6 inches; common very fine and few fine and medium pores; thin clay films on the surfaces of peds; clear boundary.

Cca—36 to 60 inches +, red (2.5YR 5/6) loam; red (2.5YR 4/6) when moist; 30 to 40 percent, by volume, segregated calcium carbonate in the uppermost 12 inches, and 15 to 20 percent in the lower part.

The A horizon ranges from 5 to 8 inches in thickness and from clay loam to sandy clay loam in texture. It ranges from dark reddish brown or reddish brown to brown in color. The B horizon ranges from clay loam to sandy clay in texture and from reddish brown to dark reddish brown in color. The development of the Cca horizon ranges from strong to weak. Depth to calcareous material ranges from 30 to 40 inches.

The following describes a typical profile of Wichita fine sandy loam, 1 to 3 percent slopes, in a field 5 miles southwest of Hamlin on Farm Road 57, 1.6 miles south and 1 mile east on the county road, and 150 feet south of the road:

- Ap—0 to 6 inches, reddish-brown (5YR 4/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; very weak, granular structure; slightly hard when dry, very friable when moist; noncalcareous; abrupt boundary.
- B1—6 to 17 inches, dark reddish-brown (2.5YR 3/4) sandy clay loam; dark reddish brown (2.5YR 2/4) when moist; weak, fine, subangular blocky and granular structure; hard when dry, friable when moist, and slightly sticky when wet; noncalcareous; thin discontinuous clay films; many fine and very fine pores; gradual boundary.
- B2t—17 to 36 inches, red (2.5YR 4/6) sandy clay; dark red (2.5YR 3/6) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist, and sticky when wet; noncalcareous; nearly continuous clay films; few very fine pores; clear boundary.
- B3—36 to 58 inches, red (2.5YR 5/8) sandy clay loam; red (2.5YR 4/8) when moist; moderate, medium, blocky structure; hard when dry, friable when moist; noncalcareous, but has weakly calcareous spots in the lower 6 inches; clear boundary.
- C—58 to 64 inches +, yellowish-red (5YR 5/8) sandy clay loam; yellowish red (5YR 4/8) when moist; more sandy than the B3 horizon, but has weakly calcareous spots.

The A horizon ranges from 5 to 15 inches in thickness. The B1 horizon ranges from 5 to 12 inches in thickness and from reddish brown to dark reddish brown in color. The color of the B2t horizon ranges from red to reddish brown. The zone of carbonate accumulation is scarcely evident to distinct.

The following describes a typical profile of Wichita loam, 1 to 3 percent slopes, in a field reached by going 3.2 miles north and west of Sylvester on Farm Road 1085, 0.3 mile west on the county road, and 100 feet south:

- Ap—0 to 8 inches, reddish-brown (5YR 4/4) loam; dark reddish brown (5YR 3/4) when moist; very weak, granular structure; slightly hard when dry, friable when moist; noncalcareous; abrupt boundary.
- B1—8 to 16 inches, dark reddish-brown (5YR 3/2) clay loam; dark reddish brown (5YR 2/2) when moist; weak to moderate, fine and medium, subangular blocky structure; hard when dry, friable when moist; noncalcareous; many very fine, common fine, and few

medium pores; thin, discontinuous clay films; few worm casts; clear boundary.

B2t—16 to 42 inches, reddish-brown (5YR 4/4) heavy clay loam; dark reddish brown (5YR 3/4) when moist; moderate, medium, blocky structure; very hard when dry, friable when moist; noncalcareous; common very fine pores; thin, nearly continuous clay films; few worm casts; gradual boundary.

C—42 to 60 inches +, yellowish-red (5YR 5/6) clay loam; yellowish red (5YR 4/6) when moist; weakly calcareous; slightly more sandy in the lower part.

The A horizon ranges from 5 to 8 inches in thickness. The B1 horizon ranges from clay loam to sandy clay loam in texture and from dark reddish brown to reddish brown in color. Depth to calcareous material ranges from 20 to 50 inches. The zone of carbonate accumulation is scarcely evident to distinct.

WOODWARD SERIES

In the Woodward series are moderately deep soils that are immature. These soils are on uplands and developed in sandy or silty material of the red beds (fig. 11). They are calcareous and have moderately rapid permeability. Their slopes are between 1 and 5 percent.

The Woodward soils have a thicker solum than the Quinlan soils, and they are less clayey than the Weymouth soils. They are more calcareous than the Carey soils with which they are associated, lack a well developed profile, and are shallower over red-bed material.

The following describes a typical profile of Woodward loam, 3 to 5 percent slopes, in a pasture reached by going 3.6 miles east of Roby on U.S. Highway No. 180, 2.5 miles south on Farm Road 1085, 0.8 mile west and 0.4 mile south on the county road, and 200 feet west of the county road:

A11—0 to 9 inches, reddish-brown (5YR 5/4) light loam, dark reddish brown (5YR 3/4) when moist; very weak, subangular blocky and granular structure; slightly hard when dry, very friable when moist; strongly calcareous; many very fine and few medium pores; few worm casts; clear boundary.

A12—9 to 20 inches, reddish-brown (5YR 5/4) light loam; dark reddish brown (5YR 3/4) when moist; weak, fine, subangular blocky and granular structure; slightly

hard when dry, friable when moist; strongly calcareous; many very fine, common fine, and few medium pores; few worm casts; contains a few soft concretions of calcium carbonate, gradual boundary.

AC—20 to 36 inches, yellowish-red (5YR 5/6) light loam; yellowish red (5YR 4/6) when moist; very weak, subangular blocky and granular structure; slightly hard when dry, very friable when moist; strongly calcareous; many very fine and fine pores; few worm casts; clear boundary.

C—36 to 40 inches +, calcareous sandy and silty red beds.

The A horizon ranges from 8 to 26 inches in thickness and from reddish brown to yellowish red in color. The texture of the A12 horizon ranges from very fine sandy loam to loam. In places the profile contains an AC1 horizon and an AC2 horizon, and these two horizons combined are as much as 40 inches thick. The AC horizon, however, is generally 10 to 20 inches thick. The thickness of the profile ranges from 24 to 54 inches.

YAHOLA SERIES

The Yahola series consists of reddish-brown, calcareous soils that are moderately coarse textured. These soils have a stratified subsoil. They are on the flood plains of streams that drain the area.

The Yahola soils are more sandy and have a more stratified AC horizon than the Spur soils. They are less stratified and less frequently flooded than the land types Loamy alluvial land and Sandy alluvial land.

The following describes a typical profile of Yahola very fine sandy loam, 0 to 1 percent slopes, 0.9 mile south of Roby on Texas Highway No. 70, west of the road on the bottom lands along Cottonwood Creek:

A1—0 to 18 inches, reddish-brown (5YR 4/4) very fine sandy loam; dark reddish brown (5YR 3/4) when moist; where this soil is plowed, the plow layer is 6 inches thick and has very weak granular structure; the structure is weak granular below the plow layer; slightly hard when dry, very friable when moist; strongly calcareous; worm casts are common; clear boundary.

AC—18 to 58 inches, reddish-brown (5YR 5/4) very fine sandy loam; reddish brown (5YR 4/4) when moist, with thin strata of light-brown (7.5YR 6/4) loamy fine sand; brown (7.5YR 5/4) when moist; very weak granular structure; slightly hard when dry, very friable when moist; strongly calcareous; few worm casts; abrupt boundary.

A16—58 to 72 inches +, buried soil of very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; very hard when dry, firm when moist; strongly calcareous.

The A1 horizon ranges from reddish brown or dark reddish brown to brown in color and from 15 to 24 inches in thickness. The AC horizon ranges from 15 to 50 inches in thickness. The stratification in the AC horizon is variable; the texture of that horizon ranges from very fine sandy loam to loamy fine sand.

General Nature of the Area

Important features about the climate, relief, drainage and water supply of Fisher County are described in this section. Also discussed are the social and industrial development and significant facts about agriculture.

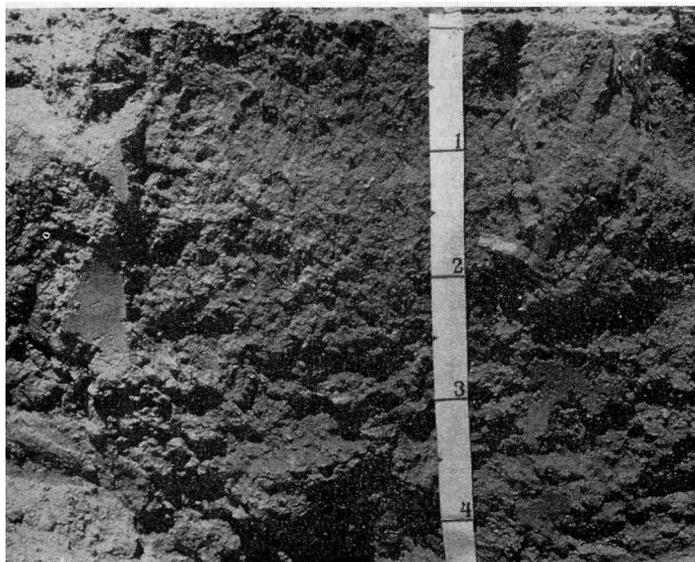


Figure 11.—A typical profile of Woodward loam.

Climate

Fisher County has a semiarid climate and an average annual rainfall of only 20.61 inches. Rainfall occurs most frequently in the form of thunderstorms. The amount of monthly and annual rainfall is extremely variable. In 1956, for example, the total annual precipitation at Roby was only 7.81 inches, the lowest annual total ever recorded for that area. In contrast, the annual total at Roby in 1941 was 41.58 inches, the highest annual total ever recorded. At Rotan during the same 30-year period (1932-1961), the total annual precipitation ranged from 9.55 inches, received in 1956, to 39.66 inches, received in 1932.

Periods of 2 to 3 weeks, when no rain is received, are fairly common. In 1 year out of every 10, less than one-tenth of an inch of rainfall is likely to be received in any month, except in April, May, and June. The greatest average monthly rainfall occurs in May and

⁴ By ROBERT B. ORTON, State climatologist, U.S. Weather Bureau.

June. In extremely wet years, little benefit is derived from much of the precipitation. In those years a large part of the rainfall is in the form of severe thunder-showers, and much of the water is lost through runoff. Table 6 gives figures for monthly and annual precipitation for Roby and Rotan for the 30-year period 1932 to 1962.

The average annual snowfall is 13 to 15 inches, and severe snowstorms are infrequent. Snow generally does not cover the ground uniformly, because of the high winds. Snow is likely to remain on the ground only 1 or 2 days, for the temperature often rises after snowfall has occurred.

The wide range of maximum and minimum temperatures typical of the Great Plains is also typical of Fisher County. January is the coldest month, and August is the hottest. Short periods of hot weather, when the daily maximum temperature reaches 100° F. or higher, sometimes occur in the months of May through September. The summers are generally hot, but good wind motion and low humidity lessen the discomfort from high temperatures. Table 7 gives maximum, minimum, and average temperatures for the period 1931 through 1960 at Abilene,

TABLE 6.—Precipitation data for selected stations

ROBY (ELEVATION 1,876 FEET)

Month	Average ¹ total	Greatest daily amount ¹		Total in driest year ²	Total in wettest year ²	One year in 10 will have—		Average number of days with more than ³ —			Snow and sleet		
						A total of less than ¹ —	A total of more than ¹ —	0. 10 inch	0. 50 inch	1. 00 inch	Aver- age ¹	Maxi- mum ¹	Year
January	1. 00	1. 65	1961	0. 34	1. 20	0	3. 13	2	(⁴)	(⁴)	0. 9	11. 0	1940
February	1. 12	3. 97	1957	. 50	2. 18	0	2. 75	2	1	(⁴)	. 3	4. 0	1940
March	. 84	. 89	1955	0	2. 72	0	2. 13	2	1	0	. 2	3. 0	1941
April	1. 86	2. 08	1954	1. 59	6. 17	. 19	4. 90	3	2	(⁴)	(⁵)	(⁵)	1949 ⁶
May	3. 77	2. 95	1939	1. 42	5. 19	1. 15	7. 15	5	3	1	0	0	
June	2. 64	3. 10	1961	. 50	6. 23	. 01	6. 12	3	2	1	0	0	
July	1. 90	3. 50	1961	1. 03	4. 55	0	5. 89	3	1	1	0	0	
August	1. 51	4. 50	1940	. 10	6. 06	0	5. 92	2	1	1	0	0	
September	2. 14	3. 15	1942	0	2. 41	0	6. 49	2	1	1	0	0	
October	2. 06	3. 50	1941	1. 35	4. 33	. 11	6. 55	3	2	1	0	0	
November	. 90	1. 20	1943	0	. 04	0	2. 91	2	(⁴)	(⁴)	(⁵)	(⁵)	1955 ⁶
December	. 87	1. 83	1946	. 98	. 50	0	3. 34	1	1	(⁴)	. 1	15. 0	1940
Year	20. 61	4. 50	1940	7. 81	41. 58	12. 22	33. 42	30	15	6	1. 5	15. 0	

ROTAN (ELEVATION 1,925 FEET)

January	0. 91	1. 83	1932	0. 31	3. 27	0. 10	2. 64	3	1	(⁴)	1. 3	8. 5	1936
February	1. 00	2. 80	1938	. 71	2. 38	0	2. 53	2	1	(⁴)	1. 3	5. 5	1956
March	. 87	1. 56	1934	0	(⁵)	(⁵)	2. 49	2	1	(⁴)	. 4	6. 0	1947
April	1. 70	2. 54	1954	1. 05	2. 98	. 09	4. 64	3	1	1	. 1	3. 0	1938
May	3. 79	3. 60	1947	2. 21	6. 03	. 82	7. 63	5	2	2	0	0	
June	2. 50	2. 80	1961	. 84	4. 43	. 26	5. 46	4	2	1	0	0	
July	2. 16	3. 20	1960	. 89	2. 50	. 10	4. 79	4	1	1	0	0	
August	1. 70	4. 30	1932	1. 17	8. 59	. 09	4. 27	3	1	(⁴)	0	0	
September	1. 98	3. 35	1932	0	7. 06	(⁵)	6. 79	3	1	1	0	0	
October	2. 00	3. 50	1941	1. 44	. 84	. 06	5. 61	4	2	1	0	0	
November	1. 09	1. 90	1961	. 06	. 05	0	3. 26	3	1	(⁴)	. 2	3. 0	1957
December	. 91	1. 83	1935	. 87	1. 53	0	2. 20	2	1	(⁴)	. 9	4. 8	1954
Year	20. 61	4. 30	1932	9. 55	39. 66	13. 42	30. 87	38	15	7	4. 2	13. 5	1947

¹ For Roby, figures are based on a 23-year record; for Rotan, they are based on a 30-year record.

² The driest year was 1956; the wettest year was 1941 for Roby and 1932 for Rotan.

³ Based on a 10-year record.

⁴ Less than one-half day.

⁵ Trace; that is, an amount too small to measure.

⁶ A trace occurred in earlier years.

in Taylor County. These temperatures are considered to be fairly representative of those in Fisher County, although they are slightly higher.

TABLE 7.—*Normal maximum, minimum, and average temperatures at Abilene, Tex., in Taylor County, for the period 1931 through 1960*

[Elevation 1,720 feet]

Month	Maximum	Minimum	Average
	°F.	°F.	°F.
January.....	56.4	32.8	44.6
February.....	60.5	36.3	48.4
March.....	68.4	41.6	55.0
April.....	77.2	51.3	64.3
May.....	83.4	60.0	71.7
June.....	91.7	68.9	80.3
July.....	94.3	72.1	83.2
August.....	94.1	71.9	83.0
September.....	87.4	64.4	75.9
October.....	78.6	53.8	66.2
November.....	65.3	40.7	53.0
December.....	58.0	34.2	46.1
Annual.....	76.3	52.3	64.3

In Fisher County the average date of the last occurrence of a temperature of 32° or lower in spring is April 2, and the average date of the first occurrence of a temperature of 32° or lower in fall is November 10. Thus, the average freeze-free season is 220 days. There is a 20-percent chance that a temperature of 32° or lower will occur in spring after April 20 and earlier than October 30 in fall, and a 5-percent chance that a temperature of 32° or lower will occur after April 25 and earlier than October 25 in fall. The average number of days between the last occurrence of a temperature of 28° in spring and the first in fall is 240.

Sunshine is abundant throughout the year. On the average, about 70 percent of the total amount possible is received. The relative humidity is low. The average relative humidity is about 75 percent at 6:00 a.m., 49 percent at noon, and about 45 percent at 6:00 p.m. The highest relative humidity generally occurs during the early morning hours in May and June and again in October. The lowest relative humidity occurs during the afternoon in March, July, and August.

Winds are strongest during intense thunderstorms, or "squalls," but these storms last for only a short time. The strongest continuous winds occur in March and April. The prevailing direction of the winds is southerly to south-southeasterly.

Severe winds or hail may accompany severe thunderstorms, especially late in spring and early in summer. Damage to crops may result from the wind, hail, or excessive rain that accompanies these storms. An average of about five thunderstorms are to be expected during each of the months of April, June, July, and August, and about eight are to be expected in May. Tornadoes occasionally occur during the most violent thunderstorms, but they are infrequent. Only nine tornadoes are known to have touched ground in this county during the period from 1896 to August 1962.

Evaporation is rather high, as would be expected in a semiarid climate. In this county the average annual

amount of moisture that evaporates from an "A" type of pan, 4 feet in diameter, is about 100 inches, according to records of the U.S. Weather Bureau. Approximately 60 percent of the average annual evaporation occurs during the growing season of May to October. The average annual evaporation from lakes is 68 inches (3).

Relief and Drainage

Fisher County is mainly nearly level to gently rolling, but some areas are rolling or hilly. The southwestern corner and the eastern third of the county are the most nearly level. The county is in the south-central part of the Rolling Plains resource area and is well dissected by drainageways.

The general slope is from southwest to northeast. The lowest area, 1,700 feet above sea level, is at the point where California Creek leaves the county. It is in the northeastern part of the county near the town of Hamlin, which is mainly just east of the county line in Jones County. The highest elevation, 2,400 feet, is in the southwestern part of the county near the town of Pyron, which is just west of the county line in Scurry County. Roby, the county seat, has an elevation of 1,876 feet. Rotan, the largest town in the county, has an elevation of 1,925 feet.

The county is in the Brazos Watershed of Texas. It has three distinct drainage patterns (fig. 12). In addition, California Creek drains the northeastern part of the county and eventually flows into the Clear Fork of the Brazos River, about 50 miles east of the county.

The largest drainage area, in the southern part of the county, is the one drained by the Clear Fork of the Brazos River and its tributaries. That river flows from west to east slightly north of the center of the county, and drains about 64 percent of the acreage. The watershed on the south side of the river covers a larger acreage than that on the north side. Cottonwood Creek is the largest tributary on the south side, and Plum Creek and Buffalo Draw drain the next largest area on the south side.

Sweetwater Creek drains the southeastern corner of the county, but much of its flow originates in Nolan County to the south. This stream joins the Clear Fork of the Brazos River in Jones County to the east.

The Double Mountain Fork of the Brazos River drains about one-fourth of the county—the northwestern and northern parts. That river enters the county near the northwestern corner, flows south and east, and leaves the county about 12 miles east of the northwestern corner. The principal tributaries of the Double Mountain Fork of the Brazos River are Rough Creek, Red Creek, White Canyon, and Gyp Creek.

During severe rainstorms the channels of the larger streams carry most of the water, and only slight flooding occurs. In 1923, however, Cottonwood Creek and parts of the Clear Fork of the Brazos River overflowed their banks. In 1932 and again in 1955 most of the soils along these streams were flooded; the flood in 1955 was the most extensive of any that have occurred.

Many of the smaller streams or tributary streams overflow during severe rains, but most of the smaller tributary streams do not carry water during the entire year. Neither the Clear Fork of the Brazos River nor Sweetwater Creek carry water during drier periods, but some

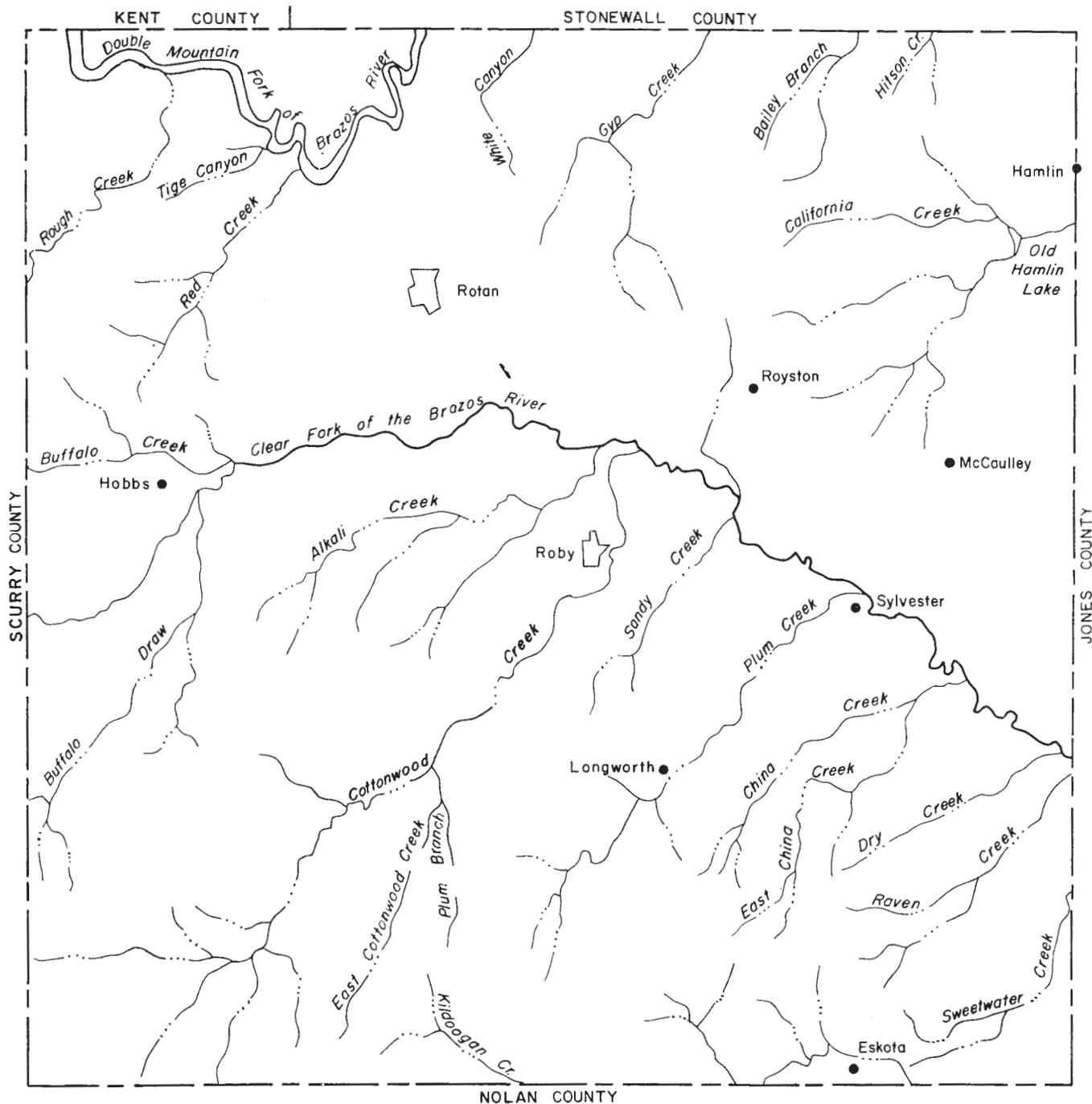


Figure 12.—Drainage pattern in Fisher County.

water remains in waterholes. A few springs along Gyp Creek have a weak flow into waterholes.

Water Supply

The county is moderately well supplied with water. The best quality water is obtained from wells in areas of Miles and Brownfield soils, generally at a depth of less than 80 feet. Also ground water of good chemical quality is obtained from wells in the Triassic rocks, at a depth as

great as 175 feet. These wells are in the southwestern and west-central parts of the county, near the county line.

In the rest of the county, the chemical quality of water from most of the wells varies from place to place. In many places the ground water from the areas underlain by Permian rocks contains calcium sulfate and is commonly called gyp water. Consequently, most of the water for drinking and household use is hauled from Roby and Rotan and stored above ground in metal cisterns or in

underground cisterns. Some water for household use consists of runoff from buildings. This water is caught and stored in underground cisterns.

The water from many of the wells in the county, although not suitable for household use, can be used for watering livestock. Also waterholes along Rough Creek, Cottonwood Creek, Buffalo Draw, and the Clear Fork of the Brazos River supply water for livestock in most years. Additional water for livestock is obtained from farm ponds that have been built in most areas of range. The deeper ponds supply water throughout the year.

For more than 25 years, the water supply for the town of Rotan was obtained from three wells in Camp Springs in Scurry County. Recently, however, the main supply of water for Rotan has been brought by pipeline from Scurry County. This water is taken from Lake Thomas on the Colorado River.

The towns of Roby, Longworth, Sylvester, and McCaulley obtain their water supply from the town of Sweetwater in Nolan County. This supply comes from manmade lakes of moderate size.

Social and Industrial Development

The area that is now Fisher County was settled late in 1876. Most of the settlers were cattlemen, who allowed their livestock to graze the open range. Among the first settlers there were only four farmers. In 1881 the settlers established the first post office at Newman, about 7 miles northeast of Eskota. In the same year, one line of a railroad was extended from east to west through Eskota. Early towns, in addition to Eskota, were Fisher (now North Roby) and Roby. When the county was organized in 1886, Roby was made the county seat.

The first fence, bringing restrictions to grazing, was built in 1883. Then the severe winter of 1884-85 brought tremendous losses to the cattlemen, and as a result, farming began to replace cattle raising. A cotton gin, which helped the cotton farmers, was built in 1888. After 1900, the growing of cotton and small grains, chiefly wheat, became the leading enterprise.

The population grew rapidly until about 1930. In 1880 it was 136; in 1900, 3,708; in 1910, 12,596; and in 1930, 13,596. After 1930, the population gradually declined. In 1940 it was 12,936, but by 1960 it had dropped to 7,861.

Transportation and markets.—Four railroad lines serve the county. One line crosses the southeastern part. The longest line in the county runs northeast from Sweetwater, in Nolan County, through Longworth, Sylvester, and McCaulley, and on through Hamlin in Jones County. The main line of the same railroad runs from northwest to southeast and crosses the southwestern corner of the county for about 15 miles. Another railroad, between Rotan and Hamlin, is used for hauling wallboard from the gypsum plant at Rotan and oil from the Royston oilfield, northeast of Royston.

Hard-surface roads connect all the towns in the county. U.S. Highway No. 180 crosses the center of the county from east to west. State Highway No. 70 runs north and south, across the center of the county. Hard-surface roads connect farms and ranches in the most thickly populated rural areas to main highways. Most of the county

roads have been improved and are passable, except during short wet periods. Most of these roads follow section lines or survey lines, except at some crossings across creeks.

Most of the farm crops are marketed locally. There are eight cotton gins in the county, and a cottonseed oil-mill is located at Rotan. Some cotton is ginned at Hamlin in nearby Jones County, and some cotton from the southern and southwestern parts is ginned at Sweetwater and Roscoe in Nolan County.

In part, the milk and poultry products are sold locally. Beef cattle are generally sold at markets outside the county.

Industries.—Agriculture is the main enterprise in the county. Many rural families, however, depend on work off the farm for part of their livelihood. A total of 213 farmers worked 100 days or more off the farm, according to the 1959 census. The cotton gins, grain elevators, and other processing plants hire several part-time employees during the seasonal rush period. Other people work part time as pumpers for oil companies.

Plants where gypsum is processed are located on the southwestern side of Roby and at Longworth and Plasterco, and wallboard is the chief finished product. The plant at Roby provides full-time employment for many people. It is located in an area where there are deposits of soft gypsum, but most of this material is unsuitable for wallboard. Gypsum for the plant is trucked from a quarry about 5 miles north of Rotan.

Exploration for oil and gas began during the late 1920's in this county. The earliest reported commercial production of oil was at the Royston field discovery well, drilled in 1928. Most of the drilling activity in the county, however, has occurred since 1950. At present there are 116 oilfields in the county designated by the Railroad Commission, and about 5 million barrels of oil are produced annually. Total cumulative oil production in the county as of January 1, 1962, was 75,585,195 barrels. The production of gas has been rather small.

Agriculture

Data significant to the agriculture of the county are discussed in this section. The statistics are from reports of the U.S. Bureau of the Census.

Number and size of farms.—Until the early thirties, the number of farms in the county gradually increased and the size of the farms decreased. Since that time, however, the number of farms has gradually decreased, and the size of farms has increased.

The number of farms decreased from 2,088 in 1930 to 864 in 1959. This decrease parallels the decline in population for the same period. The size of the average farm in 1920 was about 309 acres; in 1930, it was 236 acres; in 1940, 330 acres; in 1950, 392 acres; and in 1959, about 547 acres. The following list shows the number of farms in Fisher County, by size, in 1950, 1954, and 1959:

Size of farm:	Number in 1950	Number in 1954	Number in 1959
Less than 10 acres..	41	35	16
10 to 49 acres.....	44	50	22
50 to 99 acres.....	86	85	62
100 to 179 acres....	320	272	163
180 to 259 acres....	252	201	125
260 to 499 acres....	355	323	244
500 to 999 acres....	103	145	156
1,000 acres and over.	58	80	76

Farm tenure.—Until 1935, there was a gradual increase in the number of tenants who operated farms in the county. The number of such tenants was far greater than the number of farmers who operated their own farms. Since 1935, the number of tenants has gradually decreased. The greatest decrease occurred during the late thirties and early forties. In 1950 owners operated 801 of the 1,259 farms in the county, tenants operated 453, and managers operated 5. In 1959 owners operated 608 of the 864 farms, tenants operated 250, and managers operated 6.

Most of the tenants are crop-share tenants who furnish all of the seed, implements, and labor and take care of the farm and buildings. They generally receive two-thirds to three-fourths of the harvested crop and the owner receives one-fourth to one-third. About 10 percent of the tenants are cash tenants who pay a fixed amount per acre, generally for an allotted acreage of cotton. A few tenants are livestock-share tenants who care for the livestock and furnish some labor for growing crops. In return, this type of tenant gets some pay for his work and receives part of the income from the sale of livestock. The owner furnishes equipment, livestock, buildings, and other necessary material.

Farm equipment and labor.—During the 1930's and early 1940's, tractors and mechanical equipment largely replaced horses and mules as a source of power in this county. The number of tractors has increased since 1930. In 1950 there were 1,000 tractors in the county; in 1954, 1,072; and in 1959, 1,252. In 1959 a total of 379 farms in the county had two tractors. The tractors are generally medium size to large; four-row equipment is rapidly replacing two-row equipment.

The number of mechanical harvesters, including self-propelled combines and cotton strippers, has also increased since World War II. In 1959 some type of machine-hire custom service was used on 712 farms.

Although the use of mechanical cotton strippers and cottonpickers has increased, additional help is still needed during the cultivation and harvesting seasons. In 1954 a total of 127 regular workers was employed more than 150 days on farms in the county; in 1959 there were 314.

Crops.—Climatic limitations, chiefly low annual rainfall, reduce the number of crops that can be grown in this county. Other factors, such as bedrock near the surface, strong slopes, and the hazard of erosion, require careful selection of crops. Consequently, farming is not diversified; the main crops are cotton, grain sorghum, and wheat. The acreage of the principal crops grown in stated years is shown in table 8.

TABLE 8.—Acreage of the principal crops

Crops	1940	1950	1959
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Cotton.....	85,786	126,692	69,672
Sorghum:			
For grain or seed.....	56,841	57,590	15,826
For hay and silage.....	29,026	11,542	12,510
Wheat.....	1,055	26,449	11,328
Oats.....	(¹)	2,656	1,949
Barley.....	(¹)	306	288
Corn for all purposes.....	5,756	994	168

¹ Not recorded.

Cotton is the chief cash crop grown in the county. In 1950 a total of 54,205 bales of cotton was harvested, and in 1959 the harvest was 40,881 bales. Land to be planted to cotton is generally bedded the preceding winter. The fairly mild, dry winters are favorable for work in the fields, and most of the bedding is completed by early in spring. About the first of May, farmers begin planting in the beds. The crop is generally hoed once or twice, chiefly to kill weeds and grass, and it is cultivated three to five times to control weeds. Picking begins about the first of September. Recently many farmers have been applying a defoliant aerial spray to remove the leaves before the cotton is harvested. Harvesting is generally completed by the end of the year. Some cotton is grown on all of the deeper, smoother soils, but it is best suited to the medium-textured and moderately coarse textured soils.

Areas to be planted to sorghum are prepared in the same way as for cotton. Some of the sorghum is planted late in April, but most is planted about the first of June. Some is harvested by combine for grain, and some is harvested in bundles or baled for hay. Part of the forage sorghum is used for silage. Most of the grain sorghum is combined in October.

Wheat is generally planted in fields that have been fallowed during the summer. If the soil contains enough moisture, wheat is planted from around the middle of September to the middle of November. Wheat from the early plantings is used for pasture early in winter. The mature crop is harvested in June, using a self-propelled combine. Most of the wheat is grown on moderately fine textured soils; however, wheat is grown on a small acreage of medium-textured soils, chiefly to provide winter grazing.

Barley, oats, and rye are planted chiefly for winter grazing. These crops are planted like wheat, and the total acreage is small. The acreage planted to corn has greatly decreased. Most of it is planted in small plots and is used for roasting ears.

A small acreage of alfalfa is grown under irrigation and is used chiefly for grazing. Austrian winter peas, guar, and summer peas are also planted on a small acreage to improve the soils. A few orchards of pear trees or peach trees are in the county. Some pears are sold, but the peaches are largely grown for home consumption.

Livestock and livestock products.—Table 9 shows the number of livestock and poultry on farms and ranches in the county in stated years. Beef cattle are the most important kind of livestock. The cattle are generally raised locally and are of high quality.

Most of the cattle are of the Hereford breed, but herds of Black Angus cattle have increased in recent years. Most ranchers use purebred bulls and have grade cows,

TABLE 9.—Number of livestock on farms

Livestock	1940	1950	1959
Cattle and calves.....	20,733	24,535	24,010
Horses and mules.....	5,139	814	438
Sheep and lambs.....	13,884	3,662	1,479
Chickens ¹	131,876	73,938	43,910
Swine.....	3,192	1,829	1,953

¹ Over 4 months old.

but there are a few purebred herds, and some purebred stock is displayed at livestock shows in the larger towns. Many ranchers cull their herds annually and sell the older cows and low-quality heifers. Consequently, there is a gradual improvement in the quality of the herds.

The larger ranches are in the northwestern, northern, southwestern (excluding the Roscoe Flat area), and southeastern parts of the county. As the size of farms has increased, more farms have become small livestock farms. The operators of these livestock farms raise some of their cattle, but they also buy stockers from local auctions when hay or temporary pasture is plentiful.

On the larger ranches the beef cattle are kept on the range throughout the year. Most of the ranches are cross-fenced, and cattle are moved from pasture to pasture during the year. On some ranches the ranch operator saves one pasture for winter use. In winter cottonseed cake, baled sorghum or johnsongrass hay, and bundle feed are used to supplement the range forage. Ranchers generally have portable, covered self-feeders placed at advantageous locations to distribute the more finely ground feed. The capacity of these feeders varies, but most hold 1 week's supply of feed. In addition some ranchers plant wheat for winter grazing and crops such as sudangrass for temporary summer grazing. Temporary pastures, used for grazing in summer, allow the operator to rest the native range during part of the growing season. This aids the growth of grass and increases the production of seed.

More than 75 percent of the number of cattle produced are sold at auctions in Abilene in Taylor County, and the rest chiefly from the southern part of the county, are sold at auctions in Sweetwater in Nolan County. Only a few cattle are sold direct to feeders.

The number of dairy cows raised in this county has gradually declined since the peak was reached in the 1930's. In 1950 there were 3,434 dairy cows in the county; in 1954, 2,372; and in 1959, only 1,549. Most farmers and ranchers keep a few milk cows. The main dairy breeds are Jersey, Holstein, and Guernsey. In 1950, 39 dairies were in the county. In 1954 the number had dropped to 26, and by 1959 it had dropped to 10.

The number of horses and mules has dropped considerably since 1930. At present, horses are mainly on ranches and are used by cowhands for managing livestock. A few are kept for recreational riding.

The number of sheep in the county has never been large. Since 1950 the sheep population has ranged from about 1,500 to 4,600. The average flock contains from 100 to 200 sheep. Most of the flocks are on ranches in the southern and western parts of the county. Nearly all of the sheep are sold at auctions in San Angelo in Tom Green County.

Many farmers and ranchers keep a few chickens, mainly for home use. Only a few commercial producers are in this county.

The number of swine in this county has never been large. There have been two peak periods, however, around 1920 and between 1940 and 1945. In 1920 the number of swine was 3,900, and during the period from 1940 to 1945 it was slightly more than 3,000. During the 1920's and 1930's, most farmers kept one or two hogs for home consumption, but during World War II, some hogs were marketed by a few farmers.

In 1959 there were only 1,953 swine on 213 farms. Many of these, however, are raised on a few farms. One farm in particular is equipped to raise more than 1,000 pigs annually. Most of the hogs are marketed at packing plants in Sweetwater and Abilene.

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Glossary

- Aggregate, soil.** Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.
- Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.
- Blowout.** An excavation produced by wind action in loose soil, usually sand.
- Calcareous soil.** A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.
- Caliche.** A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.
- Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. See also Texture, soil.
- Clay film.** A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.
- Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.
- Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
- Loose.*—Noncoherent; will not hold together in a mass.
- Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
- Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

- Plastic.**—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger.
- Sticky.**—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.
- Hard.**—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
- Soft.**—When dry, breaks to powder or individual grains under very slight pressure.
- Cemented.**—Hard and brittle; little affected by moistening.
- Dispersion, soil.** Deflocculation of the soil and its suspension in water.
- Eolian deposits.** Soil parent material accumulated through wind action; commonly refers to sandy material in dunes.
- Erosion.** The wearing away of the land surface by wind, running water, and other geological agents.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. See also Surface soil; Subsoil; Solum; and Substratum.
- Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation.
- Loam.** Soil having approximately equal amounts of sand, silt, and clay. Loam contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. See also Texture, soil.
- Parent material (soil).** The horizon of weathered rock or partly weathered soil material from which soil presumably has formed; horizon C in the soil profile.
- Permeability.** The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.
- pH value.** A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity. See also Reaction, soil.
- Playa.** A flat basin or sump area on the floor of a desert valley or semidesert in the western United States. The sediments of the *playa* left by flooding are generally fine or clayey, highly charged with salt or alkali, and nearly devoid of vegetation.
- Plowpan.** A compacted layer formed in the soil immediately below the plowed layer.
- Poorly graded.** A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.
- Profile, soil.** A vertical section of the soil through all its horizons and extending into the parent material.
- Reaction, soil.** The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or “sour,” soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:
- | | <i>pH</i> | | <i>pH</i> |
|------------------------|------------|---------------------------------|----------------|
| Extremely acid..... | Below 4.5 | Neutral | 6.6 to 7.3 |
| Very strongly acid.... | 4.5 to 5.0 | Mildly alkaline | 7.4 to 7.8 |
| Strongly acid..... | 5.1 to 5.5 | Moderately alkaline.... | 7.9 to 8.4 |
| Medium acid..... | 5.6 to 6.0 | Strongly alkaline..... | 8.5 to 9.0 |
| Slightly acid..... | 6.1 to 6.5 | Very strongly
alkaline | 9.1 and higher |
- Relief.** The elevations or inequalities of a land surface, considered collectively.
- Sand.** Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. See also Texture, soil.
- Silt.** Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay. See also Texture, soil.
- Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effects of climate and living matter acting upon parent material, as conditioned by relief over periods of time.
- Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum. See also Horizon, soil.
- Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).
- Subsoil.** Technically, the B horizon; roughly, the part of the profile below plow depth. See also Horizon, soil.
- Substratum.** Any layer lying beneath the solum, or true soil; the C or R horizon. See also Horizon, soil.
- Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer. See also Horizon, soil.
- Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.
- Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.” See also Clay; Loam; Sand; and Silt.
- Tilth, soil.** The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.
- Topsoil.** A presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

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