SOIL SURVEY

Tillman County Oklahoma

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
in cooperation with
OKLAHOMA AGRICULTURAL EXPERIMENT STATION
Issued August 1974

Major fieldwork for this soil survey was done in the period 1962–1967. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1968. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Tillman County Soil and Water Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, or recreation.

Locating Soils

All of the soils of Tillman County are shown on the detailed map at the back of this publication. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with a number shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in this publication. This guide lists all the soils of the county in alphabetic order by map symbol and shows the capability classification of each. It also shows the page where each soil is described and the page for the capability unit, irrigated, and the range site to which the soil has been assigned.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and ranchers and those who work with them can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the range sites, and the windbreak-postlot groups.

Game managers, sportsmen, and others can find information about the suitability of the soils for management as wildlife habitat in the section "Wildlife Habitat."

Ranchers and others can find in the section "Use of the Soils for Range" descriptions of the range sites and the names of many of the plants that grow on each range site.

Engineers and builders can find under "Engineering Uses of the Soils" tables that contain test data, estimates of soil properties significant in engineering, and interpretations of such properties as they affect specified engineering practices.

Community planners and others can find in the engineering tables data on soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Tillman County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the text and in the section "Additional Facts About the County."

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SOIL SURVEY OF TILLMAN COUNTY, OKLAHOMA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH OKLAHOMA AGRICULTURAL EXPERIMENT STATION

TILLMAN COUNTY is in the southwestern part of Oklahoma (fig. 1). The western boundary is the North Fork of the Red River. The southern boundary is the Red River. Oklahoma counties that join Tillman County are Comanche, Cotton, Jackson, and Kiowa. Wilbarger

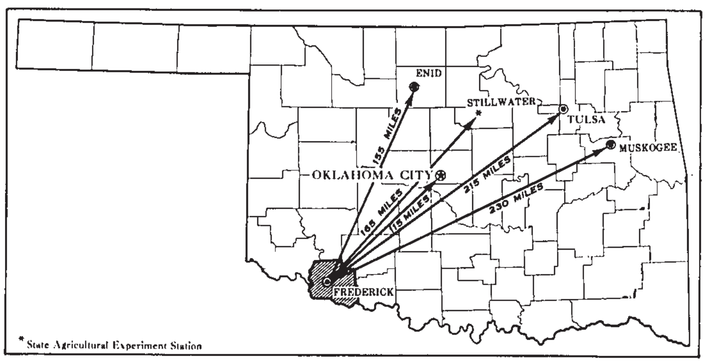

Figure 1.—**Location of Tillman County in Oklahoma.**

and Wichita are the two Texas counties that join Tillman County south of the Red River. The county has a land area of 551,040 acres, or 861 square miles. About 80 percent of the land in farms is arable.

Farming is the chief enterprise in the county. Wheat, cotton, livestock, alfalfa (hay and seed), grain sorghum, and other small grain are the leading farm products. Except for growing wheat, most farms are diversified. Some farms are used primarily for one crop or for raising livestock. Soils of the Foard, Hollister, and Tillman series in upland areas in the eastern part of the county are used mostly for growing wheat and other small grain. Soils of the Asa, Miller, and Port series along the larger streams in the eastern part of the county are used mostly to grow alfalfa and wheat. The upland areas in the western part of the county, which have soils of the Grandfield, Hardeman, and Tipton series, produce mostly cotton and grain sorghum. Most of the irrigation in the county is in this area and about 20,000 acres have been leveled.

Livestock, both swine and cattle, are raised in significant numbers in Tillman County. A large percentage of the farmers in the county depend on livestock for at least a part of their income. Most farmers follow sound conservation practices in managing their farms. Fertilization is widely practiced to improve crop yield.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Tillman County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the 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 the action of plant roots.

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. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

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. Tillman and Tipton, 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 affect their behavior in the undisturbed landscape. A variant of an established series designates soils of small known extent that differ somewhat from those of any recognized series. Cyril series, mildly alkaline variant, is an example.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Tipton loam, 0 to 1 percent slopes, is one of several phases within the Tipton series.

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 woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication 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 the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. 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 phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Tillman County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils or land types, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Tipton-Hinkle complex, 1 to 3 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Tillman and Foard soils, 1 to 3 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock land is a land type in Tillman County.

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 soil 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 soil. 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 such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then 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

The general soil map at the back of this survey shows, in color, the soil associations in Tillman County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The nine soil associations in Tillman County are described in the following pages. The terms describing texture in the title of each association is that of the surface layer of the dominant soils. In the title of association 1, for example, "loamy and sandy" refers to the surface layer of the Tipton, Hardeman, and Grandfield soils.

1. Tipton-Hardeman-Grandfield association

Deep, nearly level to moderately steep, loamy and sandy soils that have a loamy subsoil; on uplands

Association 1 is on broad uplands. Its total area is 123,000 acres, or 22 percent of the county. Tipton soils make up 59 percent of the association, Hardeman soils 20 percent, Grandfield soils 14 percent, Minco soils 4 percent, and other soils 3 percent.

Tipton soils are on broad upland flats. They are deep, nearly level to very gently sloping, well drained, and loamy throughout.

Hardeman soils are dominantly on broad upland flats. They are deep, nearly level to moderately steep, well drained, and loamy throughout.

Grandfield soils are deep, nearly level to gently sloping, and well drained; they have a sandy or loamy surface layer and a loamy subsoil.

The soils in this association have a high to medium available moisture capacity. Maintaining soil structure and controlling soil blowing are major concerns in management.

Nearly all of this association is cultivated, and about 15 percent has been leveled for irrigation. Wheat, cotton, and alfalfa are the major crops. Crops respond well to intensive management. Multirow farm machinery can be used. Wetness seldom delays tillage.

Water-producing strata underlie much of the association, particularly in the western part of the county.

2. Foard-Tillman association

Deep, nearly level to gently sloping, loamy soils that have a clayey and loamy subsoil; on uplands

Association 2 is in broad, plane areas on uplands. In places there are small creeks and isolated areas of rough, broken, reddish clays. The total area is 149,000 acres, or 27 percent of the county. Foard soils make up 35 percent of the association, Tillman soils 23 percent, Hinkle soils 18 percent, St. Paul soils 9 percent, and Clairmont, Hollister, Roscoe, Vernon, and other soils 15 percent.

Both Foard and Tillman soils are nearly level to gently sloping. Foard soils are moderately well drained and have a loamy surface layer and a clayey subsoil. Tillman soils are well drained and have a loamy surface layer and a clayey to loamy subsoil.

The soils in this association have a high available moisture capacity, but they lose much water as runoff because they have a very slowly permeable subsoil. Getting moisture into the soil is the major management concern. Surface crusts are common in areas where the soil has been cultivated for a long period. Crusting and the clayey subsoil cause rapid runoff during intense rains of short duration.

The soils in this association are used mostly for cultivated crops. Small grain is the most suitable crop, because about 60 percent of the average annual rainfall comes between seeding and harvesttime. Multirow farm machinery can be used on these soils without difficulty.

3. Vernon-Stamford association

Shallow to deep, very gently sloping to strongly sloping, loamy to clayey soils that have a loamy to clayey subsoil; on uplands

This association is mostly on narrow ridgetops and on side slopes that are dissected by small drainageways that empty into streams. The total area is 64,000 acres, or about 12 percent of the county. Vernon soils make up about 63 percent of the association, Stamford soils 11 percent, and Hilgrave, Tillman, Weymouth, and other soils and Badland make up 26 percent.

Vernon soils occur on all parts of the landscape. They are very gently sloping to strongly sloping, shallow to moderately deep, well-drained soils that have a loamy surface layer and a clayey subsoil.

Stamford soils are gently sloping, deep, well-drained soils that also have a loamy surface layer and a clayey subsoil.

The soils in this association absorb water very slowly to slowly because of the slow and very slow permeability of the subsoil.

About 20 percent of this association is cultivated, mostly to small grain. The rest is used for range. The main management concerns are preventing overgrazing, which causes woody vegetation to invade the range, and controlling water erosion in exposed, cultivated areas.

In some areas, gravel deposits are along the lower end of strong slopes, adjacent to major streams. This gravel is quarried and used extensively as road surfacing material.

4. Indiahoma association

Deep, very gently sloping and gently sloping, loamy soils that have a clayey subsoil; on uplands

Association 4 is on broad uplands that are dissected by small drainageways. The total area is about 32,000 acres, or about 6 percent of the county. Indiahoma soils make up 90 percent of the association, and the rest is Stamford, Tillman, and other soils.

The Indiahoma soils have ridge-swale microrelief that parallels the slope gradient, except where such relief has been destroyed by plowing.

Indiahoma soils are very gently sloping and gently sloping and are well drained. The surface layer is loamy, and the subsoil is clayey. Cracks form and extend to a depth of 24 to 30 inches when the soil is dry. These soils, however, can absorb a large amount of water, and as they become wet the cracks close. They are sticky when wet and droughty during the summer in most years.

The soils in this association are used mostly for cultivated crops. They are better suited to the production of small grain than to other crops. Small grain is the major crop.

5. Hollister-Abilene association

Deep, nearly level, loamy soils that have a clayey to loamy subsoil; on uplands

Association 5 is mostly in one large area on broad uplands. The total area is about 48,000 acres, or 9 percent of the county. Hollister soils make up about 52 percent of the association, Abilene soils 27 percent, and Foard, Quanah, Roscoe, Weymouth, and other soils 21 percent.

Both Hollister and Abilene soils are nearly level, deep, well-drained soils that have a loamy surface layer and a clayey to loamy subsoil. When Hollister soils are dry, cracks form and extend to a depth of more than 20 inches.

The soils of this association have a high available moisture capacity. The main management concern is improvement of water intake by maintaining or improving structure of the surface layer.

The soils of this association are used extensively for cultivated crops. Small grain, cotton, and grain sorghum are the most suitable crops. Small grain is the major crop. Large farm machinery can be used.

6. Likes-Devol association

Deep, nearly level to steep soils that are loamy to sandy throughout; on uplands

Association 6 is on uplands. It has a variable relief in most areas. It ranges from nearly level and undulating to hummocky and hilly. In some areas the relief is dunelike, or a succession of valleys and small hills. In such areas the available moisture capacity ranges from low to high. The total land area is about 25,000 acres, or 5 percent of the county. Likes soils make up 70 percent of the association, Devol soils 17 percent, and Grandfield, Hardeman, Tipton, and other soils 13 percent.

Likes soils are sloping to steep, deep, excessively drained, and sandy.

The Devol soils are nearly level to sloping. They are deep, well-drained soils that have a sandy to loamy surface layer and a loamy subsoil.

The soils of this association are used for range and cultivated crops. Some of the sandy soils are easily overgrazed because they do not hold enough moisture to sustain plant growth for long periods. Plants, however, make good growth for a short period after rain. The soils that have a loamy subsoil are suited to most crops grown in the county. Soil blowing is the main hazard.

7. *Grandfield-Devol association*

Deep, nearly level to sloping, loamy to sandy soils that have a loamy subsoil; on uplands

Association 7 is on uplands. The soils range from nearly level to undulating and hummocky. They have a medium to high available moisture capacity. The total area is 31,000 acres, or about 5 percent of the county. Grandfield soils make up about 62 percent of the association, and Devol soils 38 percent.

Grandfield soils are on the smoother parts of the landscape. They are nearly level to gently sloping, deep, well-drained, loamy to sandy soils that have a loamy subsoil.

Devol soils are nearly level to undulating and hummocky. They are deep, well-drained, sandy to loamy soils that also have a loamy subsoil.

The soils of this association are used mostly for cultivated crops. Cotton, grain sorghum, and minor acreages of small grain are grown. Soil blowing is the main hazard.

8. *Lincoln association*

Deep, nearly level to very gently sloping, sandy to loamy soils that have a sandy subsoil; on flood plains

Association 8 is on flood plains that are subject to flooding. The available moisture capacity of the soils is low to medium. The total area is 29,000 acres, or about 5 percent of the county. Lincoln soils make up 75 percent of the association, and Yahola soils 25 percent.

Lincoln soils are deep, somewhat excessively drained, sandy to loamy soils. They are underlain by stratified material that is mainly sandy. Although slopes are nearly level to very gently sloping, the surface is uneven.

Small areas of this association are used for cultivated crops; the rest is used either as tame pasture or range. Control of flooding and of soil blowing are the main management concerns.

In some areas, good quality sand is mined for use in cement.

9. *Clairemont-Asa-Miller association*

Deep, nearly level to very gently sloping soils that are loamy and clayey throughout; on flood plains

This association is on flood plains that are subject to flooding. The soils have a high available moisture capacity. The total area is about 50,040 acres, or 9 percent of the county. Clairemont soils make up 35 percent of the association, Asa soils 27 percent, Miller soils 16 percent, Port soils 14 percent, and Cyril, Lincoln, Oscar, and other soils 8 percent.

Both Clairemont and Asa soils are nearly level to very gently sloping, deep, and well drained. They are loamy throughout.

Miller soils are nearly level, deep, and moderately well drained to well drained. They are clayey throughout. When Miller soils are dry, cracks form and extend to a depth of more than 20 inches.

Flooding and crusting of the more clayey soils are the main hazards. Except for the frequently flooded part, most of this association is cultivated. These soils are suited to all crops that are adapted to Tillman County. The frequently flooded areas are generally used for pasture. Native pecan trees grow along the larger streams.

Descriptions of the Soils

In this section the soils of Tillman County are described in detail. The procedure is to describe first the soil series and then the mapping units, or kinds of soil, in that series. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which the unit belongs.

Each soil series description contains a short narrative description of a profile considered representative of the series, and a much more detailed description of the same profile that scientists, engineers, and others can use in making highly technical interpretations. The colors described are for dry soil, unless otherwise noted.

Suggestions for managing soils in dryland areas are given in the descriptions of the mapping units. Management of irrigated soils is discussed in the section "Use and Management of the Soils."

Some of the terms used in the soil descriptions are defined in the Glossary, some in the section "How This Survey Was Made," and some in the Soil Survey Manual (*6*).[1] The approximate acreage and proportionate extent of each soil mapped are shown in table 1. At the back of this soil survey is the "Guide to Mapping Units," which lists the mapping units in the county and shows the capability unit (irrigated, nonirrigated, or both), the range site, and the windbreak-postlot group each mapping unit is in, and the page where each capability unit, irrigated, and each range site is described.

Abilene Series

The Abilene series consists of smooth, nearly level soils on uplands. These soils formed under a cover of mid and short grasses in loamy and clayey sediment.

In a representative profile the surface layer is dark grayish-brown loam 11 inches thick. The upper 17 inches of the subsoil is dark grayish-brown clay loam, the next 13 inches is grayish-brown clay loam, and the lower 11 inches is light-gray clay loam. The underlying material, at a depth of 52 inches, is light-gray clay loam.

Abilene soils are well drained and have slow permeability. Available water capacity is high.

Representative profile of Abilene loam in a cultivated field 1,320 feet north and 1,160 feet west of the southeast corner of sec. 25, T. 1 S., R. 18 W.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; hard, friable; slightly acid; clear, smooth boundary.

[1] Italic numbers in parentheses refer to Literature Cited, page 62.

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

Soil	Acres	Percent	Soil	Acres	Percent
Abilene loam	14, 600	2. 6	Miller clay, saline	3, 000	0. 5
Asa silt loam	9, 800	1. 8	Minco very fine sandy loam, 0 to 1 percent slopes	2, 800	. 5
Asa-Clairemont complex	5, 300	1. 0	Minco very fine sandy loam, 1 to 3 percent slopes	1, 600	. 3
Asa-Oscar complex	700	. 1	Port silty clay loam	7, 100	1. 3
Badland-Vernon complex	1, 200	. 2	Quanah silt loam, 0 to 1 percent slopes	1, 910	. 4
Clairemont soils, channeled	17, 500	3. 2	Rock land	170	(1)
Clairemont soils, saline	6, 100	1. 1	Roscoe clay	8, 700	1. 6
Cyril fine sandy loam, mildly alkaline variant	860	. 2	Stamford silty clay loam, 3 to 5 percent slopes, eroded	4, 600	. 8
Devol loamy fine sand, undulating	11, 700	2. 1	St. Paul silt loam, thin surface, 1 to 3 percent slopes	7, 100	1. 3
Devol loamy fine sand, hummocky	4, 400	. 8	St. Paul-Hinkle complex, 0 to 1 percent slopes	1, 400	. 3
Devol fine sandy loam, 0 to 1 percent slopes	2, 500	. 4	St. Paul-Hinkle complex, 1 to 3 percent slopes	5, 400	1. 0
Foard silt loam, 0 to 1 percent slopes	21, 000	3. 8	Tillman and Foard soils, 1 to 3 percent slopes	42, 300	7. 7
Foard-Hinkle complex, 0 to 1 percent slopes	28, 200	5. 1	Tillman-Hinkle complex, 1 to 3 percent slopes	31, 400	5. 7
Grandfield loamy fine sand, 0 to 1 percent slopes	5, 240	1. 0	Tillman silt loam, moderately shallow variant, 3 to 5 percent slopes	2, 100	. 4
Grandfield loamy fine sand, undulating	13, 860	2. 5	Tipton fine sandy loam, 0 to 1 percent slopes	28, 100	5. 1
Grandfield fine sandy loam, 0 to 1 percent slopes	2, 900	. 5	Tipton fine sandy loam, 1 to 3 percent slopes	4, 800	. 9
Grandfield fine sandy loam, 1 to 3 percent slopes	12, 800	2. 3	Tipton loam, 0 to 1 percent slopes	33, 800	6. 1
Grandfield fine sandy loam, 3 to 5 percent slopes	1, 700	. 3	Tipton loam, 1 to 3 percent slopes	5, 700	1. 0
Hardeman fine sandy loam, 0 to 1 percent slopes	12, 700	2. 3	Vernon soils, 1 to 3 percent slopes	1, 600	. 3
Hardeman fine sandy loam, undulating	8, 600	1. 6	Vernon soils, 3 to 5 percent slopes	5, 300	1. 0
Hardeman fine sandy loam, 3 to 5 percent slopes	2, 200	. 4	Vernon soils, 3 to 5 percent slopes, eroded	10, 000	1. 8
Hardeman fine sandy loam, 8 to 20 percent slopes	2, 500	. 4	Vernon soils, 3 to 8 percent slopes, severely eroded	800	. 2
Hilgrave gravelly loam, calcareous variant, 5 to 15 percent slopes	2, 300	. 4	Vernon complex, 5 to 12 percent slopes	34, 800	6. 3
Hollister silt loam, 0 to 1 percent slopes	23, 500	4. 3	Vernon-Clairemont complex	3, 900	. 7
Indiahoma silty clay loam, 1 to 3 percent slopes	19, 000	3. 5	Weymouth loam, 3 to 5 percent slopes	7, 400	1. 3
Indiahoma silty clay loam, 3 to 5 percent slopes	9, 000	1. 6	Yahola soils, saline, frequently flooded	3, 100	. 6
Likes loamy fine sand, hummocky	11, 700	2. 1	Yahola soils, occasionally flooded	4, 400	. 8
Likes fine sand, hilly	9, 100	1. 7			
Lincoln soils, frequently flooded	19, 100	3. 5			
Lincoln soils, occasionally flooded	2, 500	. 4			
Miller clay	5, 200	. 9	Total	551, 040	100. 0

[1] Less than 0.05 percent.

A1—8 to 11 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; hard, friable; slightly acid; gradual, smooth boundary.

B1—11 to 17 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; hard, firm; neutral; gradual, smooth boundary.

B21t—17 to 28 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 3/3) moist; moderate, fine, blocky structure; very hard, very firm; thin clay films on ped faces; neutral; gradual, smooth boundary.

B22t—28 to 41 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine, blocky structure; very hard, very firm; thin clay films on ped faces; moderately alkaline, calcareous; gradual, smooth boundary.

B3Ca—41 to 52 inches, light-gray (10YR 7/1) clay loam, light brownish gray (10YR 6/2) moist; few, faint and distinct, yellowish-brown (10YR 5/6) mottles; weak, fine and medium, blocky structure; very hard, firm; moderately alkaline, calcareous, 15 to 25 percent segregated soft or hard calcium carbonate concretions; gradual, smooth boundary.

C—52 to 68 inches, light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) moist; common, fine and medium, yellowish-brown (10YR 5/6) mottles; massive; very hard, very firm; moderately alkaline, calcareous.

The A horizon is dark brown or dark grayish brown. The B2t horizon is typically clay loam, but is clay in some places. The clay content of the upper 20 inches of this horizon is generally about 38 percent. This part of the profile is brown, grayish brown, and dark grayish brown. The B2t horizon is neutral in the upper part and moderately alkaline and calcareous in the lower part.

These soils are outside the range for the Abilene series as currently defined, in that they have a B1 horizon and do not have a Ca horizon of soft, powdery calcium carbonate within a depth of 28 inches. They are enough like the Abilene soils in morphology, composition, and behavior, however, that a new series is not warranted.

Abilene soils are associated with Hollister, Tipton, and St. Paul soils. They have a thinner solum than Hollister soils. They differ from Tipton and St. Paul soils in having a clay content of more than 35 percent in the upper 20 inches of the B2t horizon.

Abilene loam (Ab).—This nearly level soil is on broad, smooth uplands. It has the profile described as representative for the series.

About 10 percent of the acreage mapped is a soil that is similar to this soil but has calcareous material within 16 inches of the surface, and about 5 percent is Tipton loam.

This Abilene soil is well suited to field crops. Most of the acreage is cultivated to wheat, cotton, and grain sorghum.

High-residue crops should be grown at least half the time, and the crop residue should be returned to the soil. Low-residue crops should not be grown for more than 4 consecutive years. Tilling or grazing when the soil is wet breaks down soil structure and decreases the rate of moisture intake. Capability unit IIc-1 dryland and I-2 irrigated; Hardland range site; windbreak-postlot group 3.

Asa Series

The Asa series consists of nearly level and very gently sloping soils on flood plains. These soils formed under a cover of tall native grasses and hardwoods in material weathered from loamy sediment.

In a representative profile the surface layer is 11 inches of reddish-brown silt loam and silty clay loam. The subsoil, which extends to a depth of 34 inches, is reddish-brown silty clay loam. The underlying material is reddish-brown silty clay loam.

Asa soils are well drained and have moderate permeability and high available water capacity. In these soils phosphorus reacts with the free lime and becomes unavailable to plants.

Representative profile of Asa silt loam in a cultivated field 200 feet south and 100 feet east of the northwest corner of sec. 11, T. 2 S., R. 16 W.:

Ap—0 to 7 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) moist; weak, fine, granular structure; slightly hard, friable; moderately alkaline, calcareous; abrupt, smooth boundary.

A1—7 to 11 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; moderate, medium, granular structure; slightly hard, friable; moderately alkaline, calcareous; clear, smooth boundary.

B2—11 to 34 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; moderate, medium, subangular blocky structure; hard, firm; moderately alkaline, calcareous; gradual, smooth boundary.

C—34 to 50 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; thin layers of yellowish-red (5YR 5/6) very fine sandy loam; massive; hard, firm; moderately alkaline, calcareous.

The solum ranges from 30 to 40 inches in thickness. The A horizon is mainly silt loam, but ranges to silty clay loam. It is reddish brown, dark brown, or brown. The B2 horizon is loam or silty clay loam. It generally is reddish brown, but in places it is light reddish brown, reddish yellow, or yellowish red. The C horizon is fine sandy loam to silty clay loam. It ranges from reddish brown to dark red or yellowish red.

Asa soils are more clayey in the control section than Cyril soils. They are less clayey than Miller soils. They have a thinner dark-colored surface layer than Port soils. They have a darker colored surface layer than Clairemont soils. Asa soils do not have the sodium content that is typical of Oscar soils.

Asa silt loam (As).—This soil is on smooth flood plains that are flooded occasionally. It has the profile described as representative for the series. Slopes are mainly 0 to 2 percent. About 30 percent of the acreage mapped is a soil that is similar to this soil, but has a redder surface layer.

This Asa is well suited to cultivated crops and, except for minor areas of bermudagrass pasture, is all under cultivation. The main crop is small grain. Important crops in small acreages are cotton, grain sorghum, and alfalfa.

Tillage or grazing when the soil is wet breaks down its structure and, as a result, decreases the rate of moisture intake. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue row crops should not be grown more than 4 consecutive years in any rotation. Capability unit IIw–1 dryland and IIw–1 irrigated; Loamy Bottomland range site; windbreak-postlot group 1.

Asa-Clairemont complex (At).—These nearly level soils are on smooth flood plains. The Asa soil makes up about 70 percent of the complex and the Clairemont soil about 20 percent. The two soils are so intermingled that it is impractical to show them separately on the soil map.

The Asa soil has a profile similar to the one described as representative for the series, but the surface layer is thinner. The Clairemont soil has a profile similar to the one described as representative for its series, but the surface layer is lighter colored and the solum contains salts. About 10 percent of the acreage mapped is Port silty clay loam.

Asa and Clairemont soils are suited to alfalfa, cotton, grain sorghum, small grain, tame pasture, and range. Most of the acreage is cultivated, and small grain is the main crop.

High-residue crops should be grown at least two-thirds of the time, and crop residue should be utilized for soil improvement. Low-residue row crops should not be grown more than 2 consecutive years in any rotation. Moderate salinity limits productivity and causes droughtiness, surface crusting, and breakdown of soil structure. Small grain is less affected than other crops, because this crop is seeded and does most of its growing during the time of year when the moisture supply is most favorable and when a surface crust is least likely to form. Minimum tillage at a depth of 6 inches or less helps prevent surface crusting by minimizing the amount of harmful salts brought to the surface. Capability unit IIIs–3 dryland and IIIs–2 irrigated; windbreak-postlot group 1; Asa soil in Loamy Bottomland range site and Clairmont soil in Alkali Bottomland range site.

Asa-Oscar complex (Ax).—These nearly level soils are on smooth flood plains. The Asa soil makes up about 45 percent of the complex and Oscar soils about 30 percent. These soils are so intermingled that it is impractical to map each of them separately. About 25 percent of the acreage mapped is Port silty clay loam.

The Asa soil has a profile similar to the one described as representative for its series, but the surface layer is silt loam and silty clay loam and is slightly thicker and grayer. Oscar soils have the profile described as representative for their series, and have a surface layer of silt loam or loam.

These soils are not suitable for cultivation. They can be used for tame pastures, but intensive management is essential in maintaining a uniform vegetative cover. Most of the acreage is used for range. Capability unit Vs–1 dryland; windbreak-postlot group 1; Asa soil in Loamy Bottomland range site and Oscar soil in Alkali Bottomland range site.

Badland

Badland consists of clay and shale outcrops and is characterized by moderately steep breaks and escarpments. More than half the acreage of this land lacks vegetation. Erosion is rapid. Moisture seldom penetrates to a depth of more than 10 inches. Little or no soil formation has taken place.

Badland is mapped with Vernon soils. Smaller acreages of it are included in mapping units of Stamford and Tillman soils.

Badland-Vernon complex (Bv).—This complex has slopes that are mainly 8 to 20 percent. Badland makes up about 54 percent of the acreage, and Vernon soil about 34 percent. Badland and the Vernon soil are so intermingled that it is impractical to map each one separately. Vernon soils have a profile similar to the one described as representative for the Vernon series.

About 2 percent of the acreage mapped is a colluvial clay in drainageways, and 10 percent is a soil that is similar to the representative Vernon soil, but the solum is less than 14 inches thick.

This complex is not suitable for cultivation. It supports only a limited amount of native vegetation and consequently is of little value for grazing. The moderately steep slopes and breaks areas restrict the movement of livestock. Good range management is needed to prevent further erosion. Capability unit VIIs-2 dryland; windbreak-postlot group 4; Badland in Eroded Red Clay range site and Vernon soils in Red Clay Prairie range site.

Clairemont Series

The Clairemont series consists of nearly level and very gently sloping soils on flood plains. These soils formed under a cover of hardwoods and an understory of mid and tall grasses in material weathered from loamy sediment.

In a representative profile the surface layer is 8 inches of reddish-brown silty clay loam. The underlying material, to a depth of 36 inches, is reddish-brown silty clay loam. Below this and extending to a depth of 50 inches is red silty clay loam.

Clairemont soils are well drained and have moderate permeability. Available water capacity is high.

Representative profile of a Clairemont soil, channeled, in a bermudagrass pasture 900 feet east and 250 feet south of the northwest corner of sec. 11, T. 2 S., R. 16 W.:

A1—0 to 8 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; slightly hard, firm; moderately alkaline, calcareous; clear, smooth boundary.

C1—8 to 22 niches, reddish-brown (5YR 5/4) silty clay loam, dark reddish brown (5YR 3/4) moist; structureless, but platy fragments are along bedding planes; hard, firm; moderately alkaline, calcareous; gradual, smooth boundary.

C2—22 to 36 inches, reddish-brown (2.5YR 5/5) silty clay loam, reddish brown (2.5YR 3/5) moist; structureless, but structurelike peds are along bedding planes; slightly hard, firm; porous; moderately alkaline, calcareous; gradual, smooth boundary.

C3—36 to 50 inches, red (2.5YR 5/6) silty clay loam, red (2.5YR 4/6) moist; stratifications of fine sandy loam to clay; structureless; hard, firm; moderately alkaline, calcareous.

The A horizon ranges from silt loam to silty clay loam. It is generally reddish brown but ranges to brown. The clay content at depths between 10 and 40 inches ranges from 18 to 35 percent. The C horizon is reddish-brown, red, or yellowish-red silt loam or silty clay loam.

Clairemont soils are associated with Asa, Cyril, Miller, and Port soils. They have a lighter colored surface layer than Asa and Port soils. They are less clayey than Miller soils, but are more clayey than Cyril soils.

Clairemont soils, channeled (Ca).—These soils are on flood plains that are flooded frequently. Slopes are 0 to 3 percent. Generally, the width of the flood plain is less than 600 feet. These soils have the profile described as representative for the series. The surface layer ranges from silty clay loam to silt loam. About 10 percent of the acreage mapped is a soil that is similar to this soil, but is grayer.

These Clairemont soils are used for range and pasture. Native pecan trees commonly grow on these soils, especially along larger creeks. The clearing of underbrush increases production in periods of adequate rainfall (fig. 2). Controlling insects is also beneficial. Reducing damage caused by overflow and revegetating silted or scoured areas after overflow are the main management concerns. Capability unit Vw-1 dryland; Loamy Bottomland range site; windbreak-postlot group 1.

Clairemont soils, saline (Ce).—These soils are on flood plains. They have a profile similar to the ones described as representative for the series, but they are saline and have clay at a depth of about 36 inches. Slopes are 0 to 3 percent.

About 15 percent of the acreage mapped is a nonsaline Clairemont soil, and 5 percent is Asa silt loam and Oscar silt loam.

These Clairemont soils are not suitable for cultivation. They generally support an excellent stand of native grasses that are tolerant of salt. They have a high content of harmful salts and excess water in the profile at some period in most years. Drainage ditches designed to allow free water to move out of the soil reduce salinity. Capability unit Vs-1 dryland; Alkali Bottomland range site; windbreak-postlot group 4.

Cyril Series, Mildly Alkaline Variant

This variant of the Cyril series consists of nearly level soils that are noncalcareous in the subsoil.

These soils are on flood plains. They formed under a cover of hardwood trees and an understory of tall grasses in material weathered from loamy sediment. The acreage is not large enough to warrant a new series.

In a representative profile the surface layer is brown fine sandy loam that extends to a depth of 15 inches. The subsoil is brown fine sandy loam and reaches to a depth of 32 inches. The underlying material is also brown fine sandy loam.

Cyril soils, mildly alkaline variant, are well drained. Permeability is moderate. Available water capacity is medium or high.

Representative profile of Cyril fine sandy loam, mildly alkaline variant, in a cultivated field 1,200 feet south and 200 feet west of the northeast corner of sec. 18, T. 1 N., R. 18 W.:

Ap—0 to 8 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 3/3) moist; weak, fine, granular structure; soft, very friable; mildly alkaline; plowed, smooth boundary.

A1—8 to 15 inches, brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) moist; moderate, medium, granular structure; soft, friable; mildly alkaline; clear, smooth boundary.

B—15 to 32 inches, brown (7.5YR 4/3) fine sandy loam, dark brown (7.5YR 3/3) moist; weak, coarse, prismatic structure; slightly hard, firm; mildly alkaline; gradual, smooth boundary.

C—32 to 66 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 4/3) moist; single grained; soft, very friable; mildly alkaline.

The A horizon ranges widely in color. It is brown, dark brown, dark grayish brown, grayish brown, or very dark grayish brown. Texture between depths of 10 and 40 inches is fine sandy loam, loam, or silt loam. The content of clay is

Figure 2.—**Native pecan trees and bermudagrass on Clairemont soils, channeled.**

less than 18 percent. The B horizon is brown, dark brown, dark grayish-brown, or very dark grayish-brown fine sandy loam, loam, or silt loam. It is mildly alkaline. The C horizon is fine sandy loam, loam, or clay loam. It is dark reddish gray, dark reddish brown, reddish brown, brown, or dark brown.

Cyril soils, mildly alkaline variant, are associated with Asa, Clairemont, Devol, Likes, and Port soils. They are more sandy than Asa, Clairemont, and Port soils. They are less sandy than Likes soils. They have darker colors than Devol soils.

Cyril fine sandy loam, mildly alkaline variant (Cy).—This nearly level soil is on flood plains that are flooded occasionally. It has the profile described as representative for the Cyril series, mildly alkaline variant. About 5 percent of the acreage mapped is Port soils.

This Cyril variant is used for cultivated crops. Such crops as cotton, alfalfa, small grain, and grain sorghum are suited. Hardwood forests line most stream channels.

The main management concerns are maintaining soil structure and protecting the soil against overflow. Soil blowing is only a minor concern. High-residue crops should be grown at least half the time, and crop residue should be utilized for soil improvement. Low-residue row crops should not be grown for more than 4 consecutive years in any rotation. A cover crop should be planted following a low-residue crop to protect the soil during windy periods. Capability unit IIw–2 dryland and IIw–1 irrigated; Loamy Bottomland range site; windbreak-postlot group 1.

Devol Series

The Devol series consists of nearly level to sloping soils on uplands. These soils formed under a cover of tall grasses and sagebrush in material weathered from sandy and loamy sediments.

In a representative profile the surface layer is 14 inches of light-brown loamy fine sand. The subsoil is a reddish-brown and yellowish-red fine sandy loam that extends to a depth of 40 inches. The underlying material is brown loamy fine sand.

Devol soils are well drained and have moderately rapid permeability. Available water capacity is medium or high.

Representative profile of Devol loamy fine sand, undulating, in a cultivated field 300 feet south and 150 feet east of the northwest corner of the NE¼ of sec. 20, T. 1 N., R. 18 W.:

A1—0 to 14 inches, light-brown (7.5YR 6/4) loamy fine sand, dark brown (7.5YR 4/4) moist; single grained; soft, very friable; neutral; gradual, smooth boundary.

B2t—14 to 27 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, medium, prismatic structure; slightly hard, very friable; clay bridges between sand grains; mildly alkaline; gradual, smooth boundary.

B3—27 to 40 inches, yellowish-red (5YR 5/5) fine sandy loam, yellowish red (5YR 4/5) moist; weak, coarse, prismatic structure; slightly hard, very friable; mildly alkaline; gradual, smooth boundary.

C—40 to 60 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; single grained; slightly hard, very friable; moderately alkaline.

The A horizon is light-brown and brown loamy fine sand or fine sandy loam. It is neutral or mildly alkaline. The B2t horizon is fine sandy loam that has a clay content ranging from 10 to 15 percent. It is reddish brown, yellowish red, and brown and neutral or mildly alkaline. The B3 horizon is about the same color as the B2t horizon. It is mildly alkaline or moderately alkaline. The C horizon is about the same color as the B2t horizon. It is loamy fine sand or fine sandy loam, mildly alkaline or moderately alkaline, and noncalcareous to a depth of more than 60 inches.

Mapping unit DfA is outside the defined range for the Devol series because it generally has soft powdery calcium carbonate within 35 inches of the surface. It is enough like the Devol soils in morphology, composition, and behavior, however, that a new series is not warranted.

Devol soils are associated with Cyril, mildly alkaline variant, and with Grandfield, Hardeman, and Likes soils. They are less clayey than Grandfield soils and more clayey than Likes soils. They have a lighter colored surface layer than Cyril soils. Their profile shows more distinct horizons than that of Hardeman soils.

Devol loamy fine sand, undulating (DeB).—This very gently sloping soil is on uplands where the relief is uneven and consists of low crests and valleys between the crests. It has the profile described as representative for the series.

About 5 percent of the acreage mapped is Grandfield loamy fine sand, and 4 to 7 percent is Hardeman fine sandy loam.

This Devol soil is used mostly for temporary summer pasture of sorghum crops for hay. Part of the acreage is in native range.

Controlling soil blowing and water erosion and maintaining fertility are the main concerns in management. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. If the residue is heavy, fertilizer should be applied to prevent a deficiency in plant nutrients while the residue is decomposing. Low-residue crops should not be grown more than 3 successive years. Capability unit IIIe-3 dryland and IIIe-2 irrigated; Deep Sand range site; windbreak-postlot group 2.

Devol loamy fine sand, hummocky (DeC).—This gently sloping to sloping soil is on uplands. The uneven relief consists of low dunes and narrow valleys between the dunes. This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner and the subsoil is yellower. About 10 percent of this mapping unit is Grandfield loamy fine sand.

This Devol soil is used mostly for temporary summer pasture of sorghum crops for hay. Part of the acreage is in native range.

Controlling soil blowing and maintaining fertility are the main concerns in management. High-residue crops should be grown each year, and the crop residue should be returned to the soil. If the residue is heavy, fertilizer should be applied to prevent a deficiency of plant nutrients while the residue is decomposing. Capability unit IVe-1 dryland and IVe-1 irrigated; Deep Sand range site; windbreak-postlot group 3.

Devol fine sandy loam, 0 to 1 percent slopes (DfA).—This soil is on uplands. It has a profile similar to the one described as representative for the series, but the surface layer is thicker and the subsoil is slightly more clayey. In addition, soft powdery calcium carbonate is generally within 35 inches of the surface.

About 10 to 15 percent of the mapped area is Devol loamy fine sands, and about 10 percent is Tipton fine sandy loam.

This Devol soil is used mostly for cultivated crops, chiefly cotton, alfalfa, and grain sorghum.

Soil blowing and water erosion are hazards. Maintaining soil structure and fertility is also a management concern. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. If the residue is heavy, fertilizer should be applied to prevent a deficiency in plant nutrients while the residue is decomposing. Low-residue row crops should not be grown for more than 3 consecutive years and should be followed by cover crops to protect the soil. Stubble mulching is essential. Capability unit IIe-2 dryland and IIe-2 irrigated; Sandy Prairie range site; windbreak-postlot group 2.

Foard Series

The Foard series consists of smooth, nearly level to very gently sloping soils on uplands. These soils formed under a cover of short grasses in material weathered from clayey and loamy sediment.

In a representative profile the surface layer is 7 inches of grayish-brown silt loam. The subsoil is brown and reddish-brown clay to a depth of 47 inches and reddish-yellow clay to a depth of 70 inches.

Foard soils are high in sodium and moderately well drained. Permeability is very slow. Available water capacity is high.

Representative profile of Foard silt loam, 0 to 1 percent slopes, in a cultivated field 650 feet south and 100 feet west of the northeast corner of sec. 28, T. 2 S., R. 14 W.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, firm; neutral; plowed, smooth boundary.

B21t—7 to 19 inches, brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; compound structure of weak, medium, prismatic and moderate, fine, blocky; very hard, very firm; clay films on ped surfaces; some, very dark brown, patchy films in upper part; moderately alkaline; gradual, smooth boundary.

B22t—19 to 34 inches, brown (7.5YR 5/3) clay, dark brown (7.5YR 4/3) moist; compound structure of weak, medium, prismatic and moderate, medium, blocky; very hard, very firm; clay films on ped surfaces; moderately alkaline, calcareous; gradual, smooth boundary.

B23t—34 to 47 inches, reddish-brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak, medium, blocky structure; very hard, very firm; clay films on ped surfaces; few, fine and medium, soft and hard calcium carbonate concretions; moderately alkaline, calcareous; gradual, smooth boundary.

B3—47 to 70 inches, reddish-yellow (5YR 6/6) clay, yellowish red (5YR 5/6) moist; weak, fine, blocky structure; very hard, very firm; few, fine and medium, soft calcium carbonate concretions; few fine and medium iron-manganese concretions; moderately alkaline, calcareous.

The A horizon is grayish-brown, dark grayish-brown, or brown silt loam or silty clay loam. It is neutral in reaction. The B2t horizon is dark-brown, brown, reddish-brown, dark reddish-brown, or dark grayish-brown clay or silty clay. Within the upper 16 inches, the content of exchangeable sodium is more than 15 percent. The B3 horizon generally is clay, but in places it is clay loam. It is reddish yellow, reddish brown, light reddish brown, light red, or yellowish red. The C horizon is compact clay or silty clay.

Foard soils are associated with Hinkle, Hollister, Tillman, Tillman moderately shallow variant, and Roscoe soils. They differ from Hollister, Tillman, Tillman moderately shallow variant, and Roscoe soils in having an exchangeable sodium content of more than 15 percent. They are darker colored in the surface layer and upper part of the subsoil than Hinkle soils.

Foard silt loam, 0 to 1 percent slopes (FdA).—This soil is on broad uplands. It has the profile described as representative for the series (fig. 3).

About 30 percent of the acreage mapped is a soil that is similar to this soil, but has a gradual boundary between the surface layer and the subsoil, and about 5 percent is Hollister silt loam and Tillman silt loam.

Except for the small part in native range, most of the acreage is cultivated. Small grain is the main crop, but the soil is also suited to grain sorghum and cotton.

Grazing or tilling when the soil is wet breaks down soil structure, creates a surface crust, decreases the rate of water intake, and makes the soil droughty. High-residue crops should be grown at least half the time. Crop residue should be returned to the soil for soil improvement. Low-residue crops should not be grown for more than 3 successive years. Shallow minimum tillage is desirable to avoid bringing clay to the surface and to prevent further breakdown of structure in the surface layer. Capability unit IIs–1 dryland and IIs–1 irrigated; Hardland range site; windbreak-postlot group 3.

Foard-Hinkle complex, 0 to 1 percent slopes (FhA).—These soils are on broad uplands. Foard soils make up about 75 percent of this complex, and Hinkle soils 17 percent. The two soils are so intermingled that it is not practical to map them separately. Foard soils have a profile similar to the one described as representative for the Foard series, but the surface layer is slightly thicker and in places is silty clay loam. Hinkle soils have a surface layer of silt or clay loam, but the profile is otherwise similar to the one described as representative for the Hinkle series.

About 5 percent of the acreage mapped is Hollister silt loam and 3 percent is Tillman silt loam.

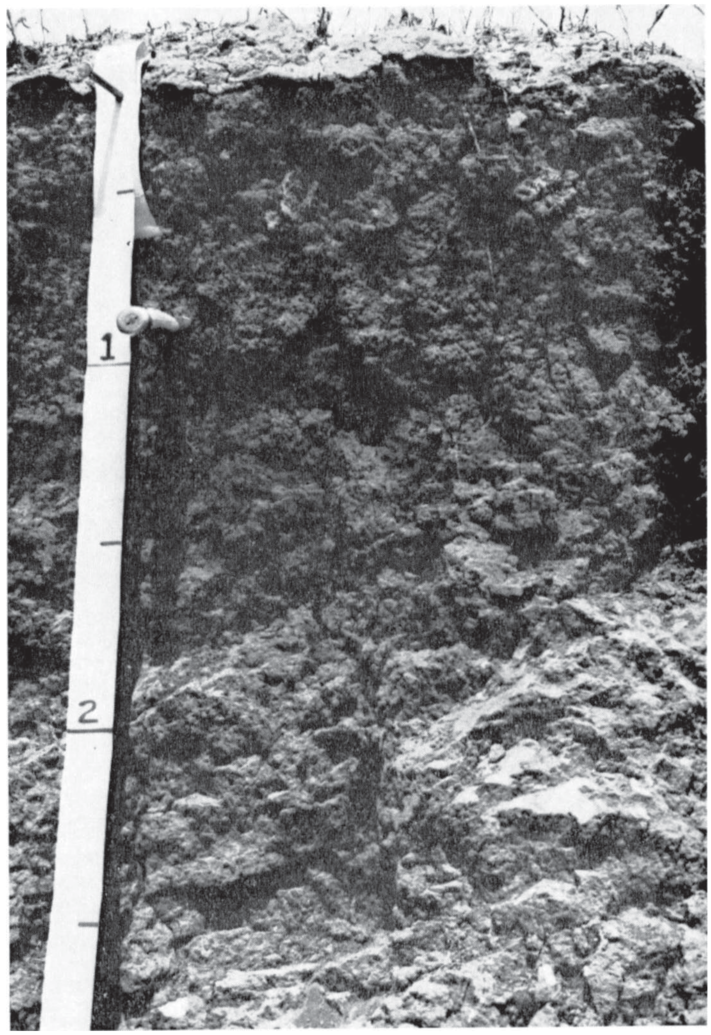

Figure 3.—Profile of Foard silt loam, 0 to 1 percent slopes.

These Foard and Hinkle soils are used mostly for cultivated crops. Small grain is the main crop, but the soils are also suited to grain sorghum and cotton. Minor areas are in tame pasture or native range. Most of the native range is overgrazed, and mesquite trees make up most of the ground cover.

These soils are saline. Tilling or grazing when they are wet causes the structure of surface layer to break down and a crust to form. It also decreases the rate of water intake and makes the soils more droughty.

High-residue crops should be grown not less than two-thirds of the time. The crop residue should be returned to the soil. Low-residue crops should not be grown more than 2 years in succession. Minimum tillage to a depth of 4 inches or less decreases the possibility of bringing clay and harmful salts to the surface layer. Adding gypsum and mulching the severely crusted areas improve the soil structure and decrease droughtiness. Capability unit IIIs–2 dryland and IIIs–2 irrigated; windbreak-postlot group 3; Foard soil in Hardland range site, Hinkle soil in Slickspot range site.

Grandfield Series

The Grandfield series consists of nearly level to gently sloping soils on uplands. These soils developed under a cover of mid and tall grasses in material weathered from loamy sediment.

In a representative profile the surface layer is reddish-brown fine sandy loam 10 inches thick. The upper part of the subsoil, to a depth of 18 inches, is reddish-brown fine sandy loam. The next layer extends to a depth of 28 inches and is yellowish-red fine sandy loam. Below this, and to a depth of 48 inches, is reddish-brown sandy clay loam. The lower part is yellowish-red fine sandy loam.

Grandfield soils are well drained and have moderate to moderately rapid permeability and medium or high available moisture capacity.

Representative profile of Grandfield fine sandy loam, 1 to 3 percent slopes, in a cultivated field 200 feet south and 400 feet east of the northwest corner of the NE¼ sec. 10, T. 2 S., R. 18 W.:

Ap—0 to 6 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, granular structure; slightly hard, friable; neutral; gradual, smooth boundary.

A1—6 to 10 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/4) moist; moderate, fine, granular structure; slightly hard, friable; neutral; gradual, smooth boundary.

B1—10 to 18 inches, reddish-brown (5YR 4/5) fine sandy loam, reddish brown (5YR 3/5) moist; weak, coarse, prismatic structure; hard, friable; few fine pores; neutral; gradual, smooth boundary.

B21t—18 to 28 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak, coarse, prismatic structure; hard, friable; thin patchy clay films on ped surfaces; mildly alkaline; gradual, smooth boundary.

B22t—28 to 48 inches, reddish-brown (2.5YR 5/5) sandy clay loam, reddish brown (2.5YR 4/5) moist; weak, medium, subangular blocky structure; hard, friable; few clay films on ped surfaces; mildly alkaline; gradual, smooth boundary.

B3—48 to 70 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak, coarse, prismatic structure; hard, friable; moderately alkaline.

The A horizon is reddish brown, dark reddish brown, dark reddish gray, dark brown, and brown fine sandy loam or loamy fine sand. It is slightly acid through mildly alkaline. The B1 and B2t horizons average about 20 percent clay in the upper 20 inches. They are reddish-brown, red, and yellowish-red fine sandy loam or sandy clay loam. The B3 and C horizons are yellowish-red and reddish-brown fine sandy loam. The depth to secondary carbonates is more than 48 inches.

Grandfield soils are associated with Devol, Hardeman, Minco, and Tipton soils, and Rock land. They are more clayey than Devol, Hardeman, and Minco soils. They are lighter colored in the surface layer than Tipton soils. They differ from Rock land in having a profile that shows distinct horizons.

Grandfield loamy fine sand, 0 to 1 percent slopes (GnA).—This nearly level, sandy soil is on uplands. It has a profile similar to the one described as representative for the series, but the surface layer is 10 to 16 inches of loamy fine sand. About 3 percent of the acreage mapped is Devol loamy fine sand.

This Grandfield soil is used for cultivated crops, chiefly grain sorghum, cotton, soybeans, and alfalfa. It is also suited to small grain.

Soil blowing and water erosion are hazards. Maintaining soil fertility is also a management concern. High-residue crops should be grown at least half the time. The crop residue should be returned to the soil, and fertilizer should be applied to prevent a deficiency in nutrients while the residue is decomposing. Low-residue crops should be planted in rotation with cover crops and should not be grown for more than 3 successive years. Capability unit IIIe-3 dryland and IIIe-2 irrigated; Deep Sand range site; windbreak-postlot group 2.

Grandfield loamy fine sand, undulating (GnB).—This sandy, very gently sloping and undulating soil is on uplands where there are very low dunes and valleys between the dunes. This soil has a profile similar to the one described as representative for the series, but the surface layer is loamy fine sand 9 to 15 inches thick.

About 5 percent of the acreage mapped is Devol loamy fine sand, and about 2 percent is Grandfield fine sandy loam.

This Grandfield soil is used mainly for cultivated crops. Small areas are sodded to bermudagrass for pasture. Grain sorghum, cotton, and soybeans are the main crops. The soil is also suited to small grain.

Soil blowing and water erosion are hazards. Maintaining soil fertility is also a management concern. High-residue crops should be grown at least half the time. The crop residue should be returned to the soil, and fertilizer should be applied to prevent a deficiency of soil nutrients while the residue is decomposing. Low-residue crops should be planted in rotation with cover crops, and should not be grown for more than 3 successive years. Capability unit IIIe-3 dryland and IIIe-2 irrigated; Deep Sand range site; windbreak-postlot group 2.

Grandfield fine sandy loam, 0 to 1 percent slopes (GrA).—This nearly level soil is on smooth uplands. It has a profile similar to the one described as representative for the series, but the combined thickness of the surface layer and upper part of the subsoil is greater, the surface layer is less red, and the subsoil is more clayey. About 10 percent of the acreage mapped is Tipton fine sandy loam.

This Grandfield soil is used for cotton, grain sorghum, small grain, and alfalfa.

Soil blowing and water erosion are hazards. Maintaining soil structure and fertility is also a management concern. High-residue crops should be grown half the time. The crop residue should be returned to the soil, and fertilizer should be applied to prevent a deficiency of soil nutrients while the residue decomposes. Low-residue crops should be planted in rotation with cover crops, and should not be grown for more than 3 successive years. Capability unit IIe-2 dryland and IIe-2 irrigated; Sandy Prairie range site; windbreak-postlot group 1.

Grandfield fine sandy loam, 1 to 3 percent slopes (GrB).—This very gently sloping soil is on smooth, low rounded knolls on uplands. It has the profile described as representative for the series (fig. 4).

About 15 percent of the acreage mapped is a soil similar to this soil, but is less clayey in the subsoil, and 3 to 5 percent is Grandfield loamy fine sand.

This Grandfield soil is used for cotton, grain sorghum, small grain, and alfalfa.

Controlling soil blowing and water erosion and maintaining soil fertility are management concerns. High-residue crops should be grown at least half the time, and the crop residue should be returned to the soil. To

Figure 4.—**Profile of Grandfield fine sandy loam, 1 to 3 percent slopes.**

prevent a deficiency in soil nutrients while the residue is decomposing, fertilizer should be applied. Low-residue crops should be grown in rotation with cover crops, and should not be grown for more than 3 successive years. Terracing and contour tillage help prevent excessive runoff. Minimum tillage at variable depths prevents formation of a plowpan and breakdown of the soil structure. Capability unit IIIe–2 dryland and IIe–1 irrigated; Sandy Prairie range site; windbreak-postlot group 1.

Grandfield fine sandy loam, 3 to 5 percent slopes (GrC).—This gently sloping soil is on uplands. It has a profile similar to the one described as representative for the series, but the surface layer is thinner.

About 15 percent of the acreage mapped is a soil that has carbonates within a depth of 35 inches but is otherwise similar to the Grandfield soil; about 5 percent is a soil that is also similar to Grandfield soil, but has lost most of its surface layer; and about 10 percent is Tipton fine sandy loam.

This Grandfield soil is used for cultivated crops and pasture.

Controlling soil blowing and water erosion and maintaining soil fertility are concerns in management. High-residue crops should be grown at least half the time. Crop residue should be returned to the soil, and fertilizer should be added to prevent a deficiency of soil nutrients during decomposition of the residue. Low-residue crops should be grown in rotation with cover crops and should not be grown for more than 3 successive years. Terracing and contour tillage help prevent excessive runoff. Keeping tillage to a minimum and varying its depth help prevent the formation of a plowpan and the breakdown of soil structure. Capability unit IIIe–2 dryland and IIIe–1 irrigated; Sandy Prairie range site; windbreak postlot group 1.

Hardeman Series

The Hardeman series consists of nearly level to moderately steep soils on uplands. These soils formed under a cover of tall and mid grasses in material weathered from loamy sediment.

In a representative profile the surface layer is 16 inches of light-brown and brown fine sandy loam. The subsoil is reddish-brown fine sandy loam to a depth of 60 inches. Below this is light-brown fine sandy loam.

Hardeman soils are well drained and have moderately rapid permeability. Available water capacity is medium or high.

Representative profile of Hardeman fine sandy loam, 0 to 1 percent slopes, in a cultivated field 200 feet south and 550 feet east of the northwest corner of sec. 35, T. 3 S., R. 19 W.:

Ap—0 to 10 inches, light-brown (7.5YR 6/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak, fine, granular structure; slightly hard, very friable; mildly alkaline; plowed, smooth boundary.

A1—10 to 16 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; moderate, medium, granular structure; slightly hard, very friable; mildly alkaline; gradual, smooth boundary.

B21—16 to 34 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; moderate, medium, prismatic structure; slightly hard, friable; soft powdery calcium carbonate; moderately alkaline, calcareous; gradual, smooth boundary.

B22—34 to 60 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; moderate, medium, prismatic structure; slightly hard, friable; few films of calcium carbonate; moderately alkaline, calcareous; gradual, smooth boundary.

B3—60 to 80 inches, light-brown (7.5YR 6/5) fine sandy loam, brown (7.5YR 4/4) moist; weak, coarse, prismatic structure; slightly hard, friable; few threads of segregated calcium carbonate between peds; moderately alkaline, calcareous.

The A horizon is dark brown, light brown, brown, or reddish brown. It is mildly alkaline or moderately alkaline. The B horizon is mostly fine sandy loam, but ranges to very fine sandy loam. It is yellowish red, reddish brown, and reddish yellow. The upper 20 inches of this horizon is mildly alkaline or moderately alkaline. Depth to calcareous material ranges from 10 to 34 inches.

Hardeman soils are associated with Devol, Grandfield, Likes, Tipton, and Yahola soils, and Rock land. They are less clayey than Grandfield and Tipton soils and more clayey than Likes soils. They have a fairly uniform texture throughout the solum, in contrast with Yahola soils, which have a stratified, variable texture. They differ from Rock land in having a profile that shows distinct horizons, but the horizons are not so distinct as those of Devol soils.

Hardeman fine sandy loam, 0 to 1 percent slopes (HaA).—This soil is on smooth uplands. It has the profile described as representative for the series.

About 3 percent of the acreage mapped is a soil that is similar to this soil, but has a surface layer of winnowed loamy fine sand, and about 5 percent is Minco very fine sandy loam.

This Hardeman soil is used mostly for growing cotton, grain sorghum, small grain, and alfalfa crops.

Soil blowing is a hazard. Maintaining soil fertility and structure is also a management concern. High-residue crops should be grown at least half the time. The crop residue should be returned to the soil, and fertilizer should be applied to prevent deficiency in plant nutrients while the residue decomposes. Low-residue crops should be planted in rotation with cover crops, and should not be grown for more than 4 successive years. Capability unit IIe–1 dryland and IIe–2 irrigated; Sandy Prairie range site; windbreak-postlot group 1.

Hardeman fine sandy loam, undulating (HaB).—This very gently sloping soil is on uplands. The uneven relief consists of low crests and narrow valleys between the crests (fig. 5). The profile of this soil is similar to the one described as representative for the series, but the surface layer is redder and thinner.

About 5 percent of the acreage mapped is an included soil that is similar to this soil, but has a surface layer of winnowed loamy fine sand, and 5 percent is Minco very fine sandy loam.

This Hardeman soil is used for growing cotton, grain sorghum, small grain, and alfalfa.

Soil blowing is a hazard. Maintaining soil fertility and soil structure are also concerns in management. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue crops should be planted in rotation with cover crops and should not be grown for more than 3 successive years. Cover crops should be grown during periods in which high winds are expected. Row crops should be planted so that the rows are perpendicular to the direction of the prevailing wind. Capability unit IIIe–1 dryland and IIe–1 irrigated; Sandy Prairie range site; windbreak-postlot group 1.

Hardeman fine sandy loam, 3 to 5 percent slopes (HaC).—This gently sloping soil is on smooth uplands. Its profile differs from the one described as representative for the series because the surface layer is redder and thinner. About 2 percent of the acreage mapped is Minco very fine sandy loam.

This Hardeman soil is used for tame pasture, cultivated crops, and range. Bermudagrass is the main pasture plant. Cotton and small grain are the main cultivated crops. The soil is also suited to grain sorghum.

Soil blowing and water erosion are hazards. Maintaining soil fertility and soil structure are also concerns in management. High-residue crops should be grown at least half the time and the crop residue returned to the soil. Low-residue crops should not be grown for more than 3 years in succession. Cover crops should be grown during periods in which high winds are expected. Row crops should be planted so that the direction of rows is perpendicular to the direction of prevailing winds. Capability unit IIIe–1 dryland and IIIe–1 irrigated; Sandy Prairie range site; windbreak-postlot group 1.

Hardeman fine sandy loam, 8 to 20 percent slopes (HaE).—This strongly sloping to moderately steep soil is on

Figure 5.—Landscape of Hardeman fine sandy loam, undulating, in foreground, and Likes loamy fine sand, hummocky, in background.

uplands. Its profile is similar to the one described as representative for the series, but the surface layer is thinner.

About 10 percent of the acreage mapped is Minco very fine sandy loam; about 5 percent is red clay that outcrops along steep slopes; about 20 percent is a soil similar to the representative Hardeman soil, except that the content of carbonate concretions is higher; and about 5 percent is a soil that is also similar to the representative Hardeman soil, but is severely eroded.

This soil is not suited to cultivated crops. It is used mostly as native range.

Controlling water erosion, establishing vegetation, and controlling the formation of gullies are management concerns. Diverting water from upslope to prevent gully formation, shaping and seeding gullies to grass, and limiting the periods of grazing are effective conservation practices. Capability unit VIe–1 dryland; Sandy Prairie range site; windbreak-postlot group 3.

Hilgrave Series, Calcareous Variant

The Hilgrave series, calcareous variant, consists of sloping to moderately steep, gravelly soils that are calcareous in the surface layer. These soils are on uplands. They formed under a cover of mid grasses and sand sagebrush in material weathered from gravelly, loamy, and sandy sediment. The acreage is not of sufficient size to warrant establishing a new series.

In a representative profile the surface layer is reddish-brown gravelly loam 8 inches thick. The upper part of the subsoil, to a depth of 24 inches, is also reddish-brown gravelly loam. The lower part, which reaches to a depth of 38 inches, is red gravelly sandy loam. The subsoil is underlain by red gravelly loamy sand. The bedrock below this layer is red, weakly cemented, gravelly conglomerate.

Hilgrave soils, calcareous variant, are well drained and have moderately rapid permeability. Available water capacity is medium.

Representative profile of Hilgrave gravelly loam, calcareous variant, 5 to 15 percent slopes, on the edge of a gravel pit, 1,300 feet west and 100 feet south of the northeast corner of sec. 11, T. 2 S., R. 16 W.:

A1—0 to 8 inches, reddish-brown (5YR 4/4) gravelly loam, dark reddish brown (5YR 3/4) moist; moderate, fine, granular structure; slightly hard, friable; about 25 percent, by volume, is waterworn gravel; moderately alkaline, calcareous; gradual, smooth boundary.

B2—8 to 24 inches, reddish-brown (2.5YR 4/4) gravelly loam, dark reddish brown (2.5YR 3/4) moist; weak, medium, granular structure; slightly hard, friable; about 40 percent, by volume, is waterworn gravel; moderately alkaline, calcareous; gradual, wavy boundary.

B3—24 to 38 inches, red (2.5YR 4/6) gravelly sandy loam, dark red (2.5YR 3/6) moist; weak, fine, granular structure; slightly hard, friable; about 40 percent, by volume, is waterworn gravel; soft powdery calcium carbonate; moderately alkaline, calcareous; gradual, wavy boundary.

C—38 to 52 inches, red (2.5YR 5/6) gravelly loamy sand, red (2.5YR 4/6) moist; single grained; slightly hard, friable; about 40 percent, by volume, is waterworn gravel; moderately alkaline, calcareous; few films of calcium carbonate; abrupt, wavy boundary.

R—52 inches, red, weakly cemented, gravelly conglomerate.

The solum ranges from 30 to 50 inches in thickness. The A horizon color is reddish brown or dark reddish brown and is about 25 percent gravel. The B horizon is reddish-brown, red, yellowish-red, light reddish-brown, or reddish-yellow gravelly loam, gravelly sandy loam, gravelly clay loam, or gravelly sandy clay loam. The C horizon is red or yellowish-red gravelly sandy loam or gravelly loamy sand. The R horizon contains weakly cemented gravel in places.

The Hilgrave calcareous variant is associated with Stamford, Vernon, and Weymouth soils. It is less clayey than Vernon and Stamford soils. It is more gravelly than Weymouth soils.

Hilgrave gravelly loam, calcareous variant, 5 to 15 percent slopes (HgE).—This is a sloping to moderately steep soil on uplands. It has the profile described as representative for the Hilgrave calcareous variant.

About 2 percent of the acreage mapped is a soil that is similar to this soil, but is less gravelly, and about 5 percent is Vernon soils.

This soil is used for range and as a source of gravel for roads. Capability unit VIe–1 dryland; Sandy Prairie range site; windbreak-postlot group 4.

Hinkle Series

The Hinkle series consists of nearly level and very gently sloping soils on uplands. These soils formed under a cover of short grasses in material weathered from loamy and clayey red beds. They are in circular areas that are 20 to 300 feet in diameter.

In a representative profile the surface layer is brown silt loam and is 6 inches thick. The upper part of the subsoil, which extends to a depth of 33 inches, is dark-brown clay. The lower part reaches to a depth of 60 inches and is reddish-brown and red clay. The underlying material is red clay.

Hinkle soils are moderately well drained and have very slow permeability. Available water capacity is high.

The Hinkle soils in Tillman County are mapped only with Foard, St. Paul, and Tillman soils.

Representative profile of Hinkle silt loam from an area of Foard-Hinkle complex, 0 to 1 percent slopes, in a cultivated field 600 feet west and 250 feet north of the southeast corner of the SW¼ of sec. 9, T. 2 S., R. 16 W.:

Ap—0 to 6 inches, brown (7.5YR 5/4) silt loam, dark brown (7.5YR 3/4) moist; weak, fine, granular structure; hard, friable; the upper ¼ inch is a light brown (7.5YR 6/4) vesicular crust; neutral; abrupt, smooth boundary.

B21t—6 to 16 inches, dark-brown (7.5YR 4/3) clay, dark brown (7.5YR 3/3) moist; weak, coarse, prismatic structure and moderate, medium, blocky structure; very hard, very firm; silt coating on the faces of prisms; continuous clay films on ped surfaces; mildly alkaline; clear, smooth boundary.

B22t—16 to 33 inches, dark brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; moderate, medium, blocky structure; very hard, very firm; continuous dark-brown (7.5YR 4/3) clay films; few soft calcium carbonate spots; numerous films and spots of salt; moderately alkaline, calcareous; gradual, smooth boundary.

B31—33 to 45 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/5) moist; weak, medium, blocky structure; very hard, very firm; patchy clay films; common, fine, hard and soft calcium carbonate concretions; moderately alkaline, calcareous; gradual, smooth boundary.

B32—45 to 60 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; weak, fine, blocky structure; very hard, very firm; common soft and hard calcium carbonate concretions; moderately alkaline, calcareous; gradual, smooth boundary.

C—60 to 72 inches, red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; massive; very hard, very firm; moderately alkaline, calcareous.

The A horizon is silt loam or clay loam and ranges widely in color. It is brown, pinkish gray, light brown, light brownish gray, grayish brown, dark grayish brown, pale brown, light yellowish brown, yellowish brown, and dark yellowish brown. It is neutral, mildly alkaline, or moderately alkaline. A surface crust, as much as a half inch thick, forms in plowed fields after rains, and the color value ranges from 1 to 2 units higher than that in the Ap horizon. The B2t horizon is clay loam or clay that is 35 to 50 percent clay. It is reddish brown, dark reddish gray, dark brown, or brown, is mildly alkaline or moderately alkaline, and has prismatic or blocky structure. In the upper 16 inches of this horizon, the content of exchangeable sodium is 15 to about 25 percent. The B3 horizon is reddish brown, red, and yellowish red and the texture is similar to that of the B2t horizon. The C horizon is red or yellowish-red clay loam or clay.

Hinkle soils are associated with Foard, Oscar, St. Paul, Tillman, and Tillman soils, moderately shallow variant. They have a lighter colored surface layer than Foard soils. They are more clayey than the similar Oscar soils. They contain more sodium than the St. Paul, the Tillman moderately shallow variant, and the Tillman soils.

Hollister Series

The Hollister series consists of nearly level soils on broad, smooth uplands. These soils formed under a cover of short grasses in loamy and clayey material.

In a representative profile the surface layer is 11 inches of dark-brown silt loam. The upper 27 inches of the subsoil is dark-brown silty clay loam and clay. The lower part is reddish-brown and red clay that extends to a depth of 72 inches.

Hollister soils are well drained and have slow permeability. Available water capacity is high.

Representative profile of Hollister silt loam, 0 to 1 percent slopes, in a cultivated field 1,000 feet east and 200 feet north of the southwest corner of sec. 19, T. 2 S., R. 17 W.:

Ap—0 to 7 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable; mildly alkaline; plowed, smooth boundary.

A1—7 to 11 inches, dark-brown (7.5YR 4/2) silt loam, very dark brown (7.5YR 2/2) moist; moderate, fine, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B1—11 to 13 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B21t—13 to 26 inches, dark-brown (7.5YR 3/2) silty clay loam, very dark brown (7.5YR 2/2) moist; moderate, medium, subangular blocky structure; hard, firm; clay films on ped surfaces; few hard calcium carbonate concretions; moderately alkaline; gradual, wavy boundary.

B22t—26 to 38 inches, dark-brown (7.5YR 4/3) clay, dark brown (7.5YR 3/3) moist; moderate, medium, blocky structure; very hard, very firm; clay films are prominent on ped surfaces; slickensides are evident and cracks filled with dark material extend into this horizon; moderately alkaline, calcareous; gradual, wavy boundary.

B23t—38 to 50 inches, reddish-brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak, medium, blocky structure; very hard, very firm; clay films on ped surfaces; moderately alkaline, calcareous; gradual, smooth boundary.

B3—50 to 72 inches, red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; weak, medium, blocky structure; extremely hard, extremely firm; few, soft and hard calcium carbonate concretions; moderately alkaline; calcareous.

The A horizon is dark brown, dark grayish brown, or very dark brown. The B1 horizon generally is silty clay loam, but in some profiles it is silt loam. It is the same color as the A horizon. The A and B1 horizons combined range from 11 to 18 inches in thickness. The B2t horizon is silty clay loam or clay and is 35 to 45 percent clay. It is dark reddish brown, brown, or dark brown. It is moderately alkaline in the upper part and calcareous in the lower part. A Bca or weak Cca horizon occurs in some profiles, but neither is continuous enough to be described as representative. The B3 horizon is clay loam or clay, but generally is clay. It is red, dark red, or yellowish red.

Hollister soils are associated with Abilene, Foard, Quanah, Tillman, and Tillman moderately shallow variant soils. They have a thicker A horizon than Foard soils. Their profile shows distinct horizons to a greater depth than those of Tillman and Tillman moderately shallow variant soils. They have a thicker solum than Abilene soils. They are more clayey than Quanah soils.

Hollister silt loam, 0 to 1 percent slopes (HoA).—This soil is on smooth uplands. It has the profile described as representative for the series (fig. 6). About 5 percent of the acreage mapped is Tillman silt loam and Foard silt loam.

This soil is used mostly for growing wheat. It is also suited to cotton and grain sorghum.

Grazing or plowing this soil when it is wet breaks down the soil structure and reduces the rate of water

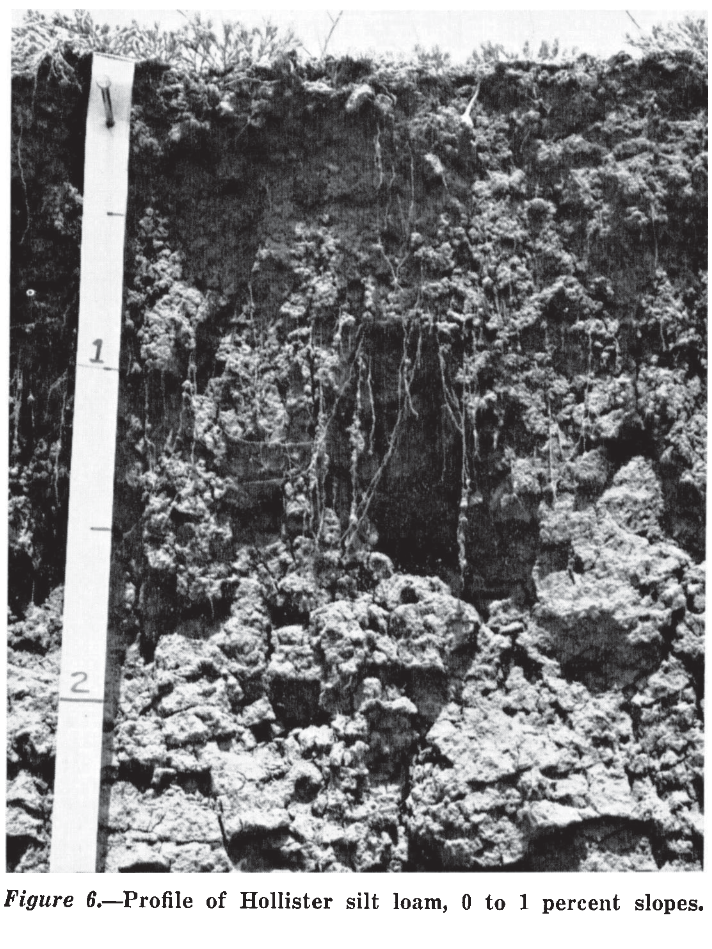

Figure 6.—Profile of Hollister silt loam, 0 to 1 percent slopes.

intake. Excessive tillage pulverizes the surface layer and makes it susceptible to soil blowing. High-residue crops should be grown at least half the time and the crop residue returned to the soil. Low-residue crops should not be grown for more than 4 successive years. Water erosion is not a hazard, but contour tillage or rows perpendicular to the slope gradient reduce runoff. Capability unit IIc–1 dryland and I–2 irrigated; Hardland range site; windbreak-postlot group 3.

Indiahoma Series

The Indiahoma series consists of very gently sloping and gently sloping soils on uplands. In areas of native range the surface has a ridge-swale microrelief known as gilgai. This gilgai relief is parallel to the slope, and its cycle is repeated at 15 to 25 foot intervals. These soils formed under a cover of short grasses in material weathered from shale and clay.

In a representative profile the surface layer is dark-brown and reddish-brown silty clay loam and is 10 inches thick. The subsoil is reddish-brown clay to a depth of 47 inches and red, hard clay below that depth.

Indiahoma soils are well drained and have very slow permeability. Available water capacity is high. When these soils are dry, cracks form to a depth of 20 inches or more.

Representative profile of Indiahoma silty clay loam, 1 to 3 percent slopes, in a native grass pasture 300 feet east and 150 feet south of the northwest corner of the NE¼ of sec. 13, T. 1 N., R. 16 W.:

A11—0 to 5 inches, dark-brown (7.5YR 4/2) silty clay loam, very dark brown (7.5YR 2/2) moist; strong, fine, granular structure; slightly hard, friable; moderately alkaline, calcareous; clear, smooth boundary.

A12—5 to 10 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; strong, medium, granular structure; slightly hard, friable; moderately alkaline, calcareous; gradual, smooth boundary.

B21—10 to 25 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; weak, fine and medium, blocky structure; extremely hard, very firm; shiny ped surfaces; a few slickensides that intersect; numerous calcium carbonate spots and hard calcium carbonate concretions; moderately alkaline, calcareous; gradual, wavy boundary.

B22—25 to 47 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; many intersecting slickensides and common parallelepiped-shaped peds; extremely hard, very firm; numerous calcium carbonate soft spots and hard concretions; moderately alkaline, calcareous; gradual, wavy boundary.

BC—47 to 60 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; massive; extremely hard, very firm; a few slickensides; a few soft calcium carbonate spots, many hard calcium carbonate concretions; moderately alkaline, calcareous.

The solum ranges from 40 to 50 inches in thickness. The A horizon is dark brown, brown, reddish brown, dark reddish gray, or reddish gray. It has weak to strong granular structure, and is moderately alkaline. The B horizon is yellowish red, reddish brown, or red. Between depths of 10 and 40 inches, it is 40 to 60 percent clay, dominantly a high shrink-swell montmorillonite clay. In the B21 horizon, between depths of 10 and 25 inches, the clay commonly has many shiny, intersecting, grooved, slickensides. When soil moisture is near field capacity, these slickensides are prominent, but their natural wedge-shaped structure is difficult to identify because the soil breaks readily into fine blocks. As the moisture content decreases, the natural structural aggregates are more stable, and small parallelepipeds can be identified. In the B22 horizon, between depths of 25 and 40 inches, the slickenside surfaces are more grooved but commonly less shiny, and they are larger than those in the B21 horizon. Also, natural parallelepipeds are common and can be identified at most soil moisture conditions.

The Indiahoma soils are associated with Stamford, Tillman, and Vernon soils. They differ from Stamford soils in having gilgai relief. They differ from Tillman and Vernon soils in having gilgai relief and slickensides close enough to intersect.

Indiahoma silty clay loam, 1 to 3 percent slopes (InB).—This soil is on uplands. It has the profile described as representative for the series. About 40 to 45 percent of the acreage mapped is a soil that is similar to this soil, but has secondary carbonates below a depth of 30 inches. When plowed, this soil has streaks of red and brown in a candy-stripe pattern.

This Indiahoma soil is used for range and cultivated crops, but is mostly under cultivation. Small grain is the main crop, but cotton and grain sorghum are also suited. Part of the acreage is bermudagrass pasture.

Runoff is a management concern because it increases the hazard of water erosion. This soil is very sticky when wet, and tilling or grazing it while wet severely damages the soil structure. Cracks form when the soil is dry, allowing rainwater to enter more rapidly, and then close as the soil becomes wet.

High-residue crops should be grown not less than two-thirds of the time, and the residue should be returned to the soil. Low-residue crops should not be grown for more than 2 years in succession. Terraces reduce runoff and decrease the hazard of erosion. Capability unit IIIe–4 dryland and IIIe–3 irrigated; Hardland range site; windbreak-postlot group 3.

Indiahoma silty clay loam, 3 to 5 percent slopes (InC).—This soil is on uplands. In areas of native range, a ridge-swale microrelief runs parallel to the slope gradient. When plowed, the surface has streaks of red and brown in a candy-stripe pattern. This soil has a profile similar to the one described as representative for the series, but the surface layer and solum are thinner. About 40 to 45 percent of the acreage mapped is a soil that is similar to this soil, but has secondary carbonates below a depth of 20 inches.

This soil is used for range and cultivated crops. Small grain is the main crop, but cotton and grain sorghum are also suited.

Runoff is a management concern because it increases hazard of water erosion. This soil is very sticky when wet, and tilling or grazing it while wet severely damages the soil structure. Cracks open when the soil is dry, allowing rainwater to enter more rapidly, and then close as the soil becomes wet.

High-residue crops should be grown 3 years out of 4, and the crop residue should be returned to the soil. Low-residue crops should not be grown for more than 1 year out of 4. Terraces and contour tillage decrease runoff and the amount of damage from water erosion. Capability unit IVe–2 dryland; Hardland range site; windbreak-postlot group 3.

Likes Series

The Likes series consists of sloping to steep soils on uplands. These soils are in hummocky areas or on hilly, uneven sand dunes and in narrow areas between the dunes.

They formed under a cover of tall grasses in material weathered from sandy sediment.

In a representative profile the surface layer is a brown loamy fine sand 6 inches thick. The next layer is strong-brown loamy fine sand that extends to a depth of 15 inches. The underlying material is reddish-yellow fine sand.

Likes soils are excessively drained and have moderately rapid permeability. Available water capacity is low or medium.

Representative profile of Likes loamy fine sand, hummocky, in an area of native range 1,400 feet south and 200 feet east of the northwest corner of sec. 10, T. 4 S., R. 18 W.:

A1—0 to 6 inches, brown (7.5YR 5/3) loamy fine sand, dark brown (7.5YR 3/3) moist; weak, fine, granular structure; soft, very friable; mildly alkaline; gradual, smooth boundary.

AC—6 to 15 inches, strong-brown (7.5YR 5/5) loamy fine sand; single grained; soft, very friable; mildly alkaline; gradual, smooth boundary.

C1—15 to 36 inches, reddish-yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 4/6) moist; single grained; loose; moderately alkaline; clear, smooth boundary.

C2—36 to 68 inches, reddish-yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 4/6) moist; single grained; loose; moderately alkaline, calcareous and weakly effervescent.

The A horizon is brown or yellowish-brown loamy fine sand or fine sand. It is neutral or mildly alkaline, and the organic-matter content is less than 1 percent. The AC horizon is brown or strong-brown loamy fine sand or fine sand. Texture between depths of 10 and 40 inches is also loamy fine sand or fine sand. The C horizon is reddish yellow, light brown, or strong brown and is mildly alkaline or moderately alkaline. Generally the soil is calcareous within 40 inches of the surface.

Likes soils are associated with Cyril, Devol, Hardeman, Lincoln, and Yahola soils. They are more sandy than Cyril, Devol, Hardeman, and Yahola soils. They differ from Lincoln soils in having loamy fine sand or coarser sand in all parts of the profile between depths of 10 and 40 inches.

Likes loamy fine sand, hummocky (LdC).—This sloping to moderately steep soil is on uplands that have an uneven relief of dunes and narrow valleys between the dunes. This soil has the profile described as representative for the series.

About 5 percent of the acreage mapped is a soil that is similar to this soil but has a surface layer of fine sand, and about 5 to 8 percent is Devol loamy fine sand.

This Likes soil is not suited to cultivated crops, but in valleys between the dunes, it is suited to bermudagrass. Nearly all of the acreage is in native grasses and is used for grazing. Controlling or deferring grazing and seeding overgrazed areas to suitable grasses reduce the hazard of erosion and increase the yield of forage. Capability unit VIe–2 dryland; Deep Sand range site; windbreak-postlot group 3.

Likes fine sand, hilly (LkE).—This strongly sloping to steep soil is on uplands that have an uneven relief of dunes and narrow valleys between the dunes. This soil has a profile similar to the one described as representative for the series, but the surface layer is fine sand.

About 14 percent of the acreage mapped is a soil similar to Likes loamy fine sand, hummocky, and small blowouts of severely eroded similar soils.

This Likes soil is too sandy and the dunes are too steep for cultivated crops. Most of the acreage is used as range. This soil is subject to severe blowing. Careful management of the native vegetation is needed to protect the soil against erosion. Capability unit VIIe–1 dryland; Dune range site; windbreak-postlot group 3.

Lincoln Series

The Lincoln series consists of nearly level and very gently sloping soils on flood plains. These soils formed under a cover of tall grasses and scattered trees in material weathered from sandy sediment.

In a representative profile the surface layer is brown loamy fine sand, 11 inches thick. The underlying material is pink fine sand.

Lincoln soils are somewhat excessively drained and have rapid permeability. Available water capacity is low or medium.

Representative profile of Lincoln soils, frequently flooded, in an area of native range 200 feet north and 2,300 feet west of the southeast corner of sec. 28, T. 1 N., R. 19 W.:

A1—0 to 11 inches, brown (7.5YR 5/3) loamy fine sand, dark brown (7.5YR 4/2) moist; weak, fine, granular structure; soft, very friable; weak bedding planes are evident in the upper part of horizon; moderately alkaline, calcareous; clear, smooth boundary.

C—11 to 60 inches, pink (7.5YR 7/4) fine sand, light brown (7.5YR 6/4) moist; single grained; pockets and thin strata of dark-colored fine sandy loam to clay are common; moderately alkaline, calcareous.

The A horizon is loamy fine sand, fine sandy loam, or clay loam. It is brown, reddish brown, yellowish brown, pinkish gray, or light brown. The C horizon is fine sand or loamy fine sand and has thin strata of loamy very fine sand or finer. It is pink, light reddish brown, yellowish red, reddish yellow, light brown, strong brown, pale brown, very pale brown, or light yellowish brown. Depth to the water table ranges from 36 to about 60 inches.

Lincoln soils are associated with Devol, Likes, and Yahola soils. They are more sandy than Devol and Yahola soils. They differ from Likes soils in having thin strata of loamy very fine sand or finer textured material between depths of 10 and 40 inches.

Lincoln soils, frequently flooded (Ln).—These soils are on flood plains that are flooded frequently. They have the profile described as representative for the series. The surface layer is loamy fine sand, fine sandy loam, or clay loam. Slopes are 0 to 3 percent.

About 5 percent of the mapped acreage is a soil similar to these soils, but flooded only occasionally, and 5 percent is Yahola soils.

These Lincoln soils are not suited to cultivation. They are suited to native range and pasture grasses and are used mostly for grazing. Capability unit Vw–3 dryland; Sandy Bottomland range site; windbreak-postlot group 2.

Lincoln soils, occasionally flooded (Lo).—These soils are on flood plains that are occasionally flooded. They have a profile similar to the one described as representative for the series, but the surface layer is redder and thicker and is loamy fine sand, fine sandy loam, or clay loam. Slopes are 0 to 3 percent. About 5 percent of the acreage mapped is Yahola soils.

These Lincoln soils are suited to grain sorghum, small grain, alfalfa, and pasture plants, and to range. They are used mostly for temporary or perennial type pasture, chiefly of bermudagrass. Some areas are seeded to grasses for temporary summer pasture or for hay.

Soil blowing is a hazard. Maintaining soil structure is also a concern in management. High-residue crops should be grown three-fourths of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 successive years. During periods in which severe soil blowing is expected, cover crops should be planted with the low-residue row crops. Seedbed preparation should be timed to avoid the critical soil-blowing period. Capability unit IVs–2 dryland and IVs–1 irrigated; Sandy Bottomland range site; windbreak-postlot group 1.

Miller Series

The Miller series consists of nearly level soils on flood plains. These soils formed under a cover of hardwood trees and an understory of grasses in material weathered from clayey sediment.

In a representative profile the surface layer is reddish-brown clay 12 inches thick. The subsoil is reddish-brown and red clay that reaches to a depth of 58 inches.

Miller soils are well drained to moderately well drained and have very slow permeability. Available water capacity is high.

Representative profile of Miller clay in a cultivated field 250 feet north and 100 feet east of the southwest corner of sec. 34, T. 2 S., R. 15 W.:

Ap—0 to 6 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate, medium, granular structure; hard, firm; moderately alkaline; plowed, smooth boundary.

A1—6 to 12 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; weak, fine, subangular blocky structure; very hard, very firm; moderately alkaline, calcareous; gradual, smooth boundary.

B21—12 to 30 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate, medium, blocky structure; extremely hard, very firm; few, fine, hard calcium carbonate concretions; many slickensides; moderately alkaline, calcareous; gradual, wavy boundary.

B22—30 to 58 inches, red (2.5YR 4/5) clay, dark red (2.5YR 3/6) moist; moderate, medium, blocky structure; extremely hard, very firm; common, fine and medium, soft and hard calcium carbonate concretions; few slickensides; moderately alkaline, calcareous.

The solum ranges from 36 to 70 inches in thickness. The A horizon is dark reddish brown or reddish brown. The B horizon is red, reddish-brown, or yellowish-red clay loam or clay. The soil between depths of 10 to 40 inches is 35 to 60 percent clay and is calcareous.

Mapping unit Me is outside the defined range for the Miller series. It generally has a dark grayish-brown (10YR 4/2) color in the surface layer, but is enough like the Miller soils in morphology, composition, and behavior that a new series is not warranted.

Miller soils are associated with Asa, Clairemont, and Port soils. They are more clayey between depths of 10 and 40 inches than those soils.

Miller clay (Mc).—This nearly level soil is on flood plains that are occasionally flooded. It has the profile described as representative for the Miller series (fig. 7).

About 5 percent of the acreage mapped is a soil that is similar to this soil, but has a lighter colored surface layer, and about 3 percent is Asa silt loam.

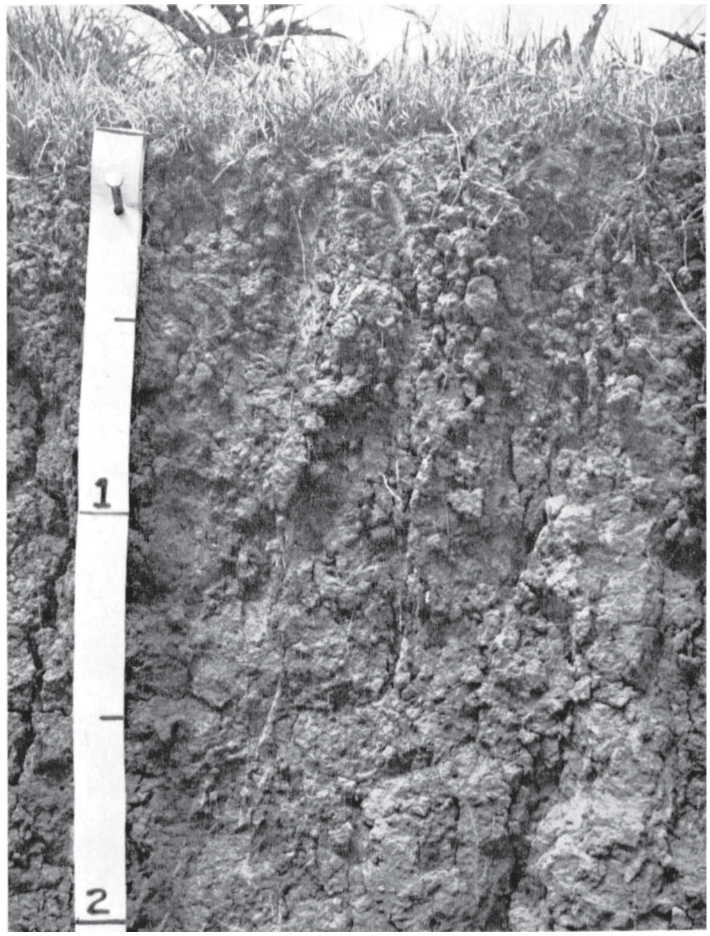

***Figure 7.*—Profile of Miller clay.**

This Miller soil is used mostly for cultivated crops, mainly alfalfa and small grain. It is also suited to cotton and grain sorghum. Part of the acreage still supports stands of hardwood trees, and part is in pasture or native range.

This soil is high in content of clay, and if it is grazed or tilled when wet, the soil structure can be damaged. A crust is likely to form. The crust and the high clay content reduce the rate of moisture intake. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 successive years. Capability unit IIIs–1 dryland and IIIs–1 irrigated; Heavy Bottomland range site; windbreak-postlot group 3.

Miller clay, saline (Me).—This nearly level soil is on flood plains that are occasionally flooded. It has a profile similar to the one described as representative for the Miller series, but it is dark grayish brown and contains concentrations of salts at a depth of about 33 inches. About 5 percent of the acreage mapped is a soil that has a profile similar to the one described as representative for the Miller series, but it has less clay in the control section.

This Miller soil is used mostly for cultivated crops, mainly alfalfa and small grain. It is also suited to grain sorghum and cotton. A small acreage is wooded with hardwood trees, and some areas are in pasture or native range.

This soil is high in content of clay, and if grazed or tilled when wet, the soil structure can be damaged. A crust is likely to form. The crust and the high clay content reduce the rate of moisture intake. Soil salinity is also a concern in management. High-residue crops should be grown at least half the time, and the crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 years in succession. Capability unit IIIs-1 dryland and IIIs-1 irrigated; Heavy Bottomland range site; windbreak-postlot group 4.

Minco Series

The Minco series consists of nearly level and very gently sloping soils on uplands. These soils formed under a cover of tall grasses in material weathered from loamy sediment.

In a representative profile the surface layer is brown very fine sandy loam 14 inches thick. The subsoil is brown very fine sandy loam that extends to a depth of 28 inches. The underlying material is light reddish-brown, brown, and light-brown very fine sandy loam.

Minco soils are well drained and have moderate permeability. Available water capacity is high.

Representative profile of Minco very fine sandy loam, 0 to 1 percent slopes, in a cultivated field 1,800 feet south and 150 feet east of the northwest corner of sec. 25, T. 4 S., R. 14 W.:

A1—0 to 14 inches, brown (7.5YR 5/3) very fine sandy loam, dark brown (7.5YR 3/3) moist; moderate, fine, granular structure; slightly hard, very friable; neutral; gradual, smooth boundary.

B2—14 to 28 inches, brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 3/4) moist; weak, coarse, prismatic structure; slightly hard, friable; neutral; gradual, smooth boundary.

C1—28 to 40 inches, brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; moderate, coarse, prismatic structure; slightly hard, friable; mildly alkaline; gradual, smooth boundary.

C2—40 to 56 inches, light reddish-brown (5YR 6/4) very fine sandy loam, reddish brown (5YR 4/4) moist; moderate, coarse, prismatic structure; slightly hard, friable; few threads of secondary carbonates; moderately alkaline, calcareous and strongly effervescent; gradual, wavy boundary.

C3—56 to 71 inches, light-brown (7.5YR 6/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; weak, coarse, prismatic structure; hard, friable; few threads and films of secondary carbonates; moderately alkaline, calcareous and strongly effervescent.

The A horizon is brown or dark brown. The B2 horizon is brown, reddish-brown, yellowish-red, or strong-brown very fine sandy loam or loam. The depth to soft, powdery carbonates generally is 40 inches, but ranges from 34 to 50 inches. The C horizon is reddish-brown, brown, yellowish-red, strong-brown, light reddish-brown, or light-brown very fine sandy loam or loam.

Minco soils are associated with Grandfield and Tipton soils. They are less clayey than those soils.

Minco very fine sandy loam, 0 to 1 percent slopes (MnA).—This soil is on smooth uplands. It has the profile described as representative for the series.

About 5 percent of the mapped acreage is Tipton loam, and about 5 percent is Hardeman fine sandy loam.

This Minco soil is used mostly for cultivated crops, chiefly cotton, alfalfa, grain sorghum, and small grain.

Erosion is a hazard. Maintaining soil structure is also a management concern. High-residue crops should be grown half the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 4 successive years. Planting row crops on the contour decreases runoff. Capability unit I–1 dryland and I–1 irrigated; Loamy Prairie range site; windbreak-postlot group 1.

Minco very fine sandy loam, 1 to 3 percent slopes (MnB).—This soil is on smooth uplands. It has a profile similar to the one described as representative for the series, but the surface layer and the solum are thinner and are more reddish in color.

About 8 percent of the acreage mapped is Tipton loam, and 5 percent is Hardeman fine sandy loam.

This Minco soil is used mostly for growing cultivated crops, mainly cotton, alfalfa, grain sorghum, and small grain.

Maintaining soil fertility and soil structure and controlling erosion are concerns in management. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 3 successive years. Terraces and contour tillage decrease runoff. Capability unit IIe–3 dryland and IIe–1 irrigated; Loamy Prairie range site; windbreak-postlot group 1.

Oscar Series

The Oscar series consists of nearly level soils on flood plains. These soils are high in content of sodium. They formed under a cover of salt-tolerant grasses in material weathered from loamy sediment, high in content of sodium.

In a representative profile the surface layer is 7 inches of brown silt loam. To a depth of 24 inches, the subsoil is dark-brown and reddish-brown silty clay loam and clay loam. The lower part is reddish-brown clay loam that reaches to a depth of 40 inches. The underlying material is reddish-brown clay loam.

Oscar soils are moderately well drained and have slow permeability. Available water capacity is medium.

The Oscar soils in this country are mapped only with Asa soils.

Representative profile of Oscar silt loam from an area of Asa-Oscar complex, in range, 1,300 feet east and 200 feet north of the southwest corner of sec. 3, T. 1 S., R. 15 W.:

A1—0 to 7 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, medium, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B21t—7 to 15 inches, dark-brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/3) moist; compound structure of moderate, coarse, prismatic and moderate, medium, blocky; hard, firm; clay films on ped surfaces; mildly alkaline; clear, smooth boundary.

B22t—15 to 24 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/4) moist; compound structure of moderate, coarse, prismatic and moderate, medium, blocky; very hard, very firm; clay films on ped surfaces; numerous, fine, granitic sand grains; few pockets of soft calcium carbonates; mildly alkaline; gradual, smooth boundary.

B31—24 to 32 inches, reddish-brown (5YR 4/4) clay loam, reddish brown (5YR 3/4) moist; weak, medium, blocky structure; very hard, very firm; numerous, fine, granitic sands; many soft and hard calcium carbonate concretions; moderately alkaline; gradual, smooth boundary.

B32—32 to 40 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak, medium, blocky structure; very hard, very firm; numerous, fine, granitic sands; many soft and hard calcium carbonate concretions; moderately alkaline, calcareous; gradual, smooth boundary.

C—40 to 60 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; massive; very hard, very firm; numerous granitic sands; many, small, soft and hard calcium carbonate concretions; moderately alkaline, calcareous.

The A horizon is dark grayish-brown, grayish-brown, dark-brown, or brown silt loam or loam. It is slightly acid or neutral. A surface crust about ½-inch thick forms on this horizon. It is glazed and whitish when dry. The B2t horizon is reddish-brown, dark-brown, or brown silty clay loam or clay loam; it is 27 to 35 percent clay. Within about 15 inches of its upper boundary, the B2t horizon in some profiles is more than 15 percent saturated with exchangeable sodium. The B3 horizon is loam or clay loam and has a clay content ranging from 18 to 30 percent. It is reddish brown, yellowish red, or strong brown. This horizon is moderately alkaline, is calcareous and has soft and hard calcium carbonate spots, and commonly contains seams and pockets of salts. The C horizon also is loam or clay loam and is the same color as the B3 horizon.

These soils are outside the range for the Oscar series. They have a dark-colored surface layer, but are enough like the Oscar soils in morphology, composition, and behavior that a new series is not warranted.

Oscar soils are less clayey in the control section than the similar Hinkle soils. They have a higher sodium content than the associated Asa and Port soils.

Port Series

The Port series consists of nearly level soils on flood plains that are flooded occasionally. These soils formed under a cover of tall and mid grasses and scattered hardwoods in material weathered from loamy sediment.

In a representative profile the surface layer, which extends to a depth 22 inches, is dark-brown and reddish-brown silty clay loam. The subsoil is yellowish-red silty clay loam that reaches to a depth of 52 inches. The underlying material is reddish-brown silty clay loam.

Port soils are well drained and have moderate permeability. Available water capacity is high.

Representative profile of Port silty clay loam in a cultivated field 200 feet west and 50 feet south of the northeast corner of sec. 18, T. 3 S., R. 14 W.:

A11—0 to 15 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, fine, granular structure; hard, firm; mildly alkaline; gradual, smooth boundary.

A12—15 to 22 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; weak, medium, subangular blocky structure; hard, firm; worm casts are common; moderately alkaline; gradual, wavy boundary.

B2—22 to 33 inches, yellowish-red (5YR 4/6) silty clay loam, yellowish red (5YR 3/6) moist; weak, fine, subangular blocky structure; hard, firm; worm casts are common; moderately alkaline; gradual, wavy boundary.

B3—33 to 52 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; weak, fine, subangular blocky structure; hard, firm; moderately alkaline, calcareous; gradual, wavy boundary.

C—52 to 72 inches, reddish-brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; massive; hard, firm; few, fine, soft calcium carbonate concretions; moderately alkaline, calcareous.

The A horizon is reddish brown, brown, dark brown, or dark grayish brown. Reaction is mildly alkaline or moderately alkaline. The B horizon is yellowish-red or reddish-brown clay loam, silt loam, loam, or silty clay loam. The clay content between depths of 10 and 40 inches ranges from 18 to 35 percent. Reaction is mildly alkaline or moderately alkaline, and calcareous material is at depths ranging from 20 to 50 inches. The C horizon has the same range in color and texture as the B horizon. It is commonly uniform in texture to a depth of several feet, but in some places it contains strata of both coarser and finer textures than those of the control section.

The Port soils are associated with Asa, Clairemont, Cyril, Miller, and Oscar soils. They are dark colored to a greater depth than Asa and Clairemont soils. They are more clayey than Cyril soils, but less clayey than Miller soils. They lack the sodium content of Oscar soils.

Port silty clay loam (Po).—This nearly level soil is on flood plains that are occasionally flooded. It has the profile described as representative for the series. About 10 percent of the acreage mapped is a soil that has a profile similar to the one described as representative for the Port series, but the dark-colored surface layer is less than 20 inches thick.

Except for small areas of pasture, most of the acreage is cultivated to small grain, alfalfa, grain sorghum, and cotton.

Grazing or tilling this soil when it is wet damages its structure. High-residue crops should be grown half of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 4 consecutive years. They should be followed by cover crops to protect the soil surface. Capability unit IIw–1 dryland and IIw–1 irrigated; Loamy Bottomland range site; windbreak-postlot group 1.

Quanah Series

The Quanah series consists of nearly level soils on uplands. These soils formed under a cover of mid grasses in material weathered from loamy red beds.

In a representative profile the surface layer is 9 inches of grayish-brown silt loam. The subsoil, which extends to a depth of 24 inches, is grayish-brown and light brownish-gray silt loam. The underlying material is gray and light brownish-gray silty clay loam.

Quanah soils are well drained and have moderately slow permeability. Available water capacity is high.

Representative profile of Quanah silt loam, 0 to 1 percent slopes, in a cultivated field 300 feet south and 50 feet east of the northwest corner of the NE¼ of sec. 35, T. 2 S., R. 18 W.:

A1—0 to 9 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, friable; moderately alkaline, calcareous; clear, smooth boundary.

B21—9 to 15 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate, medium, granular structure; slightly hard, friable; many pores and worm casts; 5 to 10 percent visible calcium carbonate; moderately alkaline, calcareous; clear, smooth boundary.

BB22ca—15 to 24 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; strong, medium, granular structure; slightly hard, friable; many pores and worm casts; soft powdery calcium carbonate makes up about 30 percent of this horizon; moderately alkaline, calcareous; gradual, smooth boundary.

C1ca—24 to 54 inches, gray (2.5Y 6/1) silty clay loam, light brownish gray (2.5Y 6/2) moist; massive; hard, firm; large concretions of soft calcium carbonate make up from 25 to 30 percent of this horizon; moderately alkaline, calcareous; gradual, smooth boundary.

C2—54 to 72 inches, light brownish-gray (2.5Y 6/2) silty clay loam, light brownish gray (2.5Y 6/2) moist; massive; very hard, very firm; few soft calcium carbonate concretions; moderately alkaline, calcareous.

The A horizon is brown, dark grayish brown, or grayish brown. It is moderately alkaline and calcareous. The B2 horizon is silt loam, loam, or clay loam. It is grayish brown, pinkish gray, pale brown, light brownish gray, or dark grayish brown. The B21 horizon is up to 3 percent, by volume, secondary carbonates in the form of films, threads, and small pockets. The B22ca horizon is 5 to 69 percent secondary carbonates in the form of films, soft masses, or hard concretions. The C horizon is gray or light-brownish gray silty clay loam, loam, or clay loam. Clay content between depths of 10 and 40 inches ranges from 20 to 32 percent in this horizon.

Quanah soils are associated with Abilene, Hollister, Tipton, and Weymouth soils. They are more silty and less sandy than Tipton and Weymouth soils. They are less clayey than Abilene and Hollister soils.

Quanah silt loam, 0 to 1 percent slopes (QuA).—This soil is on smooth uplands. It has the profile described as representative for the series. About 10 percent of the acreage mapped is Tipton loam.

This Quanah soil is cultivated to cotton, wheat, grain sorghum, and alfalfa.

Grazing or tilling when this soil is wet damages the soil structure, which results in a lowered rate of moisture intake and makes root penetration more difficult. High-residue crops should be grown at least half of the time and the crop residue returned to the soil. Low-residue crops should not be grown for more than 4 successive years. Contour tillage reduces runoff and erosion. Capability unit IIc–1 dryland and I–2 irrigated; Loamy Prairie range site; windbreak-postlot group 3.

Rock Land

Rock Land (Ro) is 35 to 90 percent granite outcrops and 10 to 50 percent gently sloping to moderately steep loamy soil material. This material is very shallow over granite bedrock. Little or no formation of soil has taken place. Included in mapping, however, is Hardeman fine sandy loam that occupies about 10 percent of the total acreage. Rock land is associated with Hardeman and Grandfield soils.

Rock land is suitable for use as range and as wildlife habitat. The vegetation is a sparse cover of short and mid grasses. Controlled grazing and protection against fire are the main management concerns. Capability unit VIIs–1 dryland; Hilly Stony Land range site; wind break-postlot group 4.

Roscoe Series

The Roscoe series consists of nearly level soils in concave depressions of the uplands. These soils formed under a cover of short grasses in material weathered from clay.

In a representative profile the surface layer, which extends to a depth of 18 inches, is gray clay. The next layer reaches to a depth of 36 inches and is light brownish-gray clay. The underlying material is gray and light-red clay.

Roscoe soils are moderately well drained and have very slow permeability. Available water capacity is high.

Representative profile of Roscoe clay in a cultivated field 300 feet south and 100 feet east of the northwest corner of sec. 30, T. 3 S., R. 16 W.:

Ap—0 to 6 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; weak, fine, blocky structure; very hard, firm; moderately alkaline, calcareous and strongly effervescent; plowed, smooth boundary.

A1—6 to 18 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; weak, fine and medium, blocky structure; very hard, firm; few, fine, hard calcium carbonate concretions; moderately alkaline, calcareous, strongly effervescent; gradual, smooth boundary.

AC—18 to 36 inches, light brownish-gray (10YR 6/2) clay, dark grayish brown (10YR 4/2) moist; distinct, common, medium, dark-brown (7.5YR 4/4) and strong-brown (7.5YR 4/6) mottles; moderate, fine and medium, blocky structure; extremely hard, very firm; many slickensides that intersect; few, fine, hard calcium carbonate concretions; moderately alkaline, calcareous and strongly effervescent; diffused, wavy boundary.

C1—36 to 64 inches, mixture of gray (10YR 5/1) and light-red (2.5YR 6/6) clay, very dark gray (10YR 3/1) and red (2.5YR 4/6) moist; massive; slickensides that intersect are common; few, fine, hard calcium carbonate concretions; moderately alkaline, calcareous and strongly effervescent; diffused, wavy boundary.

C2—64 to 82 inches, red (2.5YR 5/8) clay, red (2.5YR 4/8) moist; massive; extremely hard, very firm; moderately alkaline, calcareous and strongly effervescent.

The A horizon ranges from gray to dark gray. The AC horizon is light brownish gray, brown, grayish brown, or dark grayish brown and is mottled in shades of brown. The C horizon is brown, red, or gray. Virgin areas of Roscoe soils have gilgai microrelief; the knolls are 3 to 8 inches higher than the depressions, and the distance from the center of the knolls to the center of the depressions ranges from 7 to 12 feet. Clay content in the part of the profile between depths of 10 and 40 inches ranges from 45 to 60 percent. The clay is mainly montmorillonite.

Roscoe soils are associated with Foard and Miller soils. They have a lower chroma in the surface layer than the similar Miller soils. They have less sodium than Foard soils.

Roscoe clay (Rs).—This nearly level soil is on slightly concave uplands. It has the profile described as representative for the series. About 5 percent of the acreage mapped is a soil that is similar to this soil, but is less clayey.

This Roscoe soil is used for cultivated crops. Wheat is the main crop, but grain sorghum and cotton are also suited.

This soil receives extra water as runoff from surrounding areas. Grazing or tilling when the soil is wet damages its structure. A crust forms, slowing down the emergence of seedlings and the intake of moisture. High-residue crops should be grown half the time and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 successive years. Drainage is needed in some areas to remove ponded water. Capability unit IIIs–1 dryland and IIIs–1 irrigated; Hardland range site; windbreak-postlot group 4.

Stamford Series

The Stamford series consists of gently sloping soils on uplands. These soils formed under a cover of short grasses in material weathered from clay.

In a representative profile the surface layer is 5 inches of reddish-brown silty clay loam. The next layer, which extends to a depth of 36 inches, is reddish-brown clay. The underlying material is red clay.

Stamford soils are well drained and have very slow permeability. Available water capacity is high.

Representative profile of Stamford silty clay loam, 3 to 5 percent slopes, eroded, in a cultivated field 1,600 feet east and 200 feet south of the northwest corner of sec. 28, T. 1 N., R. 16 W.:

Ap—0 to 5 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; moderate, fine, granular structure; slightly hard, friable; moderately alkaline, calcareous; clear, smooth boundary.

AC1—5 to 24 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; weak, fine and medium, blocky structure; extremely hard, very firm; shiny ped faces; few slickensides that intersect; many soft calcium carbonate spots and a few hard concretions; moderately alkaline, calcareous; gradual, wavy boundary.

AC2—24 to 36 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; many slickensides that intersect and common medium parallelepipeds; extremely hard, very firm; many soft calcium carbonate spots and hard concretions; moderately alkaline, calcareous; gradual, wavy boundary.

C—36 to 50 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; massive; extremely hard, very firm; few slickensides; few soft calcium carbonate spots; moderately alkaline, calcareous.

The AC horizon is reddish brown or yellowish red. The C horizon is reddish brown, weak red, or red. Reaction is moderately alkaline, and the soil is calcareous in all horizons. In the part of the profile between depths of 10 and 40 inches, the clay content ranges from 45 to 60 percent.

The Stamford soils are associated with the Hilgrave calcareous variant, Indiahoma, Vernon, and Weymouth soils and Badland. They differ from Indiahoma soils in not having gilgai relief. They are more clayey than the Hilgrave calcareous variant and Weymouth soils. They differ from Vernon soils in having montmorillonitic clays. They differ from Badland in having a profile that shows distinct horizons.

Stamford silty clay loam, 3 to 5 percent slopes, eroded (SmC2).—This is a gently sloping soil on uplands. It has the profile described as representative for the series. About 25 to 75 percent of the original surface layer in most areas has been removed by erosion so that ordinary tillage implements reach deeper than the original surface layer. About 30 to 40 percent of the acreage mapped is a soil that is similar to this soil, but the surface layer is very dark grayish brown and secondary carbonates are leached to a depth of about 22 inches.

Part of the acreage is cultivated. The rest has been cultivated. Small grain is the main crop. Grain sorghum is also suited.

This soil is droughty because of the amount of water lost as runoff. Water erosion is the main hazard. Grazing or tilling when this soil is wet breaks down its structure and decreases the rate of moisture intake. High-residue crops should be grown at least three-fourths of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 1 year in the rotation. Terraces and contour tillage are needed to reduce runoff and the hazard of water erosion. Capability unit IVe-3 dryland; Red Clay Prairie range site; windbreak-postlot group 4.

St. Paul Series

The St. Paul series consists of nearly level and very gently sloping soils on uplands. These soils formed under a cover of tall and mid grasses in material weathered from loamy sediment.

In a representative profile the surface layer is dark-brown silt loam 11 inches thick. The upper part of the subsoil is reddish-brown silty clay loam and clay loam to a depth of 33 inches. The lower part, which reaches to a depth of 64 inches, is red clay loam. The underlying material is red loam.

St. Paul soils are well drained and have moderately slow permeability. Available water capacity is high.

Representative profile of St. Paul silt loam, thin surface, 1 to 3 percent slopes, in a cultivated field 100 feet south and 30 feet east of the northwest corner of the NE¼ of sec. 18, T. 3 S., R. 17 W.:

A1—0 to 11 inches, dark-brown (7.5YR 4/3) silt loam, dark brown (7.5YR 3/3) moist; weak, medium, granular structure; slightly hard, firm; mildly alkaline; gradual, smooth boundary.

B1—11 to 15 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; weak, medium, subangular blocky structure; hard, friable; moderately alkaline; gradual, smooth boundary.

B21t—15 to 24 inches, reddish-brown (2.5YR 4/3) silty clay loam, dark reddish brown (2.5YR 3/3) moist; weak, medium, blocky structure; hard, firm; clay films on ped surfaces; moderately alkaline; gradual, wavy boundary.

B22t—24 to 33 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) moist; moderate, medium, blocky structure; hard, firm; continuous clay film on ped surfaces; few soft calcium carbonate spots; moderately alkaline, calcareous; gradual, wavy boundary.

B31ca—33 to 38 inches, red (2.5YR 5/6) clay loam, red (2.5YR 4/6) moist; weak, coarse, prismatic structure; hard, firm; many soft spots of calcium carbonate; moderately alkaline, calcareous and strongly effervescent; gradual, wavy boundary.

B32—38 to 64 inches, red (2.5YR 5/6) clay loam, red (2.5YR 4/6) moist; weak, coarse, prismatic structure; hard, firm; moderately alkaline, calcareous; abrupt, wavy boundary.

IIC—64 to 72 inches, red (2.5YR 4/6) loam, dark red (2.5YR 3/6) moist; massive; few medium and coarse sand grains; many hard calcium carbonate concretions 1 to 10 millimeters in diameter, moderately alkaline.

The A horizon is reddish brown or dark brown. The B2t horizon is silty clay loam or clay loam that has a clay content of 27 to 35 percent. It is mildly alkaline or moderately alkaline and is noncalcareous. The B3 horizon is reddish brown, red, or yellowish red. The IIC horizon is red, reddish brown, yellowish red, or light reddish brown. It is loam, clay loam, silt loam, or silty clay loam.

St. Paul soils are associated with Abilene, Hinkle, Tillman, and Tipton soils. They are less clayey than Tillman soils. They are more silty in the control section than the similar Tipton soils. They are less clayey than Abilene soils. St. Paul soils contain less sodium than Hinkle soils.

St. Paul silt loam, thin surface, 1 to 3 percent slopes (SpB).—This very gently sloping soil is on uplands. It has the profile described as representative for the series. About 5 percent of the acreage mapped is Tillman silt loam.

This soil is used for cultivated crops, chiefly small grain and cotton. It is also suited to grain sorghum and alfalfa.

Runoff erodes this soil. Grazing or tilling when the soil is wet tends to destroy its structure. Maintaining soil fertility is also a concern in management. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 3 successive years. Terracing and contour tillage decrease runoff. Capability unit IIe–3 dryland and IIe–1 irrigated; Hardland range site; windbreak-postlot group 3.

St. Paul-Hinkle complex, 0 to 1 percent slopes (StA).—These soils are on upland flats. St. Paul silt loam makes up about 75 percent of this complex, and Hinkle silt loam or clay loam 15 percent. The two soils are so intermingled that it is impractical to map them separately. Except for a slightly thinner surface layer, the St. Paul soil has a profile similar to the one described as representative for the series. The profile of the Hinkle soil differs from the one described as representative for the Hinkle series in having a slightly less clayey subsoil.

About 3 to 5 percent of the acreage mapped is included Foard silt loam, and about 5 percent is Weymouth loam.

Most of the acreage is in cultivated crops, chiefly small grain. These soils are also suited to grain sorghum and cotton.

Salt concentrations reduce the rate of water intake, cause surface crusts, and damage the structure of the soil. These effects make the soil droughty and retard the emergence of seedlings. High-residue crops should be grown at least two-thirds of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 successive years. Minimum tillage, to a depth of 4 inches or less, reduces the hazard of bringing salts to the surface. Mulching severely crusted areas with cottonburs or straw hay reduces crusting. Chemical amendments, such as gypsum, slowly improve the soil structure. Capability unit IIIs–2 dryland and IIIs–2 irrigated; windbreak-postlot group 3; St. Paul soil in Hardland range site and Hinkle soil in Slickspot range site.

St. Paul-Hinkle complex, 1 to 3 percent slopes (StB).—These very gently sloping soils are on uplands. St. Paul silt loam makes up about 65 percent of this complex, and Hinkle silt loam or clay loam 20 percent. The two soils are so intermingled that it is impractical to map them separately. The St. Paul soil has a profile similar to the one described as representative for the series, but it is redder. In the profile of the Hinkle soil, there is slightly less clay and a thinner solum than is found in the profile described as representative for the series.

About 5 percent of the acreage mapped is an included Foard silt loam, and 10 percent is Weymouth loam.

Small grain is the main crop. Grain sorghum and cotton are also suited. Some areas are used for range and pasture.

Salt concentrations reduce the rate of water intake and cause surface crusting, and the breakdown of soil structure. These effects make the soil droughty and retard the emergence of seedling. High-residue crops should be grown at least two-thirds of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 successive years. Fertilizer should be added to produce more crop residue, or legumes should be grown to improve tilth. Minimum tillage to depths of less than 4 inches decreases the hazard of bringing salts to the surface. The construction of terraces should be avoided as much as possible where the soil is severely crusted. Mulching these areas, as well as applying a chemical amendment, such as gypsum, improves tilth. Tillage should be kept to a minimum following the application of chemical amendments. Capability unit IVs–1 dryland; windbreak-postlot group 3; St. Paul soil in Hardland range site and Hinkle soil in Slickspot range site.

Tillman Series

The Tillman series consists of very gently sloping and gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from clay and shale.

In a representative profile the surface layer is reddish-brown silty clay loam 8 inches thick. The upper part of the subsoil is reddish-brown silty clay loam and clay to a depth of 37 inches. The lower part is red clay that extends to a depth of 62 inches. The underlying material is red clay.

Tillman soils are well drained and have very slow permeability. Available water capacity is high.

Representative profile of Tillman silty clay loam in an area of Tillman and Foard soils, 1 to 3 percent slopes, in a cultivated field 600 feet south and 400 feet east of the northwest corner of sec. 17, T. 2 S., R. 16 W.:

Ap—0 to 8 inches, reddish-brown (5YR 5/3) silty clay loam, dark reddish brown (5YR 3/3) moist; weak, fine, granular structure; slightly hard, firm; mildly alkaline; plowed, smooth boundary.

B1—8 to 11 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; moderate, fine, subangular blocky structure; hard, firm; mildly alkaline; clear, smooth boundary.

B21t—11 to 19 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate, medium, blocky structure; very hard, very firm; clay films on ped surfaces; few small open cracks; mildly alkaline; gradual, smooth boundary.

B22t—19 to 37 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate, medium, blocky structure; very hard, very firm; clay films on ped surfaces; many hard and soft calcium carbonate concretions; small dark streaks on faces of cracks; moderately alkaline, calcareous; gradual, smooth boundary.

B23t—37 to 62 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; weak, medium, blocky structure; extremely hard, extremely firm; clay films on ped surfaces; many hard calcium carbonate concretions and soft pockets; moderately alkaline, calcareous; gradual, smooth boundary.

C—62 to 72 inches, red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; massive; some streaks and pockets of olive clay; extremely hard, extremely firm; moderately alkaline, calcareous.

The solum ranges from 60 to more than 80 inches in thickness. The A horizon is reddish-brown, brown, or dark-brown silty clay loam or silt loam. The B1 horizon is silty clay loam, silt loam, or clay. The B2t horizon is reddish-brown, red, or yellowish-red clay or clay loam. Soft, powdery carbonates are within 24 inches of the surface in this horizon. The C horizon is red clay or is shaly.

Tillman soils are associated with Foard, Hinkle, Hollister, St. Paul, Tillman, Tillman moderately shallow variant, and Vernon soils, and Badland. They differ from Badland in having a profile that shows distinct horizons. They have more distinct horizons than St. Paul soils. They have a thinner, dark-colored surface layer and subsoil than Hollister soils. They contain less sodium than Foard and Hinkle soils. These Tillman soils are thicker than the Tillman moderately shallow variant soils.

Tillman and Foard soils, 1 to 3 percent slopes (TfB).—These very gently sloping soils are on uplands. The Tillman soil makes up about 47 percent of the mapping unit, and the Foard soil 30 percent. The Tillman soil has the profile described as representative for its series (fig. 8). The surface layer is silty clay loam or silt loam. The Foard soil has a profile similar to the one described as representative for the Foard series. Tillman and Foard soils occur without any predictable regularity in pattern or relative proportions.

About 10 percent of the acreage mapped is a soil that is similar to this soil but has a solum less than 60 inches thick, about 8 percent is Hollister soils, and about 5 percent is Indiahoma silty clay loam.

Wheat and cotton are the main cultivated crops. Grain sorghum is also suited. Some of the acreage is bermudagrass pasture, and some is native range.

Slow intake of water increases runoff, and this causes the soils to erode and to be droughty. Grazing or tilling when wet breaks down the soil structure. High-residue crops should be grown at least two-thirds of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 successive years. Terraces should be constructed and these soils should be farmed on the contour to reduce runoff.

Figure 8.—**Profile of Tillman silt loam showing blocky structure in subsoil.**

Capability unit IIIe-4 dryland and IIIe-3 irrigated; Hardland range site; windbreak-postlot group 3.

Tillman-Hinkle complex, 1 to 3 percent slopes (ThB).—These very gently sloping soils are on uplands. The Tillman soil makes up about 45 percent of this complex and the Hinkle soil 25 percent. Tillman and Hinkle soils are so intermingled that it is impractical to map them separately. The Tillman soil has a profile similar to the one described as representative for the series, but the surface layer is silt loam and silty clay loam and the subsoil is yellower. The Hinkle soil has a profile similar to the one described as representative of the series, but the surface layer is silt loam or clay loam and is redder.

About 5 percent of the acreage mapped is a soil that is similar to Tillman soils, but has a solum less than 60 inches thick; 15 percent is Foard soils, and 10 percent is Hollister soils.

Small grain is the main crop. Grain sorghum is also suited. Part of the acreage is pasture and native range.

Harmful salt concentrations reduce the rate of water intake, cause surface crusting, and break down soil structure. These effects make the soil droughty and retard the emergence of seedlings. High-residue crops should be grown at least three-fourths of the time, and crop residue should be returned to the soil. Fertilizer should be added to produce more residue, or legume crops should be grown to improve the soil structure. Low-residue crops should not be grown for more than 2 successive years. Minimum tillage, to depths of less than 4 inches, decreases the hazard of bringing salts to the surface. Terrace construction should be avoided as much as possible in areas where heavy crusts form. Mulching such areas and adding a chemical amendment, such as gypsum, improve tilth. After the amendment is added, tillage should be held to a minimum. Capability unit IVs-1 dryland; windbreak-postlot group 3; Tillman soil in Hardland range site and Hinkle soil in Slickspot range site.

Tillman Series, Moderately Shallow Variant

The Tillman series, moderately shallow variant, consists of gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from shale. These soils have a shaly clay layer or a shale layer within a depth of 60 inches.

In a representative profile the surface layer is reddish-brown silt loam 7 inches thick. The upper part of the subsoil, which reaches to a depth of 11 inches, is reddish-brown clay loam. The middle part extends to a depth of 27 inches and is reddish-brown clay. The lower part is red clay and extends to a depth of 40 inches. The underlying material is red shaly clay.

Tillman soils, moderately shallow variant, are well drained and have very slow permeability. Available water capacity is high.

Representative profile of Tillman silt loam, moderately shallow variant, 3 to 5 percent slopes, 300 feet north and 100 feet west of the southeast corner of sec. 7, T. 2 S., R. 16 W.:

Ap—0 to 7 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) moist; weak, fine, granular structure; slightly hard, friable; mildly alkaline; plowed, smooth boundary.

B1—7 to 11 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate, medium, granular structure; hard, friable; mildly alkaline; clear, smooth boundary.

B21t—11 to 17 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; weak, medium, blocky structure; very hard, very firm; clay films on ped surfaces; few small open cracks; mildly alkaline; gradual, smooth boundary.

B22t—17 to 27 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate, medium, blocky structure; very hard, very firm; clay films on ped surfaces; many soft and hard calcium carbonate concretions; moderately alkaline, calcareous; gradual, smooth boundary.

B3—27 to 40 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; weak, fine, blocky structure; very hard, very firm; many soft and hard calcium carbonate concretions; moderately alkaline, calcareous; gradual, smooth boundary.

C—40 to 60 inches, red (2.5YR 4/6) shaly clay, dark red (2.5YR 3/6) moist; massive; extremely hard, very firm; moderately alkaline, calcareous.

The solum ranges from 30 to 60 inches in thickness. The A horizon is reddish brown, brown, and dark brown. The B1 horizon is reddish-brown, brown, or dark-brown clay loam or clay. It is mildly alkaline or moderately alkaline. The B2t horizon is reddish-brown, red, or yellowish-red clay or clay loam. It is mildly alkaline or moderately alkaline. The B3 horizon is similar to the B2t horizon in texture and color and is moderately alkaline.

Tillman soils, moderately shallow variant, are associated with Foard, Hinkle, Hollister, St. Paul, Tillman, and Vernon soils and Badland. They differ from Badland in having a profile that shows distinct horizons. They are darker colored than Vernon soils and have distinct horizons to a greater depth than those soils. They are more clayey than St. Paul soils. They have a thinner, dark-colored surface layer and subsoil than Hollister soils. They differ from Foard and Hinkle soils in containing less sodium. They have less distinct horizons than Tillman soils.

Tillman silt loam, moderately shallow variant, 3 to 5 percent slopes (TeC).—This gently sloping soil is on uplands. It has the profile described as representative for the Tillman moderately shallow variant.

About 20 percent of the acreage mapped is an included soil that has a profile similar to the one described as representative for the Tillman series; about 15 percent is a soil also similar to the representative Tillman soil, but the upper 20 inches of the B2t horizon is less than 35 percent clay; and about 5 percent is an included Vernon soil.

The main crop is small grain. Grain sorghum is also suitable. Uncultivated areas are used for pasture and native range.

The main concern in management is reducing runoff, which contributes to droughtiness and the hazard of erosion. Maintaining soil structure is also a concern. High-residue crops should be grown at least three-fourths of the time, and crop residue should be returned to the soil. Low-residue crops should be grown more than 1 year in 4. Terraces and contour farming are needed to reduce runoff and the hazard of erosion. Capability unit IVe-2 dryland; Hardland range site; windbreak-postlot group 3.

Tipton Series

The Tipton series consists of nearly level and very gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from loamy sediment.

In a representative profile the surface layer is grayish-brown or dark grayish-brown loam 13 inches thick. The upper part of the subsoil, to a depth of 21 inches, is dark-brown loam. The middle part, which extends to a depth of 40 inches, is dark-brown and brown clay loam. The lower part is reddish-yellow loam that reaches to a depth of 66 inches. The underlying material is reddish-yellow loam.

Tipton soils are well drained and have moderate permeability. Available water capacity is high.

Representative profile of Tipton loam, 0 to 1 percent slopes, in a cultivated field 1,000 feet north and 150 feet west of the southeast corner of the NE¼ of sec. 24 T. 1 S., R. 19 W.:

Ap—0 to 9 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; soft, very friable; neutral; plowed, smooth boundary.

A1—9 to 13 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

B1—13 to 21 inches, dark-brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) moist; moderate, fine, subangular blocky structure; slightly hard, friable; many pores and worm casts; mildly alkaline; clear, smooth boundary.

B21t—21 to 34 inches, dark-brown (7.5YR 4/3) clay loam, dark brown (7.5YR 3/3) moist; moderate, medium, subangular blocky structure; hard, firm; many pores; thin continuous films; moderately alkaline; gradual, smooth boundary.

B22t—34 to 40 inches, brown (7.5YR 5/3) clay loam, dark brown (7.5YR 4/3) moist; moderate, medium, subangular blocky structure; hard, firm; many pores; thin continuous clay films; moderately alkaline; gradual, smooth boundary.

B3—40 to 66 inches, reddish-yellow (7.5YR 6/6) loam, strong brown (7.5YR 5/6) moist; weak, coarse, prismatic structure; slightly hard, friable; few soft calcium carbonate concretions; moderately alkaline, calcareous; gradual, smooth boundary.

C—66 to 72 inches, reddish-yellow (5YR 6/6) loam, yellowish red (5YR 5/6) moist; massive; slightly hard, friable; many calcium carbonate concretions; moderately alkaline, calcareous.

The solum ranges from 44 to more than 72 inches in thickness. The A1 or Ap horizon is dark-brown, grayish-brown, dark grayish-brown loam or fine sandy loam. The upper part of the A horizon has weak or moderate, fine or medium, granular structure, but some of the lower part has weak, moderate and coarse, prismatic structure. This horizon is neutral or mildly alkaline. The B1 horizon is similar to the A horizon in color. It is loam or clay loam that has weak or moderate structure. The B2t horizon is reddish-brown, dark-brown, or brown clay loam or loam that is 20 to 33 percent clay. It has weak or moderate, medium or coarse, subangular blocky or prismatic structure. It is mildly alkaline or moderately alkaline. The B3 horizon is reddish-yellow, reddish-brown, brown, light reddish-brown, yellowish-red, or strong-brown loam or clay loam. It has weak or moderate, medium or coarse, prismatic or subangular blocky structure. This horizon is calcareous and is moderately alkaline. The depth to secondary lime is about 36 to 70 inches. The C horizon is reddish-yellow, pinkish-gray, light reddish-brown, or light-brown loam or clay loam. Buried, dark-colored horizons commonly occur at a depth of 36 to 60 inches.

Tipton soils are associated with Abilene, Grandfield, Hardeman, Minco, and Quanah soils. They are less clayey than Abilene soils. They are darker colored in the surface layer and upper part of the subsoil than Grandfield and Hardeman soils. They are more clayey than Minco soils. Tipton soils are sandier than Quanah soils.

Tipton fine sandy loam, 0 to 1 percent slopes (TpA).—This soil is on smooth uplands. It has a profile similar to the one described as representative for the series, but the surface layer is fine sandy loam. About 5 percent of the acreage mapped is an included Grandfield fine sandy loam.

This Tipton soil is used for cotton, alfalfa, grain sorghum, and small grain.

Soil blowing and water erosion are hazards. Maintaining soil structure and fertility is also a management concern. High-residue crops should be grown at least half the time. The crop residue should be returned to the soil, and fertilizer should be applied to prevent a deficiency of soil nutrients while the residue decomposes. Low-residue crops should not be grown for more than 3 successive years. Cover crops sown after low-residue crops are needed to prevent soil blowing. Contour tillage is needed to reduce runoff. Capability unit IIe–2 dryland and IIe–2 irrigated; Sandy Prairie range site; windbreak-postlot group 1.

Tipton fine sandy loam, 1 to 3 percent slopes (TpB).—This very gently sloping soil is on smooth upland. Except for a fine sandy loam surface layer, this soil has a profile similar to the one described as representative for the series.

About 10 percent of the acreage mapped is included Tipton loam and 10 percent is Grandfield fine sandy loam.

This Tipton soil is used mainly for cotton, grain sorghum, and small grain. It is also suited to alfalfa. Some of the acreage is bermudagrass pasture.

Reducing the hazards of soil blowing and water erosion and maintaining soil fertility are concerns in management. High-residue crops should be grown at least half the time. The crop residue should be returned to the soil, and fertilizer should be added to hasten decomposition and prevent a deficiency of soil nutrients while the residue is decomposing. Low-residue crops should not be grown more than 3 successive years. Cover crops should be grown in rotation with low-residue crops during windy seasons. Terraces and contour farming are needed to reduce runoff. Capability unit IIIe–2 dryland and IIe–1 irrigated; Sandy Prairie range site; windbreak-postlot group 1.

Tipton loam, 0 to 1 percent slopes (TtA).—This soil is on smooth uplands. It has the profile described as representative for the series.

About 10 percent of the acreage mapped is an included Abilene loam, Grandfield fine sandy loam, or Minco very fine sandy loam; and about 30 percent is a soil similar to this soil, but at depths above 40 inches its subsoil is slightly more clayey and is mottled with gray, yellow, and red.

This Tipton soil is used for cotton, alfalfa, grain sorghum, and small grain.

Maintaining soil structure is the main concern in management. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 4 successive years. Contour farming can help reduce runoff. Capability unit I–1 dryland and I–1 irrigated; Loamy Prairie range site; windbreak-postlot group 1.

Tipton loam, 1 to 3 percent slopes (TtB).—This very gently sloping soil is on uplands. It is less gray and has a thinner surface layer than Tipton loam, 0 to 1 percent slopes.

About 5 percent of the acreage mapped is St. Paul silt loam, and 5 percent is Tipton fine sandy loam.

This Tipton soil is used for cultivated crops, chiefly cotton, grain sorghum, and small grain.

Water erosion is the main hazard. Maintaining the soil structure and fertility is also a concern in management. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 3 successive years. Terraces and farming on the contour are needed to reduce runoff. Capability unit IIe–3 dryland and IIe–1 irrigated; Loamy Prairie range site; windbreak-postlot group 1.

Vernon Series

The Vernon series consists of very gently sloping to strongly sloping soils on uplands. These soils formed under a cover of short and mid grasses in material weathered from clay and shale.

In a representative profile the surface layer is reddish-brown silty clay loam 6 inches thick. The subsoil is red clay that extends to a depth of 18 inches. The underlying material is also red clay.

Vernon soils are well drained and have slow permeability. Available water capacity is medium.

Representative profile of a Vernon soil that has slopes of 3 to 5 percent, in native range 120 feet east and 50 feet north of the southwest corner of sec. 9, T. 2 S., R. 15 W.:

A1—0 to 6 inches, reddish-brown (5YR 5/3) silty clay loam, reddish brown (5YR 4/3) moist; weak, medium, granular structure; hard, firm; moderately alkaline, calcareous; clear, smooth boundary.

B2—6 to 18 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; weak, medium, blocky structure; extremely hard, extremely firm; few, fine, hard calcium carbonate concretions; moderately alkaline, calcareous; gradual, wavy boundary.

C—18 to 30 inches, red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; massive; many, fine and medium, soft and hard calcium carbonate concretions; moderately alkaline, calcareous.

The solum ranges from 14 to 30 inches in thickness. The A horizon is silty clay loam or clay. The B horizon is clay loam or clay and has a clay content of 35 to 50 percent. It is red or yellowish red. Its structure ranges from fine to medium blocky. The C horizon is clay or weakly consolidated shale.

Vernon soils are associated with Hilgrave, Indiahoma, Stamford, Tillman, and Weymouth soils, and Badland. They are not so dark colored as Tillman soils and horizons are not so distinct as in those soils. They are more clayey than Weymouth and Hilgrave soils. They differ from Indiahoma and Stamford soils in having mixed clay mineralogy, and they do not have the cracks that are typical of Indiahoma soils. They differ from Badland in having distinct horizons.

Vernon soils, 1 to 3 percent slopes (VeB).—These very gently sloping soils are on uplands. They have a profile similar to the one described as representative for the series, but the surface layer is silty clay loam or clay. About 5 percent of the acreage mapped is an included Tillman silty clay loam.

The main use of these Vernon soils is native range. About 25 percent of the acreage is cultivated to wheat. The soils are also suited to cotton and grain sorghum.

Maintaining the soil structure and reducing the hazard of erosion are concerns in management. High-residue crops should be grown two-thirds of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 2 successive years. Terraces and contour farming are needed to prevent damaging runoff. Capability unit IIIe-4 dryland and IIIe-3 irrigated; Red Clay Prairie range site; windbreak-postlot group 4.

Vernon soils, 3 to 5 percent slopes (VeC).—These gently sloping soils are on uplands. They have the profile described as representative for the series. The surface layer is silty clay loam or clay. About 3 to 5 percent of the acreage mapped is an included Weymouth loam.

These Vernon soils are used mainly for native range. They are also suited to grain sorghum, and about 20 percent of the acreage is cultivated to wheat.

These soils are droughty because much of the rainwater is lost as runoff. Grazing or tilling when these soils are wet damages structure. Improving soil structure and reducing the hazard of erosion are the main management concerns. High-residue crops should be grown at least three-fourths of the time, and crop residue should be returned to the soil. Low-residue crops should not be grown more than 1 year in 4. Terracing and contour tillage reduce runoff. Capability unit IVe-2 dryland; Red Clay Prairie range site; windbreak-postlot group 4.

Vernon soils, 3 to 5 percent slopes, eroded (VeC2).—These gently sloping soils are on uplands. They have a profile similar to the one described as representative for the series, but the surface layer is thinner and is generally clay. About 3 to 5 percent of the acreage mapped is an included Weymouth loam.

Most of the acreage is native range. Part of the acreage is cultivated, and part was formerly cultivated. Some areas are in small grain or temporary pasture grasses. The soils are also suited to grain sorghum.

Reducing further water erosion, decreasing droughtiness by increasing the intake of water, and improving the soil structure are the main concern in management. High-residue sown crops should be grown at least 3 years out of 4, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 1 year in 4. Terraces and contour farming are needed to reduce runoff and erosion. Capability unit IVe-3 dryland; Red Clay Prairie range site; windbreak-postlot group 4.

Vernon soils, 3 to 8 percent slopes, severely eroded (VeD3).—These gently sloping and sloping soils are on uplands. Their profile is similar to the one described as representative for the series, but erosion has removed nearly all of the original surface layer. Gullies are common. About 15 to 20 percent of the acreage mapped is an included Tillman silty clay loam that has been eroded.

These Vernon soils are eroded to the extent that cultivation is no longer practical. Most of the acreage consists of abandoned cultivated fields. Reducing further erosion and eliminating gullies are the main concerns in management. Areas without a suitable cover of grass should be seeded to native grass. Capability unit VIe-3 dryland; Eroded Clays range site; windbreak-postlot group 4.

Vernon complex, 5 to 12 percent slopes (VmE).—These soils are on uplands. About 50 percent of this complex is Vernon silty clay loam or clay, 35 percent is a soil that is similar to the representative Vernon soil but has a thinner solum or a less clayey solum, and 15 percent is an included Stamford silty clay loam. All of the soils in this complex are so intermingled that it is impractical to map them separately. The Vernon soil has a profile similar to the one described as representative for the Vernon series, but the surface layer is thinner.

All the acreage is used for native range.

Getting moisture into the soil to insure plant growth is a concern in management. These soils are droughty and can be overgrazed easily. Overgrazing allows such plants as mesquite trees and pricklypear cactus to invade. Capability unit VIe-1 dryland; Red Clay Prairie range site; windbreak-postlot group 4.

Vernon-Clairemont complex (Vn).—This complex is about 60 percent Vernon soil and 30 percent Clairmont soil. These soils are in narrow drainageways, on upland valleysides, and on narrow valley floors. They are so intermingled that it is impractical to map them separately. The Vernon soil has a profile similar to the one described as representative for its series, but the subsoil is yellower. Slopes are 8 to 12 percent. The Clairemont soil has a profile similar to the one described as representative for its series, but the surface layer is thicker. This soil has slopes of 0 to 1 percent.

About 10 percent of the acreage mapped is Tillman silty clay loam and Clairemont soils, saline.

These soils are not suitable for cultivation. The Clairemont soil is suited to pasture and range. Most of the acreage is used as range. Deferred grazing improves the plant cover, reduces runoff, and allows more rainwater to enter the soil. Capability unit VIe-4 dryland; windbreak-postlot group 4; Vernon soil in Red Clay Prairie range site and Clairemont soil in Loamy Bottomland range site.

Weymouth Series

The Weymouth series consists of gently sloping soils on uplands. These soils formed under a cover of short and mid grasses in material weathered from clayey and loamy shales.

In a representative profile the surface layer is 12 inches of reddish-brown loam. The subsoil is red clay loam that reaches to a depth of 40 inches. The underlying material also is red clay loam.

Weymouth soils are well drained and have moderate permeability. Available water capacity is high or medium.

Representative profile of Weymouth loam, 3 to 5 percent slopes, in a cultivated field 200 feet west and 400 feet south of the northeast corner of the NW¼ sec. 11, T. 3 S., R. 15 W.:

Ap—0 to 7 inches, reddish-brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; moderate, medium, granular structure; slightly hard, friable; moderately alkaline, calcareous; plowed, smooth boundary.

A1—7 to 12 inches, reddish-brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; strong, medium, granular structure; hard, firm; moderately alkaline, calcareous; clear, smooth boundary.

B2—12 to 40 inches, red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) moist; weak, fine, subangular blocky structure; slightly hard, firm; moderately alkaline, calcareous; threads, seams, and pockets of soft calcium carbonate; very porous; numerous worm casts; gradual, wavy boundary.

C—40 to 60 inches, red (2.5YR 5/6) clay loam, red (2.5YR 4/6) moist; massive; slightly hard, friable; moderately alkaline, calcareous.

The A horizon is reddish brown or brown. The B2 horizon is reddish brown, red, or yellowish red and moderately alkaline and calcareous. Layers that are more than 6 inches thick are common, and these contain a minimum of 5 percent more secondary lime than is in the substratum. Gravelly strata at varying depths also are common in these soils.

Weymouth soils are associated with Hilgrave, Quanah, Stamford, Tillman, and Vernon soils. They are less clayey than Stamford, Tillman, and Vernon soils. They are not so gravelly as Hilgrave soils, and they are more sandy and less silty than Quanah soils.

Weymouth loam, 3 to 5 percent slopes (WeC).—This gently sloping soil is on uplands. It has the profile described as representative for the series (fig. 9).

About 5 percent of the acreage mapped is an included Tillman silty clay loam, and about 10 percent is a soil similar to Weymouth loam, but has a less clayey and more gravelly subsoil.

This Weymouth soil is used mainly for cultivated crops. Small areas are used for pasture or native range. Small grain is the main crop, but grain sorghum is also suited.

***Figure 9.*—Profile of Weymouth loam, 3 to 5 percent slopes. The light-colored spots below a depth of 2 feet are calcium carbonate.**

Runoff, which causes erosion and droughty conditions, is the main hazard. Maintaining soil structure is also a management concern.

High-residue crops should be grown at least 3 years out of 4, and the residue should be returned to the soil. Low-residue crops should not be grown more than 1 year in 4. Where row crops are grown, contour farming and terraces are needed to help reduce runoff. Capability unit IVe-2 dryland; Hardland range site; windbreak-postlot group 3.

Yahola Series

The Yahola series consists of nearly level to gently sloping soils on flood plains. These soils formed under an open stand of hardwood trees and an understory of grasses, in material weathered from loamy and sandy sediment.

In a representative profile the surface layer is 14 inches of reddish-brown clay loam. The next layer, which extends to a depth of 33 inches, is reddish-brown fine sandy loam. The underlying material is reddish-yellow fine sand.

Yahola soils are well drained and have moderately rapid permeability. Available water capacity is medium or high.

Representative profile of Yahola soils, occasionally flooded, in a cultivated field, 200 feet west and 200 feet north of the southeast corner of the NE¼ of sec. 6, T. 2 S., R. 19 W.:

A1—0 to 14 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate, medium, granular structure; slightly hard, firm; moderately alkaline, calcareous; clear, smooth boundary.

C1—14 to 33 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; structureless; slightly hard, friable; thin strata of loamy fine sand and silt loam throughout this horizon; moderately alkaline, calcareous; clear, smooth boundary.

C2—33 to 60 inches, reddish-yellow (5YR 6/6) fine sand, yellowish red (5YR 5/6) moist; single grained; slightly hard, very friable; thin strata of fine sandy loam to clay loam; moderately alkaline, calcareous.

The A horizon is fine sandy loam, loam, or clay loam. More than one texture is common in the surface layer of any one mapped area. Clay loam is common in low areas, and fine sandy loam in high areas. Low areas are cut by old channels that are partly filled with weak red or reddish-brown sediment.

The upper 36 inches of the profile ranges from clay loam to fine sandy loam. At depths between 10 and 40 inches, however, the soil is 5 to 15 percent clay and is generally stratified with coarser or finer soil material. Colors are reddish brown, red, and yellowish red. Yahola soils have dark, buried horizons in some profiles.

Yahola soils are associated with Hardeman, Likes, and Lincoln soils. They are more sandy throughout than the similar Asa, Clairemont, and Port soils. They are less sandy than Lincoln and Likes soils. They differ from Hardeman soils in having less distinct horizons, and they are stratified.

Yalola soils, saline, frequently flooded (Ya).—These nearly level soils are in slight depression in flood plains that are flooded frequently. These soils have a profile similar to the one described as representative for the series, but they are saline and the surface layer is a slightly darker colored fine sandy loam to clay loam. About 10 percent of the acreage mapped is Lincoln soils.

These Yahola soils are not suited to cultivation because of flooding. They are used mostly as range. They are only marginal as range because saltcedar invades open areas and competes with grasses. During wet periods water stands at or near the surface. Capability unit Vw-2 dryland; Alkali Bottomland range site; windbreak-postlot group 4.

Yahola soils, occasionally flooded (Yh).—These soils are on flood plains that are occasionally flooded. They have the profile described as representative for the series. The surface layer ranges from clay loam to fine sandy loam. Slopes are 0 to 2 percent. About 5 percent of the acreage mapped is Lincoln soils.

These Yahola soils are mostly cultivated to cotton, grain sorghum, small grain, and alfalfa. They are also suited to bermudagrass and range grasses.

Maintaining soil structure and fertility is the main concern in management. Soil blowing is also a hazard. High-residue crops should be grown half the time. The crop residue should be returned to the soil, and fertilizer should be added to prevent a deficiency of soil nutrients while the residue decomposes. Low-residue crops should not be grown for more than 4 successive years. When row crops are grown, cover crops should be planted to reduce the hazard of soil blowing. Capability unit IIw-1 dryland and IIw-1 irrigated; Loamy Bottomland range site; windbreak-postlot group 1.

Use and Management of the Soils

This section explains the capability grouping used by the Soil Conservation Service; the management of irrigated soils when used for cultivated crops; the management of the soils for range and for windbreaks and postlots; the suitability of soils for management as wildlife habitat; and the use of the soils in engineering.

Predicted yields of the principal dryland crops under two levels of management are shown in table 2. Predicted yields of irrigated crops are shown in table 3. Management of the soils for dryland farming is suggested in the descriptions of the mapping units. Management for irrigated farming is explained in the descriptions of the capability units.

Basic Management for Cultivated Crops [2]

Cultivated soils in Tillman County need management that will conserve moisture, reduce the hazard of erosion, maintain fertility, supply organic matter, and preserve the soil structure. Following are descriptions of conservation practices commonly needed in the county. For suggested combinations of practices needed for dryland farming on individual soils, see "Descriptions of the Soils." For suggested combinations of practices for irrigated soils, see "Management of Irrigated Soils."

Minimum tillage of crops on soils, such as those of the Abilene and Hollister series, helps to protect soil structure and slows the decomposition of organic matter. Minimum tillage of Foard soils limits the amount of clay brought to the surface and helps to protect the structure of the surface layer. Minimum tillage is accomplished through the use of a long-term cropping system that includes perennial grasses or deep-rooted legumes, by using herbicides instead of cultivation for weed control, and by limiting the amount of fieldwork when preparing seedbeds and when planting and cultivating the crops. If a soil is tilled too often to the same depth, it becomes compacted at that depth and a plowpan forms. This can happen to many soils, such as the Abilene and Asa soils. Plowpans can be eliminated by varying the depth of tillage and by including perennial grasses and deep-rooted legumes in the cropping system.

Cover crops, such as small grain and Austrian winter peas, grown in combination or separately, can be planted to protect the soil against erosion and to improve fertility. Cover crops for the summer season generally are not grown in Tillman County because soil damage is less likely to occur during that period.

Field terraces, diversion terraces, and grassed waterways are among the effective measures that reduce soil loss. Contour farming is an efficient method of reducing the hazard of erosion and of maintaining terraces (fig. 10).

Crop residue management involves leaving the residue on the surface during summer, or working it partly into the surface layer, to protect the soil against erosion and to conserve moisture. Crop residue management is especially beneficial on such sandy soils as Grandfield and Hardeman. Organic matter, or humus, supplied by crop residue improves the structure of the surface layer. This, in turn, increases the rate of infiltration and the capacity for storing water, reduces the hazard of erosion, and helps to prevent the formation of a crust. Examples of such soils are those of the Indiahoma, Tillman, and Vernon series.

Soil-improving crops, or high-residue crops, are grown to preserve or improve the physical properties of the soil and its productivity. They also help to reduce erosion and to control weeds, insects, and diseases. A cropping system that improves the soil includes crops that produce large amounts of residue, for example, small grain and sorghum if it is drilled. Low-residue crops, in contrast, produce only small amounts of residue. Examples are corn and other row crops.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, all the kinds of soil are grouped at three levels, the capability class, the subclass, and the unit.

[2] Prepared with the assistance of M. D. GAMBLE, agronomist, Soil Conservation Service.

Figure 10.—**Diversion terrace keeps runoff from Vernon soils, 1 to 3 percent slopes, on the left, from damaging Asa-Clairemont complex, on the right.**

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

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 having limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes 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 United States, shows 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 limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, but have other limitations that restrict their use.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are 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 designated by adding an Arabic numeral to the subclass symbol, for example, IIe-3 or IIIe-4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

The eight classes in the capability system and the subclasses and units in Tillman County are described in the list that follows. The unit designation for each soil in the county can be found in the "Guide to Mapping Units."

Class I soils have few limitations that restrict their use.

Unit I-1. Deep, nearly level, well-drained soils that are loamy throughout. These soils are on uplands.

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

Subclass IIe. Soils subject to moderate erosion unless protected.

Unit IIe-1. Deep, nearly level, well-drained, moderately coarse textured soils that have a moderately coarse textured or medium-textured subsoil. These soils are on uplands.

Unit IIe-2. Deep, nearly level, well-drained, moderately coarse textured soils that have a moderately coarse textured, medium-textured, or moderately fine textured subsoil. These soils are on uplands.

Unit IIe-3. Deep, very gently sloping, well-drained, medium-textured soils that have a medium-textured or moderately fine textured subsoil. These soils are on uplands.

Subclass IIw. Soils subject to seasonal overflow.

Unit IIw-1. Deep, nearly level and very gently sloping, well-drained soils that are loamy throughout. These soils are on uplands.

Unit IIw-2. Deep, nearly level, well-drained soils that are loamy throughout, but have a slightly coarser textured surface layer than soils in unit IIw-1. These soils are on flood plains.

Subclass IIs. Soils have very slow permeability.

Unit IIs-1. Deep, nearly level, moderately well drained loamy soils that have a clayey or loamy subsoil. These soils are on uplands.

Subclass IIc. Soils are moderately limited by climate.

Unit IIc-1. Deep and moderately deep, nearly level, well-drained soils that have a loamy and clayey subsoil.

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

Subclass IIIe. Soils subject to severe erosion unless protected.

Unit IIIe-1. Deep, very gently sloping and gently sloping, well-drained soils that are loamy throughout. These soils are on uplands.

Unit IIIe-2. Deep, very gently sloping and gently sloping, well-drained soils that are loamy throughout, but have a slightly coarser textured surface layer than soils in unit IIIe-1. These soils are on uplands.

Unit IIIe-3. Deep, nearly level and very gently sloping, well-drained sandy soils that have a loamy subsoil. These soils are on uplands.

Unit IIIe-4. Deep, moderately deep, and shallow, very gently sloping, well-drained loamy and clayey soils that have a loamy and clayey subsoil. These soils are on uplands.

Subclass IIIs. Soils have severely limiting soil features.

Unit IIIs-1. Deep, nearly level, well drained to moderately well drained, clayey soils that have a clayey or loamy subsoil; on flood plains.

Unit IIIs-2. Deep, nearly level, moderately well drained, loamy soils that have a loamy or clayey subsoil; on uplands.

Unit IIIs-3. Deep, nearly level and very gently sloping, well-drained soils that are loamy throughout; on flood plains.

Class IV soils have very severe limitations that reduce 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-1. Deep, gently sloping or sloping, well-drained sandy soils that have a loamy subsoil. These soils are on uplands.

Unit IVe-2. Deep, moderately deep, and shallow, gently sloping, well-drained, loamy or clayey soils that have a loamy or clayey subsoil. These soils are on uplands.

Unit IVe-3. Deep, moderately deep, and shallow, gently sloping, well-drained, eroded loamy or clayey soils that have a clayey or loamy subsoil. These soils are on uplands.

Subclass IVs. Soils have severely limiting soil features.

Unit IVs-1. Deep, very gently sloping, moderately well drained and well drained loamy soils that have a clayey and loamy subsoil. These soils are on uplands.

Unit IVs-2. Deep, nearly level and very gently sloping, somewhat excessively drained loamy and sandy soils that have a sandy subsoil. These soils are on flood plains.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

Subclass Vw. Soils subject to flooding.

Unit Vw-1. Deep, nearly level and very gently sloping, well-drained soils that are loamy throughout. These soils are on flood plains.

Unit Vw-2. Deep, nearly level and very gently sloping, well-drained, saline soils that are loamy throughout. These soils are on flood plains.

Unit Vw-3. Deep, nearly level and very gently sloping, somewhat excessively drained sandy and loamy soils that have a sandy subsoil. These soils are on flood plains.

Subclass Vs. Soils have severely limiting soil features.

Unit Vs-1. Deep, nearly level and very gently sloping, well drained and moderately well drained soils that are loamy throughout and are generally saline or high in sodium. These soils are on flood plains.

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

Subclass VIe. Soils limited chiefly by risk of erosion, unless protective cover is maintained.

Unit VIe-1. Deep, moderately deep, and shallow, sloping to moderately steep loamy or clayey soils that have a loamy or clayey subsoil. These soils are on uplands.

Unit VIe-2. Deep, sloping to moderately steep, excessively drained soils that are sandy throughout. These soils are on uplands.

Unit VIe-3. Moderately deep and shallow, gently sloping and sloping, well-drained, severely eroded loamy or clayey soils that have a clayey or loamy subsoil. These soils are on uplands.

Unit VIe–4. Deep, moderately deep, and shallow, nearly level to strongly sloping, well-drained loamy and clayey soils that have a clayey and loamy subsoil. These soils are on uplands and flood plains.

Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion, unless protective cover is maintained.

Unit VIIe–1. Deep, strongly sloping to steep, excessively drained soils that are sandy throughout. These soils are on uplands.

Subclass VIIs. Land types that are severely limited by available moisture capacity, stones, or other soil features.

Unit VIIs–1. Shallow, gently sloping to moderately steep loamy soil material and granite rock outcrops on uplands.

Unit VIIs–2. Moderately deep and shallow, strongly sloping to moderately steep, well-drained to excessively drained clayey soil material and shale outcrops mixed with loamy or clayey soils. All are on uplands.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Tillman County.)

Predicted yields of dryland crops

Table 2 gives estimated, long-term, average yields of important dryland crops and tame pasture under two levels of management. The figures in columns A represent predicted yields under customary management, or that management followed by a large number of farmers in the county. This management includes: (1) proper rates of seeding, proper dates of planting, and efficient methods of harvesting; (2) sufficient control of weeds, insects, and diseases to insure good plant growth; (3) terracing and contour farming where needed; and (4) use of fertilizer in small amounts.

The figures in columns B represent predicted yields under improved management. This management includes the first three practices listed under customary management, plus (1) use of fertilizer in amounts needed for high, profitable production; (2) the use of adapted, improved varieties of seed; (3) surface drainage where needed; (4) residue management and those tillage practices that help in controlling erosion, maintain soil structure, increase water infiltration, and aid seedling emergence; and (5) a cropping system suited to the operator's goals and the capacity of the soil.

The yield predictions were made by soil scientists on the basis of consultations with farmers and records from the Oklahoma Agricultural Experiment Station. Crop failures were considered in arriving at averages.

Management of Irrigated Soils

This section provides general information about irrigation in Tillman County and suggests management, by capability units, of the soils under irrigation. Predicted yields of irrigated soils are shown in table 3.

Irrigation practices and source of water supply

The 1964 Census of Agriculture reported 16,681 acres of irrigated land on 154 farms in Tillman County. Cotton was the main irrigated crop. Grain sorghum, wheat, and alfalfa were other crops commonly irrigated.

Irrigation water in the county comes from wells, most of which were drilled in the period 1954–56. The irrigated acreage reached a maximum in 1956, but has since declined. Most of the irrigated acreage is in the western third of the county. In that area the wells yield 100 to 500 gallons per minute. The water-bearing deposits average approximately 40 feet in thickness and have a saturated thickness of 34 feet. The Tipton soils are the dominant irrigated soils. Less extensively irrigated are the Hardeman, Grandfield, and Devol soils.

For the most part, water-bearing deposits are lacking in the eastern two-thirds of the county. Streamflow is at times sufficient to support limited irrigation. The period of greatest flow, however, is during the period when there is least need for irrigation water (fig. 11). A few wells along larger streams produce some water for irrigation. A limited supply of additional water for irrigation can be obtained by building farm ponds and flood-control structures.

Irrigation water is most frequently delivered through gated pipe into contour furrows. Most of the irrigated acreage has been leveled; about 20,000 acres had been leveled by 1967. Concrete-lined ditches and underground pipe decrease seepage and the loss of water by percolation (fig. 12). Sprinklers save water on sloping soils having a high intake of water and on soils where leveling is not practical (fig. 13).

Before converting a dryland area to irrigation—

1. Water rights must be obtained.
2. The suitability of the soils for irrigation must be determined.
3. An adequate supply of water must be available.
4. The salt content of the water and the effect of the salt on pumps and other equipment must be taken into account.
5. A proper design for the irrigation system must be made.
6. The cost of the irrigation system must be estimated.
7. Crops suitable for the irrigated soils must be selected.
8. A system of cropping and fertilization must be devised that will avoid depletion of the soils.
9. The irrigator needs to know when to irrigate and how much water to apply.

Technical assistance in planning, designing, and operating irrigation systems is available at the local office of the Soil Conservation Service and from other agencies of the Department of Agriculture.

Descriptions of irrigated soils, by capability unit

The management suggestions that follow are for soils already under irrigation. To find the names of soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

TABLE 2.—*Predicted average yields per acre of principal dryland crops under two levels of management*

[Figures in columns A indicate yields under customary management; figures in columns B indicate yields under improved management. Absence of a figure indicates crop is seldom grown on, or is not suited to, the soil specified. Only arable soils are listed]

Soil	Alfalfa		Cotton		Grain sorghum		Wheat		Bermudagrass pasture	
	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Lb. of lint*	*Lb. of lint*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*A.U.M.*[1]	*A.U.M.*[1]
Abilene loam	1.2	2.2	215	295	24	32	18	26	4.5	5.6
Asa silt loam	1.7	3.0	290	405	26	42	22	32	6.0	8.0
Asa-Clairemont complex	0.8	1.5	150	195	15	22	13	18	4.5	5.6
Asa-Oscar complex									4.5	5.6
Clairemont soils, channeled									6.5	8.5
Clairemont soils, saline									4.5	5.6
Cyril fine sandy loam, mildly alkaline variant	1.7	3.0	290	405	26	40	18	23	6.0	8.0
Devol loamy fine sand, undulating			170	270	22	29	14	21	4.2	5.3
Devol loamy fine sand, hummocky			140	235	20	27			4.2	5.3
Devol fine sandy loam, 0 to 1 percent slopes	1.3	2.0	180	290	24	31	14	23	4.5	5.6
Foard silt loam, 0 to 1 percent slopes			160	225	18	25	14	20	3.0	4.5
Foard-Hinkle complex, 0 to 1 percent slopes			135	180	15	22	11	15	2.0	3.5
Grandfield loamy fine sand, 0 to 1 percent slopes	0.8	1.5	175	270	22	29	14	21	4.2	5.3
Grandfield loamy fine sand, undulating			170	270	22	29	14	21	4.2	5.3
Grandfield fine sandy loam, 0 to 1 percent slopes	1.6	2.5	215	350	24	32	18	26	5.0	6.0
Grandfield fine sandy loam, 1 to 3 percent slopes	1.1	2.2	205	300	21	28	16	21	4.5	5.6
Grandfield fine sandy loam, 3 to 5 percent slopes			190	280	19	25	13	18	4.5	5.6
Hardeman fine sandy loam, 0 to 1 percent slopes	1.6	2.5	215	325	23	30	17	22	4.5	5.6
Hardeman fine sandy loam, undulating	1.1	2.2	205	270	21	29	15	20	4.0	5.5
Hardeman fine sandy loam, 3 to 5 percent slopes			200	260	20	29	15	20	4.0	5.5
Hollister silt loam, 0 to 1 percent slopes			215	295	24	32	18	26	4.5	5.6
Indiahoma silty clay loam, 1 to 3 percent slopes			145	185	15	22	13	19	2.0	3.6
Indiahoma silty clay loam, 3 to 5 percent slopes			115	160	11	15	10	14	1.5	3.5
Lincoln soils, frequently flooded									5.0	6.5
Lincoln soils, occasionally flooded	0.8	1.5			13	15	13	19	5.0	6.5
Miller clay	1.0	1.7	150	195	15	22	13	18	4.5	6.5
Miller clay, saline	0.8	1.5	140	180	12	20	11	15	4.2	5.3
Minco very fine sandy loam, 0 to 1 percent slopes	1.6	2.7	290	405	26	41	20	30	5.0	6.0
Minco very fine sandy loam, 1 to 3 percent slopes	1.3	2.2	235	360	24	37	18	27	4.5	5.6
Port silty clay loam	1.7	3.0	290	405	26	42	22	32	6.0	8.0
Quanah silt loam, 0 to 1 percent slopes	1.5	2.5	215	295	22	29	17	25	4.5	5.6
Roscoe clay			130	165	14	19	11	15	3.5	4.5
Stamford silty clay loam, 3 to 5 percent slopes, eroded					6	10	9	11	1.0	3.2
St. Paul silt loam, thin surface, 1 to 3 percent slopes	1.3	2.2	230	290	22	29	18	24	4.5	5.6
St. Paul-Hinkle complex, 0 to 1 percent slopes			135	180	15	22	11	15	2.0	3.5
St. Paul-Hinkle complex, 1 to 3 percent slopes			110	155	14	18	10	14	1.5	3.2
Tillman and Foard soils, 1 to 3 percent slopes			145	190	15	22	13	19	2.0	3.5
Tillman-Hinkle complex, 1 to 3 percent slopes					14	18	10	14	1.5	3.2
Tillman silt loam, moderately shallow variant, 3 to 5 percent slopes					14	18	10	14	1.5	3.2
Tipton fine sandy loam, 0 to 1 percent slopes	1.6	2.5	240	350	23	36	18	27	5.0	6.0
Tipton fine sandy loam, 1 to 3 percent slopes	1.1	2.2	210	315	21	27	18	22	4.5	5.6
Tipton loam, 0 to 1 percent slopes	1.6	2.7	290	405	26	41	20	30	5.0	6.0
Tipton loam, 1 to 3 percent slopes	1.1	2.2	240	350	23	36	17	27	4.5	5.6
Vernon soils, 1 to 3 percent slopes			145	185	15	22	12	17	2.0	3.5
Vernon soils, 3 to 5 percent slopes					12	17	10	14	1.5	3.2
Vernon soils, 3 to 5 percent slopes, eroded					6	10	9	11	1.0	3.2
Weymouth loam, 3 to 5 percent slopes					14	18	10	14	1.5	3.2
Yahola soils, saline, frequently flooded									4.5	5.6
Yahola soils, occasionally flooded	1.6	2.5	240	350	28	35	16	24	6.0	8.0

[1] Animal-unit-month is a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of months a pasture can be grazed during a single grazing season without injury to the sod. An acre of pasture that provides 2 months of grazing for two cows has a carrying capacity of 4 animal-unit-months.

Figure 11.—**Channel of Deep Red Creek. Stream has limited capacity for supplying irrigation water.**

CAPABILITY UNIT I-1 (IRRIGATED)

This unit consists of deep, well-drained, nearly level soils on uplands. These soils have a medium textured surface layer and a medium textured or moderately fine textured subsoil. The surface of the soil is smooth, and leveling is easy. These soils are well suited to border, furrow, or sprinkler irrigation. Most of the irrigated acreage in the county is in this unit.

Proper use of irrigation water, maintaining an adequate level of fertility, protecting the soil structure, and controlling insects are the main management needs. Soil blowing is only slight. High-residue crops should be grown at least one-fourth of the time. Low-residue crops should not be grown for more than 4 consecutive years. Cover crops planted after row crops help to control soil blowing during the windy season.

Cotton is the main irrigated crop. Grain sorghum, tame pasture, alfalfa, and small grain are grown also.

CAPABILITY UNIT I-2 (IRRIGATED)

This unit consists of deep and moderately deep, well-drained, nearly level soils on uplands. The texture of the surface layer is medium, and the texture of the subsoil is medium, moderately fine, and fine. The surface of the soil is smooth, and leveling is easy. Permeability is slow or moderately slow.

These soils are suited to border and sprinkler irrigation, but only a small acreage is irrigated because a reliable supply of water is lacking.

The main management needs are preserving soil structure, maintaining fertility, and managing water properly. Soil structure and fertility can be maintained by returning crop residue to the soil, by fertilizing according to soil tests, and by minimum, but timely, tillage. High-residue crops should be grown at least one-fourth of the time. Low-residue crops should not be grown for more than 4 consecutive years.

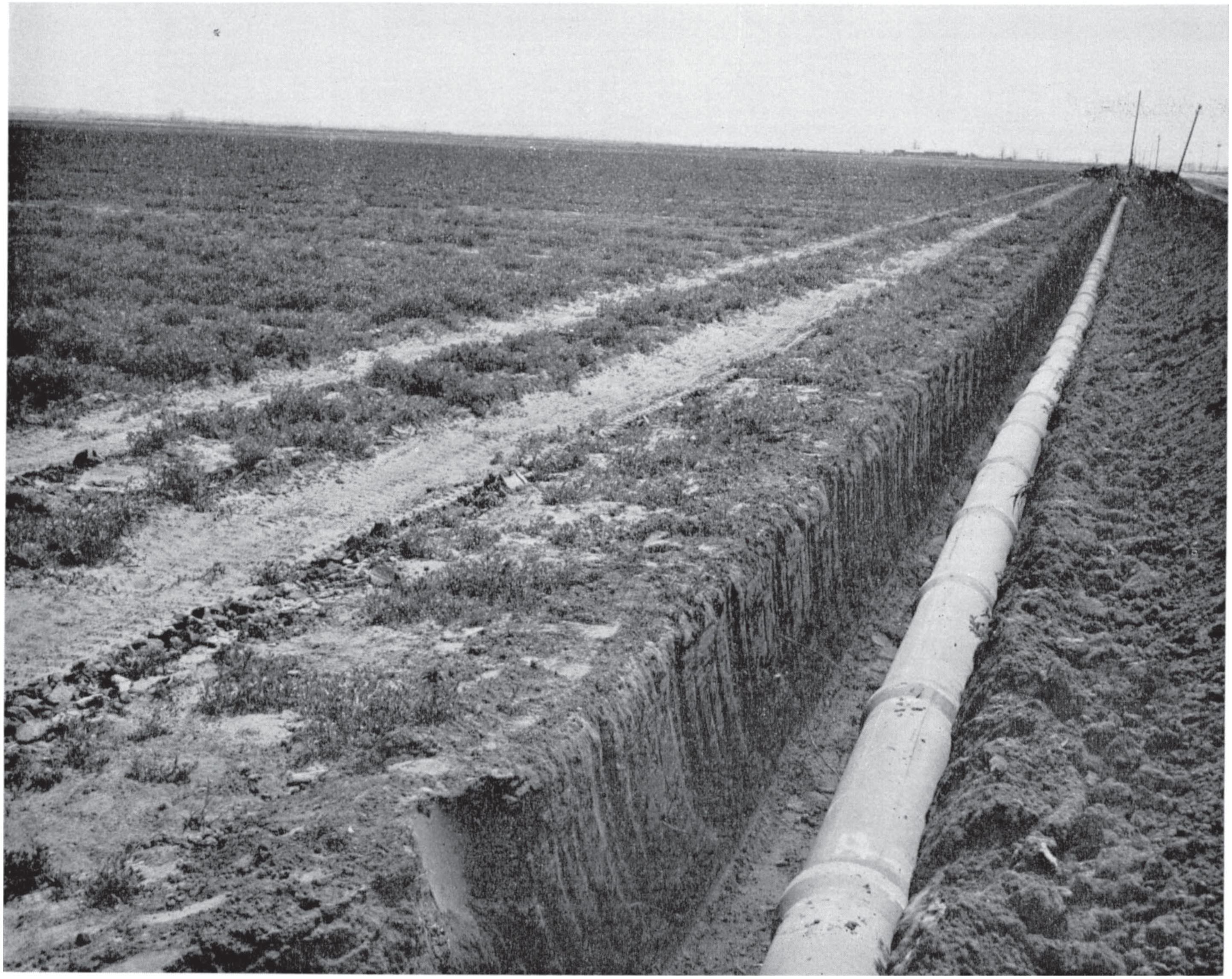

***Figure 12.*—Installing underground concrete pipe in Hardeman fine sandy loam, 0 to 1 percent slopes.**

Alfalfa, cotton, grain sorghum, small grain, and tame pasture are suited to these soils.

CAPABILITY UNIT IIe-1 (IRRIGATED)

This unit consists of deep, very gently sloping, well-drained soils on uplands. The surface layer is moderately coarse textured and medium textured. The subsoil is moderately coarse textured, medium textured, and moderately fine textured. Permeability is moderate, moderately rapid, or moderately slow.

The soils are suited to flood, border, and sprinkler irrigation. The extent of flood and border irrigation is limited because land leveling is more difficult on these very gently sloping soils.

Controlling moderate water erosion and soil blowing and maintaining soil structure and an adequate level of fertility are the main concerns in management. High-residue crops should be grown at least one-fourth of the time. A cropping system that provides for returning crop residue to the soil helps to reduce the hazards of soil blowing and water erosion. The residue also supplies the organic matter needed for maintaining soil structure and fertility. Low-residue crops should not be grown for more than 4 consecutive years. Crops on these soils respond well to fertilization.

Cotton, grain sorghum, small grain, alfalfa, and tame pasture grasses are the major crops grown. Special crops, such as orchard and garden crops, are well suited.

CAPABILITY UNIT IIe-2 (IRRIGATED)

This unit consists of deep, nearly level, well-drained soils on uplands. The texture of the surface layer is moderately coarse, and the texture of the subsoil is moderately coarse, medium, and moderately fine. Permeability is moderate or moderately rapid. Land leveling is not difficult.

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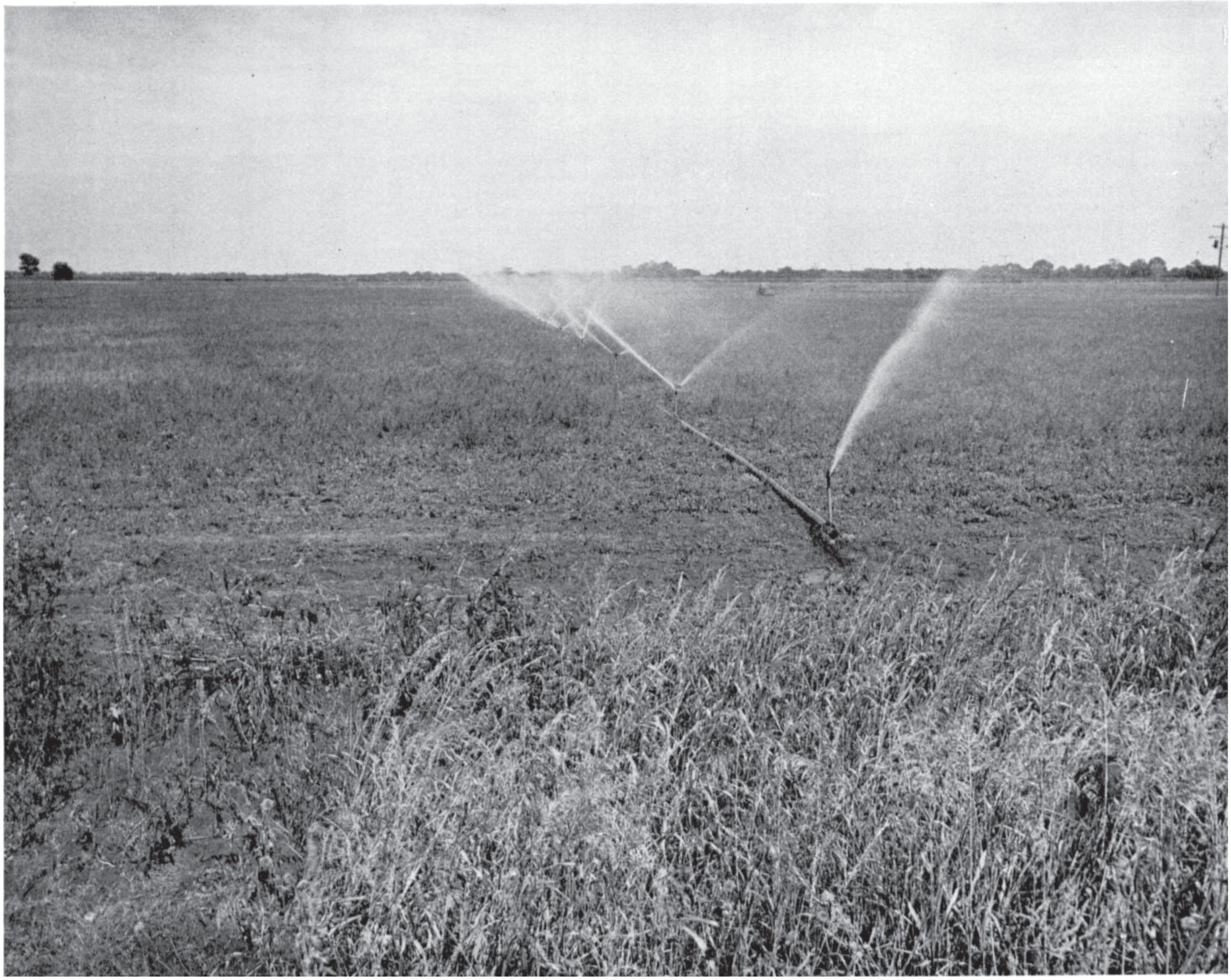

Figure 13.—**Sprinkler irrigation of alfalfa on Cyril fine sandy loam, mildly alkaline variant.**

These soils are easily tilled and respond well to management. They are well suited to border, furrow, or sprinkler irrigation, and a large acreage is irrigated.

The main needs in management are properly managing water and maintaining soil structure and a high level of fertility. Soil blowing is a hazard. High-residue crops should be grown at least one-fourth of the time. Low-residue crops should not be grown for more than 4 consecutive years. Cover crops should be planted following row crops to prevent soil blowing during windy seasons. Fertilization and insect control should be a part of irrigation farming.

The main irrigated crops are cotton, grain sorghum, alfalfa, and small grain. The soils are also suited to tame pasture and to orchard and garden crops.

CAPABILITY UNIT IIw-1 (IRRIGATED)

This unit consists of deep, well-drained, nearly level and gently sloping soils on flood plains. The texture of the surface layer and the subsoil is moderately coarse, medium, and moderately fine. Permeability is moderate. The slope and depth of the soil make land leveling practical.

Maintaining soil structure and controlling the hazards of soil blowing and overflow are concerns in management. Conservation-treated watersheds that include structures for flood control aid in reducing flood damage. High-residue crops should be grown at least one-fourth of the time. The residue should be worked into the surface layer to improve the soil structure, increase the level of fertility, and reduce the hazard of erosion. Low-residue crops should not be grown for more than 4 years in succession.

Crops on these soils respond well to fertilization, and fertilizer is needed to insure an economic return. Insect control is essential.

Alfalfa, grain sorghum, cotton, small grain, and tame pasture are suited to these soils when irrigated.

CAPABILITY UNIT IIs-1 (IRRIGATED)

The one soil in this unit, Foard silt loam, 0 to 1 percent slopes, is a deep, moderately well drained, very slowly permeable soil that is high in sodium content. It is on uplands. It has a medium-textured surface layer and a fine textured to moderately fine textured subsoil. Irrigation water is scarce and of poor quality. The thin surface layer and clayey subsoil make leveling difficult. Consequently, only a small acreage is irrigated. Borders, furrows, or sprinklers are suitable.

The main concerns in managing this soil are reducing the formation of a surface crust, increasing the water intake, and maintaining the soil structure. High-residue crops should be grown at least half the time. The residue should be returned to the soil and be worked into the surface layer. This practice reduces the tendency of the soil to form a crust and increases the rate of moisture intake. Low-residue crops should not be grown for more than 3 successive years. Fertilization improves crop yields and increases the amount of crop residue.

The main crops suited to this soil, where irrigated, are grain sorghum, small grain, cotton, bermudagrass for pasture, and alfalfa.

CAPABILITY UNIT IIIe-1 (IRRIGATED)

This unit consists of deep, gently sloping, well-drained soils on uplands. The texture of the surface layer is moderately fine, and the texture of the subsoil is moderately coarse, medium, or moderately fine. Permeability is moderate and moderately rapid. Sprinklers are the most suitable for irrigation, but special care is essential to avoid increasing the erosion hazard.

Controlling water erosion, maintaining soil structure, and maintaining adequate soil fertility are the main management concerns. High-residue crops should be grown at least half the time. The crop residue should be returned to the soil and worked into the surface layer to reduce the erosion hazard. This practice also improves the soil structure, increases the fertility level, and increases the rate of moisture intake. Low-residue crops should not be grown for more than 3 successive years. Diversion terraces are needed in places to intercept overhead water. Fertilization and insect control should be a part of irrigation farming.

Cotton, grain sorghum, and small grain are the main irrigated crops. Alfalfa and tame pasture are also suited.

CAPABILITY UNIT IIIe-2 (IRRIGATED)

This capability unit consists of deep, nearly level and very gently sloping, well-drained soils on uplands. The surface layer has a coarse texture, and the subsoil has a moderately coarse or a moderately fine texture. Permeability is moderate or moderately rapid. These soils are best suited to sprinklers.

Controlling soil blowing and maintaining adequate soil fertility are the main concerns in management. High-residue crops should be grown about two-thirds of the time. Large amounts of crop residue worked into the surface layer help in reducing the hazard of soil blowing. The residue also provides organic material, which maintains the fertility level and improves tilth. Low-residue crops should not be grown in consecutive years. A row crop should be followed by a winter cover crop to protect the soil against soil blowing. Plowing should be delayed as long as possible in spring, so that the freshly disturbed soil is not blown away during periods of high winds. Fertilization and insect control should be a part of irrigation farming.

Grain sorghum, cotton, and alfalfa are the main irrigated crops. Orchard and garden crops, small grain, and special crops are also suitable for irrigation.

CAPABILITY UNIT IIIe-3 (IRRIGATED)

This unit consists of deep, moderately deep, and shallow, very gently sloping soils on uplands. These soils are moderately well drained and well drained. The texture of the surface layer is medium, moderately fine, and fine, and the texture of the subsoil is fine and moderately fine. Permeability is very slow or slow.

These soils are in areas where irrigation water is of poor quality and limited quantity. Also, land leveling is impractical. The surface layer is too thin for cuts of more than 4 inches, and the shrink-swell potential of some of these soils is high. Consequently, only a small acreage is irrigated.

Controlling water erosion and improving soil structure to allow easier penetration by moisture and plant roots are management concerns. High-residue crops should be grown at least half the time, and the residue should be managed to improve soil structure and fertility. Low-residue crops should not be grown for more than 2 consecutive years. Applying fertilizer and controlling insects are important management practices in irrigation farming.

The soils in this unit are suited to grain sorghum, small grain, and tame pasture.

CAPABILITY UNIT IIIs-1 (IRRIGATED)

This unit consists of deep, nearly level, moderately well drained and well drained soils on flood plains. The surface layer has a fine texture and the subsoil a fine and moderately fine texture. These soils are occasionally flooded. Permeability is very low.

The fine-textured surface layer makes tillage difficult. Land leveling can be accomplished, but leveled soils require more fieldwork because they shrink and swell with changes in moisture content. Salinity reduces plant growth on some of these soils. These soils are suited to borders, furrows, and sprinklers, but they generally are remote from a reliable supply of water.

Among the management concerns are preventing crusting, increasing permeability, and protecting soil structure. High-residue crops should be grown two-thirds of the time, and crop residue should be returned to the soil and worked into the surface layer. This practice reduces surface crusting and increases the rate of moisture intake. Low-residue crops should not be grown in consecutive years. Fertilization and insect control are essential.

Grain sorghum, small grain, cotton, bermudagrass for pasture, and alfalfa are suitable crops for irrigation.

CAPABILITY UNIT IIIs-2 (IRRIGATED)

This unit consists of deep, nearly level soils on uplands and flood plains. The texture of the surface layer is medium and moderately fine, and the texture of the subsoil is medium, moderately fine, and fine. Permeability is very slow, moderately slow, or moderate.

Some of these soils have concentrations of harmful salts. Crop suitability varies. Many crops are not suited to these soils.

The harmful salts prevent the stored moisture from being readily available to plants. Border, furrow, or sprinkler irrigation systems are suited to these soils. Leveling these soils, however, is not feasible because the surface layer is thin and the salt-affected layers should not be exposed or spread over the surface. Only a small acreage of these soils is irrigated, because a reliable supply of water is lacking.

Reducing surface crusts, increasing the moisture intake, and improving soil structure and the level of fertility are the concerns in management. High-residue crops should be grown at least three-fourths of the time. The residue should be returned to the soil and worked into the surface layer to reduce surface crusting. This practice also improves the soil structure and increases the rate of moisture intake. Over a long period it increases the level of fertility and the supply of organic matter. Low-residue crops should not be grown in consecutive years. Fertilization and insect control are essential.

CAPABILITY UNIT IVe-1 (IRRIGATED)

Only Devol loamy fine sand, hummocky, is in this unit. It is a deep, well-drained, gently sloping and sloping soil on uplands. The surface layer is coarse textured, and the subsoil is moderately coarse textured. Permeability is moderately rapid. The uneven slopes make irrigation somewhat difficult. Sprinklers are the most feasible for irrigating.

Controlling soil blowing and water erosion and maintaining soil fertility are the main management concerns. Generally land shaping is desirable for better utilization and distribution of water. High-residue crops should be grown at least three-fourths of the time. Adequate amounts of crop residue should be left in and on the surface. This residue helps to control soil blowing, decreases the loss of water by evaporation, and provides organic matter for soil fertility and the improvement of soil structure. Fertilization and insect control are essential.

The principal crops grown on these soils are bermudagrass for pasture and sorghum grasses for cut hay or pasture. Grain sorghum is also suited.

CAPABILITY UNIT IVs-1 (IRRIGATED)

Only Lincoln soils, occasionally flooded, is in this unit. These are deep, somewhat excessively drained, nearly level and very gently sloping soils on flood plains. The texture of the surface layer is coarse, moderately coarse, and moderately fine. The subsoil is coarse textured. Permeability is rapid.

The water table generally is within 6 feet of the surface, but usually the quantity of water produced by this water table is not sufficient to support irrigation. Some irrigation systems operate through the use of a series of wells connected by one pump—a "sand-point system." These soils are suited only to sprinkler irrigation. Flood and border systems are not practical because water is unevenly distributed in sandy areas.

Controlling soil blowing, maintaining soil structure and a high level of fertility, and controlling infrequent overflow are concerns in management. High-residue crops should be grown at least half the time, and crop residue should be returned to the soil. Low-residue crops should not be grown for more than 3 years in succession. Flood damage can be reduced if conservation treatment is applied to all land in the watershed. Proper fertilization and insect control are essential.

The main crops are sorghum grass for cut hay or pasture, bermudagrass for pasture, grain sorghum, and alfalfa. Cotton and small grain are also suitable.

Predicted yields of irrigated crops

Predictions of average yields per acre of the principal crops grown on soils suited to irrigation in Tillman County are given in table 3. The yields shown are those that can be expected over a period of years and are for two levels of management.

In columns A are yields expected under a low level of management. The practices do not include use of definite cropping systems, growing crops that improve the soil, applying fertilizers, or efficient use of irrigation water.

In columns B are yields that can be expected under a high level of management. In this county high level of management includes (1) land leveling where applicable; (2) proper use of irrigation water; (3) proper tillage; (4) use of crop residue; (5) use of a cropping system that includes a soil improving crop; (6) use of commercial fertilizer; and (7) the use of improved varieties of adapted plants.

Use of the Soils for Range [3]

Range is land on which the natural plant community is composed principally of grasses, forbs, and shrubs valuable for grazing, in sufficient quantity to justify grazing use. About 26 percent of the acreage of Tillman County is native range on which domestic livestock is raised. The raising of beef cattle is the major livestock enterprise and includes cow-calf and feeder-steer systems. Ranges are commonly grazed the year around, and the forage is supplemented with protein and hay.

Conservation treatment of rangeland involves planning and applying range management and conservation practices, which can be classified in three broad groups as plant management practices, accelerating practices, and livestock control practices. Practices such as proper grazing use, deferred grazing, and rotation-deferred grazing relate to plant management. Range seeding, brush control, and other practices that specifically speed up the improvement of range cover over that obtained through grazing management alone are accelerating practices. The third group, livestock control practices, facilitates the handling of livestock and includes fencing, stock watering facilities, and other practices that result in better distribution of livestock.

Grazing systems should be scheduled so that enough cover remains to protect the soil and to keep an adequate quantity and quality of desirable plants. Repeated or prolonged overuse of a range site reduces the ability of the plants to produce deep roots, seeds, and new shoots that are essential for reproduction and maintaining the stand.

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[3] By GARY GERLOFF, range conservationist, Soil Conservation Service.

TABLE 3.—*Predicted average yields per acre of principal irrigated crops under two levels of management*

[Only the soils suitable for irrigation are listed. Figures in columns A indicate yields under low-level management; figures in columns B indicate yields under high-level management. Absence of a figure indicates crop is seldom grown or is not suited to the soil specified]

Soil	Alfalfa		Cotton		Grain sorghum		Wheat		Bermudagrass pasture	
	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Lb. of lint*	*Lb. of lint*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*A.U.M.*[1]	*A.U.M.*[1]
Abilene loam	3	5	650	850	70	108	36	54	6	12
Asa silt loam	4	6	650	850	70	108	36	54	6	12
Asa-Clairemont complex	3	5	450	600	40	75	25	35	4	9
Cyril fine sandy loam, mildly alkaline variant	4	6	600	775	70	100	35	50	6	12
Devol loamy fine sand, undulating	3	5	495	720	40	81	36	45	5	10
Devol loamy fine sand, hummocky	----	----	----	----	30	65	----	----	4	8
Devol fine sandy loam, 0 to 1 percent slopes	4	6	600	775	70	100	35	50	6	12
Foard silt loam, 0 to 1 percent slopes	3	5	550	800	30	70	30	40	4	9
Foard-Hinkle complex, 0 to 1 percent slopes	2	4	500	750	----	----	28	36	4.5	9
Grandfield loamy fine sand, 0 to 1 percent slopes	4	6	550	720	40	81	36	45	5	10
Grandfield loamy fine sand, undulating	3	5	500	650	40	75	30	40	5	10
Grandfield fine sandy loam, 0 to 1 percent slopes	4	6	610	800	70	110	30	50	6	12
Grandfield fine sandy loam, 1 to 3 percent slopes	4	6	550	750	54	100	27	45	6	10
Grandfield fine sandy loam, 3 to 5 percent slopes	3	5	500	700	40	70	30	40	4	8
Hardeman fine sandy loam, 0 to 1 percent slopes	4	6	600	800	70	108	36	54	6	12
Hardeman fine sandy loam, undulating	4	6	600	775	60	100	30	45	6	11
Hardeman fine sandy loam, 3 to 5 percent slopes	3	5	550	725	40	70	30	40	3	8
Hollister silt loam, 0 to 1 percent slopes	3	5	650	800	70	108	36	54	6	12
Indiahoma silty clay loam, 1 to 3 percent slopes	----	----	----	----	30	60	25	40	6	10
Lincoln soils, occasionally flooded	3	5	500	750	50	90	25	45	6	12
Miller clay	3	5	550	800	50	85	35	50	5	10
Miller clay, saline	2	4	500	750	36	72	27	45	4.5	9
Minco very fine sandy loam, 0 to 1 percent slopes	4	6	650	850	70	108	36	54	6	12
Minco very fine sandy loam, 1 to 3 percent slopes	4	6	600	800	60	100	30	45	6	11
Port silty clay loam	4	6	650	850	70	108	36	54	6	12
Quanah silt loam, 0 to 1 percent slopes	3	5	650	850	70	108	36	54	6	12
Roscoe clay	2	4	500	720	60	100	36	54	5	10
St. Paul silt loam, thin surface, 1 to 3 percent slopes	3	5	600	750	60	95	35	50	6	10
St. Paul-Hinkle complex, 0 to 1 percent slopes	3	5	500	700	30	70	25	35	4	8
Tillman and Foard soils, 1 to 3 percent slopes	----	----	----	----	45	75	30	40	5	10
Tipton fine sandy loam, 0 to 1 percent slopes	4	6	600	800	70	108	36	54	6	12
Tipton fine sandy loam, 1 to 3 percent slopes	4	6	600	775	60	100	30	45	6	11
Tipton loam, 0 to 1 percent slopes	4	6	650	850	70	110	36	54	6	12
Tipton loam, 1 to 3 percent slopes	4	6	600	800	60	100	30	45	6	11
Vernon soils, 1 to 3 percent slopes	----	----	----	----	35	60	25	35	3	7
Yahola soils, occasionally flooded	4	6	600	800	70	105	35	50	6	12

[1] Animal-unit-month is a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of months a pasture can be grazed during a single grazing season without injury to the sod. An acre of pasture that provides 2 months of grazing for two cows has a carrying capacity of 4 animal-unit-months.

Experienced range managers generally recognize signs of improvement or decline in range condition and adjust management to fit the condition.

One of the chief objectives of good range management is to keep the range in excellent condition, or at least in good condition. When this is done, moisture is conserved, yields are maintained or improved, and the soil is protected against deterioration. It is essential to be able to recognize important changes in the kind of cover on a range site. The changes are so gradual that they are often overlooked or misunderstood. Lush growth, encouraged by heavy rain, may lead to the conclusion that the range site is in good condition and improving. Actually, this type of cover is often weedy and the long-term trend is toward a condition that will afford less forage. On the other hand, range in excellent condition that is being closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that conceals its quality.

Specific information about the stocking of range is not included in this publication. Technical personnel of the local agricultural agencies can help ranchers in classifying range, in estimating its condition, and in determining the number of animals the range can support.

Range sites and condition classes

Effective range management requires knowledge of the capabilities of the different kinds of soil and the kinds and amounts of herbage that can be produced. It also requires the ability to evaluate the present condition of a range site in relation to its potential for production.

For the purpose of classifying range resources, soils are grouped in range sites. Each site has a distinctive potential plant community. The composition of the plant community depends on a combination of environmental factors, among which are soil and climate. The potential plant community, or climax vegetation, reproduces itself so long as the environment remains undisturbed.

Range condition refers to the composition of the existing native vegetation on a given site in relation to what the site is capable of producing. It is expressed in terms of condition classes.

The condition of a range site is classified according to the percentage of the present vegetation that is climax vegetation. The purpose of a range condition class is to establish a basis for predicting the degree of improvement possible under good management. The four range condition classes are defined in the paragraphs that follow.

A range site is in *excellent* condition if 76 to 100 percent of the present vegetation is of the same kind as the potential plant community for the site. It is in *good* condition if the percentage is between 51 and 75, in *fair* condition if the percentage is between 26 and 50, and in *poor* condition if the percentage is 25 or less.

A range site in excellent condition is at or near its maximum productivity. It has a plant cover that adequately protects the soil, encourages the absorption of moisture, and helps maintain an adequate level of fertility.

The plants of a specific range site are grouped, according to their response to prolonged heavy grazing, as *deceasers*, *increasers*, and *invaders*.

Decreasers are plants in the climax vegetation that decrease in abundance under continued, excessive grazing. These plants are generally the most productive and most palatable perennials.

Increasers are plants that generally become more abundant as the decreasers decline. Increasers are normally less palatable and less productive than decreasers.

Invaders are plants that are not part of the climax community or that do not grow naturally on a specific soil. These plants invade as a result of various kinds of disturbances. They may be woody or herbaceous annuals or perennials. They are less productive and less palatable than the climax plants of the site. Invaders may come from an adjoining site or from a great distance.

Descriptions of range sites

In the descriptions of range sites that follow are the significant soil characteristics pertinent to range productivity, the names of the principal native plants where the site is in good condition, and the species to be expected on a site that has declined to poor condition.

The annual herbage yields are estimates based on clippings made near the end of the growing season on sites in excellent condition. The weights given are of air-dry herbage clipped at ground level. Shrub and tree yields were not included.

ALKALI BOTTOMLAND SITE

This site consists of deep, nearly level and very gently sloping soils on flood plains. These soils are loamy throughout. They have a high concentration of toxic salts in the surface layer or the subsoil or both.

The vegetation is limited to plants that are tolerant of droughtiness and alkali salts. The dominant plants vary, depending on the severity of the effects of the alkali. Among the characteristic plants are rhomopod, whorled dropseed, inland saltgrass, alkali sacaton, western wheatgrass, white tridens, and blue grama.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 3,200 pounds in years of favorable moisture conditions and 1,800 pounds in years of unfavorable moisture conditions.

DEEP SAND SITE

This site consists of deep, nearly level to sloping, sandy soils on uplands. These soils have a loamy or sandy subsoil (fig. 14). The undulating to hummocky relief is one of low sand dunes and narrow valleys between the dunes.

Under the best of conditions the main grasses are sand bluestem, little bluestem, and switchgrass. Because of fluctuating yields on this site, stocking the range with a base herd presents a difficulty. If this site is overgrazed, skunkbrush, sand sagebrush, sand dropseed, sandbur, and annuals become dominant.

When this site is in excellent condition, the estimated annual yield of air-dry herbage per acre is 3,700 pounds when moisture conditions are favorable and 1,400 pounds when they are unfavorable.

DUNE SITE

This site consists of Likes fine sand, hilly, a deep, strongly sloping to steep soil on uplands. This soil is sandy throughout. The relief is one of sand dunes and narrow valleys between the dunes. This soil is fairly stable, but when overgrazed it becomes susceptible to blowing.

If areas of this range site are in poor or fair condition they sometimes require complete protection from grazing until the range cover is restored. Increased stands of blowout grass, giant sandreed, little bluestem, and sand bluestem indicate that the condition of a dune is improving.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 1,900 pounds in years of adequate moisture supply and 800 pounds in years when moisture supply is inadequate.

ERODED CLAYS SITE

This site consists of Vernon soils, 3 to 8 percent slopes, severely eroded. These are moderately deep and shallow, gently sloping and sloping, clayey and loamy soils on uplands. They have a clayey and loamy subsoil.

Among the predominant plants on this site are side-oats grama, blue grama, and western wheatgrass. Continued overgrazing allows pricklypear cactus and mesquite to invade. Deferred grazing throughout the summer is sometimes essential to protect the soils against erosion.

When in excellent condition, the average annual yield of air-dry herbage per acre is 1,500 pounds in years when soil moisture is adequate and 800 pounds per acre in years when it is inadequate.

ERODED RED CLAY SITE

This site consists of Badland, which is a strongly sloping to moderately steep mixture of clay and shale outcrops on uplands (fig. 15). The surface is mostly barren and has broken fragments of exposed rock. Most of the rainwater is lost as runoff. Badland is droughty.

Productivity on this site is very low. Grasses are chiefly buffalograss, vine-mesquite, side-oats grama, blue grama, and Texas grama. Mesquite has invaded most of these sites.

Figure 14.—**Typical landscape of Deep Sand range site in fair condition. The soil is Likes loamy fine sand, hummocky.**

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 600 pounds in years with sufficient rain and 200 pounds in years without sufficient rain.

HARDLAND SITE

This site consists of deep and moderately deep, nearly level to gently sloping, loamy or clayey soils on uplands. These soils have a clayey or loamy subsoil. Some have concentrations of sodium that restrict the variety of plants and limit their growth.

In most places the site supports short grasses, mainly blue grama and buffalograss. About 60 percent of the climax vegetation consists of side-oats grama, blue grama, western wheatgrass, vine-mesquite, and tall dropseed. Little bluestem, sand bluestem, and other tall grasses grow in areas where water concentrates. Continuous overgrazing allows many annual grasses, pricklypear cactus, and mesquite trees to invade.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 2,800 pounds in years of favorable moisture conditions and 1,500 pounds in years of unfavorable moisture conditions.

HEAVY BOTTOMLAND SITE

This site consists of deep, nearly level, clayey soils on flood plains. These soils have a clayey or loamy subsoil. Some are saline, which affects plant selection and limits growth.

A large amount of the climax vegetation on this site consists of grasses that grow in cool seasons, mainly wildryes. The principal decreasers are switchgrass, indiangrass, big bluestem, eastern gamagrass, and little bluestem. Increasers are mainly side-oats grama, blue grama, and buffalograss. Among the invading grasses are silver bluestem, tumble windmillgrass, and annual brome. Trees and brush grow where overflow is most frequent.

When this site is in excellent condition, the average

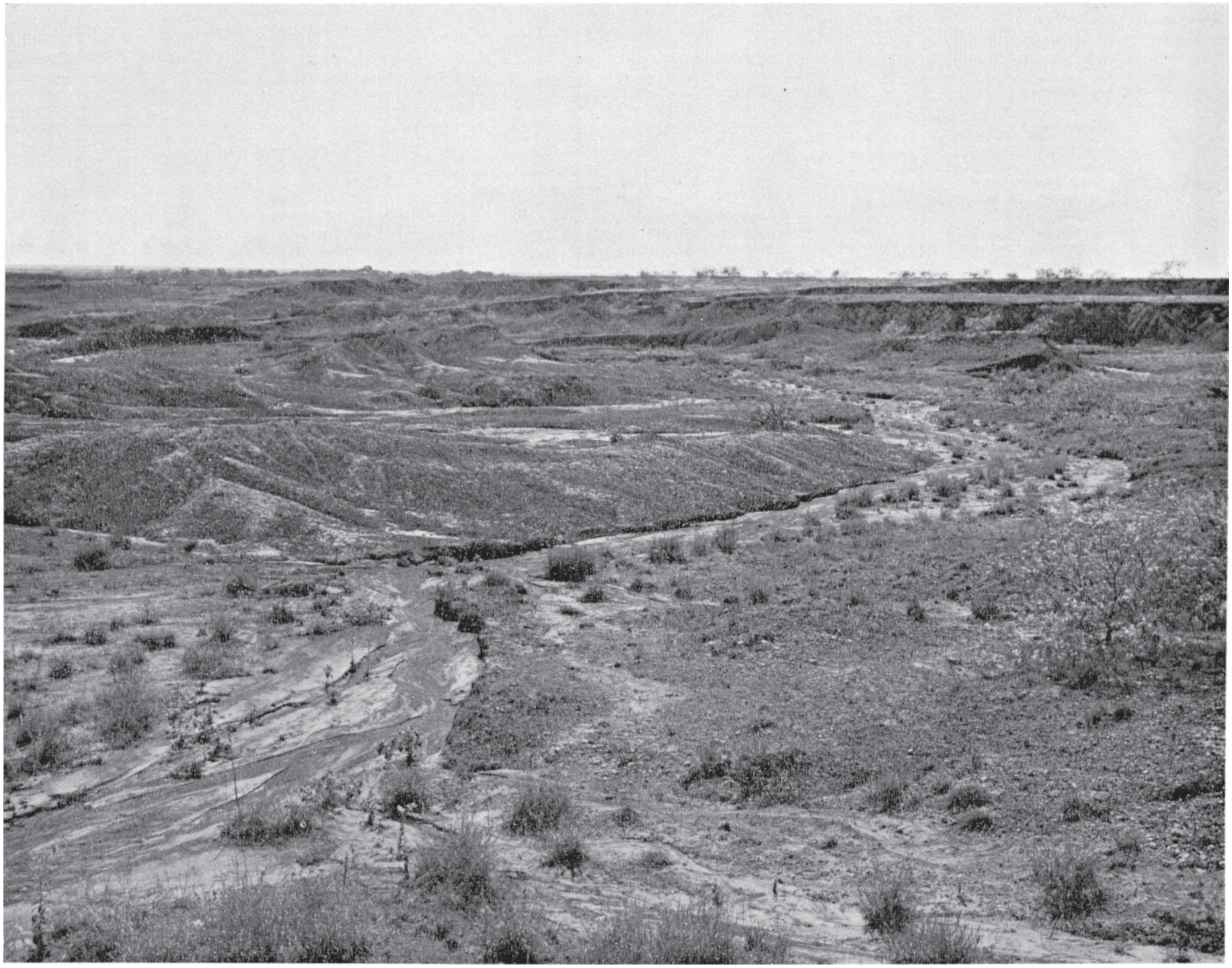

Figure 15.—**Typical landscape of Badland-Vernon complex in Eroded Red Clay range site.**

annual air-dry herbage per acre is 4,500 pounds in years when the supply of moisture is favorable and 2,000 pounds in years when it is unfavorable.

HILLY STONY LAND SITE

This site consists of Rock land, a land type that is 35 to 90 percent granite outcrops and 10 to 50 percent very shallow, gently sloping to moderately steep loamy soil material on uplands. Most of the rainwater received is lost as runoff.

Big bluestem and little bluestem are dominant grasses in the deep soil pockets. Hairy grama is the major decreaser on the shallow soil material. An important part of the vegetation is made up of forbs, greenthread, and black sampson.

When this site is in excellent condition, the average annual air-dry herbage per acre is 1,800 pounds in years when moisture conditions are favorable and 1,000 pounds in years when they are not favorable.

LOAMY BOTTOMLAND SITE

This site consists of deep, nearly level and very gently sloping soils on flood plains. These soils are loamy throughout.

Trees, grasses, and forbs grow well on this site. The climax vegetation consists of tall and mid grasses, such as big bluestem, eastern gamagrass, indiangrass, switchgrass, Canada wildrye, Virginia wildrye, and western wheatgrass. Among the woody plants are pecan, elm, oak, hackberry, and cottonwood. Some areas of this site have deteriorated and are covered by less palatable and less productive grasses, such as silver bluestem, meadow dropseed, annual bromes, and buffalograss.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 5,500 pounds in years of favorable moisture conditions and 2,000 pounds in years of unfavorable moisture conditions.

LOAMY PRAIRIE SITE

This site consists of deep and moderately deep, nearly level and very gently sloping soils on uplands (fig. 16). These soils are loamy throughout.

When this site is in good condition or better, it has a cover that is mostly sand bluestem, indiangrass, little bluestem, switchgrass, and other tall grasses. If the range is overgrazed, blue grama, side-oats grama, and buffalograss increase, and the tall grasses decrease. Under continued grazing, silver bluestem, three-awn, windmillgrass, and similar invader grasses become dominant.

When this site is in excellent condition, the average annual air-dry herbage per acre is 4,200 pounds in years when soil moisture is favorable and 1,800 pounds in years when it is not favorable.

RED CLAY PRAIRIE RANGE SITE

This site consists of shallow, moderately deep and deep, very gently sloping to moderately steep, clayey or loamy soils on uplands. These soils have a clayey or loamy subsoil.

Little bluestem and side-oats grama are among the principal decreasers. Western wheatgrass, switchgrass, and vine-mesquite grow where moisture is adequate. Common invaders are annual three-awn, Japanese bromegrass, little barley, and other less desirable weedy grasses and forbs. Continued overuse of the range results in barren areas and the invasion of pricklypear cactus and mesquite trees.

To improve the vegetation, grazing should be deferred during the growing season. Recovery of the vegetation generally is slow because the soils are droughty.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 2,200 pounds in years of favorable moisture conditions and 1,000 pounds in years of unfavorable moisture conditions.

Figure 16.—**Loamy Prairie range site in excellent condition. The soil is Minco very fine sandy loam, 1 to 3 percent slopes.**

494-879—74——5

SANDY BOTTOMLAND SITE

This site consists of deep, nearly level and very gently sloping loamy or sandy soils on flood plains. The subsoil is sandy. The water table is sometimes within the root zone.

This site normally supports switchgrass, sand bluestem, indiangrass, little bluestem, and other tall grasses. Woody increasers are cottonwood, willow, saltcedar, and associated species. If the range is overgrazed, short grasses and sand sagebrush increase.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 3,000 pounds in years of favorable moisture conditions and 1,800 pounds in years of unfavorable moisture conditions.

SANDY PRAIRIE SITE

This site consists of deep and moderately deep, nearly level to moderately steep soils on uplands. These soils are loamy throughout.

Sand bluestem, indiangrass, switchgrass, and little bluestem are the principal decreasers. Side-oats grama and blue grama are the main increasers. Sand plum and skunkbrush are common woody invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 4,000 pounds in years when the soil moisture is favorable and 2,000 pounds in years when it is not favorable.

SLICKSPOT SITE

This site consists of deep, nearly level and very gently sloping, loamy soils on uplands. These soils have a clayey or loamy subsoil and are high in sodium content. The concentration of sodium salts restricts the variety of plants and limits their growth.

Alkali sacaton, blue grama, and white tridens are the principal decreasers. Whorled dropseed and fall witchgrass are common increasers. Rhombopod, curlycup gumweed, and pricklypear cactus are the principal invaders.

When this site is in excellent condition, the average annual yield of air-dry herbage per acre is 1,800 pounds in years of favorable moisture conditions and 800 pounds in years of unfavorable moisture conditions.

Windbreaks and Postlots [4]

Natural stands of commercial woodland make up less than 1 percent of Tillman County. Cottonwood, pecan, American elm, willow, hackberry, ash, mulberry, and redcedar are native to the county.

Windbreaks are needed principally for protection of farmsteads and livestock. Two to five rows of trees and shrubs are considered effective. Postlots should be established only on those soils on which rapid tree growth is possible.

Black locust, catalpa, and bois-d'arc (Osage-orange) are the trees commonly planted in postlots. Some landowners also value red (native) mulberry. Black locust will grow on most soils suitable for postlots. Catalpa should be planted only on loamy soils on bottom land.

The soils of Tillman County have been grouped and rated according to their capacity to produce noncommercial trees for windbreaks and postlots. Each group is made up of soils that are similar in characteristics affecting rate of tree growth and development, that are suitable for the same kinds of trees, and that present similar difficulties connected with establishing and maintaining the plantings.

The four windbreak-postlot groups are described in the following paragraphs. The management needed in establishing and maintaining windbreaks and postlots is suggested for each group. The Guide to Mapping Units shows the group to which each soil in the county has been assigned.

WINDBREAK-POSTLOT GROUP 1

This group consists of deep, nearly level to gently sloping, loamy and sandy soils on flood plains and uplands. These soils have slight limitations for windbreaks and postlots.

The suitability of these soils for tree growth is good. Windbreaks and postlots can be established successfully.

For the tall row in windbreaks, such trees as Siberian or Asiatic elm, cottonwood, and sycamore are suitable. Trees of intermediate height are black locust, hackberry, green ash, bois-d'arc, and Russian (white) mulberry. Among the suitable evergreens for intermediate rows are Austrian pine, ponderosa pine, and eastern redcedar.

If a shrub row is desired, desert willow, tamarisk (saltcedar), and low-growing varieties of arborvitae are suitable. Sandhill plum is a suitable shrub on the sandy soils. Russian mulberry, if planted at closer than normal spacing, is effective in the shrub row. It should be severely toppruned at the age of about 5 years and about every 3 years thereafter. Bois d'arc can be planted in outside rows and the posts can be harvested. The prolific sprouting that follows post cutting produces a thick wind barrier.

All the soils in this group are suitable for postlots of black locust. All are suitable for bois-d'arc. The soils on flood plains are especially well suited to catalpa. Cottonwood, which has potential for commercial production, is suited to the soils on flood plains.

WINDBREAK-POSTLOT GROUP 2

This grup consists of deep, nearly level and very gently sloping, sandy and loamy soils on uplands and flood plains. These soils have moderate limitations for windbreaks and postlots.

The suitability of these soils for tree growth is fair. Field and farmstead windbreaks can be established and grown.

For the tall row in windbreaks, Siberian and Asiatic elm are suited. Suitable trees of intermediate height are black locust, hackberry, green ash, Russian mulberry Austrian pine, ponderosa pine, and eastern redcedar. Some of the shrubs suited to these soils are desert willow, tamarisk, and low-growing varieties of arborvitae.

All the soils are suited to postlots of black locust. Catalpa should be planted only on the flood plains.

WINDBREAK-POSTLOT GROUP 3

This group consists of deep and moderately deep, nearly level to steep, loamy, sandy, and clayey soils on uplands and flood plains. These soils have severe limita-

[4] Prepared with the assistance of CHARLES P. BURKE, woodland conservationist, Soil Conservation Service.

tions for windbreaks and postlots, and their suitability for tree growth is poor.

Farmstead windbreaks can be established and grown, but the survival rate is generally low, growth is slow, and life expectancy is short.

For the tall row in the windbreak, Siberian and Asiatic elm are suited. Suitable trees of intermediate height are black locust, hackberry, green ash, Russian mulberry, Austrian pine, ponderosa pine, and eastern redcedar. Shrubs suited to these soils are desert willow, tamarisk, and low-growing varieties of arborvitae.

Bois-d'arc can be grown for posts on the loamy and clayey soils, but growth generally is very slow.

WINDBREAK-POSTLOT GROUP 4

This group consists of shallow, moderately deep and deep, nearly level to moderately steep, loamy and clayey soils on uplands and flood plains. These soils have very severe limitations for windbreaks and postlots.

The suitability of these soils for tree growth generally is very poor. Establishing windbreaks and postlots is not practical.

Wildlife Habitat [5]

The wildlife population of any area depends upon the availability of food, cover, and water in a suitable combination. Habitat is established, improved, or maintained by establishing desirable vegetation and developing water supplies in suitable places.

In table 4 each of the soils in Tillman County is rated according to its suitability for elements of wildlife habitat and three classes of wildlife. These ratings refer only to the suitability of the soil and do not take into account the climate, the present use of the soil, or the distribution of wildlife and human populations. The suitability of individual sites has to be determined by onsite inspection.

The soils are rated well suited, suited, poorly suited, and unsuited.

Well suited means that habitat generally is easily created, improved, or maintained; that the soil has few or no limitations that affect management; and that satisfactory results can be expected.

Suited means that habitat can be created, improved, or maintained in most places; that the soil has moderate limitations that affect management; and that moderate intensity of management and fairly frequent attention are required for satisfactory results.

Poorly suited means that habitat can be created, improved, or maintained in most places; that the soil has severe limitations; that habitat management is difficult and expensive and requires intensive effort; and that results are not always satisfactory.

Unsuited indicates that it is impractical or impossible to create, improve, or maintain a habitat and that unsatisfactory results are probable.

The column heading "Grain and seed crops" refers to corn, sorghum, millet, soybeans, and other grain-producing or seed-producing annual plants.

"Grasses and legumes" refers to those that are established by planting that furnish food and cover for wildlife. Suitable species for planting are weeping lovegrass, Johnsongrass, native grass, ryegrass, and panicgrass. Among the suitable legumes are clover, annual lespedeza, and brush lespedeza.

"Wild herbaceous upland plants" refers to native or introduced perennial grasses, forbs, and weeds that provide food and cover for upland wildlife. Examples of these are beggarweed, perennial lespedeza, western ragweed, foxtail millet, wild bean, pokeberry, and cheatgrass.

"Hardwood woody plants" refers to nonconiferous trees, shrubs, and woody vines that produce fruits, nuts, buds, catkins, or foliage (browse) used extensively as food by wildlife. These plants generally become established through natural processes, but may be planted. Species are oak, elm, cottonwood, Chittam, black locust, sand plum, sumac, Osage-orange, Russian-olive, mulberry, hackberry, grape, greenbrier, and pecan.

"Coniferous woody plants" are cone-bearing trees and shrubs that are used mainly as cover but may furnish food in the form of browse, seeds, or fruitlike cones. They become established through natural processes or may be planted. Examples are pines, cedars, and ornamentals.

"Wetland food and cover plants" are annual and perennial wild herbaceous plants, except submersed or floating aquatics, that grow on moist or wet sites. These plants furnish food or cover mostly for wetland wildlife. Some examples are smartweed, barnyard grass, wild millet, spikerush and other rushes, sedges, and burreed.

"Shallow water developments" are those where low dikes and water-control structures are established to create habitat principally for waterfowl. They may be so designed that they can be drained, planted, and flooded, or they may be used as permanent impoundments to grow submersed aquatics. Both fresh water and brackish water impoundments are considered.

"Ponds" are locations where water of suitable depth and quality can be impounded for fish production as one of the primary uses.

"Openland wildlife" refers to quail, dove, cottontail rabbit, jack rabbit, coyote, fox, meadowlark, field sparrow, and other birds and mammals that normally live on cropland, pasture, meadow, lawn, and in other openland areas where grasses, herbs, and shrubby plants grow.

"Woodland wildlife" refers to squirrel, deer, raccoon, wild turkey, and other birds and mammals that normally live in wooded areas where hardwood trees and shrubs and coniferous trees grow.

"Wetland wildlife" refers to ducks, geese, rail, heron, shore birds, mink, muskrat, and other mammals and birds that normally live in wet areas, marshes, and swamps.

Engineering Uses of the Soils [6]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

[5] By JEROME F. SYKORA, biologist, Soil Conservation Service.

[6] By HARRY A. ELAM, engineer, Soil Conservation Service.

TABLE 4.—*Suitability of soils for elements of*

[Ratings are explained in the text. An asterisk in the first column indicates that at least one mapping unit in the series is made up of two instructions for

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grass and legumes	Wild herbaceous upland plants	Hardwood woody plants
Abilene: Ab	Well suited	Well suited	Well suited	Poorly suited
*Asa: As, At, Ax	Suited	Well suited	Well suited	Suited
For Clairemont part of At, see Clairemont series; for Oscar part of Ax, see Oscar series.				
*Badland: Bv.				
Variable material; varying suitability. For Vernon part of Bv, see Vernon series.				
Clairemont: Ca, Ce	Suited	Well suited	Well suited	Suited
Cyril, mildly alkaline variant: Cy	Suited	Well suited	Well suited	Well suited
Devol: DeB, DeC, DfA	Suited	Suited	Well suited	Poorly suited
*Foard: FdA, FhA	Well suited	Well suited	Well suited	Poorly suited
For Hinkle part of FhA, see Hinkle series.				
Grandfield: GnA, GnB, GrA, GrB, GrC	Well suited	Well suited	Well suited	Poorly suited
Hardeman: HaA, HaB, HaC, HaE	Well suited	Well suited	Well suited	Poorly suited
Hilgrave, calcareous variant: HgE	Suited	Suited	Suited	Poorly suited
Hinkle	Well suited	Well suited	Well suited	Poorly suited
Mapped only with Foard, St. Paul, and Tillman soils.				
Hollister: HoA	Well suited	Well suited	Well suited	Poorly suited
Indiahoma: InB, InC	Well suited	Well suited	Well suited	Poorly suited
Likes:				
LdC	Suited	Suited	Suited	Poorly suited
LkE	Poorly suited	Suited	Suited	Poorly suited
Lincoln:				
Ln	Unsuited	Suited	Suited	Poorly suited
Lo	Poorly suited	Suited	Suited	Poorly suited
Miller: Mc, Me	Suited	Suited	Suited	Suited
Minco: MnA, MnB	Well suited	Well suited	Well suited	Poorly suited
Oscar	Suited	Suited	Suited	Suited
Mapped only with Asa soils.				
Port: Po	Suited	Well suited	Well suited	Well suited
Quanah: QuA	Well suited	Well suited	Well suited	Poorly suited
Rock land: Ro.				
Variable material; varying suitability.				
Roscoe: Rs	Suited	Suited	Suited	Poorly suited
Stamford: SmC2	Well suited	Well suited	Well suited	Poorly suited
*St. Paul: SpB, StA, StB	Well suited	Well suited	Well suited	Poorly suited
For Hinkle part of StA and StB, see Hinkle series.				
*Tillman: TfB, ThB	Well suited	Well suited	Well suited	Poorly suited
For Foard part of TfB, see Foard series; for Hinkle part of ThB, see Hinkle series.				
Tillman, moderately shallow variant: TeC	Well suited	Well suited	Well suited	Poorly suited
Tipton: TpA, TpB, TtA, TtB	Well suited	Well suited	Well suited	Poorly suited
*Vernon: VeB, VeC, VeC2, VeD3, VmE, Vn.	Suited	Suited	Suited	Unsuited
For Clairemont part of Vn, see Clairemont series.				
Weymouth: WeC	Suited	Well suited	Well suited	Poorly suited
Yahola:				
Ya	Poorly suited	Well suited	Well suited	Well suited
Yh	Suited	Suited	Well suited	Well suited

[1] Pond reservoir.

wildlife habitat and kinds of wildlife

or more kinds of soil. Since the different soils in a unit may have different properties and limitations, it is important to note and follow the referring to other series]

Elements of wildlife habitat—Continued				Kinds of wildlife		
Coniferous woody plants	Wetland food and cover plants	Shallow water developments	Ponds	Openland wildlife	Woodland wildlife	Wetland wildlife
Poorly suited	Unsuited	Suited	Suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Poorly suited	Well suited	Suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Suited [1]	Well suited	Suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Poorly suited	Well suited	Well suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Poorly suited	Suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Suited	Well suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Poorly suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Unsuited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Well suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Suited	Well suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Well suited	Well suited	Poorly suited	Unsuited.
Suited	Unsuited	Unsuited	Unsuited	Suited	Poorly suited	Unsuited.
Suited	Unsuited	Unsuited	Unsuited	Suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Poorly suited [1]	Suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Poorly suited	Suited	Poorly suited	Unsuited.
Poorly suited	Poorly suited	Poorly suited	Well suited [1]	Suited	Suited	Poorly suited.
Poorly suited	Unsuited	Unsuited	Poorly suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Suited [1]	Suited	Suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Suited [1]	Well suited	Well suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Poorly suited	Suited	Well suited	Suited	Poorly suited	Poorly suited.
Poorly suited	Unsuited	Unsuited	Well suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Well suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Unsuited	Well suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Suited	Suited	Poorly suited	Unsuited.
Unsuited	Unsuited	Unsuited	Well suited	Suited	Unsuited	Unsuited.
Poorly suited	Unsuited	Unsuited	Poorly suited	Well suited	Poorly suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Unsuited	Suited	Well suited	Unsuited.
Poorly suited	Unsuited	Poorly suited	Unsuited	Suited	Well suited	Unsuited.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational sites.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-county movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5, 6, and 7, which show, respectively, estimates of soil properties significant in engineering, interpretations for various engineering uses, and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in table 6, and it can also be used to make other useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables. Also, inspection of sites, especially the small

TABLE 5.—*Estimated soil*

[No column for "Depth to seasonal high water table" is included, because the depth is more than 6 feet in all but three mapping units; the series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, table. The sign> means "more than;" the sign< means "less than"]

Soil series and map symbols	Hydrologic soil group	Depth to bedrock	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO
		Inches	*Inches*			
Abilene: Ab	C	40->60	0–11	Loam	ML-CL or CL	A-4
			11–68	Clay loam	CL or ML	A-6 or A-7
*Asa: As, At, Ax. For Clairemont part of At, see Clairemont series; for Oscar part of Ax, see Oscar series.	B	>60	0–7	Silt loam	CL-ML or ML	A-4
			7–50	Silty clay loam	CL or ML-CL	A-6
*Badland: Bv[1]. Properties of Badland too variable for reliable estimates; for Vernon part of unit, see Vernon series.						
Clairemont: Ca, Ce	B	>60	0–50	Silty clay loam	ML-CL	A-6
Cyril, mildly alkaline variant: Cy	B	>60	0–66	Fine sandy loam	SM or ML	A-2 or A-4
Devol: DeB, DeC, DfA	B	>60	0–14	Loamy fine sand	SM	A-2
			14–40	Fine sandy loam	SM or ML	A-2 or A-4
			40–64	Loamy fine sand	SM	A-2
*Foard: FdA, FhA. For Hinkle part of FhA, see Hinkle series.	D	>60	0–7	Silt loam	ML or CL	A-4 or A-6
			7–70	Clay	CL or CH	A-7
Grandfield: GnA, GnB, GrA, GrB, GrC	B	>72	0–28	Fine sandy loam	SM or ML	A-2 or A-4
			28–48	Sandy clay loam	SC or CL	A-4
			48–70	Fine sandy loam	SM or ML	A-4 or A-2
Hardeman: HaA, HaB, HaC, HaE	B	>60	0–80	Fine sandy loam	SM or ML	A-4
Hilgrave, calcareous variant: HgE	B	30–52	0–24	Gravelly loam	GM	A-2 or A-1
			24–38	Gravelly sandy loam	GM	A-2 or A-1
			38–52	Gravelly loamy sand	GM or GW	A-2 or A-1

See footnote at end of table.

ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have meanings in soil science that may not be familiar to engineers. The Glossary defines these terms.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*7*) used by the Soil Conservation Service engineers, Department of Defense, and others, and the AASHO system (*1*) adopted by the American Association of State Highway Officials.

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, ML–CL.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest.

The U.S. Department of Agriculture system of classifying soils according to texture is primary for farm use,

properties significant in engineering

Lincoln, Ln and Lo, 3 to 5 feet; and Yahola, Ya, 0 to 1 foot. An asterisk in the first column indicates that at least one mapping unit in and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of the

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH*	
100	100	85–98	60–75	0. 63– 2. 0	0. 12–0. 16	6. 1–6. 5	Low.
100	100	90–100	70–80	0. 06– 0. 20	0. 15–0. 19	6. 6–8. 4	Moderate.
100	100	90–100	70–90	0. 63– 2. 0	0. 14–0. 18	7. 9–8. 4	Low.
100	100	95–100	80–95	0. 63– 2. 0	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	95–100	85–95	0. 63– 2. 0	0. 15–0. 19	7. 9–8. 4	Moderate.
100	90–100	70–85	30–55	0. 63– 2. 0	0. 09–0. 13	7. 4–7. 8	Low.
100	100	80–100	15–35	2. 0 – 6. 3	0. 06–0. 13	6. 6–7. 8	Low.
100	100	80–100	30–60	2. 0 – 6. 3	0. 09–0. 13	6. 6–8. 4	Low.
100	100	80–100	15–35	2. 0 – 6. 3	0. 06–0. 13	7. 4–8. 4	Low.
100	100	90–100	70–92	0. 63– 2. 0	0. 14–0. 18	6. 6–7. 3	Low.
100	100	90–100	90–98	<0. 06	0. 14–0. 18	7. 9–8. 4	High.
100	100	85–96	30–60	2. 0 – 6. 3	0. 09–0. 13	6. 1–7. 8	Low.
100	100	90–100	40–60	0. 63– 6. 3	0. 12–0. 16	7. 4–7. 8	Low.
100	100	90–100	30–60	2. 0 – 6. 3	0. 09–0. 13	7. 9–8. 4	Low.
100	100	85–100	40–65	2. 0 – 6. 3	0. 09–0. 13	7. 4–8. 4	Low.
60–75	60–75	40–50	20–30	2. 0 – 6. 3	0. 09–0. 12	7. 9–8. 4	Low.
50–60	50–60	20–30	15–25	2. 0 – 6. 3	0. 05–0. 08	7. 9–8. 4	Low.
50–60	50–60	10–30	5–20	6. 3 –20. 0	0. 03–0. 05	7. 9–8. 4	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Hydrologic soil group	Depth to bedrock	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO
		Inches	*Inches*			
Hinkle. Mapped only in complexes with Foard, St. Paul, and Tillman soils.	D	40–60	0–6	Silt loam	ML or CL–ML	A–4
			6–72	Clay	CL or CH	A–7
Hollister: HoA	D	60–75	0–11	Silt loam	ML or CL–ML	A–4
			11–26	Silty clay loam	CL or ML–CL	A–6 or A–7
			26–72	Clay	CL or CH	A–7
Indiahoma: InB, InC	D	>60	0–10	Silty clay loam	CL or ML–CL	A–6 or A–7
			10–60	Clay	CH or MH	A–7
Likes: LdC, LkE	A	>60	0–15	Loamy fine sand	SM	A–2
			15–68	Fine sand	SP–SM	A–3 or A–2
Lincoln: Ln, Lo	A	>60	0–11	Loamy fine sand	SM	A–2
			11–60	Fine sand	SP–SM	A–2
Miller: Mc, Me	D	>60	0–58	Clay	MH or CH	A–7
Minco: MnA, MnB	B	>60	0–71	Very fine sandy loam	ML	A–4
Oscar. Mapped only in complex with Asa soils.	D	>60	0–7	Silt loam	ML or CL–ML	A–4
			7–15	Silty clay loam	CL or ML–CL	A–6 or A–7
			15–60	Clay	ML or CL–ML	A–6 or A–7
Port: Po	B	>60	0–72	Silty clay loam	CL or ML	A–6 or A–7
Quanah: QuA	B	20–40	0–24	Silt loam	ML or CL–ML	A–4
			24–72	Silty clay loam	CL or ML–CL	A–6
Rock land: Ro. Properties of Rock land too variable for reliable estimates.						
Roscoe: Rs	D	>60	0–70	Clay	CL or CH	A–7
Stamford: SmC2	D	>60	0–5	Silty clay	CL or ML–CL	A–6 or A–7
			5–50	Clay	CL or CH	A–7
*St. Paul: SpB, StA, StB. For Hinkle part of StA and StB, see Hinkle series.	B	>60	0–11	Silt loam	ML or CL	A–4
			11–24	Silty clay loam	ML or CL	A–6 or A–7
			24–64	Clay loam	CL or ML	A–6 or A–7
*Tillman: TfB, ThB. For Foard part of TfB, see Foard series; for Hinkle part of ThB, see Hinkle series.	C	60–>80	0–11	Silt loam	ML or CL–ML	A–4
			11–72	Clay	CL or CH	A–7
Tillman, moderately shallow variant: TeC.	C	30–60	0–7	Silt loam	ML or CL–ML	A–4
			7–40	Clay	CL or C	A–7 or A–6
Tipton: TpA, TpB, TtA, TtB	B	>60	0–21	Loam	ML or ML–CL	A–4
			21–40	Clay loam	CL or ML	A–6
			40–72	Loam	ML or CL	A–4 or A–6
*Vernon: VeB, VeC, VeC2, VeD3, VmE, Vn. For Clairemont part of Vn, see Clairemont series.	D	14–30	0–6	Silty clay loam	CL or ML	A–6 or A–7
			6–18	Clay	CL or CH	A–7
Weymouth: WeC	B	20–40	0–12	Loam	ML or CL	A–4
			12–40	Clay loam	ML or CL	A–6
Yahola: Ya, Yh	B	>60	0–14	Clay	CL or ML	A–6 or A–7
			14–33	Fine sandy loam	SM or ML	A–2 or A–4
			33–60	Fine sand	SP or SM	A–3

[1] Soils are subject to flooding.

significant in engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH*	
100	100	90–100	70–90	0. 63– 2. 0	0. 14–0. 18	6. 6–8. 4	Low.
100	100	90–100	85–95	<0. 06	0. 14–0. 18	7. 4–8. 4	Moderate or high.
100	100	90–100	70–90	0. 63– 2. 0	0. 14–0. 18	7. 4–7. 8	Low.
100	100	95–100	85–95	0. 20– 0. 63	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	90–100	85–95	0. 06– 0. 20	0. 14–0. 18	7. 9–8. 4	High or moderate.
100	100	95–100	85–95	0. 06– 0. 20	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	90–100	85–95	<0. 06	0. 14–0. 18	7. 9–8. 4	High.
100	100	50–75	13–30	2. 0 – 6. 3	0. 06–0. 09	6. 6–7. 8	Low.
100	100	60–80	5–12	6. 3 –20. 0	0. 04–0. 06	7. 4–8. 4	Low.
100	100	50–75	15–30	6. 3 –20. 0	0. 06–0 09	7. 9–8. 4	Low.
100	100	60–80	5–10	6. 3 –20. 0	0. 04–0. 06	7. 9–8. 4	Low.
100	100	90–100	85–95	<0. 06	0. 14–0. 18	7. 9–8. 4	High.
100	100	90–100	60–80	0. 63– 2. 0	0. 12–0. 16	6. 6–8. 4	Low.
100	100	90–100	70–95	0. 20– 0. 63	0. 14–0. 18	6. 1–7. 3	Low.
100	100	95–100	85–95	0. 06– 0. 20	0. 15–0. 19	7. 4–7. 8	Moderate.
100	100	90–100	70–95	0. 06– 0. 20	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	97–100	85–95	0. 63– 2. 0	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	90–100	70–90	0. 63– 2. 0	0. 14–0. 18	7. 9–8. 4	Low.
100	100	95–100	85–95	0. 20– 0. 63	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	90–100	85–95	<0. 06	0. 14–0. 18	7. 9–8. 4	High.
100	100	90–100	85–95	0. 06– 0. 20	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	90–100	85–95	<0. 06	0. 14–0. 18	7. 9–8. 4	High.
100	100	90–100	75–90	0. 63– 2. 0	0. 14–0. 18	7. 4–7. 8	Low.
100	100	95–100	85–95	0. 20– 0. 63	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	90 100	75–95	0. 20– 0. 63	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	95–100	75–90	0. 20– 0. 63	0. 14–0. 18	7. 4–7. 8	Low.
100	100	90–100	85–95	<0. 06	0. 14–0. 18	7. 4–8. 4	High.
100	100	95–100	75–90	0. 20– 0. 63	0. 14–0. 18	7. 4–7. 8	Low.
100	100	90–100	85–95	<0. 06	0. 14–0. 18	7. 4–8. 4	High.
100	100	90–100	55–85	0. 63– 2. 0	0. 12–0. 16	6. 6–7. 8	Low.
100	100	90–100	70–85	0. 63– 2. 0	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	90–100	60–85	0. 63– 2. 0	0. 12–0. 16	7. 9–8. 4	Low.
100	100	95–100	85–95	0. 06– 0. 20	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	90–100	85–95	0. 06– 0. 20	0. 14–0. 18	7. 9–8. 4	High.
100	100	90–100	55–85	0. 63– 2. 0	0. 12–0. 16	7. 9–8. 4	Low.
100	100	90–100	65–85	0. 63– 2. 0	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	90–100	75–95	2. 0 – 6. 3	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	70–85	30–55	2. 0 – 6. 3	0. 09–0. 13	7. 9–8. 4	Low.
100	100	65–80	5–12	6. 3 – 20. 0	0. 04–0. 06	7. 9–8. 4	Low.

TABLE 6.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soils in for referring to other series that

Soil series and map symbols	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Farm ponds: Reservoir area
Abilene: Ab	Fair: thickness of suitable material.	Fair: moderate shrink-swell potential.	Moderate traffic-supporting capacity.	Features favorable except soil is nearly level.
*Asa: As, At, Ax. For Clairemont part of At, see Clairemont series; for Oscar part of Ax, see Oscar series.	Good or fair: material variable.	Fair: moderate shrink-swell potential.	Moderate traffic-supporting capacity; flooding.	Moderate seepage potential; flooding.
*Badland: Bv. No interpretations; material variable; for Vernon part of Bv, see Vernon series.				
Clairemont: Ca, Ce	Fair: thickness of suitable material.	Fair: moderate shrink-swell potential.	Moderate traffic-supporting capacity; flooding.	Moderate seepage potential.
Cyril, mildly alkaline variant: Cy	Good: easily eroded on steep slopes.	Good to fair: variable material; traffic-supporting capacity.	Flooding	Moderate seepage potential.
Devol: DeB, DeC, DfA	Poor to good: thickness of suitable material.	Good	Features generally favorable; erodible on slopes.	High seepage potential.
*Foard: FdA, FhA. For Hinkle part of FhA, see Hinkle series.	Poor: thickness of suitable material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable except soil is nearly level.
Grandfield: GnA, GnB, GrA, GrB, GrC	Good to fair: thickness of suitable material.	Good to fair: low shrink-swell potential.	Features generally favorable; high to moderate traffic-supporting capacity.	Moderate seepage potential.
Hardeman: HaA, HaB, HaC, HaE	Good: erodible on slopes.	Good to fair: low shrink-swell potential.	High to moderate traffic-supporting capacity; slopes erodible.	Moderate seepage potential; some steep slopes.
Hilgrave, calcareous variant: HgE	Poor: gravelly material.	Good	Features favorable except for slopes.	High seepage potential.
Hinkle. Mapped only with Foard, St. Paul, and Tillman soils.	Poor: dispersed soil material.	Poor: highly dispersed material; moderate or high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable.
Hollister: HoA	Fair: thickness of suitable material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable except soil is nearly level.
Indiahoma: InB, InC	Poor: thickness of suitable material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable.
Likes: LdC, LkE	Poor: sandy material.	Good	Slopes subject to moderate erosion; other features favorable.	High seepage potential.

interpretations

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions appear in the first column of the table]

Soil features affecting—Continued				
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Fair slope stability	Well drained	Slow permeability	Slow permeability; nearly level.	Features favorable.
Fair slope stability; medium compressibility.	Well drained	Flooding	Flooding	Flooding.
Fair slope stability; medium compressibility.	Well drained; flooding	Flooding; saline in places.	Flooding; saline in places.	Flooding.
Fair slope stability	Well drained; flooding	Flooding; medium or high available water capacity.	Flooding	Flooding.
Fair stability; seepage potential.	Well drained	Moderately rapid permeability; medium or high available water capacity.	Surface texture	Soil blowing and water erosion hazards.
High compressibility; dispersed material; piping.	Moderately well drained; very slow permeability.	Very slow permeability; high sodium content.	Very slow permeability; nearly level.	Vegetation difficult to establish.
Fair slope stability; medium compressibility.	Well drained	Moderate to moderately rapid permeability; medium or high available water capacity.	Surface texture	Soil blowing hazard.
Fair slope stability	Well drained	Moderately rapid permeability.	Moderately rapid permeability.	Soil blowing and water erosion hazards.
High seepage potential	Well drained	Moderately rapid permeability; medium available water capacity.	Sloping to moderately steep.	Sloping to moderately steep.
Unstable; highly dispersed material; piping.	Moderately well drained; very slow permeability.	Very slow permeability; high sodium content.	Poor stability; dispersed material.	Vegetation difficult to establish.
Fair slope stability; high compressibility.	Well drained	Slow permeability	Slow permeability	Features favorable.
Fair slope stability; high compressibility.	Well drained	Very slow permeability	Very slow permeability	Vegetation difficult to establish.
High seepage potential; erodible.	Excessively drained	Moderately rapid permeability; low or medium available water capacity.	Sandy texture	Erosion hazard.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Farm ponds: Reservoir area
Lincoln: Ln, Lo	Poor: sandy material.	Good	Flooding	High seepage potential; flooding.
Miller: Mc, Me	Poor: clayey material.	Poor: high shrink-swell potential.	Flooding; low traffic-supporting capacity.	Soil is nearly level; flooding.
Minco: MnA, MnB	Good	Good	Moderate traffic-supporting capacity.	Moderate seepage potential.
Oscar. Mapped only with Asa soils.	Poor: dispersed soil material.	Poor: dispersed soil material; high sodium content.	Flooding; unstable material.	Flooding; soil is nearly level.
Port: Po	Good	Fair: moderate shrink-swell potential.	Flooding; moderate traffic-supporting capacity.	Flooding; moderate seepage potential.
Quanah: QuA	Fair: thickness of suitable material.	Fair: moderate traffic-supporting capacity.	Moderate traffic-supporting capacity.	Moderate seepage potential; soil is nearly level.
Rock land: Ro. No interpretations. Material too variable.				
Roscoe: Rs	Poor: clayey material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable except soil is nearly level.
Stamford: SmC2	Poor: clayey material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable.
*St. Paul: SpB, StA, StB. For Hinkle part of StA and StB, see Hinkle series.	Fair: thickness of suitable material.	Fair: moderate shrink-swell potential.	Moderate traffic-supporting capacity.	Moderate seepage potential.
*Tillman: TfB, ThB. For Foard part of TfB, see Foard series; for Hinkle part of ThB, see Hinkle series.	Fair to poor: thickness of suitable material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable.
Tillman, moderately shallow variant: TeC	Fair to poor: thickness of suitable material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable.
Tipton: TpA, TpB, TtA, TtB	Good	Fair: moderate shrink-swell potential.	Moderate traffic-supporting capacity.	Moderate seepage potential.
*Vernon: VeB, VeC, VeC2, VeD3, VmE, Vn. For Clairemont part of Vn, see Clairemont series.	Poor: clayey material.	Poor: high shrink-swell potential.	Low traffic-supporting capacity.	Features favorable.
Weymouth: WeC	Fair: thickness of suitable material.	Fair: moderate shrink-swell potential.	Moderate traffic-supporting capacity.	Moderate seepage potential.
Yahola: Ya, Yh	Good to fair: stratified material.	Good to fair: stratified material.	Flooding	High seepage potential; flooding.

interpretations—Continued

Soil features affecting—Continued				
Farm ponds—Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
High seepage potential; erodible.	Somewhat excessively drained; flooding.	Rapid permeability; flooding; low or medium available water capacity.	Sandy texture in control section; flooding.	Flooding.
Fair slope stability; high compressibility.	Well drained to moderately well drained; flooding.	Very slow permeability; flooding.	Soil is nearly level; flooding.	Flooding.
Fair slope stability; medium compressibility.	Well drained	Features favorable	Features favorable	Features favorable.
Unstable; dispersed material; subject to piping.	Moderately well drained; flooding.	Slow permeability; flooding; high sodium content.	Soil is nearly level; unstable material.	Flooding; vegetation difficult to establish.
Fair slope stability; medium compressibility.	Well drained; flooding	Flooding	Soil is nearly level; flooding.	Flooding.
Fair slope stability; medium compressibility.	Well drained	Features favorable	Soil is nearly level	Features favorable.
Fair slope stability; high compressibility.	Moderately well drained; very slow permeability.	Very slow permeability	Soil is nearly level; very slow permeability.	Soil is nearly level; concave slopes.
Fair slope stability; high compressibility.	Well drained	Very slow permeability	Very slow permeability	Vegetation difficult to establish.
Medium compressibility; fair slope stability.	Well drained	Features favorable	Features favorable	Features favorable.
Fair slope stability; high compressibility.	Well drained	Very slow permeability	Very slow permeability	Vegetation difficult to establish.
Fair slope stability; high compressibility.	Well drained	Very slow permeability	Very slow permeability	Vegetation difficult to establish.
Fair slope stability; medium compressibility.	Well drained	Features favorable	Features favorable	Features favorable.
Fair slope stability; high compressibility.	Well drained	Slow permeability; medium available water capacity.	Shallow and moderately deep soils; very gently sloping to strongly sloping.	Vegetation difficult to establish.
Fair slope stability; medium compressibility.	Well drained	High or medium available water capacity.	Features favorable	Features favorable.
High seepage potential.	Well drained; flooding	Moderately rapid permeability; flooding.	Moderately rapid permeability; flooding.	Flooding.

TABLE 7.—*Engineering*

[Tests performed by Oklahoma Department of Highways in accordance with standard

Soil name and location	Parent material	Oklahoma report number SO—	Depth	Shrinkage: Limit	Shrinkage: Ratio	Shrinkage: Volume change from field moisture equivalent
			Inches	*Percent*	*Percent*	*Percent*
Abilene loam: About 1,320 feet north and 1,160 feet west of the southeast corner of sec. 25, T. 1 S., R. 18 W.	Loamy and clayey sediment.	5 736	0–8	15	1. 81	15
		5 737	17–28	9	2. 02	55
		5 738	54–62	10	1. 98	50
Foard silt loam, 0 to 1 percent slopes: About 400 feet east and 750 feet south of the northwest corner of sec. 14, T. 2 S., R. 15 W.	Loamy and clayey sediment.	5 750	0–8	14	1. 83	22
		5 751	8–16	10	2. 03	59
		5 752	37–50	8	2. 08	62
Hardeman fine sandy loam, 0 to 1 percent slopes: About 200 feet south and 50 feet east of the northwest corner of sec. 35, T. 3 S., R. 19 W.	Loamy sediment.	5 739	0–10	[2] NP	NP	NP
		5 740	16–34	NP	NP	NP
Tipton loam, 0 to 1 percent slopes: About 1,800 feet south and 200 feet east of the northwest corner of sec. 13, T. 2 S., R. 19 W.	Loamy sediment.	5 745	0–10	15	1. 78	13
		5 746	19–35	13	1. 86	23
		5 747	66–80	14	1. 84	27
Vernon soils, 3 to 5 percent slopes: About 120 feet east and 50 feet north of the southwest corner of sec. 9, T. 2 S., R. 15 W.	Clays and shale.	5 748	0–6	11	1. 92	51
		5 749	6–18	11	1. 96	54

[1] Mechanical analyses according to the AASHO Designation: T88–57(*1*). Results by this procedure may differ somewhat from results 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

but the textural classification is useful in engineering also. In this system, soils are classified according to the proportional amounts of different sizes of mineral particles. A soil that is 40 percent clay particles, for example, is called clay. Beginning with the largest, the particle sizes are designated as cobblestones, gravel, sand, silt, and clay. Rarely does a soil consist of particles of only one size, but in many places particles of one size are dominant. Soil texture is a characteristic closely associated with workability, fertility, permeability, erodibility, and other important soil characteristics.

Table 7 shows the AASHO and Unified classifications for tested soils in the county. Table 5 shows classification of all soils in the county according to all three systems of classification.

Estimated soil properties significant in engineering

In table 5 the soil series of the county and their map symbols are listed and certain properties significant in engineering are described. The estimates in the columns headed "Depth from surface" and "USDA texture" are based on a modal profile, or a representative profile for the soil series. The estimates in the remaining columns cover the range for the series in this county. For the soils in the county that were tested, estimates in table 5 are based on the test data listed in table 7. For the other soils, estimates are based on test data obtained from similar soils in the county and in other counties and on past experience in engineering.

In determining the hydrologic group, the entire soil profile is considered. The soils are classified in four hydrologic groups—A, B, C, and D. The basis of the grouping is the intake of water at the end of a storm of long duration and the characteristics of the soil after prior wetting and opportunity for swelling, without consideration of the protective effect of vegetation. Group A consists mostly of sandy soils that have the lowest runoff potential. Group D consists mostly of clays that have the highest runoff potential.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary.

Permeability, as used in this table, refers only to the downward movement of water through undisturbed soil material. The estimates are based on structure and porosity of the soil as it occurs in place. Such features as plowpans and surface crust were not considered.

test data

procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis [1]						Liquid limit	Plasticity index	Classification	
Percentage passing sieve—			Percentage smaller than—					AASHO	Unified
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.				
						Percent			
100	98	72	60	22	19	25	8	A-4(7)	CL
100	98	80	65	37	33	42	22	A-7-6(13)	CL
100	96	74	63	35	30	40	21	A-6(12)	CL
100	100	92	84	29	23	30	13	A-6(9)	CL
100	99	93	84	44	39	48	26	A-7-6(16)	CL
100	99	94	82	47	41	46	27	A-7-6(16)	CL
100	99	61	39	10	9	NP	NP	A-4(5)	ML
100	99	55	39	11	10	NP	NP	A-4(4)	ML
100	98	73	53	19	15	25	7	A-4(8)	ML-CL
100	98	75	60	28	25	31	14	A-6(10)	CL
100	99	81	68	26	24	33	15	A-6(10)	CL
100	97	89	80	38	32	43	21	A-7-6(13)	CL
100	98	94	88	61	51	50	27	A-7-6(17)	CL

millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soil.

[2] Nonplastic.

Available water capacity, given in terms of inches per inch of soil, is the approximate amount of capillary water in the soil when it is wet to field capacity. When the amount of moisture in the soil is at the wilting point of plants, the amount of water shown in the table will wet the soil material described to a depth of 1 inch without further percolation.

Reaction is expressed in terms of pH value. A pH of 4.5 to 5.0 indicates very strong acidity, and a pH of 9.1 or higher indicates very strong alkalinity.

The shrink-swell potential indicates the change in volume to be expected when the moisture content changes. It is estimated primarily on the basis of the amount and kind of clay in a soil.

Engineering interpretations

Table 6 gives interpretations of engineering properties of the soils and estimates of the suitability of the soils for engineering uses. The data apply to the soil considered representative of the series. A detailed representative profile of each series is described in the section "Descriptions of the Soils." Some soil features are favorable for certain kinds of engineering work but unfavorable for others. The column headings in table 6 are explained in the following paragraphs.

Topsoil is soil material used to cover or resurface an area where vegetation is to be established and maintained. Properties considered are those that affect the productivity and workability of the soil material and the amount of suitable material available.

Road fill, or subgrade, is soil material on which a subbase is laid and the pavement is built. Suitability ratings are based on the performance of the soil material as subgrade when excavated and compacted or compacted and used in place. No specific values should be inferred from the estimates of traffic-supporting capacity.

Highway location refers to suitability for trafficways that consist of the underlying local soil material (called the subgrade), the base material of gravel, crushed rock, or cement-stabilized soil (called the subbase); and the actual road surface or pavement, either flexible or rigid. No specific values should be inferred from the estimates of traffic-supporting capacity.

Pond reservoirs are areas behind a dam or embankment where water is collected and stored for use. The floor of the reservoir area is normally undisturbed except where soil material may be borrowed for embankment construction.

Pond embankments are raised structures of soil material constructed across drainageways in order to impound water. The embankments are generally less than 20 feet high, are constructed of "homogeneous" soil material, and are compacted to medium density.

Agricultural drainage is the removal of excess water from the soil. Considered are those features and qualities of the soil that affect the installation and performance of surface and subsurface drainage practices.

Irrigation is the artificial application of water to cropland by a sprinkler system or by overland flow.

Terraces and diversions are low ridges or channels constructed on the approximate contour to divert runoff water to a safe disposal area.

Grassed waterways are natural drainageways lined with suitable vegetation and maintained for the purpose of conveying excess water.

Engineering test data

Table 7 shows the results of testing on samples taken from five soils in the county. Selected layers of the soils were sampled, and the samples were tested by the Oklahoma Department of Highways according to standard procedures. The samples tested were taken from profiles considered modal for the series. They do not represent all of the soils of Tillman County, or even the maximum range of characteristics of each series sampled.

Volume change from field moisture equivalent is the volume change, expressed as a percentage of the dry volume of the soil mass, when the moisture content is reduced from the moisture equivalent to the shrinkage limit. The field moisture equivalent is the minimum moisture content at which a smooth soil surface will absorb no more water within 30 seconds when the water is added in individual drops. This is the moisture content required to fill all the pores in sands and to approach saturation in cohesive soils.

Shrinkage limit is the percent moisture at which a soil ceases to decrease in volume, even though additional moisture is removed.

Shrinkage ratio is the relation of change in volume of the soil material to the water content of the soil material when at the shrinkage limit. The change in volume is expressed as a percentage of the weight of the soil material when ovendry.

Mechanical analysis shows the percentages, by weight, of soil particles that pass through sieves of specified sizes. Sand and other coarser materials do not pass through the No. 200 sieve. Silt is that material larger than 0.002 millimeter in diameter that passes through the No. 200 sieve, and clay is that fraction passing through the No. 200 sieve that is smaller than 0.002 millimeter in diameter. The clay fraction was determined by the hydrometer method, rather than by the pipette method most soil scientists use in determining the clay in soil samples.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from semisolid to plastic. If the moisture content is further increased, the material changes from plastic to liquid. The plastic limit is the moisture content at which the soil material passes from semisolid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. 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 plastic.

Formation and Classification of the Soils

This section describes the major factors of soil formation and tells how these factors have affected the soils of Tillman County. It briefly describes the system of soil classification used in the United States and shows the series classification of the soils of the county according to that system.

Factors of Soil Formation

The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors of soil formation. They act on the parent material accumulated through weathering and bring about the development of genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the nature of the profile and determines some of the characteristics. Finally, time is needed to change the parent material into a soil. It may be much or little, but generally much time is required to develop a profile that has distinct horizons.

The five factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made. A variation in any one of the factors results in a different kind of soil.

Parent material

Parent material is weathered, unconsolidated material from which a soil forms. In many soils, it is considered to be similar to the C horizon. It affects the color, texture, natural fertility, and other characteristics of the soil.

The two general types of parent material in Tillman County are residual and alluvial material. About two-thirds of the land area of Tillman County is underlain by sediments of Permian age (*3*). These sediments are considered residual. The main soils that formed in these deposits are those of the Abilene, Foard, Hollister, Indiahoma, Tillman, and Vernon series.

Deposits of Quaternary age have influenced soil formation in about one-third of the county. The Quaternary system is represented in this county by deposits of alluvium on flood plains along the major streams, and by older loamy and sandy alluvial deposits on uplands (*3*).

The main soils that developed in the alluvium on flood plains are those of the Asa, Clairemont, Cyril, Lincoln, Miller, and Yahola series. The flood plain deposits are generally less than 40 feet thick.

The main soils that formed in the older loamy and sandy deposits of Quaternary age on uplands are Devol, Grandfield, Hardeman, Minco, and Tipton. These deposits are approximately 50 feet thick.

Climate

The temperate, continental climate of Tillman County is characterized by rains of high intensity. Moisture and warm temperatures have been sufficient to promote the formation of distinct horizons in many of the soils. Differences in soils, however, cannot be attributed to climate, because the climate is uniform throughout the county. Heavy rains have caused rapid runoff that has eroded some of the soils. This erosion is an indirect effect of climate.

For a more complete description of the climate, refer to the section "Climate" on page 61.

Plant and animal life

Plants and animals are active in soil formation. Plants and micro-organisms grow in the weathered parent material and help break down rock structure and produce organic residue. As the residue is produced, an organic layer (the A1 horizon) is formed.

The organic layer is the most fertile part of the soil. It is the part that man comes in direct contact with in the planting and tilling of crops. It is the layer in which bacteria, fungi, and other micro-organisms decompose organic matter, convert humus to simpler forms, liberate plant nutrients, and fix nitrogen. Large organisms, such as earthworms, contribute to the translocation of plant residue, to aeration, and to the development of soil structure.

The kind and amount of vegetation regulate the thickness of the A1 horizon, and have a direct effect on its structure. The dominant vegetation in more than half of the county is mid and short grasses. Mid and tall grasses are the dominant vegetation over about one-third of the county. Grasses result in the formation of a dark-colored A1 horizon, like that of Tipton soils.

Trees and tall grasses are the dominant vegetation of the bottom lands in the county. Trees have had little effect on the development of soils in this county.

Relief

Relief affects the formation of soil through its influence on soil moisture, drainage, erosion, soil temperature, and plant cover. The relief features of Tillman County are determined largely by the varying degrees to which the underlying material resists weathering and geologic erosion.

About 33 percent of Tillman County consists of nearly level soils on uplands; 40 percent consists of very gently sloping and gently sloping soils on uplands; 12 percent is sloping to steep soils on uplands; and about 15 percent is soils on flood plains.

The effects of relief are evident in Hollister and Vernon soils, which formed from similar parent material but have different soil characteristics. Hollister soils are nearly level and have little surface runoff. Vernon soils are very gently sloping to strongly sloping and have much surface runoff. The stronger the slope, the more the rainwater runs off instead of moving through the soil and promoting the development of a deeper solum.

Time

Time, as a factor in soil formation, cannot be measured strictly in years. The length of time required for a soil to develop genetic horizons depends on the intensity and interactions of the soil-forming factors that promote losses, gains, transfers, and interreactions of soil constituents necessary for the formation of soil horizons. Soils that have no distinct genetic horizons are young or immature. Mature or older soils have approached equilibrium with their environment and tend to have well defined horizons.

The soils of Tillman County range from young to old. Some of the older soils in Tillman County are Hollister and Tillman soils. These soils are deep and have well expressed horizons. Clairemont and Yahola soils are on flood plains; they have been forming for a short time and show little horizon differentiation.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research.

Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories, so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*4*). The system currently used by the National Cooperative Soil Survey (*5*) was developed in the early sixties; it was adopted in 1965, and supplemented in March 1967 and in September 1968. The system is under continual study, and readers interested in the development of the system should refer to the latest literature available.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 8 shows the classification of each soil series of the county by family, subgroup, and order, according to the current system. All six categories of the classification system are explained in the following paragraphs.

ORDER.—Soils are grouped into orders according to properties that seem to have resulted from the same processes acting to about the same degree on the parent material. Ten soil orders are recognized in the current system: Alfisols, Aridisols, Entisols, Histosols, Inceptisols, Mollisols, Oxisols, Spodosols, Ultisols, and Vertisols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates. Five of the ten soil orders are represented in Tillman County. These are Alfisols, Entisols, Inceptisols, Mollisols, and Vertisols.

Alfisols have a clay-enriched B horizon that is high

TABLE 8.—*Classification of the soil series by higher categories*

Series	Family	Subgroup	Order
Abilene [1]	Fine, mixed, thermic	Pachic Argiustolls	Mollisols.
Asa	Fine-silty, mixed, thermic	Fluventic Haplustolls	Mollisols.
Clairemont	Fine-silty, mixed, calcareous, thermic	Typic Ustifluvents	Entisols.
Cyril, mildly alkaline variant [2]	Coarse-loamy, mixed, thermic	Cumulic Haplustolls	Mollisols.
Devol [3]	Coarse-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Foard	Fine, montmorillonitic, thermic	Typic Natrustolls	Mollisols.
Grandfield	Fine-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Hardeman	Coarse-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Hilgrave, calcareous variant [4]	Loamy-skeletal, mixed, thermic	Typic Ustochrepts	Inceptisols.
Hinkle	Fine, montmorillonitic, thermic	Mollic Natrustalfs	Alfisols.
Hollister	Fine, mixed, thermic	Pachic Paleustolls	Mollisols.
Indiahoma	Fine, montmorillonitic, thermic	Paleustollic Chromusterts	Vertisols.
Likes	Mixed, thermic	Typic Ustipsamments	Entisols.
Lincoln	Sandy, mixed, thermic	Typic Ustifluvents	Entisols.
Miller [5]	Fine, mixed, thermic	Vertic Haplustolls	Mollisols.
Minco	Coarse-silty, mixed, thermic	Udic Haplustolls	Mollisols.
Oscar [6]	Fine-silty, mixed, thermic	Typic Natrustalfs	Alfisols.
Port	Fine-silty, mixed, thermic	Cumulic Haplustolls	Mollisols.
Quanah	Fine-silty, mixed, thermic	Typic Calciustolls	Mollisols.
Roscoe	Fine, montmorillonitic, thermic	Typic Pellusterts	Vertisols.
Stamford	Fine, montmorillonitic, thermic	Typic Chromusterts	Vertisols.
St. Paul	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Tillman	Fine, mixed, thermic	Typic Paleustolls	Mollisols.
Tillman, moderately shallow variant.[7]	Fine, mixed, thermic	Vertic Argiustolls	Mollisols.
Tipton	Fine-loamy, mixed, thermic	Pachic Argiustolls	Mollisols.
Vernon	Fine, mixed, thermic	Typic Ustochrepts	Inceptisols.
Weymouth	Fine-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Yahola	Coarse-loamy, mixed, calcareous, thermic	Typic Ustifluvents	Entisols.

[1] These soils are taxadjuncts to the Abilene series. They have B1 horizons, but do not have Ca horizons of soft powdery calcium carbonate within 28 inches of the surface. They are enough like the Abilene series in morphology, composition, and behavior, however, so that a new series is not warranted.

[2] The Cyril mildly alkaline variant is noncalcareous in the subsoil. The acreage is not sufficient to warrant a new series.

[3] Mapping unit DfA is a taxadjunct to the Devol series. It usually has soft powdery calcium carbonate within 35 inches of the surface. The soils in DfA are enough like the Devol soils in morphology, composition, and behavior, however, so that a new series is not warranted.

[4] The Hillgrave calcareous variant consists of soils that are calcareous in the surface layers. The acreage is not sufficient to warrant a new series.

[5] Mapping unit Me is a taxadjunct to the Miller series. It usually has a dark grayish-brown (10YR 4/2) color in the surface layer. It is enough like the Miller series in morphology, composition, and behavior, however, so that a new series is not warranted.

[6] These soils are taxadjuncts to the Oscar series. They have a dark-colored surface layer but are enough like the Oscar series in morphology, composition, and behavior, so that a new series is not warranted.

[7] The Tillman moderately shallow variant has layers of shaly clay or shale within 60 inches of the surface. The acreage is not sufficient to warrant a new series.

in base saturation. The order is represented in this county by the Devol, Grandfield, and Hinkle series.

Entisols are young soils that lack genetic horizons or have only the beginnings of such horizons. The order is represented in this county by the Clairemont, Likes, Lincoln, and Yahola series.

Inceptisols are young soils that lack some diagnostic horizons but show only weak evidence of eluviation or illuviation. The order is represented in this county by the Hardeman, Hillgrave, Vernon, and Weymouth series.

Mollisols have a dark-colored surface layer and are high in bases. The order is represented in this county by the Abilene, Asa, Cyril, Foard, Hollister, Miller, Minco, Port, Quanah, St. Paul, Tillman, and Tipton series.

Vertisols are characterized by a high percentage of montmorillonite clay and a resulting tendency to shrink and swell excessively. The order is represented in this county by the Indiahoma, Roscoe, and Stamford series.

SUBORDER.—Each order is divided into suborders, primarily on the basis of soil characteristics that indicate genetic similarity. The suborders have a narrower climatic range than the order. The criteria for suborders reflect either the presence or absence of waterlogging or soil differences resulting from climate or vegetation.

GREAT GROUP.—Each suborder is divided into great groups on the basis of uniformity in kind and sequence of genetic horizon. The great group is not shown in table 8, because the name of the great group is the same as the last word in the name of the subgroup.

SUBGROUP.—Each great group is divided into subgroups, one representing the central (typic) concept of the group, and other groups, called intergrades, that have properties of one great group but also one or more properties of another great group.

FAMILY.—Families are established within subgroups, primarily on the basis of properties important to plant growth. Some of these properties are texture, mineralogy, reaction, soil temperature, permeability, consistence, and thickness of horizons.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

Climate [7]

The location of Tillman County in the Red Bed Plains region of southwestern Oklahoma provides a temperate, continental climate. Gradual changes between the definite seasons are often marked by rapid changes in temperature, somewhat erratic rainfall, and significant extremes of daily and annual weather. The mild winters furnish several brief periods of low temperature and moderate snow cover. Variable weather in spring is characterized by the greatest amounts and intensities of precipitation and the most frequent occurences of severe local storms and tornadoes. Summers are long and hot. Moderate winds and showers or thunderstorms ease the heat. A secondary peak of rainfall occurs early in fall and is followed by many pleasant, sunny days and cool nights. Tables 9 and 10 summarize the records of temperature and precipitation at Frederick.

Weather records for Frederick show January as the coldest month, which averages below freezing in 1 year out of 15. The temperature on the coldest day each year averages 8° F. and has ranged from 23° in 1941 down to −8° in 1911. Summer temperatures reach 90° or higher on an average of 118 days, and on 44 days per year they reach 100° or higher. The temperature on the hottest day each year averages 109° and during the past 62 years has ranged from 100° in 1950 to 117° in 1943. Table 10 lists probabilities by specific dates for last freezing temperature in the spring and the first freezing temperature in the fall.

[7] By Stanley G. Holbrook, State climatologist, National Weather Service, U.S. Dept. of Commerce.

The freeze-free season averages from 210 days in the northeastern part of the county to 225 days along the southern border. Dates of the last freezing temperatures in spring have ranged from March 9 in 1961 and 1967 to April 22 in 1931, while those of the first freeze in fall have ranged from October 17 in 1914 to November 29 in 1965.

Seasonal distribution of precipitation provides about 13 percent of the moisture in winter, 33 percent in spring, 30 percent in summer, and 24 percent in fall. The past 58 years of records show annual precipitation has ranged from 14.40 inches in 1910 to 43.79 inches in 1941. Greatest monthly totals ranged from 4.13 inches in February 1911 to 11.91 inches in October 1919. Daily totals of 0.50 inch or more occur on an average of 19 days per year with totals of 1.00 inch or more on 7 days per year. Wet days with 3 to 4 inches of rain occur in about 1 year out of 4, while the greatest daily rainfall, which was 5.95 inches, was on October 9, 1918.

Average seasonal snowfall of 6.2 inches is usually provided by 2 to 6 snowstorms and accounts for nearly 10 percent of the winter moisture. Winter snowfall of 14.0 inches or more occurs in 1 season out of 10 with greatest snow depth of 20.5 inches recorded in 1948–49 when a record 20.0 inches of this total fell in January. Snow cover usually melts within 1 to 4 days, but did remain on the ground for 22 days in January 1930. The greatest snow depth of 11 inches was recorded on January 29, 1954.

Prevailing winds are from the south, except late in winter when northerly winds predominate. The percentage of possible sunshine received ranges from 60 percent in January to 82 percent in July. An average year has

Table 9.—*Temperature and precipitation data*

[All data from Frederick, Tillman County, elevation 1,289 feet. Period of record, 1938–67]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly highest maximum	Average monthly lowest minimum	Average monthly total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Days with a snow cover of 1 inch or more	Average depth of snow on days with snow cover
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	54	29	75	10	1.0	0.1	2.7	2	2
February	60	33	79	16	1.4	.1	3.3	1	2
March	68	39	88	21	1.6	.1	3.0	(1)	3
April	78	50	94	34	2.4	.5	5.2	(1)	8
May	85	59	99	45	4.7	1.3	8.9		
June	93	68	104	57	3.5	1.2	6.0		
July	99	72	107	65	2.1	.2	4.0		
August	99	71	108	62	2.2	.1	4.6		
September	91	64	103	49	2.3	(2)	5.5		
October	81	53	94	37	2.6	.3	5.6		
November	66	40	82	24	1.4	(2)	3.2	(1)	2
December	57	32	75	17	1.1	.1	2.9	1	2
Year	78	51	(3) 109	(4) 8	26.3	18.1	32.7	4	3

[1] Less than 0.5 day.
[2] Trace.
[3] Average annual highest temperature.
[4] Average annual lowest temperature.

TABLE 10.—*Probabilities of last freezing temperature in spring and first in fall*

[Based on data from Frederick, Tillman County, elevation 1,289 feet. Period of record, 1921–50]

Probability	Dates for given probability and temperature				
	16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10 later than	March 12	March 14	March 30	April 8	April 16
2 years in 10 later than	March 3	March 8	March 23	April 2	April 10
5 years in 10 later than	February 13	February 23	March 9	March 22	March 31
Fall:					
1 year in 10 earlier than	December 6	November 25	November 19	November 5	October 28
2 years in 10 earlier than	December 12	December 2	November 25	November 10	November 1
5 years in 10 earlier than	December 23	December 15	December 6	November 21	November 9

160 clear days, 95 partly cloudy, and 110 cloudy days. Annual lake evaporation averages 64.5 inches; 68 percent of this total occurs during the period May through October.

Thunderstorms number 49 per year, and a few of these produce damaging surface winds of 60 to 80 miles per hour. Severe hailstorms occur in the county on an average of 6 years out of 10; five occurred in 1964. Five out of six hail paths average 3 miles in width; length of the path exceeds 15 miles in only one-third of the storms. The past 94 years of record show that 40 tornadoes have struck in the county in 23 different years.

Additional Facts About the County

Tillman County is mostly an upland prairie. The topography ranges from nearly level to steep. About 73 percent of the county is uplands where slopes are 0 to 5 percent, and 12 percent is uplands where slopes are more than 5 percent. Flood plains along the drainageways make up about 15 percent of the county. The drainage pattern is southeastward to the Red River, which forms the southern boundary of the county.

Oil and natural gas are produced in Tillman County, but the county's major natural resource is its agricultural soils, and farming is its leading enterprise. Industries consist of a leather goods plant, garment facilities, a monument company, and an aircraft engine repair plant.

About 80 percent of the acreage consists of arable soils. Most of this acreage is cropland, but some livestock is raised on most farms. In years of favorable moisture supply, many cattle are brought into the county to graze wheat pasture. More acreages are being planted to bermudagrass for pasture.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of a soil to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Badlands. Areas of rough, irregular land where most of the surface is occupied by ridges, gullies, and deep channels.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Broad-base terrace. A ridge-type terrace 10 to 20 inches high and 15 to 30 feet wide that had gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. This kind of terrace controls erosion by diverting runoff along the contour at a nonscouring velocity. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Channery soil. A soil that contains thin, flat fragments of sandstone, limestone, or schist, as much as 6 inches in length along the longer axis. A single piece is called a fragment.

Chiseling. Tillage of soil with an implement having one or more soil penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage for control of soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

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 when dry or moist; does 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 into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming (or contour tillage). Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Crusty soil. A soil tending to form a thin, massive or platy surface layer under the beating action of raindrops.

Diversion or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Dryfarming. Production of crops that require some tillage in a subhumid or semiarid region, without irrigation. Usually involves use of periods of fallow, during which time enough moisture accumulates in the soil to allow the production of cultivated crop.

Dune. A mound or ridge of loose sand piled up by the wind.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes, or to loess in blankets on the surface.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors, such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediment, that borders a stream and is subject to flooding unless protected artificially.

Forb. Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.

Grassed waterway. A natural or constructed waterway, typically broad and shallow and covered by grass for protection against erosion; used to conduct surface water away from cropland.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Gypsum. Calcium sulphate.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, or sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Irrigation water is released at high points and flows onto the field without controlled distribution.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR a value of 6, and a chroma of 4.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. 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 acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

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. A soil that has a lower pH is acid, and a soil that has a higher pH is alkaline. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
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.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but sand may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the base of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeters); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter)

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.

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 primarily 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 either *single grain* (each grain by itself as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans.

Subsoiling. Tillage of a soil below normal depth, ordinarily to shatter a hardpan or claypan.

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface 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 in which permanent sod is maintained.

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."

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.

Variant, soil. A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

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