SOIL SURVEY OF

Swisher County, Texas

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Texas Agricultural Experiment Station

Issued December 1974

Major fieldwork for this soil survey was done in the period 1960–69. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1970. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Tule Creek Soil and Water Conservation District.

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, and recreation.

Locating Soils

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

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. 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. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described.

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 those who work with farmers can learn about use and management of the soils from the soil descriptions and from the descriptions of the range sites.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Ranchers and others can find, under "Range Management," groupings of the soils according to their suitability for range, and also 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 estimates of soil properties and information about soil features that affect engineering practices.

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 Swisher 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 in the section "General Nature of the County."

Cover: Irrigated cotton on a Pullman clay loam.

Contents

	Page
How this survey was made	1
General soil map	2
1. Pullman association	2
2. Mansker-Estacado-Bippus association	2
3. Rough broken land-Berda association	4
Descriptions of the soils	5
Acuff series	5
Berda series	6
Bippus series	6
Drake series	8
Estacado series	9
Lipan series	9
Lofton series	10
Mansker series	10
Olton series	12
Potter series	14
Pullman series	15
Randall series	16
Roscoe series	17
Rough broken land	18
Tulia series	18
Use and management of the soils	20
Capability grouping	20
Dryland capability units	21
Irrigated capability units	22
Predicted yields	23
Range management	24
Range sites and condition classes	24
Descriptions of thr range sites	25
Use and management of the soils—Con.	
Windbreaks	27
Use of the soils for wildlife	28
Engineering uses of the soils	30
Engineering classification systems	30
Estimated engineering properties	31
Interpretations of engineering properties	31
Formation and classification of the soils	38
Factors of soil formation	38
Climate	39
Plant and animal life	39
Parent material	39
Relief	40
Time	40
Processes of horizon differentiation	40
Classification of the soils	40
General nature of the county	41
Climate	41
Geology	42
History and settlement	43
Livestock	43
Transportation and markets	43
Literature cited	44
Glossary	44
Guide to mapping units Following	45

Issued December 1974

SOIL SURVEY OF SWISHER COUNTY, TEXAS

BY WAYBURN D. MITCHELL, LOUIS L. JACQUOT, AND BILLY R. CHANCE, SOIL CONSERVATION SERVICE

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

SWISHER COUNTY is in the south-central part of the Texas Panhandle (fig. 1). It has a total area of 573,440 acres, or 896 square miles. Tulia is the county seat.

This county is a nearly level, playa-pocked, short-grass prairie. It has a few draws that have entrenched 50 to 250

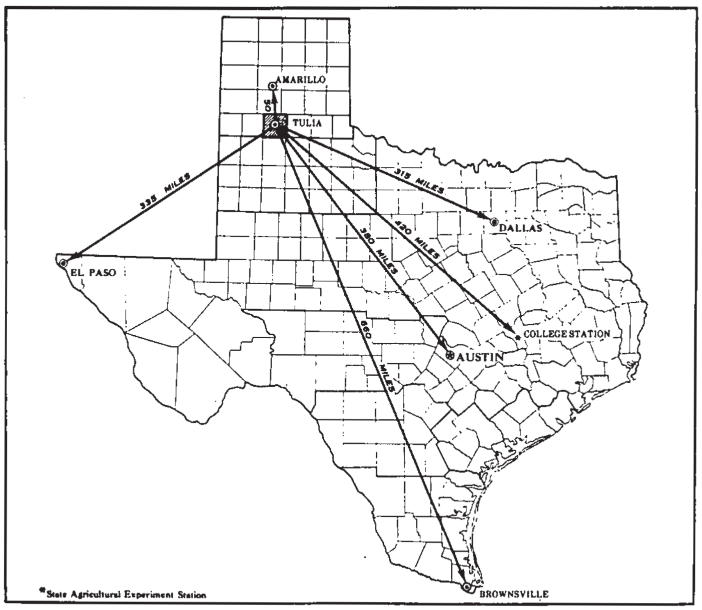

Figure 1.—**Location of Swisher County in Texas.**

feet below the general level of the High Plains. Elevation ranges from about 3,250 feet in the eastern part, where Tule Creek leaves the county, to 3,700 feet in the northwestern part.

Development of the county has depended on farming. About 80 percent of the land area is cultivated, and most of this is irrigated. The major crops are grain sorghum, wheat, cotton, and soybeans. About 20 percent of the county is in native range that is grazed by cattle. Thousands of cattle are fattened in feedlots on locally grown feedstuffs.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Swisher 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. Tulia and Olton, for example, are the names of two soils. 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.

Soils of one series can differ in texture of the surface layer 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 Tulia clay loam, 0 to 1 percent slopes, is one of several phases within the Tulia 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 buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from 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 Swisher County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed 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. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Mansker-Tulia complex, 5 to 8 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. Rough broken land and Berda soils is an undifferentiated group in this county.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded or so variable that it has not been 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. Rough broken land is a land type in this county.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or to a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current 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 Swisher 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 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 three soil associations in Swisher County are discussed in the following pages. The terms for texture used in the title for several of the associations apply to the surface layer. For example, in the title for association 1, the word "loamy" refers to texture of the surface layer.

1. Pullman association

Deep, nearly level to gently sloping, very slowly permeable, loamy soils of uplands

This association is on a broad, smooth plain that is little dissected.

The soils in this association make up about 93 percent of the county. Pullman soils make up about 76 percent of the association (fig. 2). The remaining 24 percent is minor soils.

The Pullman soils have a surface layer that is firm, brown clay loam about 8 inches thick. The next layer is very firm, brown clay about 24 inches thick. Below this is firm, yellowish-red clay about 50 inches thick. The next lower layer is friable, pink clay loam about 25 inches thick that is about 40 percent, by volume, segregated carbonates. Below this, to a depth of 100 inches, is reddish-yellow, friable clay loam.

Minor soils of this association are mainly in the Mansker, Estacado, Lofton, Randall, Roscoe, and Olton series. Randall soils are on playa floors. Lofton and Roscoe soils occupy playa benches or slightly depressional areas surrounded by Pullman soils. Mansker, Estacado, and Olton soils are on side slopes of playas.

Most areas of the soils in this association are used for irrigated crops. A few areas are dryfarmed, and a few areas are in native vegetation and are used as range. Most crops commonly grown in the county are well suited to these soils.

2. Mansker-Estacado-Bippus association

Deep, nearly level to sloping, moderately permeable, loamy soils of uplands and bottom lands

This soil association occupies side slopes and bottoms of draws and creeks of Swisher County (fig. 3).

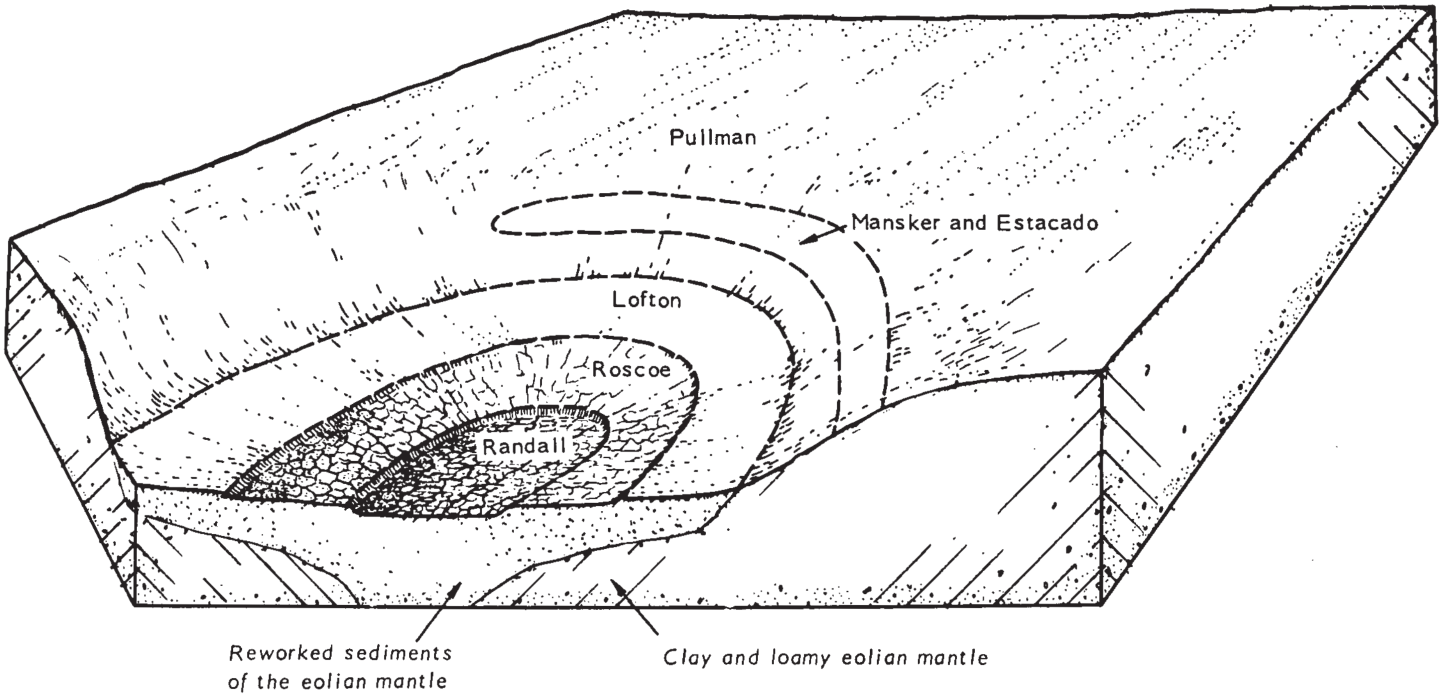

Figure 2.—**Typical pattern of soils in the Pullman association.**

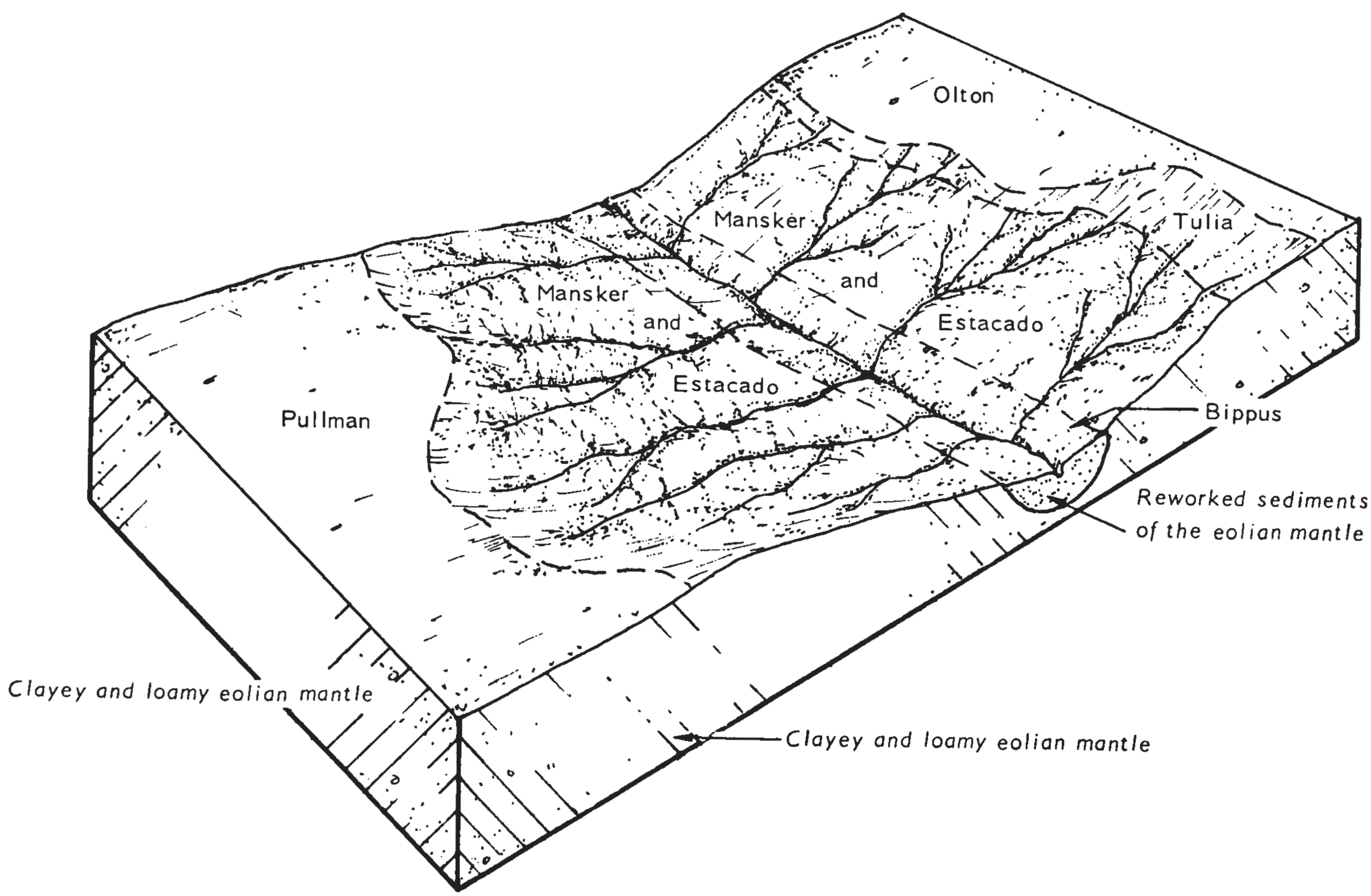

Figure 3.—**Typical pattern of soils in the Mansker-Estacado-Bippus association.**

The soils in this association make up about 6 percent of the county. About 24 percent of the association is Mansker soils, 18 percent is Estacado soils, and 15 percent is Bippus soils. The remaining 43 percent is minor soils.

Mansker soils are calcareous and friable throughout. The surface layer is dark grayish-brown clay loam about 11 inches thick. The next layer extends to a depth of 90 inches. In sequence from the top, it is about 16 inches of brown clay loam, 15 inches of very pale brown clay loam that is about 40 percent, by volume, segregated carbonates, 26 inches of yellowish-red clay loam; and 22 inches of red sandy clay loam. Mansker soils are on the side slopes of the draws. These soils are nearly level to sloping. They are well drained. Runoff is medium to rapid.

Estacado soils are calcareous and friable throughout. The surface layer is dark grayish-brown clay loam about 14 inches thick. The next layer is clay loam that extends to a depth of 85 inches. The upper 32 inches is pink and is about 40 percent, by volume, segregated carbonates in the lower part. The next 15 inches is reddish yellow, and the lower 24 inches is yellowish red. Estacado soils are on the side slopes of the draws. These soils are nearly level to gently sloping. They are well drained. Runoff is slow.

Bippus soils are calcareous and friable throughout. The surface layer is 24 inches thick. It is dark-brown loam in the upper 6 inches and dark grayish-brown clay loam in the lower part. The next layer is brown clay loam about 26 inches thick. The underlying layer extends to a depth of 60 inches. It is very dark grayish-brown clay loam that contains a few soft masses of carbonates. These soils are nearly level. They are well drained but are flooded in places for short periods following heavy rainfall.

Minor soils of this association are mainly in the Pullman, Olton, Tulia, and Potter series. Pullman and Olton soils are nearly level to gently sloping and make up the greater part of the minor soils. These soils are along the outer edges of the draws. Tulia and Potter soils are on the more sloping parts of the draws.

The soils in this association are used mostly for range. A few areas are cultivated, but erosion and flooding limit their use.

3. *Rough broken land-Berda association*

Rough broken land and deep, rolling to hilly, moderately permeable, loamy soils of uplands

This association is along Tule Creek (fig. 4). It is made up mostly of steep divides, narrow valleys, and nearly vertical escarpments.

The soils in this association make up about 1 percent of the county. About 27 percent is Rough broken land, and 18 percent is Berda soils. The remaining 55 percent is minor soils.

Rough broken land consists of very steep and strongly dissected areas. It is on the steeper side slopes and on narrow bridges.

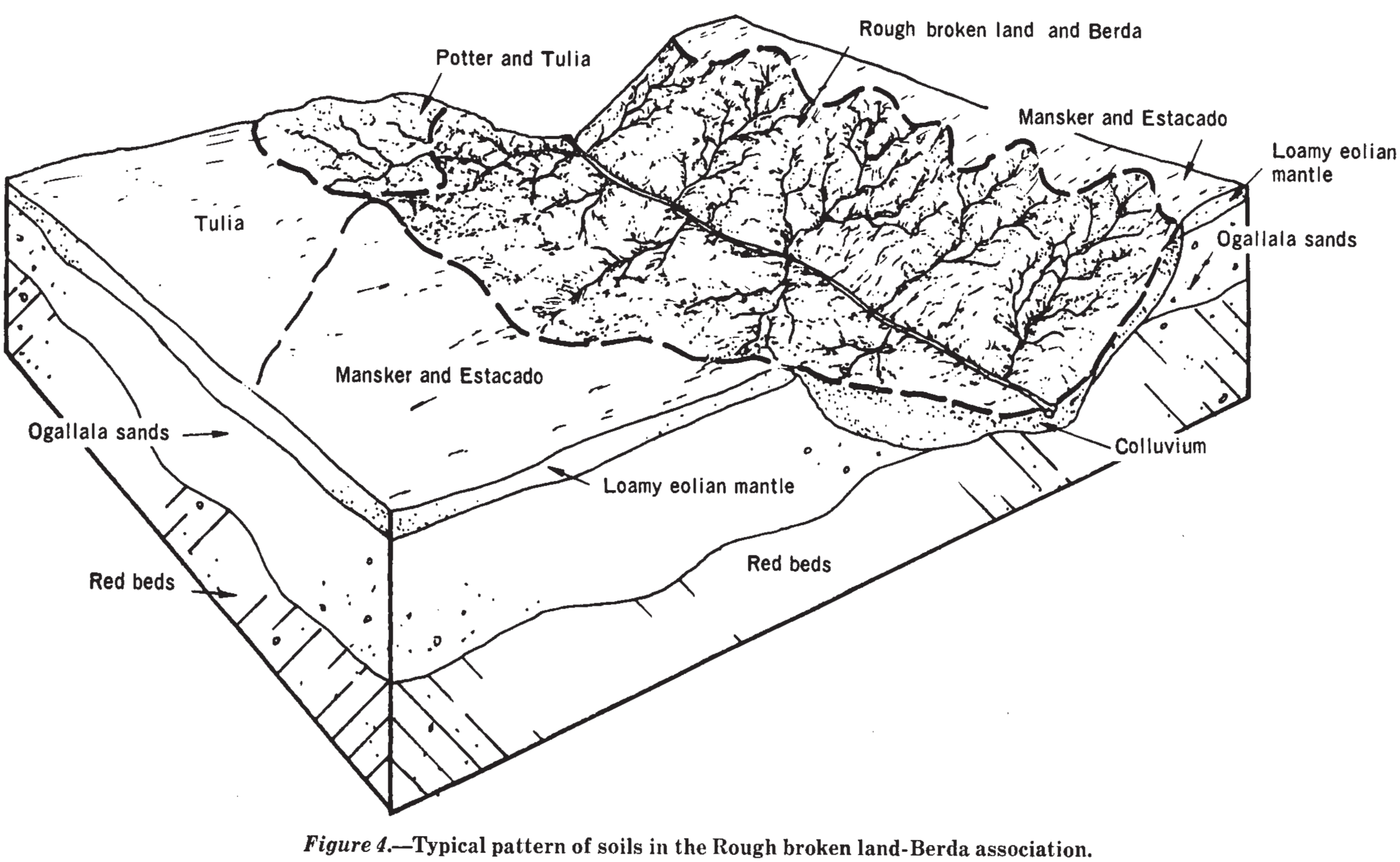

Figure 4.—Typical pattern of soils in the Rough broken land-Berda association.

Berda soils have a surface layer of brown loam about 6 inches thick. The next layer extends to a depth of 60 inches. It is pale-brown, friable loam in the upper 24 inches. Below that it is friable, pale-brown clay loam that contains a few thin strata of very fine sandy loam and is about 5 percent, by volume, segregated carbonates. Berda soils are rolling to hilly and formed in colluvium on foot slopes. These soils are well drained. They have medium runoff and moderate permeability.

Minor soils of this association are mainly in the Mansker, Estacado, Tulia, and Potter series. Mansker, Estacado, and Tulia soils occupy less sloping areas. Potter soils occupy areas above the Rough broken land and Berda soils in the more sloping areas.

The soils of this association are used mostly for native range. They are not suited to cultivation, because of slope and the hazards of erosion and soil blowing. These soils are better suited to limited grazing or wildlife, or both, than to most other uses.

Descriptions of the Soils

This section describes the soil series and mapping units in Swisher County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of the soils.

The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Rough broken land, for example, does not belong to a soil series, but nevertheless it is listed in alphabetical order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The information commonly presented by discussions of the capability units is given in the mapping units. An explanation of the capability classification system begins on page 20. The page for the range site can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*5*).[1]

Acuff Series

The Acuff series consists of deep, gently sloping soils along draws and near playas. These soils are well drained. They developed in eolian materials on the High Plains. The soil surface is plane to convex. Areas are 10 to 60 acres in size and irregular in shape.

In a representative profile, the surface layer is friable, brown loam about 9 inches thick. The next layer, in sequence from the top, consists of 38 inches of friable sandy clay loam that is reddish brown in the upper part and yellowish red in the lower part; 13 inches of pink sandy clay loam that is about 30 percent, by volume, segregated carbonates; and 20 inches of pink sandy clay loam that has about 10 percent, by volume, segregated carbonates. This layer extends to a depth of 80 inches.

Acuff soils have high available water capacity. Runoff is medium, and permeability is moderate.

These soils are used mostly for crops. A few areas are in native range.

Representative profile of Acuff loam, 1 to 3 percent slopes, 12 miles east and 1 mile south of Tulia, 150 feet

[1] Italic numbers in parentheses refer to Literature Cited, p. 44.

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

Soil	Area	Extent
	Acres	*Percent*
Acuff loam, 1 to 3 percent slopes	630	0. 1
Bippus loam	2, 824	. 5
Bippus loam, channeled	2, 847	. 5
Drake loam, 1 to 3 percent slopes	956	. 2
Drake loam, 3 to 5 percent slopes	1, 946	. 3
Lipan clay	4, 317	. 8
Lofton clay loam	32, 391	5. 6
Mansker and Estacado soils, 0 to 1 percent slopes	13, 753	2. 4
Mansker and Estacado soils, 1 to 3 percent slopes	25, 970	4. 5
Mansker and Estacado soils, 3 to 5 percent slopes	5, 545	. 9
Mansker-Tulia complex, 5 to 8 percent slopes	1, 584	. 3
Olton clay loam, 0 to 1 percent slopes	4, 896	. 8
Olton clay loam, 1 to 3 percent slopes	15, 375	2. 7
Potter and Tulia soils	1, 871	. 3
Pullman clay loam, 0 to 1 percent slopes	379, 714	66. 2
Pullman clay loam, 1 to 3 percent slopes	33, 731	5. 9
Randall clay	22, 064	3. 9
Roscoe clay	11, 289	2. 0
Rough broken land and Berda soils	2, 165	. 4
Tulia clay loam, 0 to 1 percent slopes	1, 593	. 3
Tulia clay loam, 1 to 3 percent slopes	4, 084	. 7
Tulia complex, 3 to 5 percent slopes	3, 895	. 7
Total	573, 440	100. 0

west and 25 feet north of the northeast corner of sec. 98, block A, Arnold and Barrett Survey:

Ap—0 to 9 inches, brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; friable; many fine roots; mildly alkaline; abrupt, smooth boundary.

B21t—9 to 18 inches, reddish-brown (5YR 5/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard, friable; common fine roots; common worm casts; few clay films; mildly alkaline; gradual, smooth boundary.

B22t—18 to 33 inches. reddish-brown (5YR 5/4) sandy clay loam; reddish brown (5YR 4/4) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; very hard, friable; few fine roots; common fine pores; common worm casts; continuous thin clay films on ped surfaces; calcareous in the lower part and has few, fine, soft masses of carbonates; moderately alkaline; gradual, smooth boundary.

B23t—33 to 47 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard, friable; few fine roots; common fine pores; few worm casts; few clay films; carbonates on ped surfaces and inside pores; calcareous, moderately alkaline; clear, smooth boundary.

B24tca—47 to 60 inches, pink (5YR 8/3) sandy clay loam, pink (5YR 7/3) moist; weak, medium, subangular blocky structure; hard, friable; few fine roots; many fine pores; few clay films; about 30 percent, by volume, soft and hard masses of calcium carbonate; calcareous, moderately alkaline; gradual, smooth boundary.

B25t—60 to 80 inches, pink (5YR 7/4) sandy clay loam, reddish yellow (5YR 6/6) moist; weak, medium, subangular blocky structure; hard, friable; few fine roots; many fine pores; few clay films; about 10 percent, by volume, finely segregated calcium carbonate; calcareous, moderately alkaline.

The A and B21t horizons are less than 20 inches thick. The A horizon is reddish brown or brown. It is 4 to 10 inches thick. The B2t is loam to clay loam or sandy clay loam. Content of clay is 25 to 35 percent, and content of silt is less than 40 percent. The B22t and B23t horizons are reddish brown or yellowish red. Free carbonates occur at a depth of 18 to 28 inches. Depth to the Btca horizon is 30 to 60 inches. It is pink or light reddish brown. This horizon is 20 to 60 percent, by volume, lumps and concretions of carbonates. The B25t horizon is pink, yellowish red, or light reddish brown. It is about 3 to 20 percent, by volume, segregated carbonates.

Part of the acreage of the soils in Swisher County named for this series is outside the range of the series because the dark-colored upper part of the profile is less than 10 inches thick. This difference does not alter the usefulness or behavior of these soils.

Acuff loam, 1 to 3 percent slopes (AcB).—This soil occupies areas near draws and playas. These areas are 10 to 60 acres in size and irregular in shape.

Included with this soil is mapping are areas of Olton soils up to 5 acres in size. These Olton soils make up less than 10 percent of any given area. A few areas of Pullman, Estacado, and Mansker soils up to 4 acres in size are also included.

This soil is well suited to crops. Principal crops are sorghum, winter wheat, and some cotton.

The hazards of water erosion and soil blowing are moderate. Soil blowing can be controlled by managing crop residue on the surface. Mechanical practices such as terracing or bench leveling help to control water erosion. Plowpans form if this soil is plowed when it is wet. An irrigation system that permits irrigation without wasting water or causing erosion is needed. The use of crops that return a large amount of crop residue to the soil helps to maintain soil tilth. Capability units IIIe-2, dryland, and IIIe-2, irrigated; Deep Hardland range site.

Berda Series

The Berda series consists of calcareous, deep, rolling to hilly soils that formed in colluvium. These soils are on foot slopes and in valleys. Soil surfaces are concave.

In a representative profile, the surface layer is brown, very friable loam about 6 inches thick. The next layer is pale-brown, friable loam in the upper 24 inches. The lower part of this layer, which reaches to a depth of 60 inches, is friable, pale-brown clay loam that has a few thin strata of very fine sandy loam and is about 5 percent, by volume, segregated carbonates.

These soils are well drained. Runoff is medium, and permeability is moderate. Available water capacity is high.

Berda soils are used mostly for range and wildlife habitat.

Berda soils are mapped only in an undifferentiated group with Rough broken land.

Representative profile of a Berda loam in an area of Rough broken land and Berda soils, about 13 miles east and 2 miles south of Tulia, 1,600 feet south and 1,700 feet west of the northeast corner of sec. 84, block A, Arnold and Barrett Survey:

A—0 to 6 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak, fine, granular structure; slightly hard, very friable; many fine and medium roots; few worm casts; few caliche pebbles 5 to 25 millimeters in diameter; calcareous, moderately alkaline; clear, smooth boundary.

B21—6 to 30 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky structure; hard, friable; common fine and medium roots; few fine and medium pores; few worm casts; few lumps of calcium carbonate 5 to 15 millimeters in diameter; calcareous, moderately alkaline; gradual, smooth boundary.

B22ca—30 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate, medium to very coarse, platy structure; hard, friable; few medium roots; few fine pores; few brownish iron stains; 5 percent, by volume, lumps of calcium carbonate 1 to 3 millimeters in diameter; thin strata of very fine sandy loam and loam; calcareous, moderately alkaline.

The A horizon is 6 to 9 inches thick. It is grayish-brown or brown fine sandy loam to loam. The B21 horizon is 14 to 28 inches thick. It is pale-brown or light-brown loam to clay loam and is 20 to 30 percent clay. Depth to the B22ca horizon is 20 to 40 inches. It is pale-brown or light-brown loam to clay loam and is 20 to 30 percent clay. It also includes thin layers of loam to very fine sandy loam that are less than 18 percent clay. This horizon is 3 percent to about 8 percent, by volume, segregated calcium carbonate.

Bippus Series

The Bippus series consists of deep, nearly level loamy soils along draws. These soils formed in reworked sediment of the eolian mantle. They are calcareous and friable throughout the profile. The soil surface is concave.

In a representative profile (fig. 5), the surface layer is 24 inches thick. It is dark-brown loam in the upper 6 inches and dark grayish-brown clay loam in the lower 18 inches. The next layer is brown clay loam about 26 inches thick. The lower part has a few carbonate films. Below this, to a depth of more than 60 inches, is very dark grayish-brown clay loam that has a few soft masses of carbonates.

These soils are well drained. Permeability is moderate, and runoff is medium. Available water capacity is high.

Bippus soils are used mainly for range.

Representative profile of Bippus loam, about 2.5 miles east of Tulia, 2,500 feet west and 50 feet south of the northeast corner of sec. 37, block M–15, Denison and Pacific Railroad Survey:

A11—0 to 6 inches, dark-brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate, fine, subangular blocky structure; hard, friable; few worm casts; calcareous, moderately alkaline; clear, smooth boundary.

A12—6 to 24 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, coarse, prismatic structure parting to moderate, fine, subangular blocky structure; hard, friable; few fine pores; few worm casts; calcareous, moderately alkaline; clear, smooth boundary.

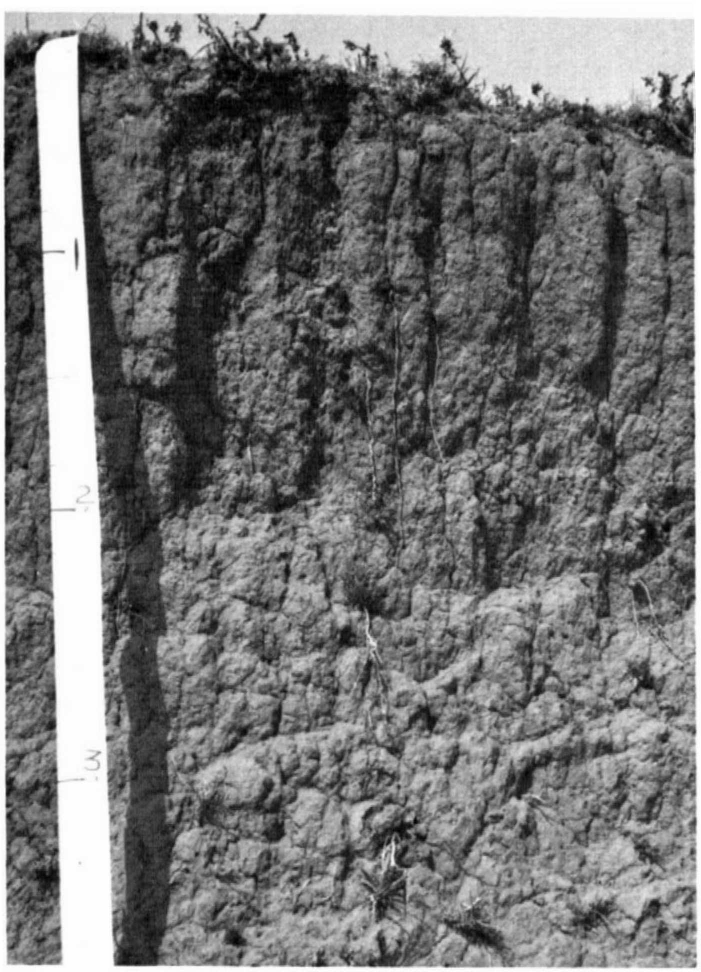

Figure 5.—**Profile of Bippus loam.**

B21ca—24 to 34 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate, fine, subangular blocky structure; hard, friable; few fine pores; few worm casts; few films of lime; calcareous, moderately alkaline; gradual, smooth boundary.

B22ca—34 to 50 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, friable; few fine pores coated with lime; few worm casts; few films of lime; calcareous, moderately alkaline; gradual, smooth boundary.

Ab—50 to 60 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; moderate, medium, subangular blocky structure; hard, friable; few soft masses of lime 1 to 3 millimeters in diameter; calcareous, moderately alkaline.

The solum ranges from 50 inches to more than 70 inches in thickness. A horizon is 21 to 30 inches thick. It is dark brown or dark grayish brown. The B2 horizon is brown or grayish brown and is 25 to 35 percent clay. Structure is moderate, coarse, prismatic to moderate, fine or medium, subangular blocky. Below a depth of 50 inches, the profile in some places has a buried, very dark grayish-brown A horizon, and in other places it has a C horizon that contains lime.

Bippus loam (Bp).—This soil occupies bottom lands along draws. Mapped areas range from 10 acres to more than 400 acres in size. These areas average 1,200 feet in width and in places are 2 miles or more in length. Slope is less than 1 percent. This soil has the profile described as representative for the Bippus series.

Included with this soil in mapping are meandering stream channels that make up 3 to 8 percent of most areas. Narrow bands of gently sloping Tulia, Mansker, and Estacado soils are along the edges of mapped areas and make up less than 5 percent of the total area.

This soil is in narrow areas and is near soils that are not in cultivation. Most of the area is in native range. A few irregularly shaped areas up to about 40 acres in size are cultivated. The principal crops are small grain and sorghum.

The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Applications of nitrogen and phosphate fertilizer increase production under irrigation. Crop residue left at or near the surface helps to control erosion and to maintain soil tilth. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Capability units IIe–1, dryland, and IIe–1, irrigated; Loamy Bottomland range site.

Bippus loam, channeled (Bu).—This soil occupies the flood plain of the draws. Areas range from 10 acres to more than 200 acres in size. These areas average 400 feet in width and in places are 2 miles or more in length. A meandering stream channel, 10 to 40 feet wide and 3 to 10 feet deep during periods of heavy rainfall, makes this soil undesirable for cultivation. Slope is less than 1 percent downstream.

The surface layer is friable, dark-brown loam about 24 inches thick. The next layer is friable, brown clay loam about 30 inches thick that contains a few soft masses of lime. Below this is friable, very dark grayish-brown clay loam that is about 5 percent, by volume, soft masses of lime and that extends to a depth of 65 inches.

Included with this soil in mapping are stream channels that make up 5 to 15 percent of most areas. Narrow bands of gently sloping Mansker, Estacado, and Tulia soils occur on the outer edges and make up less than 10 percent of any given area.

Almost all of the acreage of this soil is used for range. Capability unit Vw-1, dryland; Loamy Bottomland range site.

Drake Series

The Drake series consists of deep, gently sloping, high-lime soils of low, smooth, crescent-shaped dune areas near the larger playas. These soils formed in reworked sediment of the eolian mantle. The soil surface is convex.

In a representative profile (fig. 6), the surface layer is friable, grayish-brown loam about 8 inches thick. The underlying material is friable, light-gray clay loam to a depth of 60 inches.

These soils are well drained and moderately permeable. Available water capacity is moderate, and runoff is rapid.

Drake soils are poorly suited to cultivation. They are better suited to native range than to most other uses.

Representative profile of Drake loam, 1 to 3 percent slopes, in a cultivated field about 7 miles south and 6.5 miles west of Tulia, or 2,300 feet west and 3,400 feet south of the northeast corner of sec. 57, block M-11, Adam, Beaty, and Moulton Railroad Survey:

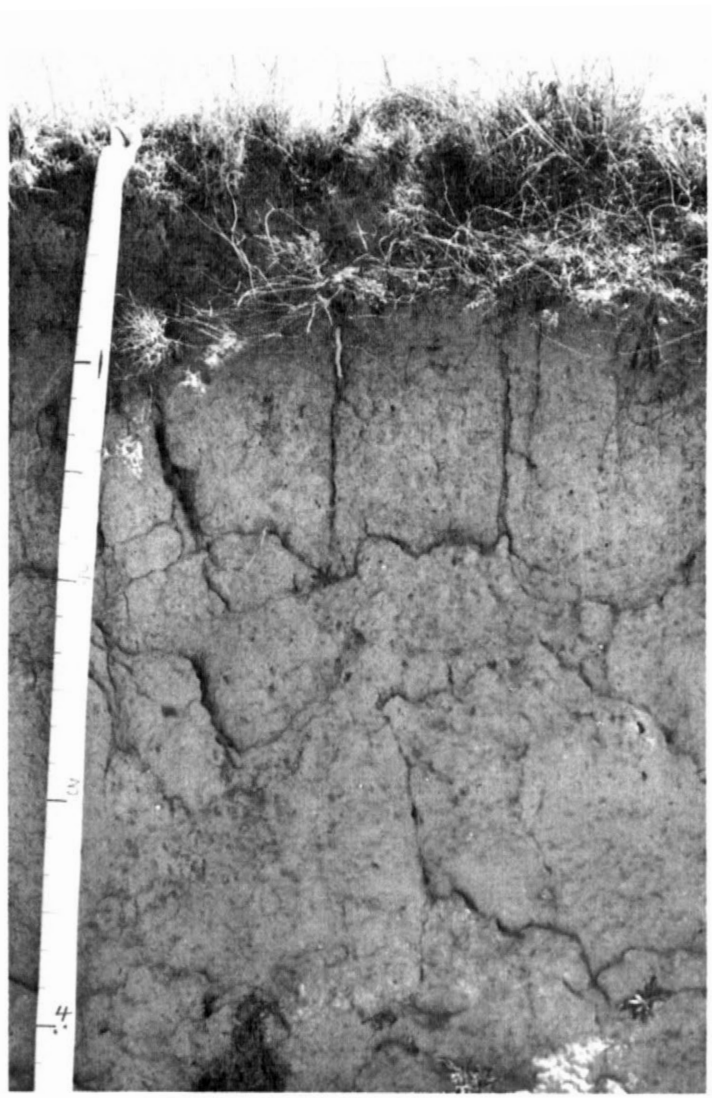

Figure 6.—Profile of a Drake loam.

Ap—0 to 8 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; hard, friable; calcareous, moderately alkaline; gradual, smooth boundary.

C1—8 to 24 inches, light-gray (10YR 7/1) clay loam, light brownish gray (10YR 6/2) moist; weak, coarse, prismatic structure parting to weak, fine, granular structure; hard, friable; many, fine and very fine, old root channels, inner walls of which are partly lined with calcium carbonate; calcareous, moderately alkaline; diffuse, smooth boundary.

C2—24 to 60 inches, light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) moist; massive (structureless); hard, friable; fine and very fine old root channels are common in upper part, and some contain threads of calcium carbonate; porous soil mass contains much uniformly dispersed calcium carbonate; calcareous, moderately alkaline.

Content of calcium carbonate in the profile ranges from 15 to 30 percent. Structure in undisturbed areas is granular. The A horizon is 6 to 10 inches thick. It is thinnest near the crest of the dunes. It is grayish brown, pale brown, or light brownish gray. In places where the A horizon is darker, it is less than 7 inches thick. The C1 horizon is 10 to 24 inches thick. It is light gray, gray, very pale brown, or light brownish gray. The C2 horizon is 2 to 8 feet thick. It is massive and light gray to light brownish gray. The C1 and C2 horizons are loam to clay loam and are 20 to 35 percent clay.

Drake loam, 1 to 3 percent slopes (DrB).—This soil is on smooth, low dunes that are on the leeward side of some of the larger playas. The elevation of the dunes ranges from about 3 to 8 feet above the surrounding High Plains. Areas of this soil range from 15 to 40 acres in size but are mostly about 25 acres. Slopes are mostly about 2 percent. This soil has the profile described as representative of the Drake series.

Included with this soil in mapping are a few, small, narrow areas of Mansker and Estacado soils, 1 to 3 percent slopes, and a few areas of Drake loam, 3 to 5 percent slopes. These included soils are 1 to 3 acres in size and represent less than 8 percent of the areas mapped as this soil.

Most of the acreage of this soil is used for crops. Small grain and sorghum are the main crops.

This soil is high in lime, which causes chlorosis in many plants. The hazards of soil blowing and erosion are severe. This soil is better suited to high-residue or close-spaced crops than to most other crops. Alfalfa is well suited if ample amounts of irrigation water and of phosphate fertilizer are applied. Crop residue managed on the soil surface helps to control soil blowing and erosion and to maintain soil tilth. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Capability units IVe-9, dryland, and IIIe-9, irrigated; High Lime range site.

Drake loam, 3 to 5 percent slopes (DrC).—This soil occupies playa dunes. The elevation of the dunes ranges from about 7 feet to 15 feet above the surrounding High Plains. Areas of this soil range from 20 to 50 acres in size but are mostly near 30 acres in size. Slopes are mainly 4 percent.

This soil is friable and is high in lime content. The surface layer is grayish-brown loam about 6 inches thick.

The next layer is light-gray clay loam about 14 inches thick. The underlying layer, to a depth of 60 inches, is massive, light-gray clay loam.

Included with this soil in mapping are small areas of Drake loam, 1 to 3 percent slopes. These included soils make up as much as 8 percent of some areas. Narrow bands of Tulia, Mansker, and Estacado soils are included near the edge of mapped areas.

Most of the acreage of this soil has been cropped but is now used for grazing.

The high lime content causes chlorosis in many plants. The hazards of soil blowing and erosion are severe. Crops that produce a large amount of residue should be grown, and crop litter should be kept on the surface to control soil blowing and erosion. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Irrigated and fertilized legumes or perennial grasses produce a moderate amount of forage, and they should be grown to help keep soil tilth in areas used for tilled crops. Capability units VIe-3, dryland, and IIIe-9, irrigated; High Lime range site.

Estacado Series

The Estacado series consists of deep, nearly level to gently sloping soils that formed in the eolian mantle of the High Plains. These soils are in moderately convex areas along draws, around playas, and on nearly level plains. They are calcareous and friable throughout.

In a representative profile, the surface layer is dark grayish-brown clay loam about 14 inches thick. The lower part contains many worm casts. The next layer is clay loam to a depth of 85 inches. The upper 32 inches is pink, the next 15 inches is reddish yellow, and the lower 24 inches is yellowish red.

These soils are well drained. Permeability is moderate, and runoff is slow. Available water capacity is high.

The Estacado soils are mapped only in an undifferentiated group with the Mansker soils.

Representative profile of an Estacado clay loam in an area of Mansker and Estacado soils, 1 to 3 percent slopes, 3.5 miles east of Tulia, 200 feet south and 100 feet west of the northeast corner of sec. 11, block M-15, Denison and Pacific Railroad Survey:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, friable; calcareous, moderately alkaline; abrupt, smooth boundary.

A1—6 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, very fine, subangular blocky structure parting to moderate, fine, granular structure; hard, friable; many worm casts; few soft lumps of lime 1 to 3 millimeters in diameter; calcareous, moderately alkaline; clear, smooth boundary.

B21tca—14 to 28 inches, pink (7.5YR 7/4) clay loam, brown (7.5YR 5/4) moist; moderate, fine, subangular blocky structure parting to moderate, fine, granular structure; hard, friable; many worm casts; few clay films; about 10 percent, by volume, segregated lumps of lime 3 to 15 millimeters in diameter; calcareous, moderately alkaline; gradual, smooth boundary.

B22tca—28 to 46 inches, pink (7.5YR 8/4) clay loam, reddish yellow (7.5YR 7/8) moist; moderate, fine, granular structure; hard, friable; few fine pores; few worm casts; few clay films; about 40 percent, by volume, lime that is mostly well mixed with the soil mass; common lumps of lime up to 15 millimeters in diameter; calcareous, moderately alkaline; gradual, wavy boundary.

B23tca—46 to 61 inches, reddish-yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; moderate, fine, subangular blocky structure; hard, friable; common fine pores, few clay films; few lumps of lime 1 to 3 millimeters in diameter; calcareous, moderately alkaline; gradual, smooth boundary.

B24t—61 to 85 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate, medium, subangular blocky structure; hard, friable; few fine pores; few clay films; few lumps of lime 1 to 2 millimeters in diameter; calcareous, moderately alkaline.

The solum ranges from 70 inches to more than 100 inches in thickness. The A horizon is 11 to 16 inches thick. It is loam to clay loam, and it is brown, grayish brown, or dark grayish brown. Accumulations of calcium carbonate are at or near the top of the Bt horizon, and the zone of maximum carbonate accumulation begins at a depth of 11 to 30 inches. The Bt horizon ranges from clay loam to sandy clay loam and is 20 to 35 percent clay. The B21tca horizon is 5 to 20 inches thick. It is pink, light brown, or brown. The B22tca horizon is 14 to 30 inches thick and is 20 to 50 percent visible carbonates. It is pink, light reddish brown, reddish yellow, or light brown. The B23tca horizon is 15 to 25 inches thick and is 3 percent to about 20 percent visible carbonates. It is reddish yellow to strong brown or yellowish red. Clay films in some places are thin and patchy and in other places are nearly continuous. The B24t horizon is 25 inches to more than 40 inches thick and is less than 5 percent visible carbonates. It is reddish yellow to yellowish red.

Lipan Series

The Lipan series consists of deep, nearly level soils that formed on playa benches. These benches are from 3 to 10 feet above the floor of the playas. Areas of Lipan soils are irregular to crescent shaped. They are mostly on the eastern side of playa benches and extend to the lower rim of the playas. The surface has a nearly level, micromound relief when in native grass. The slopes are concave to plane. These soils receive runoff water from higher lying soils.

In a representative profile, the surface layer is very firm gray clay about 20 inches thick. The next layer is very firm gray clay and extends to a depth of 65 inches.

These soils are moderately well drained. Permeability is very slow, and runoff is slow. Available water capacity is high.

Lipan soils are mainly used for dryland and irrigated crops.

Representative profile of Lipan clay about 9 miles north and 3 miles east of Tulia, 300 feet west and 25 feet north of the southeast corner of sec. 122, block 9, J. H. Gibson Survey:

A1—0 to 20 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, fine, blocky structure parting to very fine blocky and granular structure; very hard, very firm; many fine roots; few worm casts; calcareous, moderately alkaline; gradual, smooth boundary.

AC1—20 to 45 inches, gray (10YR 6/1) clay, gray (10YR 5/1) moist; intersecting slickensides that part to parallelepipeds and moderate, very fine, blocky structure; very hard, very firm; few fine roots and pores; few worm casts; few specks of lime; calcareous, moderately alkaline; diffuse, smooth boundary.

AC2—45 to 65 inches, gray (10YR 6/1) clay, gray (10YR 5/1) moist; intersecting slickensides that part to parallelepipeds and weak, fine, blocky structure; very hard, very firm; few fine roots and pores; common specks of lime; calcareous, moderately alkaline.

Content of clay in the profile ranges from 40 to 60 percent. The A horizon is 13 to 22 inches thick. It is gray to dark gray. The AC horizon extends to a depth of more than 40 inches. It is light gray, gray, dark gray, light brownish gray, grayish brown, brown, pale brown, or very pale brown. Visible carbonates range from a few films to more than 30 percent by volume.

Lipan clay (Lc).—This is a nearly level soil on benches of some of the larger playas in the county. Areas of this soil are from 10 acres to about 300 acres in size.

Included with this soil in mapping are a few areas of Roscoe, Randall, and Lofton soils about 1 to 5 acres in size. Some areas of Lipan soils that have slopes of 1 to 2 percent are also included.

This soil is well suited to grain sorghum, wheat, and cotton.

The hazard of soil blowing on this soil is severe. Crop residue left on or near the soil surface helps to control soil blowing and to maintain soil tilth. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Capability units IVs–1, dryland, and IVs–1, irrigated; Deep Hardland range site.

Lofton Series

The Lofton series consists of deep, nearly level soils on benches 3 to 15 feet above playa bottoms and 10 to 30 feet below the main level of the High Plains. These soils also occupy slight depressions on the High Plains. Areas are 5 acres to about 200 acres in size and are nearly round to irregular in shape. Slopes are dominantly less than 0.6 percent.

In a representative profile, the surface layer is dark grayish-brown clay loam about 10 inches thick. The next layer, to a depth of about 45 inches, is very firm clay that is dark gray in the upper part and grayish brown in the lower part. Between depths of 45 and 60 inches, it is friable, light brownish-gray clay loam that is high in lime. The underlying material is pink clay loam that extends to a depth of 72 inches.

The available water capacity is high. Permeability is very slow. Runoff is very slow. Lofton soils receive runoff water from higher lying soils. During periods of heavy rainfall, the lower lying areas of these soils at times are inundated for a few days. These soils are moderately well drained.

Most areas of these soils are used for crops. Lofton soils are well suited to cultivation.

Representative profile of Lofton clay loam about 3 miles west and 0.4 mile north of Kress, 3,200 feet west and 2,900 feet south of the northeast corner of sec. 46, block M–13, Tyler Tapp Railroad Survey:

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, firm; common, fine, fibrous roots; mildly alkaline; abrupt, smooth boundary.

B21t—10 to 18 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; strong, medium, blocky structure; very hard, very firm; few, fine, fibrous roots; few fine pores; distinct clay films slightly darker than crushed color of soil material in this horizon; mildly alkaline; gradual, smooth boundary.

B22t—18 to 30 inches, dark-gray (10YR 4/1) clay, very dark (10YR 3/1) moist; strong, medium, blocky structure; very hard, very firm; few, fine, fibrous roots; distinct clay films; calcareous in the lower part, moderately alkaline; gradual, smooth boundary.

B23t—30 to 45 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; moderate, medium, blocky structure; very hard, very firm; few fine roots; few clay films; thin coating of lime on ped surfaces; few lumps and concretions of lime 3 to 10 millimeters in diameter, and increasing in number with depth; calcareous, moderately alkaline; gradual, smooth boundary.

B24tca—45 to 60 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; weak, medium, blocky structure; hard, friable; few fine roots; few fine pores; few faint clay films; about 30 percent lime, by volume, mostly in soft lumps 5 to 20 millimeters in diameter; few concretions 3 to 10 millimeters in diameter; calcareous, moderately alkaline; diffuse, smooth boundary.

Cca—60 to 72 inches, pink (7.5YR 8/4) clay loam, light brown (7.5YR 6/4) moist; massive (structureless), hard, friable; few fine pores; about 20 percent lime, by volume, mostly in soft lumps 5 to 20 millimeters in diameter; calcareous, moderately alkaline.

The A horizon ranges from 6 to 12 inches in thickness. It is very dark grayish brown, dark grayish brown, dark gray, or very dark gray. Reaction is moderately alkaline to mildly alkaline. The B21t horizon is 8 to 16 inches thick. It is dark gray, gray, grayish brown, brown, or dark grayish brown. Clay content ranges from 40 to 50 percent. Reaction is moderately alkaline to mildly alkaline. The B22t horizon is 8 to 18 inches thick. It is gray, dark gray, grayish brown, brown, or dark grayish brown. Clay content is 40 to 50 percent. Reaction is mildly alkaline to moderately alkaline. The B23t horizon is 10 to 24 inches thick. It is gray, grayish brown, light brownish gray, dark gray, or dark grayish brown. Clay content is 40 to 50 percent. The B24tca horizon ranges from 40 to 60 inches in depth. It is gray, grayish brown, light brownish gray, pale brown, or brown. It is clay loam to silty clay or clay. Lime content ranges from 10 percent to about 40 percent by volume. The C horizon is at a depth of 45 inches to more than 65 inches. It is pink to light-brown clay loam to clay.

Lofton clay loam (Lo).—This is a nearly level soil on playa benches and in slightly depressional areas.

Included with this soil in mapping are areas of Lipan, Roscoe, and Randall soils that are less than 5 acres in size. Some soils in areas near Pullman soils have a reddish or yellowish substratum. Other areas of included soils are similar to the Lofton soils, but they are clay loam throughout. A few areas of Lofton soils that have slopes up to 1.5 percent are also included.

Most areas of this soil are cultivated. The main crops are small grain, grain sorghum, and cotton.

Crop residue left on the soil surface helps to control soil blowing and to maintain soil tilth. These soils are well suited to irrigation. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Capability units IIIe–5, dryland, and IIs–1, irrigated; Deep Hardland range site.

Mansker Series

The Mansker series consists of deep, nearly level to sloping and gently rolling soils that formed in the eolian mantle of the High Plains. These soils are in convex areas along draws and around playas. They are calcareous and friable throughout.

In a representative profile, the surface layer is dark grayish-brown clay loam about 11 inches thick. Next, in sequence from the top, are 16 inches of brown clay loam, 15 inches of very pale brown clay loam, 26 inches of yellowish-red clay loam, and 22 inches of red sandy clay loam.

Mansker soils are well drained. Runoff is medium to rapid, and permeability is moderate. Available water capacity is high.

Most areas of these soils are used for crops. They are well suited to production of most crops grown in the county. The high content of lime causes chlorosis in some plants.

Representative profile of a Mansker clay loam in an area of Mansker and Estacado soils, 0 to 1 percent slopes, 3,100 feet west and 50 feet south of the northeast corner of sec. 9, block RC, Tyler Tapp Railroad Survey, about 4.3 miles east and 3 miles north of Tulia:

A—0 to 11 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, very fine, subangular blocky and granular structure; hard, friable; common worm casts; few calcium carbonate concretions 1 to 5 millimeters in diameter; calcareous, moderately alkaline; clear, smooth boundary.

B21ca—11 to 27 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate, very fine, subangular blocky and granular structure; hard, friable; many fine pores; many worm casts; about 20 percent, by volume, calcium carbonate concretions 1 to 5 millimeters in diameter; common threads of calcium carbonate increasing with depth; calcareous, moderately alkaline; gradual, smooth boundary.

B22ca—27 to 42 inches, very pale brown (10YR 8/4) clay loam, very pale brown (10YR 7/4) moist; weak, fine, granular structure to moderate, fine, subangular blocky structure; hard, friable; few fine roots; few fine pores; few worm casts; estimated 40 percent, by volume, lumps and concretions of calcium carbonate 5 to 25 millimeters in diameter; calcareous, moderately alkaline; diffuse, smooth boundary.

B23tca—42 to 68 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; weak, fine, granular structure to moderate, fine, subangular blocky structure; hard, friable; few fine roots; few fine pores; few clay films; estimated 20 percent, by volume, lumps and concretions of calcium carbonate 2 to 20 millimeters in diameter; calcareous, moderately alkaline; gradual, smooth boundary.

B24t—68 to 90 inches, red (2.5YR 5/8) sandy clay loam; red (2.5YR 4/8) moist; moderate, medium, subangular blocky structure; hard, friable; few fine pores; few clay films; soil mass is noncalcareous but is about 5 percent, by volume, calcium carbonate concretions 10 to 20 millimeters in diameter; calcareous, moderately alkaline.

The solum is more than 60 inches thick. The A horizon ranges from 11 to 16 inches in thickness. It is brown, grayish brown, or dark grayish brown. Accumulations of calcium carbonate are at or near the top of the B2 horizon, and the zone of maximum accumulation begins at a depth of 10 to 30 inches. The B2 horizon ranges from clay loam to sandy clay loam. In the upper part it is typically clay loam that is slightly less than 35 percent clay, and in the lower part it is sandy clay loam that is 25 to 30 percent clay. The B21ca horizon is brown, light brown, very pale brown, pale brown, light reddish brown, or pinkish gray. Visible carbonates range from 20 to 30 percent. The B22ca horizon is pink, pinkish gray, light brown, and very pale brown. Visible carbonates range from 20 to 60 percent. The Bt horizon is red, reddish yellow, or yellowish red. Visible carbonates range from 5 to 30 percent.

Mansker and Estacado soils, 0 to 1 percent slopes (MeA).—These soils occupy plains. Areas are 25 to 300 acres in size and are somewhat oval or elongated. Slope is mostly 0.3 percent. The total acreage is about 50 percent Mansker soils, 40 percent Estacado soils, and 10 percent other soils. Mansker and Estacado soils are intermingled in about 80 percent of the acreage, but only one of these soils occurs in the rest.

The profile of this Mansker soil is the one described as representative of the series.

The Estacado soil is calcareous and friable throughout. The surface layer is about 14 inches of dark grayish-brown clay loam. The next 32 inches is pink clay loam. Below this is 16 inches of reddish-yellow clay loam, which is underlain by yellowish-red clay loam that extends to a depth of 85 inches.

Included with these soils in mapping are areas of Olton soils, areas of Tulia soils up to 5 acres in size in most mapped areas, and narrow bands of Pullman soils near the edge of mapped areas. Soils in a few areas are less than 15 percent carbonates in the carbonate-enriched layers. These included soils are less than 15 percent of any one area.

These soils are used for crops and range. The principal crops are small grain, sorghum, and cotton.

The hazard of soil blowing is severe, and the hazard of water erosion is slight. Managing crop residue on the soil surface helps to control soil blowing. Terraces and contour tillage are needed in dryfarmed areas to help control water losses. Irrigation water should be applied by a system (fig. 7) that does not waste water or cause erosion. Capability units IIIe-6, dryland, and IIe-1, irrigated; Deep Hardland range site.

Mansker and Estacado soils, 1 to 3 percent slopes (MeB).—These soils are on uplands. They have convex slopes and are around playa basins and along draws. The areas are circular or elongated, follow the contour of the land, and are 25 to 200 acres in size. Slopes are mostly about 2 percent. The total acreage is about 45 percent Mansker soils, 40 percent Estacado soils, and 15 percent

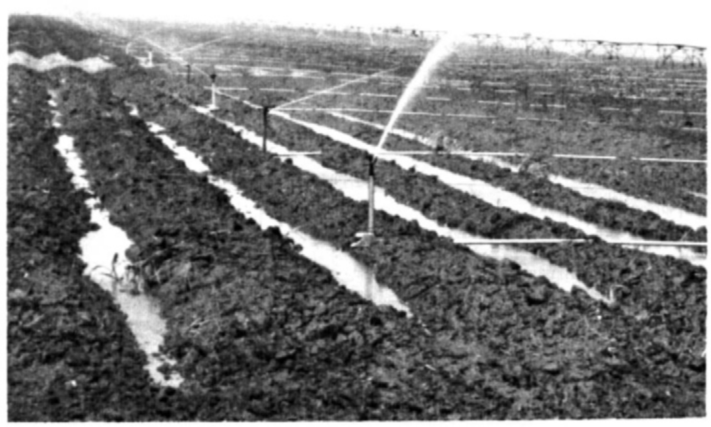

Figure 7.—Mansker and Estacado soils irrigated by a sprinkler system.

other soils. Mansker and Estacado soils are intermingled in about 80 percent of the acreage, but only one of these soils occurs in the rest.

The Mansker soil is calcareous and friable throughout. The surface layer is dark grayish-brown clay loam about 11 inches thick. The next 57 inches is clay loam that is brown in the first 16 inches, very pale brown in the next 15 inches, and yellowish red in the remaining 26 inches. Below this, and extending to a depth of 90 inches, is red sandy clay loam.

The profile of this Estacado soil is the one described as representative of the series.

Included with these soils in mapping are areas of Tulia soils that occupy as much as 10 percent of most mapped areas. Spots of Olton soils 1 to 3 acres in size are in a few areas. A few areas of soils have less than 15 percent calcium carbonate in the profile.

The soils in this unit are used for crops and range. The main crops are small grain, sorghum, and cotton.

The hazard of water erosion is moderate, and the hazard of soil blowing is severe. Mechanical practices to hold water on the soils, such as using terraces, farming on the contour, and managing crop residue on the soil surface, help to control water erosion and soil blowing. Irrigated areas should be bench leveled or sprinkler irrigated so that water is not wasted and the soils are not eroded. Use of alfalfa or a similar soil-improving crop in the cropping system helps to maintain soil tilth. Capability units IIIe-2, dryland, and IIIe-2, irrigated; Deep Hardland range site.

Mansker and Estacado soils, 3 to 5 percent slopes (MeC).—These soils are on the sides of large playas and along draws. The areas are crescent-shaped, irregular bands that have simple to complex, convex slopes along the draws and simple convex slopes near the playas. They range from 4 acres to about 200 acres in size. Slopes are mainly 4 percent. The total acreage is about 45 percent Mansker soils, 40 percent Estacado soils, and 15 percent other soils. Mansker and Estacado soils are intermingled in about 80 percent of the acreage, but only one of these soils occurs in the rest.

The Mansker soil is calcareous and friable. The surface layer is grayish-brown clay loam about 11 inches thick. The next 35 inches is clay loam that is brown in the upper 10 inches, very pale brown in the next 15 inches, and yellowish red in the lower 20 inches. Below this, and extending to a depth of 80 inches, is yellowish-red clay loam.

The Estacado soil is calcareous and friable. The surface layer is grayish-brown clay loam about 11 inches thick. The next layer is brown clay loam about 15 inches thick. The next 25 inches is light reddish-brown clay loam. Below this, and extending to a depth of more than 80 inches, is reddish-yellow clay loam.

Included with these soils in mapping are thin bands of Pullman or Lofton soils on the edges of some mapped areas. Irregularly shaped spots of Olton soils less than 5 acres in size occur within some areas. The steeper areas are up to 20 percent Tulia soils.

The soils in this unit are used mostly for range, but a few small areas are used for crops. The main crops are small grain and sorghum.

The hazards of soil blowing and water erosion are severe. In cultivated areas some shallow gullies are caused by water running down cow trails or field roads. Terraces and contour farming are needed to control erosion and to help conserve water. Where high-residue crops are grown and the residue is managed on the surface, the hazards of soil blowing and water erosion are reduced. Irrigated areas should be bench leveled or sprinkler irrigated to prevent waste of water and to control erosion. Close-spaced crops that produce a large amount of residue are needed. Perennial grasses or legumes in the crop rotation help to maintain soil tilth. Capability units IVe-6, dryland, and IVe-3, irrigated; Hardland Slopes range site.

Mansker-Tulia complex, 5 to 8 percent slopes (MtD).—This complex of soils is on side slopes and ridges along draws. In a typical area, the Mansker soil is on side slopes and the Tulia soil is on knolls and ridges. The relief is excessive. Slopes are gently undulating to gently rolling. Mapped areas range from 12 acres to more than 200 acres in size. The Mansker soil makes up about 55 percent of the complex, the Tulia soil about 30 percent, and included areas of Acuff, Estacado, and Potter soils about 15 percent.

The Mansker soil is calcareous and friable. The surface layer is grayish-brown clay loam about 11 inches thick. The next layer is brown clay loam about 14 inches thick. Below this is 14 inches of very pale brown clay loam. The next 30 inches is yellowish-red clay loam. Below this, to a depth of 80 inches, is yellowish-red sandy clay loam.

The Tulia soil is calcareous and friable. The surface layer is dark yellowish-brown loam about 4 inches thick. The next layer is brown loam about 8 inches thick. The next 12 inches is very pale clay loam. It is about 40 percent, by volume, segregated calcium carbonate. The next 14 inches is light reddish-brown clay loam. It is about 20 percent, by volume, segregated calcium carbonate. Below this, to a depth of 80 inches, is reddish-yellow clay loam.

Included with these soils in mapping are areas of steeper soils where geologic erosion is active. These included soils make up as much as 15 percent of some mapped areas. Also included are areas of soils that have slopes of up to 16 percent.

The soils in this mapping unit are used for range. The hazards of water erosion and soil blowing are severe. Capability unit VIe-2, dryland; Hardland Slopes range site.

Olton Series

The Olton series consists of deep nearly level to gently sloping soils that formed in the eolian mantle of the High Plains. These soils have convex to plane relief.

In a representative profile (fig. 8), the surface layer is friable, reddish-brown clay loam about 6 inches thick. The next layer is clay loam that reaches to a depth of 80 inches. The upper 30 inches of this clay loam is firm to very firm and reddish brown. The next 20 inches is pink and friable and is high in segregated lime. The lower 24 inches is friable and reddish yellow.

These soils are well drained and moderately slowly permeable. Available water capacity is high, and runoff is very slow to slow.

Olton soils are used mostly for crops. A few areas are in native range. These soils are well suited to most crops commonly grown in the county.

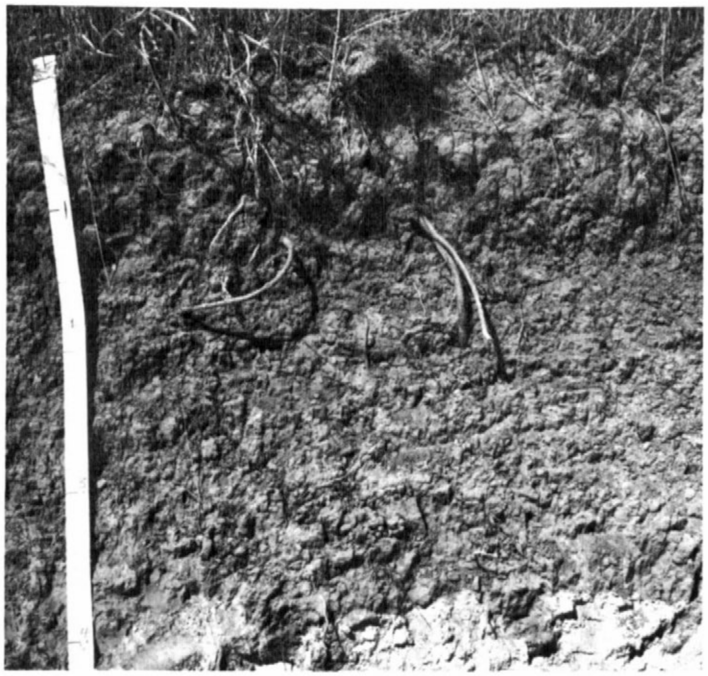

Figure 8.—**Profile of an Olton clay loam.**

Representative profile of Olton clay loam, 1 to 3 percent slopes, about 6.0 miles east and 3.5 miles south of Tulia, 2,200 feet west and 300 feet south of the northeast corner of sec. 144, block A, Arnold and Barrett Survey:

A1—0 to 6 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; weak, fine, subangular blocky structure and moderate, fine, granular structure; hard, friable; common, fine, fibrous roots; few fine pores; few worm casts; neutral; clear, smooth boundary.

B21t—6 to 12 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate, fine, subangular blocky structure; very hard, firm; common, fine, fibrous roots; few fine pores; few worm casts; few thin clay films, slightly darker than crushed color of soil material in this horizon; neutral; clear, smooth boundary.

B22t—12 to 18 inches, reddish-brown (5YR 5/3) clay loam, reddish brown (5YR 4/3) moist; moderate, fine and medium, blocky structure; very hard, firm; few, fine, fibrous roots; few fine pores; few worm casts; common distinct clay films; mildly alkaline; gradual, smooth boundary.

B23t—18 to 28 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate, fine and medium, blocky structure; very hard, very firm; slightly heavier textured than horizon above; few, fine, fibrous roots; few fine pores; few worm casts; common distinct clay films; few carbonate films; calcareous, moderately alkaline; gradual, smooth boundary.

B24t—28 to 36 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; moderate, medium subangular blocky structure; very hard, firm; few fine roots; few fine pores; few worm casts; few clay films; few threads of lime, and increasing in number with depth; calcareous, moderately alkaline; gradual, smooth boundary.

B25tca—36 to 56 inches, pink (5YR 8/4) clay loam, reddish yellow (5YR 7/6) moist; moderate, medium, blocky structure; hard, friable; few fine roots; common fine pores; few worm casts; few clay films; 35 percent, by volume, soft pink caliche that is well mixed with the soil mass; few concretions of calcium carbonate 2 to 10 millimeters in diameter; calcareous, moderately alkaline; diffuse, smooth boundary.

B26t—56 to 80 inches, reddish-yellow (5YR 7/6) clay loam, reddish yellow (5YR 6/6) moist; moderate, medium, blocky structure; hard, friable; few fine pores; few fine masses of calcium carbonate 5 to 10 millimeters in diameter; calcareous, moderately alkaline.

The solum ranges from 60 inches to more than 80 inches in thickness. Secondary carbonates occur at a depth of 14 to 28 inches. The A horizon is 6 to 11 inches thick. It is brown, dark brown, reddish brown, or dark reddish gray. The upper part of the Bt horizon is clay loam to clay and is 35 to 45 percent clay. It is reddish brown, dark reddish brown, brown, or dark brown. The lower part is clay loam and is about 35 to 40 percent clay. It is reddish yellow, yellowish red, brown, strong brown, or reddish brown. Structure is moderate, fine to medium, subangular blocky to blocky. The Btca horizon is at a depth between 30 and 60 inches. It is pink, light reddish brown, light brown, or reddish yellow and is 20 to 60 percent calcium carbonate, by volume.

Olton clay loam, 0 to 1 percent slopes (OIA).—This soil is in areas that are irregular to somewhat oval. It has a smooth, weakly convex to plane relief and a dominant slope of about 0.5 percent. Areas range from 60 to 350 acres in size but are dominantly about 150 acres.

The surface layer is friable, reddish-brown clay loam about 8 inches thick. The subsoil, to a depth of about 40 inches, is reddish-brown firm clay loam. A layer of friable pink clay loam that is high in calcium carbonate extends from a depth of 40 inches to about 65 inches. The next lower layer reaches to a depth of 80 inches and is friable reddish-yellow clay loam.

Included with this soil in mapping are areas of Pullman, Mansker, and Estacado soils in narrow bands near the edges of mapped areas and small, irregular areas within mapped areas. These included soils are less than 8 percent of the total area.

Practically all areas of this soil are cultivated and are very well suited to dryland and irrigated farming. Cotton, grain sorghum, and small grain are the principal crops.

The hazard of soil blowing is slight. Crop residue left on the surface helps to control soil blowing and to maintain soil tilth. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Capability units IIIe-6, dryland, and IIe-1, irrigated; Deep Hardland range site.

Olton clay loam, 1 to 3 percent slopes (OIB).—This soil is on plains and the side slopes of draws and playas. Areas range from 50 acres to about 300 acres in size but are mostly about 100 acres. They are somewhat irregular in shape. Most of them are curving bands, 300 to 1,200 feet long, that parallel the relief of the landscape. Slopes are smooth and convex. This soil has the profile described as representative of the Olton series.

Included with this soil in mapping are a few areas of Pullman soils, 1 to 5 acres in size. A few areas on side slopes of playas include Mansker and Estacado soils. Some areas of soils that have a loam surface layer are also included.

Most areas of this soil are cultivated. The principal crops are small grain, sorghum, and cotton.

The hazards of water erosion and soil blowing are moderate. Crop residue kept on soil surface helps to control soil blowing and erosion and to maintain soil tilth.

Mechanical practices such as bench leveling or terracing provide better control and distribution of water. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Capability units IIIe–2, dryland, and IIIe–2, irrigated; Deep Hardland range site.

Potter Series

The Potter series consists of gently sloping to moderately steep soils that are very shallow to shallow over thick caliche beds. Areas of these soils are 200 to 400 feet wide and up to 1 mile long. They follow the contour of the land. These soils are convex and have slopes of 3 to 20 percent.

In a representative profile (fig. 9), the surface layer is friable, very dark grayish-brown gravelly loam about 4 inches thick. The underlying material, to a depth of 12 inches, is light brownish-gray gravelly loam and is about 90 percent caliche pebbles and plates. Below this, to a depth of 60 inches, is pinkish-white caliche.

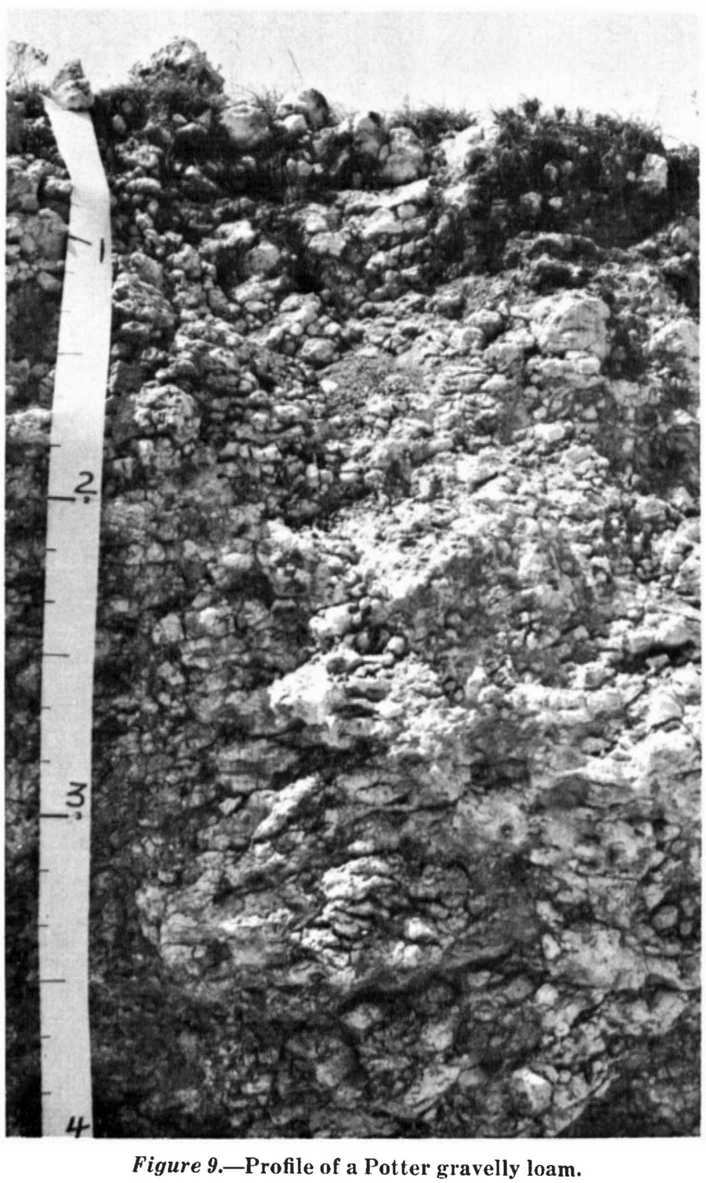

Figure 9.—**Profile of a Potter gravelly loam.**

Available water capacity is low, and runoff is medium to rapid.

These soils are well drained. Permeability is moderate. Geologic erosion is active.

Potter soils are used for range.

Representative profile of a Potter gravelly loam in an area of Potter and Tulia soils, 3 miles east and 0.4 mile north of Tulia, 0.45 mile north and 0.1 mile east of the southwest corner of sec. 7, block M–15, Denison and Pacific Railroad Survey.

A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) moist; moderate, fine granular structure; hard, friable; few worm casts; common caliche pebbles 2 to 15 millimeters in diameter; calcareous, moderately alkaline; abrupt, smooth boundary.

C1ca—4 to 12 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; hard, friable; about 90 percent hard caliche pebbles and plates 2 to 8 centimeters thick and 8 to 12 centimeters across; remaining 10 percent is soil around cobblestones and between plates; pendants 6 millimeters long on underside of plates; few worm casts; about 20 percent caliche 1 to 3 millimeters in diameter in soil part; calcareous, moderately alkaline; abrupt, wavy boundary.

C2ca—12 to 60 inches, pinkish-white (7.5YR 8/2) caliche of about loam texture, pink (7.5YR 7/4) moist; massive (structureless); very firm, very hard; few fine pores; few black stains; calcareous; moderately alkaline.

The A horizon ranges from 4 to 12 inches in thickness. It is generally brown, grayish brown, pale brown, or light brown. In areas where the A horizon is less than 7 inches thick, it is very dark grayish brown or dark grayish brown. It is mainly loam but ranges to clay loam. Caliche fragments and concretions range from 3 to 30 percent of the soil mass. The C1ca horizon is 50 to 95 percent fragments and weakly cemented caliche plates 2 to 10 centimeters thick and 8 to 50 centimeters across. The rest is a light brownish gray to pink limy earth. The C2ca horizon is massive caliche several feet thick. It contains loamy material and plates that can barely be cut with a spade.

Some of the soils of Swisher County named for this series are outside the range of the series, because the color of their surface layer is darker. This difference, however, does not alter their usefulness or behavior.

Potter and Tulia soils (Pt).—These soils occupy the steeper rims of draws that traverse the county. Areas are 200 to 400 feet wide and about 800 to 5,000 feet long. Slopes are convex and range from 3 to 20 percent. Geologic erosion is active.

The Potter soils make up about 60 percent of the mapping unit; the Tulia soils, about 30 percent; and caliche outcrop and areas of included soils, about 10 percent.

A Potter soil in this mapping unit has the profile described as representative of the Potter series.

The Tulia soils are friable and calcareous. The surface layer is dark yellowish-brown loam about 4 inches thick. The next layer is brown loam about 10 inches thick that contains common films and threads of calcium carbonate. Below this is very pale brown clay loam about 16 inches thick that has many, coarse, soft masses and few fine concretions of calcium carbonate. The next layer is light reddish-brown clay loam about 15 inches thick. It has a slight accumulation of clay and a few, coarse, soft masses of calcium carbonate. The lower layer, to a depth of more than 85 inches, is reddish-yellow sandy clay loam that has a slight accumulation of clay and a few films of calcium carbonate.

Caliche outcrop is nearly barren caliche or caliche covered by 1 to 3 inches of soil material that supports only a few plants.

The Potter soils and the caliche outcrop occupy the ridges and the steeper areas. The Tulia soils occupy drainageways and lower lying areas.

Included with these soils in mapping are a few areas where the caliche layers are harder than 3 on Mohs' scale. Mansker soils are also included in a few of the drainageways.

This mapping unit supports a thin cover of native grasses and is used mostly for range. A few areas are mined for caliche that is used for roadbeds of local roads. Capability unit VIIs–1, dryland; Very Shallow range site.

Pullman Series

The Pullman series consists of deep, nearly level to gently sloping soils that formed in calcareous eolian materials of the High Plains. Pullman soils occupy broad, smooth areas that are interrupted by draws and playas. The slopes are typically less than 0.6 percent but range to 3 percent near playas and draws.

In a representative profile (fig. 10), the surface layer is firm, brown clay loam about 8 inches thick. The next layers, in sequence from the top, are 24 inches of brown, very firm clay; 18 inches of yellowish-red, firm clay; 25 inches of friable, pink clay loam that is about 40 percent, by volume, segregated calcium carbonate; and 25 inches of reddish-yellow, friable clay loam.

These soils are well drained. Runoff is slow, and permeability is very slow. Available water capacity is high.

Pullman soils are used for growing irrigated and dryland crops.

Representative profile of Pullman clay loam, 0 to 1 percent slopes, about 7 miles east and 1 mile north of Tulia, 3,600 feet west and 100 feet north of the northeast corner of sec. 133, block M–10, Beaty, Seale, and Forwood Survey:

Ap—0 to 8 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak, fine, granular structure; hard, firm; few fine roots; mildly alkaline; abrupt, smooth boundary.

B21t—8 to 22 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; moderate, fine to medium, blocky structure; very hard, very firm; few fine roots; few fine pores; distinct clay films; few streaks of soil from the Ap horizon in old vertical cracks; peds are wedge shaped and are alined horizontally; mildly alkaline; clear, smooth boundary.

B22t—22 to 32 inches, brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; moderate, medium, blocky structure; very hard, very firm; few fine roots; common fine pores; distinct clay films; peds are alined horizontally; lime films on ped surfaces; few lumps of lime 1 to 3 millimeters in diameter; calcareous, moderately alkaline; gradual, smooth boundary.

B23t—32 to 50 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; moderate, fine and medium, blocky structure; hard, firm; few fine roots; common fine pores; prominent clay films; peds are alined vertically, are noncalcareous in places, and have a few threads and small lumps of lime on their ped surfaces; few black stains; calcareous, moderately alkaline; clear, wavy boundary.

Figure 10.—Profile of a Pullman clay loam.

B24tca—50 to 75 inches, pink (5YR 8/4) clay loam, reddish yellow (5YR 7/6) moist; weak, medium, subangular blocky structure; hard, friable; few fine pores; few worm casts; thin clay films; estimated 40 percent, by volume, lime lumps 15 to 35 millimeters in diameter; calcareous, moderately alkaline; diffuse, smooth boundary.

B25t—75 to 100 inches, reddish-yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; moderate, medium, subangular blocky structure; hard, friable; common fine pores; common lumps of lime 3 to 10 millimeters in diameter; calcareous, moderately alkaline.

The solum is more than 80 inches thick. Secondary lime occurs at a depth of 15 to 25 inches. An accumulation of calcium carbonate is at a depth of 30 to 60 inches. The A horizon ranges from 4 to 12 inches in thickness. It is clay loam, but 1 to 2 inches of silt loam accumulation is common where range is near cultivated areas. It is brown, grayish brown, dark brown, or dark grayish brown. Reaction is neutral to moderately alkaline. The B21t horizon is 6 to 18 inches thick. Clay content of the upper part of the Bt horizon is 45 to 60 percent. It is brown, dark grayish brown, or grayish brown. The structure is moderate, fine to medium, blocky. Peds are wedge shaped and are alined horizontally. The B22t horizon is 8 to 18 inches thick. It is 1 to 3 percent, by volume, secondary lime. The lower part of the Bt horizon, except for the Bca horizon, is reddish brown, brown, yellowish red, or reddish yellow. It is of clay loam to clay texture and is 38 to 45 percent clay. Structure is moderate fine to medium blocky. The Bca horizon is pink, light-brown, brown, or reddish-yellow clay loam or clay that is 25 to 60 percent, by volume, calcium carbonate.

Pullman clay loam, 0 to 1 percent slopes (PuA).—This soil is on a nearly continuous plain that is dotted by playas. Slope is dominantly less than 0.4 percent. The only visible slope is toward draws and playas, but the general slope is toward the east at about 10 feet per mile. This soil has the profile described as representative of the Pullman series.

Included with this soil in mapping are a few oblong or circular areas, 1 to 5 acres in size, of Olton, Mansker, Estacado, Lofton, and Randall soils. These included soils occupy less than 3 percent of the total area.

Most of this soil is irrigated. Some areas are dryfarmed, and a few small acres are used for range. Crops are grain sorghum, wheat, cotton, soybeans, and corn.

This soil is well suited to irrigation. It cracks when it dries. When it is wetted, the water first moves into the subsoil at a moderate rate. Then the soil swells and tends to seal, and water moves very slowly downward. This characteristic allows uniform wetting with irrigation water by the furrow method. Fertilizer is needed to maintain crop production.

This soil is droughty under dryland farming. Tilth can be improved and soil blowing controlled by leaving crop residue on or near the surface and plowing to leave a cloddy surface. Capability units IIIe–5, dryland, and IIs–1, irrigated; Deep Hardland range site.

Pullman clay loam, 1 to 3 percent slopes (PuB).—This soil is in areas 500 feet to more than 1,000 feet wide. These areas are elongated and encircle or partially encircle playas, or they occupy the upper sides of sloping areas along draws. Slopes are mostly 1.5 to 2 per cent. The relief is plane to convex. The upper edges join Pullman clay loam, 0 to 1 percent slopes. The lower edges join Mansker, Estacado, Tulia, Lofton, or Randall soils.

The surface layer is firm, brown clay loam about 6 inches thick. The next layer, to a depth of about 30 inches, is brown, very firm clay that has wedge-shaped peds alined horizontally. Below this, to a depth of about 45 inches, is yellowish-red, firm clay that has blocky peds alined vertically. A pink, calcareous clay loam layer occurs at a depth of about 45 inches and extends to a depth of about 70 inches. Below this is friable, reddish-yellow clay loam that extends to a depth of 100 inches.

Included with this soil in mapping are elongated areas of Mansker, Estacado, Tulia, Lofton, Randall, and Olton soils that are generally less than 4 acres in size. These included soils make up less than 8 percent of the total area.

This soil is mostly in irrigated and dryland cotton, grain sorghum, small grain, and soybeans. Other areas are in native range.

Mechanical practices, such as terracing (fig. 11), contour tillage, and bench leveling, help to control water erosion. Leaving crop residue on the surface and plowing to leave a cloddy surface are ways to control soil blowing and maintain soil tilth. Capability units IIIe–1, dryland, and IIIe–1, irrigated; Deep Hardland range site.

Figure 11.—**Constructing a parallel terrace system on Pullman soils.**

Randall Series

The Randall series consists of deep, nearly level soils that have gilgai microrelief and that formed in reworked sediment consisting of eolian material. These soils, generally 10 to 40 feet below the main level of the High Plains, make up the floors of playas. A few areas are in slight depressions surrounded by Pullman soils. Within the larger playas, Randall soils are surrounded by higher lying Roscoe, Lipan, and Lofton soils.

In a representative profile, the surface layer is very sticky, dark-gray clay about 18 inches thick. The next layer is very sticky, gray clay about 27 inches thick. The underlying material is very sticky, light brownish-gray clay that extends to a depth of 70 inches.

Runoff water from surrounding soils inundates Randall soils after heavy rainfall. In places, these soils are inundated from 1 to 3 months in most years. Most of this water evaporates or is used for irrigation. Internal drainage is very slow, and permeability is very slow. These soils are somewhat poorly drained. The available water capacity is high.

Randall soils are used mainly for grazing.

Representative profile of Randall clay, 400 feet east and 100 feet north of the southeast corner of sec. 33, block R.C., Tyler Tapp Railroad Survey, about 2 miles east and 4 miles north of Tulia:

A1—0 to 18 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, medium, blocky structure parting to moderate, fine, blocky structure; very hard, very firm, very sticky and plastic; many shrinkage cracks up to 3 centimeters wide; few, black, shot-shaped pellets 3 to 5 millimeters in diameter; mildly alkaline; gradual, smooth boundary.

AC—18 to 45 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, medium, blocky structure; extremely hard, very firm, very sticky and plastic; few intersecting slickensides that part to parallelepipeds; few, black, shot-shaped pellets 3 to 5 millimeters in diameter; mildly alkaline; diffuse, smooth boundary.

C—45 to 70 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; weak, medium, blocky structure; very hard, very firm, very sticky and plastic; few, black, shot-shaped pellets 3 to 5 millimeters in diameter; few thin strata of clay loam in the lower part; calcareous, moderately alkaline.

The A horizon ranges from 12 to 25 inches in thickness. It is gray, dark gray, or very dark gray. Reaction is neutral to moderately alkaline. The AC horizon is 15 to 35 inches thick. It is gray or dark gray. Reaction ranges from mildly alkaline to moderately alkaline. The C horizon is at a depth of 40 to 60 inches. It ranges from clay to clay loam and is more than 35 percent clay. It is gray, light gray, very pale brown, or yellowish brown to light yellowish brown.

Randall clay (Ra).—This nearly level soil occupies floors of the playas that pock the smooth High Plains landscape. Areas are oval to oblong and 1 to 100 acres in size.

Included with this soil in mapping are a few areas of Roscoe soils. A few areas of Randall soils that have an A horizon thicker than 25 inches are also included.

This soil is generally unsuited to cultivation, because of the hazard of flooding and undesirable physical characteristics. Some areas of this soil are cultivated where they are drained or excess water is diverted. The clayey surface layer is difficult to till. Crop residue left on or near the surface improves soil tilth. The native vegetation is sedges, smartweeds, and other aquatic plants and grasses, such as buffalograss and western wheatgrass around the outer edges. Prolonged inundation kills the grasses and leaves the soil bare when the water evaporates. In these barren areas the hazard of soil blowing is severe. Emergency tillage that roughens the surface helps to control soil blowing. This soil furnishes temporary habitat for migratory ducks and geese. Capability units VIw-1, dryland; IVs-1, dryland (drained), and IVs-1, irrigated (drained); included in the range site of the surrounding soil.

Roscoe Series

The Roscoe series consists of deep, nearly level soils that formed in reworked sediment derived from eolian material and deposited on playa benches. These benches encircle the playa bottoms; they are 7 to 15 feet above them and 5 to 30 feet below the main level of the High Plains. Where in native grass, Roscoe soils have a weak gilgai microrelief. These soils are smooth to slightly concave.

In a representative profile (fig. 12), the surface layer is dark-gray, very firm clay about 26 inches thick. The next layer is about 30 inches thick. It is grayish-brown, very firm clay. The underlying material is light-gray clay loam to a depth of 64 inches, and light-gray clay to a depth of 75 inches.

These soils are moderately well drained. Runoff and permeability are very slow. In places, these soils are inundated for short periods following heavy rainfall. Available water capacity is high.

Representative profile of Roscoe clay, 12 miles west and 1 mile south of Tulia, 4,600 feet west and 450 feet south of the northeast corner of sec. 10, block M-11, Adam, Beaty, and Moulton Railroad Survey:

Figure 12.—**Profile of Roscoe clay.**

Ap—0 to 6 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, fine, granular structure; very hard, very firm, sticky and plastic; common fine roots; calcareous, moderately alkaline; abrupt, smooth boundary.

A1—6 to 26 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; intersecting slickensides parting to parallelepipeds and moderate, fine, blocky structure; very hard, very firm, sticky and plastic; few fine roots; few black concretions 1 to 3 millimeters in diameter; calcareous, moderately alkaline; diffuse, smooth boundary.

AC—26 to 56 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; intersecting slickensides parting to parallelepipeds and moderate, fine, blocky structure; extremely hard, very firm; few fine roots; few black concretions 1 to 5 millimeters in diameter; few films and lumps of calcium carbonate 2 to 10 millimeters in diameter; calcareous, moderately alkaline; gradual, smooth boundary.

C1ca—56 to 64 inches, light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) moist; massive (structureless) but porous; hard, firm, slightly plastic; few fine roots; common lumps of calcium carbonate 5 to 15 millimeters in diameter; calcareous, moderately alkaline; gradual, smooth boundary.

C2—64 to 75 inches, light-gray (10YR 7/2) clay, light brownish gray (10YR 6/2) moist; weak, medium, blocky structure; very hard, very firm, plastic; few fine roots, few lumps of calcium carbonate 5 to 10 millimeters in diameter; calcareous, moderately alkaline.

When the soil is dry, cracks ½ to 1 inch wide extend to a depth of as much as 50 inches. The A horizon ranges from 18 to 36 inches in thickness. It is gray to dark gray. Reaction is mildly alkaline to moderately alkaline. The AC horizon is grayish brown, light brownish gray, or dark grayish brown. The C1ca and C2 horizons range from clay to clay loam in texture. They range from light gray to very pale brown, grayish brown, or yellowish brown in color. These horizons are 2 percent to about 25 percent, by volume, segregated calcium carbonate.

Roscoe clay (Ro).—This soil occurs on playa benches and in slight depressions. Mapped areas are 5 to 200 acres in size and are nearly round or irregular in shape. Slopes are dominantly less than 0.5 percent, but they are 1 percent in some narrow bands.

Included with this soil in mapping are areas, generally less than 5 acres in size, of Lofton, Lipan, and Randall soils. A few areas are soils that are gray to a depth of more than 40 inches. A few small areas of Roscoe soils that have slopes of more than 1 percent are also included.

This soil is well suited to cultivation. The main crops are small grain and sorghum.

This soil is droughty under dryland farming and in places is flooded for short periods following heavy rainfall. Soil tilth can be improved and soil blowing can be controlled by leaving crop residue on or near the surface. Fertilizer is needed to maintain crop production under irrigation. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Capability units IVs–1, dryland, and IVs–1, irrigated; Deep Hardland range site.

Rough Broken Land

Rough broken land consists of rolling to very steep, deeply dissected areas that include narrow valleys and nearly vertical escarpments. The vegetation generally is sparse. Most areas are used for range or wildlife habitat.

Rough broken land and Berda soils (Ru).—This mapping unit is a nearly continuous area along Tule Creek where the creek leaves the county on the eastern side. A fall of about 250 feet from the level of the High Plains to the floor of Tule Creek takes place within a horizontal distance of 1,200 to 3,200 feet. Most of the area is rolling to very steep, and slopes range from 10 to 75 percent. This area is deeply dissected and consists of narrow valleys, steep divides, and nearly vertical escarpments. These nearly barren escarpments are prominent but not extensive.

Rough broken land makes up about 45 percent of this mapping unit. It is on the steeper side slopes and narrow ridges and has a fair cover of vegetation.

Berda soils make up about 35 percent of this mapping unit. These are rolling to hilly soils that formed in colluvium on foot slopes and in valleys. They have the profile described as representative for the Berda series. The texture of their surface layer ranges from fine sandy loam to loam.

Included in mapping are areas of Tulia and Potter soils that make up about 20 percent of the acreage.

Rough broken land and Berda soils are used for native range and wildlife habitat and are suited to limited use for these purposes. The hazard of water erosion is severe. Capability unit VIIs–1, dryland; Rough Breaks range site.

Tulia Series

The Tulia series consists of deep, nearly level to sloping soils that formed in the eolian mantle of the High Plains. These soils occupy moderately convex surfaces along draws and around playas. They are friable and calcareous.

In a representative profile, the surface layer is dark yellowish-brown loam about 4 inches thick. The next layer is 10 inches of brown loam that contains common films and threads of calcium carbonate. Below this is 16 inches of very pale brown clay loam containing many, coarse, soft masses and a few fine concretions of calcium carbonate (fig. 13). The next 15 inches is light reddish-brown clay loam that has a few, coarse, soft masses of calcium carbonate. The lower 40 inches is reddish-yellow sandy clay loam that has a slight clay accumulation and a few films of calcium carbonate.

These soils have high available water capacity. They are well drained, and permeability is moderate. Runoff is slow to rapid.

These soils are used for crops and native range. They are suited to sorghum, small grain, and cotton. The high content of lime may cause chlorosis in some plants.

Representative profile of a Tulia loam in an area of Tulia complex, 3 to 5 percent slopes, 12 miles west and 1 mile north of Tulia, 0.2 mile west and 0.25 mile south of the northeast corner of sec. 104, block M–6, Stone, Kyle, and Kyle Survey:

A1—0 to 4 inches, dark yellowish-brown (10YR 4/4) loam, dark yellowish brown (10YR 3/) moist; weak, fine, subangular blocky structure; hard, friable; many roots; few worm casts; few small caliche pebbles; calcareous, moderately alkaline; clear, smooth boundary.

B21ca—4 to 14 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; moderate, fine, subangular blocky structure and weak, fine, granular structure; hard, friable; many roots; many worm casts; common threads and films of calcium carbonate; few caliche pebbles; calcareous, moderately alkaline; gradual, smooth boundary.

B22ca—14 to 30 inches, very pale brown (10YR 8/3) clay loam, very pale brown (10YR 7/4) moist; weak,

Figure 13.—**Profile of a Tulia loam showing masses and concretions of calcium carbonate.**

fine, subangular blocky structure; hard, friable; few worm casts; many, coarse, soft masses and few, fine, slightly cemented concretions of calcium carbonate; calcium carbonate equivalent is about 55 percent; calcareous, moderately alkaline; diffuse, smooth boundary.

B23tcab—30 to 45 inches, light reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 5/4) moist; weak, fine, subangular blocky structure; hard, friable; many very fine pores; few thin clay films; few, coarse, soft masses of calcium carbonate; calcium carbonate equivalent is about 20 percent; calcareous, moderately alkaline; gradual, smooth boundary.

B24tb—45 to 85 inches, reddish-yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; moderate, medium, subangular blocky structure; hard, friable; few fine pores; few clay films on ped faces; few films and threads of calcium carbonate; calcareous, moderately alkaline.

The A horizon ranges from 4 to 8 inches in thickness. It is grayish brown, dark grayish brown, brown, dark brown, or dark yellowish brown. It is loam or clay loam. An accumulation of calcium carbonate is at or near the top of the B horizon, and the maximum content of carbonates begins at a depth of 10 to 24 inches. The calcium carbonate equivalent of the Btca horizon ranges from 15 to 70 percent. The B21ca horizon is 6 to 14 inches thick. It is very pale brown, light brown, brown, or pinkish gray. The B22ca horizon is 6 to 26 inches thick. It is pink, very pale brown, light brown, brown, or light reddish brown. It is clay loam to sandy clay loam. Depth to the Btb horizon is 20 to 50 inches. The B23tcab horizon is 5 to 16 inches thick. It is reddish yellow, light reddish brown, light brown, or pink. It ranges from loam to clay loam or sandy clay loam. The B24tb horizon is reddish yellow, yellowish red, light reddish brown, light brown, or pink. It ranges from loam to clay loam or sandy clay loam.

Some Tulia soils of mapping unit TuC in Swisher County are outside of the range of the Tulia series because they lack 40 percent carbonates within 40 inches of the surface This difference does not alter their usefulness or behavior.

Tulia clay loam, 0 to 1 percent slopes (TlA).—This soil occurs dominantly within larger areas of Mansker and Estacado soils. The areas of this soil are nearly level, are irregular in shape, and range from 4 acres to about 200 acres in size.

The profile is calcareous and friable throughout. The surface layer is brown clay loam about 6 inches thick. The next layer is light-brown clay loam about 14 inches thick. It is about 15 percent, by volume, segregated calcium carbonate. Below this is pink clay loam about 20 inches thick. It is about 35 percent, by volume, segregated calcium carbonate. The next layer is light reddish-brown clay loam about 14 inches thick. It is about 15 percent, by volume, segregated calcium carbonate. The lower layer, which extends to a depth of 80 inches, is reddish-yellow sandy clay loam.

Included with this soil in mapping are areas of Mansker and Estacado soils 3 to 5 acres in size that occur in most mapped areas. In a few areas are soils that lack 40 percent carbonates within 40 inches of the surface. About 5 to 15 percent of most areas is a soil that is similar to this Tulia soil, except that it has clay films in the upper part.

This Tulia soil is used for native range and for crops. The principal crops are small grain and sorghum.

The hazard of soil blowing is severe, and the hazard of water erosion is moderate. Terraces and contour tillage in dryfarmed areas help to control runoff. An irrigation system that permits irrigation without wasting water or causing erosion is needed. Crop residue managed on the soil surface helps to control soil blowing. Capability units IVe–2, dryland, and IIIe–6, irrigated; Hardland Slopes range site.

Tulia clay loam, 1 to 3 percent slopes (TlB).—Areas of this soil have convex slopes that are dominantly about 2 percent. These areas are irregular along draws and are crescent shaped near playas. They range from 4 acres to more than 200 acres in size.

This soil is calcareous and friable throughout. The surface layer is grayish-brown clay loam about 6 inches thick. The next layer is very pale brown clay loam about 12 inches thick. Below this is pink clay loam about 22 inches thick. It is about 25 percent, by volume, segregated calcium carbonate. The next lower layer, reaching to a depth of 80 inches, is reddish-yellow clay loam.

Included with this soil in mapping are areas of Potter soils that are less than 5 acres in size and are less than 10 percent of any mapped area. A few areas include up to 20 percent Mansker and Estacado soils. A few areas are soils that lack 40 percent carbonates within 40 inches of the surface. Other areas are soils that have a surface layer of loam. About 5 to 15 percent of most areas is a soil that is similar to this Tulia soil but has clay films in its upper part.

This Tulia soil is used for crops and range. The principal crops are small grain and sorghum.

The hazards of soil blowing and water erosion are severe. Terraces and contour tillage help to control runoff and water erosion. Management of crop residue on the surface also helps to control soil blowing and water erosion. Bench leveling or a sprinkler system is needed if this soil is irrigated. Capability units IVe–2, dryland, and IIIe–6, irrigated; Hardland Slopes range site.

Tulia complex, 3 to 5 percent slopes (TuC).—This complex of soils is near Mansker and Estacado soils on side slopes of large playas and along draws. Areas range from 4 acres to nearly 300 acres in size. Slopes are convex and crescent shaped near playas and along narrow draws. A Tulia soil in this complex has the profile described as representative of the series.

Tulia soils make up about 60 percent of this mapping unit. Texture of the surface layer ranges from loam to clay loam.

Included with this soil in mapping is a soil similar to Tulia soils, except that clay films are in the upper part of the subsoil. This soil makes up about 30 percent of mapped areas. Other soils that are less than 40 percent carbonates in the carbonate-enriched layers make up about 10 percent of most mapped areas. A few areas include up to 20 percent Mansker and Estacado soils. There are inclusions of Potter soils that are less than 5 acres in size and make up less than 10 percent of any one area.

Most of this complex is in range. A few small areas are used for crops. The main crops are small grain or sorghum. Crops that produce a large amount of residue grown in close-spaced rows are better suited to these soils than are most other crops.

The hazards of soil blowing and water erosion are severe. In places shallow gullies are formed by water running down cow trails or field roads. Crop residue managed on the soil surface helps to control soil blowing and water erosion and to maintain soil tilth. Bench leveling or a sprinkler system is needed if these soils are irrigated. Capability units IVe–6, dryland, and IVe–3, irrigated; Hardland Slopes range site.

Use and Management of the Soils

This section discusses the use of the soils of Swisher County for dryfarmed and irrigated crops, range, windbreaks, wildlife habitat, and engineering. The system of capability classification adopted by the Soil Conservation Service is briefly explained. The capability classification of any soil in the county can be obtained by referring to the "Guide to Mapping Units" at the back of this survey. Yields of commonly grown crops are given. Information is provided on the suitability of the soils for building highways, farm ponds, and other engineering structures. Further suggestions for managing the soils can be found in the section "Descriptions of the Soils."

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are group according to their limitations when used for field crops, the risk of damage when they are so 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 horticultural crops or to 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 or for engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

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, defined as follows:

- Class I soils have few limitations that restrict their use. (None in Swisher County.)
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, or wildlife.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, or wildlife.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, range, or wildlife.
- Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes. (None in Swisher County.)

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*, not used in Swisher County, 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, though they have other limitations that restrict their use largely to pasture, range, wildlife or recreation.

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, IIIe-2 or IIIe-6. 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.

Following are brief descriptions of the capability units in Swisher County. The information about management that is commonly presented for each capability unit has been given for each mapping unit in the section "Descriptions of the Soils."

Dryland capability units

Unit IIe-1. Deep, nearly level bottom-land soils that have a loam surface layer and are moderately permeable.

Unit IIIe-1. Deep, gently sloping soils that have a clay loam surface layer and a very slowly permeable clay subsoil.

Unit IIIe-2. Deep, gently sloping soils that have a loam or clay loam surface layer and are moderately permeable to moderately slowly permeable.

Unit IIIe-5. Deep, nearly level soils that have a clay loam surface layer and a very slowly permeable clay subsoil.

Unit IIIe-6. Deep, nearly level soils that have a clay loam surface layer and are moderately permeable to moderately slowly permeable.

Unit IVe-2. Deep, nearly level to gently sloping soils that have a clay loam surface layer and are moderately permeable.

Unit IVe-6. Deep, gently sloping soils that have a loam to clay loam surface layer and are moderately permeable.

Unit IVe-9. Deep, gently sloping, limy soils that have a loam surface layer and are moderately permeable.

Unit IVs-1. Deep, clayey soils that are very slowly permeable and that may receive runoff water from surrounding soils.

Unit Vw-1. Deep, nearly level bottom-land soils that have a loam surface layer, are frequently flooded, and are moderately permeable.

Unit VIe-2. Deep, gently undulating to gently rolling soils that have a loam to clay loam surface layer and are moderately permeable.

Unit VIe-3. Deep, gently sloping, high-lime soils that have a loam surface layer and are moderately permeable.

Unit VIw-1. Deep, clayey, very slowly permeable soils of playas.

Unit VIIs-1. Deep to very shallow, gently sloping to very steep soils that have a gravelly loam to loam surface layer and are moderately permeable.

GENERAL PRACTICES OF DRYFARMING

Management is needed on the soils of Swisher County to control soil blowing and water erosion and to conserve rainfall. The chief factors affecting management are the variability of rainfall and the intensity of rains and high winds.

Stubble mulching (fig. 14) is a method of managing crop residue for protection against soil blowing. Planting, tillage, and harvesting are performed by implements that leave most of the crop residue on the soil surface and anchored in the soil. If there is not enough crop residue on the surface to control soil blowing, an emergency method that gives temporary protection is tillage to make the surface of the soil cloddy.

Figure 14.—**Stubble mulching protects Pullman soils from blowing.**

On nearly level soils, terracing and contour farming are used mainly for conserving rainfall. These practices are used on the gently sloping soils mainly for controlling erosion, but they are also used for conserving rainfall. Contour farming is used to control erosion and conserve rainfall in many areas that have not been terraced.

Grassed waterways also help to control erosion by carrying runoff water at a safe, nonerosive rate. This is water that has collected in natural drainageways, field terraces, and diversion terraces. Grassed waterways are most effective where they are stabilized by grass or other plant cover and are protected from grazing and fire.

A flexible cropping system is needed on the soils of Swisher County that are used for dryfarmed crops. Wheat and sorghum are the major dryfarmed crops. The cropping system varies widely. In many places, farmers use a system that provides a fallow period after harvest so that moisture is stored in the subsoil for use by the next crop.

Irrigated capability units

Unit IIe–1. Deep, nearly level soils that have a loam to clay loam surface layer and are moderately permeable to moderately slowly permeable.

Unit IIs–1. Deep, nearly level soils that have a clay loam surface layer and are very slowly permeable.

Unit IIIe–1. Deep, gently sloping soils that have a clay loam surface layer and are very slowly permeable.

Unit IIIe–2. Deep, gently sloping soils that have a loam to clay loam surface layer and are moderately permeable to moderately slowly permeable.

Unit IIIe–6. Deep, nearly level to gently sloping soils that have a clay loam surface layer and are moderately permeable.

Unit IIIe–9. Deep, gently sloping, high-lime soils that have a loam surface layer and are moderately permeable.

Unit IVe–3. Deep, gently sloping, calcareous soils that have a loam or clay loam surface layer and are moderately permeable.

Unit IVs–1. Deep, clayey soils that are very slowly permeable and that at times receive water from surrounding soils.

MANAGING IRRIGATED SOILS

Irrigation began in Swisher County after the first irrigation wells were drilled during the early part of the 1940's. The number of wells increased slowly until the first part of the 1950's. Then a drought emphasized the need for supplemental irrigation, and the number of irrigation wells increased. An estimated 4,644 wells are furnishing water to about 350,000 irrigated acres.

Most of the wells produce water of high quality from the Ogallala Formation from a depth of 125 to 325 feet.

Figure 15.—**Grain sorghum on Pullman soils irrigated by the graded furrow method.**

A few deep wells produce water from the Santa Rosa Formation from a depth of 750 to 900 feet. This water contains harmful salts. Most wells produce less than 700 gallons per minute.

The nearly level, smooth soils of the High Plains are well suited to graded furrow irrigation (fig. 15), which is the method most commonly used. Most of the irrigated soils are in the Pullman, Olton, Mansker, Estacado, and Lofton series. Most areas require some leveling or smoothing before they are irrigated. Water is pumped from the irrigation wells into open ditches or underground pipelines. These ditches or pipelines convey the water to the high ends of the fields, where it flows into furrows. Some of the more sloping areas are leveled and irrigated by the graded-border and graded-furrow methods. Sprinkler irrigation systems are used on the more permeable soils.

Grain sorghum, wheat, and cotton are the principal irrigated crops in Swisher County. There are smaller acreages of corn, forage sorghum, soybeans, castor beans, and perennial grasses.

The main practices needed on soils used for irrigation are suitable cropping systems, management of crop residue, and management of water.

Essentially the same cropping systems as those used for dryland can be used under irrigation. On irrigated soils, however, the intensity is different and a better fertility program is needed because the crops produce more and use a larger amount of plant nutrients.

The most practical way to improve and to maintain fertility and to improve soil tilth is to return large amounts of fertilized crop residue to the soil. Nitrogen added to the soil helps to decompose the residue and to prevent a nitrogen shortage in the following crop.

Under irrigation, crop residue is left on the surface to help control soil blowing. Following harvest, the residue is chopped by a shredder and anchored in the soil by a tandem disc. This allows the residue to begin decomposing and prevents soils from blowing and washing. This cover of residue is maintained on or near the surface of the soil until the seedbed is prepared for preirrigation and planting.

Fertilizer is added to nearly all the irrigated crops in the county. The amount added is based on previous cropping history, soil tests, results of research, and the production goal. Technicians of the Soil Conservation Service or the Agricultural Extension Service will assist farmers in planning fertilization programs. Generally, soils under irrigation are low in nitrogen and phosphorus but are high in potassium.

Water must be applied to the soils in such a way that the waste of water and the loss of soil through erosion are prevented (fig. 16). Also, it must be applied in amounts determined by the needs of the crops grown. Roscoe clay and other clayey soils require heavier applications of irrigation water than the Tulia and other loamy soils.

Predicted Yields

Predicted average yields per acres of the principal crops grown on the soils of Swisher County are given in table 2. The predicted yields of wheat, grain sorghum,

***Figure 16.*—Erosion caused by tailwater on Pullman soils.**

forage sorghum, cotton, and soybeans are given for dry-farmed and irrigated soils under a high level of management. These are average yields to be expected over a period of years. Although small acreages of crops other than those listed are grown in Swisher County, the yields for these crops are not listed, because data on yields are not available.

The figures given in the table are based on information obtained from research, on interviews with farmers, and on observations of others who know the soils and crops of the county. Table 2 includes only those soils that are used mostly for crops.

A high level of management is one in which farmers use all of the better practices for managing soils, plants, and water. A high level of management for dryland soils in this county consists of—

1. Managing crop residue in a way that effectively controls erosion and protects the soil.
2. Using a cropping sequence that maintains an adequate supply of organic matter.
3. Conserving rainwater.
4. Maintaining fertility by the timely application of fertilizer and by growing soil-improving crops.
5. Controlling insects, disease, and weeds.
6. Keeping tillage to a minimum and tilling only when the moisture content is such that compaction is minimized.

TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*

[A dash in the column indicates that data are not available for this soil and crop]

Soil	Dryland soils				Irrigated soils				
	Cotton (lint)	Grain sorghum	Wheat	Forage sorghum	Cotton (lint)	Grain sorghum	Wheat	Forage sorghum	Soy-beans
	Lbs	*Lbs*	*Bu*	*Tons*	*Lbs*	*Lbs*	*Bu*	*Tons*	*Bu*
Acuff loam, 1 to 3 percent slopes	175	1, 150	14	2. 5	800	7, 000	45	20	35
Bippus loam	185	1, 200	15	2. 8	830	7, 300	45	20	35
Drake loam, 1 to 3 percent slopes	100	700	9	2. 0	500	5, 000	25	14	18
Drake loam, 3 to 5 percent slopes	-	-	-	-	-	4, 500	20	13	16
Lipan clay	155	850	12	2. 3	800	6, 500	40	18	30
Lofton clay loam	190	1, 200	16	3. 0	850	8, 000	50	22	45
Mansker and Estacado soils, 0 to 1 percent slopes	170	950	13	2. 3	750	6, 500	45	20	40
Mansker and Estacado soils, 1 to 3 percent slopes	165	900	12	2. 0	700	5, 500	40	19	35
Mansker and Estacado soils, 3 to 5 percent slopes	-	-	-	-	-	5, 000	35	17	-
Olton clay loam, 0 to 1 percent slopes	175	1, 000	14	2. 5	850	8, 000	50	22	45
Olton clay loam, 1 to 3 percent slopes	165	900	12	2. 0	800	7, 500	45	20	40
Pullman clay loam, 0 to 1 percent slopes	170	950	13	2. 5	850	8, 000	50	22	45
Pullman clay loam, 1 to 3 percent slopes	160	850	12	2. 0	800	7, 500	45	20	40
Randall clay [1]	150	800	14	2. 8	750	7, 000	45	20	40
Roscoe clay	180	1, 050	14	2. 8	830	7, 500	45	20	40
Tulia clay loam, 0 to 1 percent slopes	140	750	12	2. 1	650	5, 000	35	18	35
Tulia clay loam, 1 to 3 percent slopes	130	650	11	2. 0	600	4, 500	30	17	32
Tulia complex, 3 to 5 percent slopes	-	-	-	-	-	4, 000	25	16	-

[1] Crops are grown on this soil only in areas that are drained.

7. Planting improved crop varieties.
8. Using terraces and other mechanical aids and maintaining them.

A high level of management for irrigated soils consists of the foregoing practices, and in addition—

1. Applying water according to the needs of the crops and the soil.
2. Coordinating tillage operations with irrigation.
3. Using properly designed irrigation systems (figs. 17, 18) and land treatments to help reduce erosion.

Range Management [2]

Ranching is important in Swisher County, although it is not one of the main farm enterprises. Native grass grows on approximately 20 percent of the acreage of the county. Most of the range is in small areas of 40 to 500 acres and is used with cropland. Cattle are usually grazed on winter wheat, but they also have access to the range. The larger operating units are located along the draws. The largest ranch covers about 14,000 acres.

Feedlots have had some influence on livestock operations in the county. Many stockmen raise stocker cattle, which will later be placed in feedlots for finishing.

Range sites and condition classes

A range site is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants. Range sites differ in ability to produce significantly different kinds or proportions of plant species or in total annual production. Significant differences are those great enough to require some variation in management, such as a different rate of stocking.

Differences in kinds, proportions, and amounts of plants that different sites are capable of supporting are related to differences in such factors as soil, topography, and climate. Range sites therefore can be identified by the kinds of soil known to be capable of producing a dis-

[2] By JOHN A. WRIGHT, range conservationist, Soil Conservation Service.

***Figure 17.*—A properly designed irrigation system on Olton soils that have been leveled. Crop is soybeans.**

***Figure 18.*—Tailwater pit on Pullman soils for catching and using water that would otherwise be wasted.**

tinctive combination of vegetation, or potential plant community.

Most of the native range of Swisher County has been heavily grazed for several generations, and the original plant cover has been altered. The range now produces less forage of fewer varieties than it did originally. The condition of the range has been altered through use.

Range condition is rated by comparing the composition of the existing plant community with that of the potential, or original, plant community. Four range condition classes are recognized: excellent, good, fair, and poor. A range is in *excellent* condition if 76 to 100 percent of the existing vegetation is of the same composition as that of the potential stand. 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 less than 26. Figures 19 and 20 show range in poor and in good condition.

Descriptions of the range sites

There are six range sites in Swisher County. In the range site descriptions, the soils and the composition of the potential plant community are discussed. The average herbage production shown is the range of production from unfavorable years to favorable years. The soils in each range site can be determined by referring to the "Guide to Mapping Units" at the back of this survey. Randall clay has not been placed in a range site but is included in the range site of the surrounding soils.

DEEP HARDLAND RANGE SITE

This site consists of loamy to clayey, smooth, nearly level to gently sloping soils on uplands. The soils are moderately permeable to very slowly permeable. The available water capacity is high. This site is accessible to livestock and is favored for grazing. Most of the range of the county is in this site.

The potential plant community on this site consists of short grasses, mainly blue grama and buffalograss. Other grasses are side-oats grama and three-awn. Overgrazing causes the stands of blue grama to become thinner and stands of the buffalograss to become thicker.

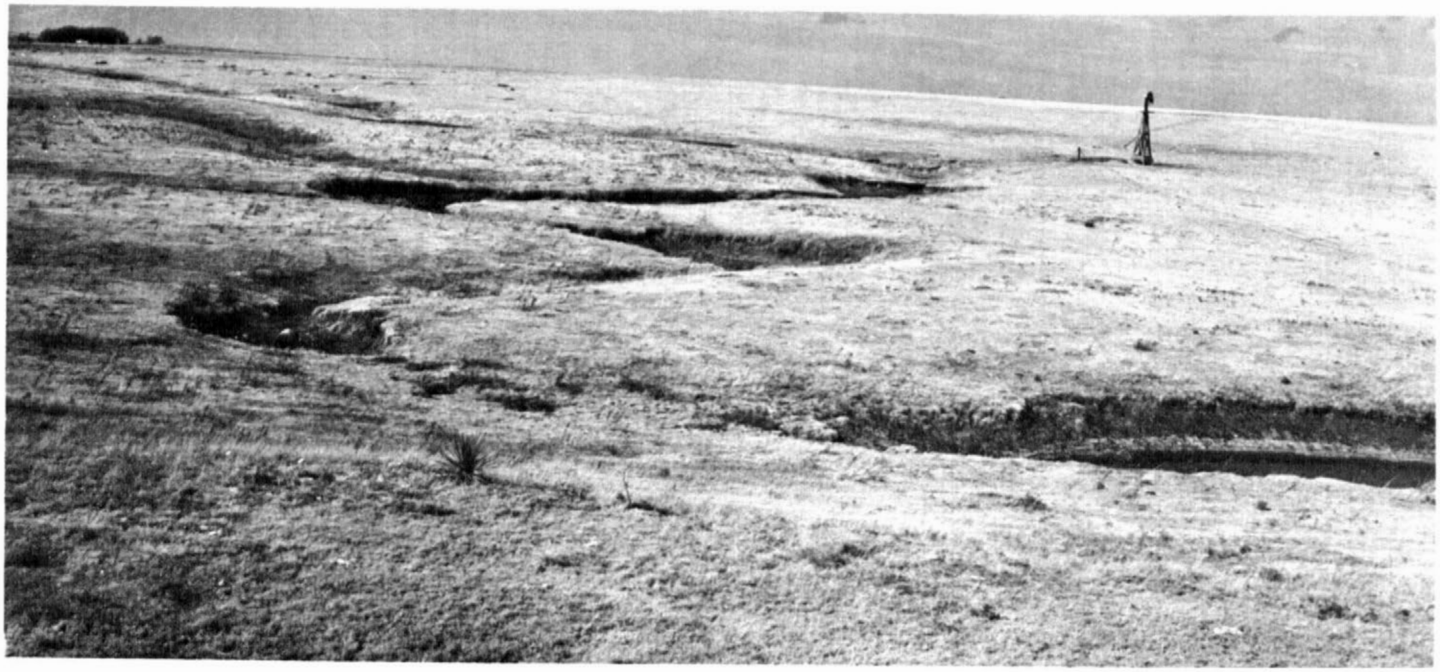

Figure 19.—Loamy Bottomland range site in poor condition. Soil is Bippus loam.

Figure 20.—Loamy Bottomland range site in good condition. Soil is Bippus loam.

Annual acre yield of air-dry herbage is about 1,000 pounds in unfavorable years and 2,200 pounds in favorable years.

HARDLAND SLOPES RANGE SITE

This site consists of loamy, nearly level to sloping soils in and around playa basins and in areas along drainageways (fig. 21). The soils are moderately permeable. The available water capacity is high.

Figure 21.—**Hardland Slopes range site in excellent condition. Soils are Mansker and Estacado.**

The potential plant community on this site is made up of grasses, mainly side-oats grama, blue grama, buffalograss, little bluestem, and silver bluestem. Overgrazing causes the stands of buffalograss to become thicker and the stands of other grasses to become thinner.

Annual acre yield of air-dry herbage is about 1,300 pounds in unfavorable years and 2,200 pounds in favorable years.

VERY SHALLOW RANGE SITE

This site consists of gently sloping to moderately steep soils on uplands. These soils are gravelly loam and loam. They are moderately permeable. The available water capacity is low to high. The site is characterized by outcrops of caliche.

The vegetation is normally sparse, and the potential plant community consists mainly of side-oats grama, hairy grama, blue grama, and little bluestem. Other grasses are dropseed and three-awn. Overgrazing causes the dropseed and three-awn to increase and the other grasses to decrease.

Annual acre yield of air-dry herbage is about 600 pounds in unfavorable years and 1,000 pounds in favorable years.

HIGH LIME RANGE SITE

This site consists of loamy, gently sloping soils on the crescent-shaped dunes that partly encircle the larger playas on the southeast. The soils are moderately permeable. The available water capacity is moderate.

The potential plant community consists of side-oats grama, blue grama, buffalograss, little bluestem, and silver bluestem. Overgrazing causes the stands of buffalograss to become thicker and the stands of other grasses to become thinner.

Annual acre yield of air-dry herbage is about 1,100 pounds in unfavorable years and 1,800 pounds in favorable years.

ROUGH BREAKS RANGE SITE

This site consists of loamy, rolling to hilly soils and of very steep rough broken land that has little soil development. The soils are moderately permeable. The available water capacity is high.

This site is capable of producing many kinds of vegetation, but the plant cover is thin and many areas are not accessible to livestock. The principal vegetation in the potential plant community is side-oats grama, buffalograss, blue grama, and little bluestem. Overgrazing causes the buffalograss to increase and the other grasses to decrease.

Annual acre yield of air-dry herbage is about 500 pounds in unfavorable years and 900 pounds in favorable years.

LOAMY BOTTOMLAND RANGE SITE

This site consists of deep, nearly level, loamy soils. These soils are on the flood plain along streambeds and in draws or valleys. They are moderately permeable. The available water capacity is high.

This site is capable of producing good quality forage for livestock and wildlife. The principal vegetation in the potential plant community is buffalograss, blue grama, vine-mesquite, sand bluestem, little bluestem, switchgrass, indiangrass, side-oats grama, Canada wildrye, and western wheatgrass. Overgrazing causes the stands of buffalograss to become thicker and the stands of other grasses to become thinner.

Annual acre yield of air-dry herbage is about 1,500 pounds in unfavorable years and 2,400 pounds in favorable years.

Windbreaks

Tree windbreaks are valuable because they help to reduce the wind velocity. They are used to protect soils, crops, and farmsteads from damaging wind and blowing dust. They also provide shelter for livestock, provide shelter and food for wildlife, and add beauty to the farm or ranch. In Swisher County, windbreaks are used mainly to protect farmsteads and feedlots (fig. 22).

Trees are difficult to establish in Swisher County, and the success of tree windbreaks depends largely on the care and protection given them. If water for irrigation is available, trees can be established on all soils in the county. The trees should be watered as needed until they are well established.

The trees and shrubs most suitable for windbreaks on the moderately slowly permeable or very slowly permeable soils, such as the Pullman, Lofton, and Olton soils, are Chinese elm, Arizona cypress, Russian-olive, and wild plum. The moderately permeable soils, such as the Acuff, Tulia, and Mansker soils, are best suited to Chinese elm, redcedar, wild plum, and desert willow.

Two or three rows of trees are most practical for a windbreak. Windbreaks need to include at least one row of tall trees and one row of evergreens. Trees planted in a two-directional pattern at right angles give greater protection from the prevailing winds.

After the trees have been planted, they must be cultivated and cared for. They need to be protected from fire and from trampling and grazing by livestock.

Figure 22.—**Windbreak on Pullman soils is used to protect farmsteads from damaging winds.**

Use of the Soils for Wildlife

Swisher County is a nearly level prairie that is dissected by a few intermittent streams and is pocked with playas. The principal kinds of wildlife are bobwhite quail, blue quail, dove, pheasant, hawks, various songbirds, and jackrabbits. Also present are raccoons, badgers, foxes, skunks, and coyotes. A few ponds and lakes are stocked with channel catfish, bass, and perch. Playas are especially valuable in furnishing food and cover for ducks (fig. 23) and geese. A few turkeys, white-tailed deer, mule deer, and aoudad sheep are found in Tule Canyon.

Successful management of wildlife on any tract of land requires, among other things, that food, cover, and water be available in a suitable combination. Lack of any one of these necessities, an unfavorable balance between them, or an inadequate distribution of them may severely limit or account for the absence of desired wildlife species. Information on soils provides a valuable tool in creating, improving, or maintaining suitable food, cover, and water for wildlife.

Most wildlife habitats are managed by planting suitable vegetation, by manipulating existing vegetation so as to bring about natural establishment, by increasing or improving desired plants, or by combinations of such measures. The influence of a soil on the growth of plants is known for many kinds of plants and can be inferred for others from a knowledge of the characteristics and behavior of the soil. In addition, water areas can be created or natural ones improved as wildlife habitats. Information on soils is useful for these purposes.

Figure 23.—**Mallard duck nest near a playa. Soil is Roscoe clay.**

Interpretations of the suitability of soils for wildlife habitat serve a variety of purposes. They are an aid in selecting the more suitable sites for various kinds of management. They serve as indicators of the intensity of management needed to achieve satisfactory results. They also serve as a means of showing why it may not be feasible generally to manage a particular area for a given kind of wildlife. These interpretations also may serve in broad-scale planning of wildlife management areas, parks, and nature areas, or for acquiring wildlife lands.

Soil properties that affect the growth of wildlife habitat are: (1) thickness of soil useful to crops, (2) texture of the surface layer, (3) available water capacity, (4) wetness, (5) surface stoniness or rockiness, (6) hazard of flooding, and (7) slope.

The areas of soils shown on the soil survey maps are rated without regard to positional relationships to adjoining mapped areas. The size, shape, or location of the mapped areas does not affect the rating. Certain influences on habitats, such as elevation and aspect, must be appraised on the site.

In table 3 the soils are rated for suitability for six elements of wildlife habitat and three kinds of wildlife. These ratings are based upon limitations imposed by the characteristics or behavior of the soils. Four levels of suitability are recognized. Numerical ratings of 1 to 4 indicate the degree of soil suitability for a given habitat element. A rating of 1 means well suited and indicates that habitats generally are easily created, improved, or maintained; that the soil has few or no limitations that affect management; and that satisfactory results can be expected. A rating of 2 means suited and indicates that habitats 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 may be required for satisfactory results. A rating of 3 means poorly suited and indicates that habitats can be created, improved, or maintained in most places; that the soil has rather severe limitations; that habitat management is difficult and expensive and requires intensive effort; and that results are not always satisfactory. For short-term use, soils rated 3 may provide easy establishment and temporary values. A rating of 4 means unsuited and indicates that the soil limitation is so extreme that it is impractical, if not impossible, to manage the designated habitat element. Unsatisfactory results are probable.

TABLE 3.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife*

[1 means well suited, 2 means suited, 3 means poorly suited, and 4 means unsuited]

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood trees and shrubs	Wetland food and cover plants	Shallow water developments	Openland	Brushland	Wetland
Acuff: AcB	1	1	1	4	4	4	1	3	4
Berda	4	4	1	4	4	4	1	3	4
Mapped only in an undifferentiated group with Rough broken land.									
Bippus: Bp, Bu	1	1	1	4	4	4	1	3	4
Drake: DrB, DrC	1	1	1	4	4	4	1	3	4
Lipan: Lc	2	2	2	4	4	3	2	3	3
Lofton: Lo	1	1	1	4	4	4	1	3	4
Mansker:									
MeA, MeB, MeC	1	1	1	4	4	4	1	3	4
MtD	2	1	1	4	4	4	1	3	4
For Tulia part, see Tulia series.									
Olton: OlA, OlB	1	1	1	4	4	4	1	3	4
Potter: Pt	4	3	3	4	4	4	3	3	4
For Tulia part, see Tulia series.									
Pullman: PuA, PuB	1	1	1	4	4	4	1	3	4
Randall: Ra	3	2	2	4	2	2	2	3	1
Roscoe: Ro	2	2	2	4	4	3	2	3	3
Rough broken land: Ru	4	4	1	3	4	4	3	3	4
For Berda part, see Berda series.									
Tulia: TlA, TlB, TuC	1	1	1	4	4	4	1	3	4

The elements of wildlife habitat rated in table 3 are defined in the following paragraphs.

Grain and seed crops are agricultural grains or seed-producing annuals that are planted to produce food for wildlife. Examples are corn, sorghum, millet, soybeans, wheat, oats, and sunflower.

Grasses and legumes are perennial grasses and legumes that are established by planting and that furnish food and cover for wildlife. Examples are blue grama, side-oats grama, western wheatgrass, and fescue. Legumes are such plants as clover and alfalfa.

Wild herbaceous upland plants are perennial grasses, forbs, and weeds that provide food and cover for wildlife. Examples of these are beggarweed, bigtop dalea, dotted gayfeather, black sampson, heath aster, side-oats grama, and bluestem.

Hardwood trees and shrubs are nonconiferous trees, shrubs, and woody vines that produce fruits, nuts, buds, catkins, or foliage (browse) used extensively as food by wildlife. These plants commonly become established through natural processes but, in places, are planted. Examples are shin oak, willow, mesquite, whitebrush, skunkbush, catclaw, and mustang grape.

Wetland food and cover plants are annual and perennial wild herbaceous plants in moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover that is extensively and dominantly used by wetland forms of wildlife. Examples are smartweed, barnyardgrass, rushes, sedges, and cattails.

Shallow water developments are low dikes and water-control structures established to create habitat principally for waterfowl. They may be designed so that they can be drained, planted, and flooded so that they can be used as permanent impoundments to grow submerged aquatics.

The three kinds of wildlife rated in table 3 are defined in the following paragraphs.

Open-land wildlife consists of birds and mammals that normally frequent cropland, pastures, and areas overgrown with grasses, herbs, and shrubby growth. Examples of this kind of wildlife are quail, dove, jackrabbits, and pheasant.

Brushland wildlife consists of birds and mammals that normally frequent areas of hardwood trees and shrubs. Examples of brushland wildlife are deer, turkey, raccoon, and coyote.

Wetland wildlife consists of birds and mammals that normally frequent such areas as ponds, streams, ditches, lakes, and playas. Examples of this kind of wildlife are ducks, geese, rails, coots, and cranes.

Engineering Uses of the Soils [3]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. In this section are discussed those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water storage facilities, erosion control structures, and sewage disposal systems. Among the soil properties most important in engineering are permeability, compressibility, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction.

Information concerning these and related soil properties is furnished in tables 4 and 5.

The estimates and interpretations of the soil properties given in these tables can be used in—

1. Planning of farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soil.
2. Selecting potential locations for highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, residential, and recreational areas.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. The estimated values for bearing capacity and traffic-supporting capacity expressed in words should not be assigned specific values. Estimates are generally made to depths of about 5 feet, and interpretations do not apply to greater depths. Small areas of other soils are included in the mapping units that may have different engineering properties than those listed. Even in these situations, however, the soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Some terms used by soil scientists may be unfamiliar to engineers, and some words have different meanings in soil science than they have in engineering. Among the terms that have special meaning in soil science are sand, silt, clay, subsoil, and horizon. These and other terms are defined in the Glossary at the back of this survey.

Engineering classification systems

The two systems most commonly used in classifying samples of soil horizons for engineering are the AASHO system (*1*), adopted by the American Association of State Highway Officials, and the Unified system (*7*), used by the SCS engineers, Department of Defense, and others.

The AASHO system is used to classify soils according to those properties that affect use in highway construction. 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 shear strength, or the best soils for subgrade (foundation), and, at the other extreme, A–7, are clay soils that have low strength when wet. The best soils for subgrade are therefore classified as A–1, the next best A–2, and so on to class A–7, 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; and A–7–5, A–7–6. If soil material is near a classification boundary, it is given a symbol showing both classes; for example, A–2 or A–4. Within each group, the relative 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 for the poorest.

In the Unified system soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped in 15 classes. The eight classes of coarse-grained soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC. The six classes of fine-grained soils are identified as ML, CL, OL, MH, CH, and OH. The one class of highly organic soils is identified at Pt. Soils on the borderline between two classes are designated by symbols for both classes, for example MH–CH.

[3] By DAN C. HUCKABEE, area engineer, Soil Conservation Service, Amarillo, Tex.

The estimated AASHO and Unified classifications for all soils mapped in the survey area are given in table 4.

Estimated engineering properties

Table 4 provides estimates of soil properties important to engineering. No soil tests were made in this county. The estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples in nearby counties, test data from comparable soils in adjacent areas, and detailed experience in working with the individual kinds of soil in the survey area.

In the column headed "Hydrologic group," the soils are placed in one of four groups on the basis of intake of water at the end of long-duration storms occurring after prior wetting and opportunity for swelling and without the protective effects of vegetation. The groups range from open sands (lowest runoff potential—Group A) to heavy clays (highest runoff potential—Group D). Descriptions of these four groups are as follows:

Group A.—Soils that have a high infiltration rate even when thoroughly wetted. They consist chiefly of deep, well-drained to excessively drained sand or gravel, or both. These soils have a high rate of water transmission, which results in a low runoff potential.

Group B.—Soils that have a moderate infiltration rate when thoroughly wetted. They consist chiefly of moderately deep to deep, moderately well drained to well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C.—Soils that have a slow infiltration rate when thoroughly wetted. They consist chiefly of soils having a layer that impedes the downward movement of water or soils having moderately fine texture to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission.

Group D.—Soils that have a very slow infiltration rate when thoroughly wetted. They consist chiefly of clay soils that have a high swelling potential; soils that have a high permanent water table; soils that have a claypan or clay layer at or near the surface; and shallow soils underlain by nearly impervious materials. These soils have a very slow rate of water transmission.

Columns for "Depth to bedrock" and "Seasonal high water table" were not included in table 4 because it is many feet to bedrock and the water table is deep under all the soils except Potter, which is 4 to 12 inches deep to gravelly loam and caliche pebbles.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. Sand, silt, clay, and some of the other terms used in the USDA textural classification are defined in the Glossary in the back of this survey.

Permeability relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils are not considered.

Available water capacity is the amount of water a soil can hold and make available to plants. It is the numerical difference between the percentage of water at field capacity and the percentage of water at the time plants wilt. The rate is expressed as inches of water per inch of soil depth.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value, and relative terms used to describe soil reaction, are explained in the Glossary. All soils in Swisher County range from neutral to moderately alkaline. They are alkaline because calcium carbonate, which causes few problems of corrosivity or structural stability, is present.

Salinity of the soil is based on the electrical conductivity of the saturated soil extract, as expressed in millimhos per centimeter at 25°C. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its corrosiveness to other materials. Since no saline soils are found in Swisher County, this column was omitted from the table.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

Interpretations of engineering properties

Table 5 contains selected information useful to engineers and others who plan to use soil material in construction of highways, farm facilities, buildings, and sewage disposal systems. Detrimental or undesirable features are emphasized, but very important desirable features also may be listed. The ratings and other interpretations in this table are based on estimated engineering properties of the soils in table 4, on available test data, and on field experience. While, strictly, the information applies only to soil depths indicated in table 4, it is reasonably reliable to depths of about 6 feet for most soils, and more than 6 feet for others.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used as a topdressing for lawns, gardens, roadbanks, and the like. The ratings indicate suitability for such use. Ordinarily, only the surface layer is removed for topsoil, but other layers may also be suitable.

Road subgrade is material used to build embankments. The ratings indicate performance of soil material moved from borrow areas for these purposes.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. The soil features, favorable as well as unfavorable, are the principal ones that affect geographic location of highways.

Foundations for low buildings are affected chiefly by features of the undisturbed soil that influence its capacity to support low buildings that have normal foundation loads. Specific values of bearing strength are not assigned.

Septic tank filter fields are affected mainly by permeability, location of water table, and susceptibility to flooding. The degree of limitations and principal reasons for assigning moderate or severe limitations are given.

TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first

Soil series and map symbols	Hydrologic group	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
		Inches			
Acuff: AcB	B	0–9	Loam	CL	A–6
		9–47	Sandy clay loam	CL	A–6, A–7
		47–80	Sandy clay loam	CL	A–6
Berda. Mapped only in an undifferentiated group with Rough broken land.	B	0–60	Loam and clay loam	CL, SC	A–6, A–4
Bippus: Bp, Bu	B	0–6	Loam	CL	A–6, A–4
		6–60	Clay loam	CL	A–6, A–4
Drake: DrB, DrC	B	0–60	Loam and clay loam	CL, ML	A–6, A–4
Estacado. Mapped only in an undifferentiated group with Mansker soils.	B	0–14	Clay loam	CL	A–6
		14–28	Clay loam	CL	A–6, A–7–6
		28–85	Clay loam	CL	A–6, A–7–6
Lipan: Lc	D	0–70	Clay	CH	A–7–6
Lofton: Lo	D	0–10	Clay loam	CL	A–6, A–7–6
		10–45	Clay	CH, CL	A–7–6
		45–72	Clay loam	CL	A6–, A–7–6
*Mansker: MeA, MeB, MeC, MtD. For Estacado part of MeA, MeB, MeC, see Estacado series. For Tulia part of MtD, see Tulia series.	B	0–11	Clay loam	CL	A–4, A–6
		11–27	Clay loam	CL	A–6, A–4
		27–90	Clay loam	CL	A–6
Olton: OlA, OlB	C	0–12	Clay loam	CL	A–6, A–4
		12–36	Clay loam	CL	A–6, A–7
		36–80	Clay loam	CL, ML–CL	A–6
*Potter: Pt. For Tulia part, see Tulia series.	C	0–4	Gravelly loam	ML or CL	A–4 or A–6
		4–60	Gravelly loam and caliche of about loam texture.	GM, GC, SM, SC	A–2, A–4, A–6
Pullman: PuA, PuB	D	0–8	Clay loam	CL	A–6, A–7–6
		8–50	Clay	CH, CL	A–7–6
		50–100	Clay loam	CL	A–7–6, A–6
Randall: Ra	D	0–70	Clay	CH	A–7–6
Roscoe: Ro	D	0–56	Clay	CH, CL	A–7–6
		56–64	Clay loam	CL	A–7
		64–75	Clay	CH, CL	A–7–6
*Rough broken land: Ru. For Berda part, see Berda series. Properties too variable to be rated.					
Tulia: TlA, TlB, TuC	B	0–14	Loam	SM, ML, CL, SC	A–4, A–6
		14–45	Clay loam	CL, SC, ML	A–4, A–6
		45–85	Sandy clay loam	CL, ML	A–4, A–6

significant in engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for column of this table. The symbol < means less than]

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	95–100	51–65	0. 63–2. 00	0. 14–0. 17	7. 4–7. 8	Low.
100	100	95–100	65–70	0. 63–2. 00	0. 15–0. 17	7. 4–8. 4	Low.
95–100	95–100	90–95	65–75	0. 63–2. 00	0. 13–0. 15	7. 9–8. 4	Low.
95–100	95–100	80–95	40–60	0. 63–2. 00	0. 14–0. 17	7. 9–8. 4	Low.
100	100	85–95	55–65	0. 63–2. 00	0. 16–0. 18	7. 9–8. 4	Low.
100	95–100	85–95	51–70	0. 63–2. 00	0. 16–0. 20	7. 9–8. 4	Low.
100	100	80–90	51–65	0. 63–2. 00	0. 13–0. 15	7. 9–8. 4	Low.
100	98–100	95–100	55–85	0. 63–2. 00	0. 15–0. 17	7. 9–8. 4	Low.
95–100	95–100	85–95	60–90	0. 63–2. 00	0. 14–0. 16	7. 9–8. 4	Low.
95–100	95–100	95–100	75–90	0. 63–2. 00	0. 13–0. 17	7. 9–8. 4	Low.
95–100	95–100	90–100	75–95	<0. 06	0. 15–0. 17	7. 9–8. 4	High.
100	100	98–100	70–90	0. 20–0. 63	0. 17–0. 19	7. 4–8. 4	Moderate.
100	100	95–100	80–90	<0. 06	0. 16–0. 18	7. 4–8. 4	High.
100	95–100	95–100	70–80	0. 06–0. 20	0. 15–0. 16	7. 9–8. 4	Moderate.
95–100	95–100	85–95	55–70	0. 63–2. 00	0. 15–0. 18	7. 9–8. 4	Low.
90–100	90–100	85–95	60–80	0. 63–2. 00	0. 13–0. 16	7. 9–8. 4	Low.
100	95–100	90–95	70–80	0. 63–2. 00	0. 14–0. 18	7. 9–8. 4	Low.
100	95–100	85–100	55–65	0. 63–2. 00	0. 16–0. 18	6. 6–7. 3	Low.
100	90–100	95–100	70–80	0. 2–0. 63	0. 16–0. 18	7. 4–8. 4	Moderate.
90–100	90–100	90–95	60–70	0. 2–0. 63	0. 13–0. 15	7. 9–8. 4	Moderate.
80–95	70–90	60–85	51–70	0. 63–2. 00	0. 12–0. 16	7. 9–8. 4	Low.
30–80	25–75	20–60	12–50	0. 63–2. 00	<0. 02	7. 9–8. 4	Low.
100	100	95–100	70–90	0. 20–0. 63	0. 16–0. 18	6. 6–8. 4	Moderate.
100	100	95–100	85–95	<0. 06	0. 14–0. 16	6. 6–8. 4	High.
95–100	90–100	95–100	90–95	0. 06–0. 20	0. 14–0. 16	7. 9–8. 4	Moderate.
100	100	96–100	60–98	<0. 06	0. 14–0. 18	6. 6–8. 4	High.
100	98–100	95–100	80–92	<0. 06	0. 12–0. 16	7. 4–8. 4	High.
100	100	95–100	75–90	<0. 06	0. 10–0. 15	7. 9–8. 4	Moderate.
100	100	95–100	80–95	<0. 06	0. 10–0. 15	7. 9–8. 4	High.
93–99	90–98	85–95	35–65	2. 0–6. 3	0. 14–0. 18	7. 9–8. 4	Low.
90–98	88–100	80–98	40–80	0. 63–2. 00	0. 12–0. 16	7. 9–8. 4	Low.
95–99	90–100	85–95	51–80	0. 63–2. 00	0. 14–0. 18	7. 9–8. 4	Low.

TABLE 5.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different

Soil series and map symbols	Suitability as source of—		Degree of limitations and soil features affecting—				Farm ponds	
	Topsoil	Road subgrade	Highway location	Foundations for low buildings	Septic tank filter fields	Sewage lagoons	Reservoir areas	Embankments
Acuff: AcB	Poor where 4 to 6 inches of loam. Fair where 6 to 10 inches of loam.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: fair resistance to piping and erosion.
Berda. Mapped only in an undifferentiated group with Rough broken land.	Good	Fair: fair traffic-supporting capacity.	Moderate where slopes are 10 15 percent: fair traffic-supporting capacity. Severe where slopes are 15 to 20 percent.	Moderate where slopes are 10 to 15 percent. Severe where slopes are 15 to 20 percent.	Severe: 10 to 20 percent slopes.	Severe: 10 to 20 percent slopes.	Moderate: moderate permeability.	Moderate: fair resistance to piping and erosion.
Bippus:								
Bp	Good where 16 to 30 inches of loam. Fair where 6 to 16 inches of loam.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: fair resistance to piping and erosion.
Bu	Good where 16 to 30 inches of loam. Fair where 6 to 16 inches of loam.	Fair: fair traffic-supporting capacity.	Severe: flooding hazard.	Severe: flooding hazard.	Severe: flooding hazard.	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: fair resistance to piping and erosion.
Drake: DrB, DrC	Fair where 6 to 10 inches of loam.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight	Severe: highly calcareous material.	Severe: highly calcareous material.	Moderate: fair resistance to piping and erosion.
Estacado. Mapped only in an undifferentiated group with the Mansker soils.	Fair: clay loam texture.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight	Slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: fair stability; fair resistance to piping and erosion.
Lipan: Lc	Poor: clay texture.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight	Slight	Moderate: high compressibility.
Lofton: Lo	Fair: clay loam texture.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight	Slight	Moderate: high compressibility.
*Mansker: MeA, MeB, MeC, MtD. For Estacado part of MeA, MeB, MeC, see Estacado series. For Tulia part of MtD, see Tulia series.	Fair: clay loam texture.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Slight where slopes are 0 to 6 percent. Moderate where slopes are 6 to 8 percent.	Slight where slopes are 0 to 5 percent. Moderate where slopes are 5 to 8 percent.	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: fair stability; fair resistance to piping and erosion.

engineering properties

properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Degree of limitations and soil features affecting—Continued				Soil features affecting—			Corrosivity class and contributing soil features (uncoated steel)
Recreation							
Camp areas	Picnic areas	Intensive play areas	Paths and trails	Irrigation	Terraces and diversions	Grassed waterways	
Slight	Slight	Slight where slopes are 1 to 2 percent. Moderate where slopes are 2 to 3 percent.	Slight	All features favorable.	All features favorable.	All features favorable.	Moderate: sandy clay loam texture.
Moderate where slopes are 10 to 15 percent. Severe where slopes are 15 to 20 percent.	Moderate where slopes are 10 to 15 percent. Severe where slopes are 15 to 20 percent.	Severe: 10 to 20 percent slopes.	Slight where slopes are 10 to 20 percent. Moderate where slopes are 15 to 20 percent.	Slopes of 10 to 20 percent.	Slopes of 10 to 20 percent.	Slopes of 10 to 20 percent.	Moderate: clay loam texture.
Slight	Slight	Slight	Slight	Receives outside water.	Receives outside water.	All features favorable.	Moderate: clay loam texture.
Severe: flooding hazard.	Moderate: flooding hazard.	Moderate: flooding hazard.	Slight	Flooding hazard	Flooding hazard	Flooding hazard	Moderate: clay loam texture.
Moderate: dustiness.	Moderate: dustiness.	Moderate: dustiness; 2 to 5 percent slopes.	Moderate: dustiness.	Slopes; moderate intake rate.	High in lime; erodible.	High in lime; difficult to establish some plants.	High: conductivity.
Moderate: clay loam texture.	Moderate: clay loam texture.	Moderate: clay loam texture.	Moderate: clay loam texture.	Moderate intake rate.	All features favorable.	All features favorable.	Moderate: clay loam texture.
Severe: clay texture: very slow permeability.	Severe: clay texture.	Severe: clay texture; very slow permeability.	Severe: clay texture.	Very slow intake rate.	Depressional topography.	All features favorable.	High: clay texture.
Severe: very slow permeability.	Moderate: clay loam texture.	Severe: very slow permeability.	Moderate: clay loam texture.	Very slow intake rate.	May receive outside water.	All features favorable.	High: conductivity.
Moderate: clay loam texture.	Moderate: clay loam texture.	Moderate where slopes are 2 to 6 percent: clay loam texture. Severe where slopes are 6 to 8 percent.	Moderate: clay loam texture.	Moderate intake rate; slopes.	Slopes	Slopes	Moderate: clay loam texture; conductivity.

TABLE 5.—*Interpretations of*

Soil series and map symbols	Suitability as source of—		Degree of limitations and soil features affecting—				Farm ponds	
	Topsoil	Road subgrade	Highway location	Foundations for low buildings	Septic tank filter fields	Sewage lagoons	Reservoir areas	Embankments
Olton: OlA, OlB	Fair: clay loam texture.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: moderately slow permeability.	Slight where slopes are 0 to 2 percent. Moderate where slopes are 2 to 3 percent.	Moderate: moderately slow permeability.	Moderate: fair resistance to piping and erosion.
*Potter: Pt. For Tulia part, see Tulia series.	Poor where only 4 to 6 inches of loam: 10 to 30 percent fragments. Fair where 6 to 12 inches of loam: 3 to 10 percent fragments.	Fair: fair traffic-supporting capacity.	Moderate where slopes are 3 to 15 percent: fair traffic-supporting capacity. Severe where slopes are 15 to 20 percent.	Moderate where slopes are 3 to 15 percent. Severe where slopes are 15 to 20 percent.	Moderate where slopes are 3 to 10 percent. Severe where slopes are 10 to 20 percent.	Severe: highly calcareous material.	Severe: highly calcareous material.	Severe: 4 to 12 inches deep to gravelly loam and caliche.
Pullman: PuA, PuB	Poor where 4 to 6 inches of clay loam. Fair where 6 to 12 inches of clay loam.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight	Slight	Moderate: fair resistance to piping and erosion.
Randall: Ra	Poor: clay texture.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: flooding hazard.	Severe: flooding hazard; high shrink-swell potential.	Severe: very slow permeability.	Slight	Slight	Moderate: fair stability; high compressibility.
Roscoe: Ro	Poor: clay texture.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight	Slight	Moderate: fair slope stability; fair resistance to piping and erosion.
*Rough broken land: Ru. Too variable to be rated. For Berda part, see Berda series.								
Tulia: TlA, TlB, TuC.	Good where 20 to 22 inches of loam. Fair where 10 to 20 inches of loam.	Fair: fair traffic-supporting capacity.	Moderate where slopes are 6 to 15 percent: fair traffic-supporting capacity. Severe where slopes are 15 to 20 percent.	Slight where slopes are 0 to 6 percent. Moderate where slopes are 6 to 15 percent. Severe where slopes are 15 to 20 percent.	Slight where slopes are 0 to 5 percent. Moderate where slopes are 5 to 10 percent. Severe where slopes are 10 to 20 percent.	Moderate where slopes are 2 to 7 percent: moderate permeability. Severe where slopes are 7 to 20 percent.	Moderate: moderate permeability.	Moderate: fair slope stability; poor resistance to piping and erosion.

engineering properties—Continued

Degree of limitations and soil features affecting—Continued				Soil features affecting—			Corrosivity class and contributing soil features (uncoated steel)
Recreation							
Camp areas	Picnic areas	Intensive play areas	Paths and trails	Irrigation	Terraces and diversions	Grassed waterways	
Moderate: clay loam texture; moderately slow permeability.	Moderate: clay loam texture.	Moderate: clay loam texture; moderately slow permeability.	Moderate: clay loam texture.	Moderately slow intake rate.	All features favorable.	All features favorable.	Moderate: clay loam texture.
Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are 15 to 20 percent.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are 15 to 20 percent.	Moderate where slopes are 3 to 6 percent. Severe where slopes are 6 to 20 percent.	Slight where slopes are 3 to 15 percent. Moderate where slopes are 15 to 20 percent.	Slopes; 4 to 12 inches to gravelly loam and caliche.	Slopes; 4 to 12 inches to gravelly loam and caliche.	Slopes; 4 to 12 inches to gravelly loam and caliche.	Moderate: conductivity.
Moderate: clay loam texture; very slow permeability.	Moderate: clay loam texture.	Moderate: clay loam texture, very slow permeability.	Moderate: clay loam texture.	Very slow intake rate.	All features favorable.	All features favorable.	High: clay texture.
Severe: flooding hazard; clay texture.	Severe: flooding hazard; clay texture.	Severe: flooding hazard; clay texture.	Severe: flooding hazard; clay texture.	Very slow intake rate; flooding hazard.	Depressional topography.	Depressional topography.	High: clay texture.
Severe: clay texture; very slow permeability.	Severe: clay texture.	Severe: clay texture; very slow permeability.	Severe: clay texture.	Very slow intake rate.	Depressional topography.	Depressional topography.	High: clay texture.
Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are 15 to 20 percent.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are 15 to 20 percent.	Slight where slopes are 0 to 2 percent. Moderate where slopes are 2 to 6 percent. Severe where slopes are 6 to 20 percent.	Slight where slopes are 0 to 15 percent. Moderate where slopes are 15 to 20 percent.	Moderate intake rate; slopes.	Slopes	Slopes	Moderate: sandy clay loam texture.

Sewage lagoons are influenced chiefly by soil features such as permeability, location of water table, and slope. The degree of limitation and principal reasons for assigning moderate or severe limitations are given.

Reservoir areas are affected mainly by loss of water through seepage, and the soil features are those that influence such seepage.

Embankments serve as dams. The soil features, of both the subsoil and the substratum, are those important to the use of soils for constructing embankments.

Camp areas are areas that are suitable for tent and camp trailer sites and for the accompanying activities of outdoor living. They are used frequently during the camping season. These areas require little site preparation and are suitable for unsurfaced parking for cars and camp trailers, for heavy foot traffic by humans or horses, and for vehicular traffic. The soils are nearly free of coarse fragments and rock outcrops. Suitability of soil for supporting vegetation is a separate item to be considered in the final evaluation of selecting a site for these uses. Items considered in establishing ratings are wetness, flooding hazard, permeability, slope, surface layer texture, coarse fragments, and stoniness or rockiness.

Picnic areas are rated on the basis of soil features only and not on the basis of other features, such as presence of trees or lakes, that may affect the desirability of a site. Suitability of a soil for supporting vegetation is a separate item to be considered in the final evaluation when selecting sites for these uses. Items considered in establishing ratings are wetness, flooding hazard, slope, surface layer texture, and stoniness or rockiness.

Intensive play areas are those areas to be developed for playgrounds and for organized games, such as baseball, football, and badminton. They are subject to intensive foot traffic. Areas selected for this use generally require a nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface. The most desirable soils are free of rock outcrops and coarse fragments. It is assumed that good vegetative cover can be established and maintained on areas where needed. Items affecting this use considered in evaluations are wetness, flooding hazard, permeability, slope, surface layer texture, depth to hard bedrock, stoniness, and coarse fragments.

Paths and trails are areas that are to be used for trails, cross-county hiking, bridle paths, and nonintensive uses that allow for random movement of people. It is assumed that these are to be used as they occur in nature and that little soil is to be moved for the planned recreational use. Ratings are based on soil features only and do not include other items that may be important in the selection of a site for this use. Soils rated as having severe limitations may be best from the natural beauty or use standpoint, but they do require more preparation or maintenance for such use. Items considered in establishing rating are wetness, flooding hazard, slope, surface stoniness or rockiness.

The suitability of soils for irrigation depends on the intake rate, water-holding capacity, depth, slope, susceptibility to water erosion, and susceptibility to flooding.

Soil features that affect the suitability of a soil for terraces and diversions are texture, slope, depth to caliche, and stability. Level terraces should not be constructed on soils that have a dense clay subsoil, because water ponds behind the terraces and drowns out the crops.

Grassed waterways are constructed to carry off excess water that is discharged from terraces, diversions, and other areas. Soils that are shallow to caliche tend to be droughty, and vegetation is difficult to establish and maintain on them. Irrigation tailwater may drown out the vegetation, leaving the soil bare and subject to erosion.

Corrosivity indicates the potential danger to uncoated steel structures, at a depth of 4 feet, from chemical action that dissolves or weakens the structural material. Structural materials may corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or soil horizon. Corrosivity of concrete is not a problem in Swisher County, and therefore this column was omitted from the table.

Winter grading is not a problem in Swisher County. Prolonged periods of cold weather are not severe enough to cause the soils to freeze below a depth of about 6 inches. This shallow frozen condition usually lasts for such short periods of time that it presents no serious problems. For this reason this column was omitted from table 5.

Sand and gravel are not found in commercial quantities in Swisher County. Therefore, there is no column for sand and gravel.

Drainage is not a problem on most soils of Swisher County, but Randall, Bippus, Lipan, Lofton, and Roscoe soils may become temporarily inundated following periods of heavy rainfall.

Formation and Classification of the Soils

This section discusses the factors of soil formation and briefly describes important processes in the development of soil horizons. In addition, the system of classifying soils is discussed, and each soil series represented in the county is placed in the major categories of the system.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the organisms on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme instances, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for the differentiation of horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on soils that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Climate

The climate of Swisher County is uniform, but its effects have been modified by local differences in relief and runoff. An example is Randall clay, which formed in poorly drained playas.

Because rainfall is low and there are long, dry periods, soil development is slow. Except where the soils are irrigated, they are seldom wet below the root zone; therefore, many of them have a horizon of calcium carbonate accumulation. Leaching has not removed free lime from the upper layers of the Mansker, Tulia, Potter, Berda, Drake, and Lipan soils.

In some soils, such as the Pullman, Lofton, Olton, and Acuff, clay is moving from the surface layer into the subsoil. This is evidenced by the presence of clay films or by a more clayey texture in the subsoil than in the surface layer. The downward movement of clay is a process similar to the downward movement of carbonates by leaching, but it takes place at a much slower rate. It apparently begins after all the carbonates have been leached out.

Climate has affected the formation of some of the soils through the action of wind. The Drake soils formed on the eastern slopes of playas in calcareous windblown sediments.

The wet climate of past geologic ages influenced the deposition of parent materials. Parent materials during these ages were also affected by wind. The wind affected soil development from the time it deposited sands over pre-existing alluvial materials in the Illinoian stage of the Pleistocene to its present shifting of coarse sands on the surface (*2*).

Plant and animal life

Plants, earthworms, micro-organisms, and other forms of life that live on and in the soil contribute to the development of the soil profile. The kinds of organisms are determined mainly by the climate and by the kind of parent material.

In Swisher County, climate has limited the kind of vegetation mainly to grasses. The short grasses growing throughout most of the county contribute organic matter to the surface layer. When the fine roots die and decompose, they add organic matter to the rest of the solum. As the roots decay they provide food for bacteria, actinomycetes, and fungi. The network of pores and tubes left by decaying roots also hastens the passage of air and water through the soil.

Earthworms are the most obvious form of animal life in most of the soils. The subsoil of the Mansker and Tulia soils contains many worm casts, which are the round, granular excretions left by burrowing earthworms. In contrast, the subsoils of the Pullman soils contain few or no worm nests and worm casts. Worm casts add greatly to the movement of air, water, and plant roots through the soil profile.

Because of the part they play in releasing plant nutrients from the parent material, micro-organisms are important in the formation of soils. They take nitrogen from the air and store it in the soil. Also, they are active in helping to decompose plant residue.

In some areas, rodents that dwell in the soil have played a part in the development of a soil profile. By their burrowing these animals mix the soil material, and this mixing tends to offset the effects of the leaching of carbonates and the downward movement of clay. Nests made by rodents occur in some soils. The nests, or krotovinas, range from about 4 to 18 inches in diameter. They are filled with grayish-brown, silty material that has a high content of organic matter. Bison, pronghorn antelope, deer, rabbits, and other animals have also influenced the formation of the soils.

Man also has influenced soil formation by fencing the range and allowing it to be overgrazed, changing the vegetation, and clearing and plowing the soils for crops. He has clean-harvested the crops and has not controlled runoff and soil blowing. Because of these practices, organic matter has been depleted and silt and clay particles have been blown from the plow layer. Heavy machinery and untimely tillage have compacted soils and have slowed the infiltration of water and air. Irrigation also has changed the natural moisture regime in some areas.

Parent material

Parent material has probably had more influence than any other factor on the kinds of soil that have formed in this county (*2*, *3*). Most of the soils in the county formed in the eolian mantle of the High Plains.

High Plains deposits have two main parts. The lower part is the Ogallala Formation, and the upper part is an eolian mantle. The Ogallala Formation consists of very strongly calcareous outwash of sand, gravel, and caliche.

The upper part of the High Plains deposits consists of an eolian mantle that blankets much of the county. This mantle consists of alternating layers of clay, clay loam, sandy clay loam, and loam interbedded with layers of soft caliche. The kind of soil that formed at any given place of the High Plains depends mainly on the kind of parent material at the surface at that particular place. The Pullman soils, for example, formed in material from the finer textured layers. The Mansker and Tulia soils are calcareous because they have formed in limy material. The Olton and Acuff soils formed in layers of clay loam or sandy clay loam.

Several soils formed in reworked sediment from the eolian mantle. Among these are the Randall, Drake, and Bippus soils. The Randall soils formed in playa basins in beds of clay settlings. The Drake soils formed in windblown sediment that has a high content of lime and that has blown out of the bottoms of playas during dry periods. The Bippus soils formed in valley fill and in material deposited by streams.

A more detailed discussion of the formations in the county is given in the subsection "Geology."

Relief

Relief influences the formation of soils through its effects on drainage and runoff. If other factors of soil formation are equal, the degree of profile development depends mainly on the average amount of moisture that enters and passes through the soil. Steep soils take in less moisture than less sloping ones, and they are more susceptible to erosion. Therefore, they normally have a thinner, less developed profile.

Most soils in the county, such as the Pullman, Olton, and Acuff, are nearly level or gently sloping. Most of the moisture from rainfall has penetrated those soils; therefore, relief has not been a limiting factor in the development of a soil profile.

In contrast, the Potter soils have been strongly influenced by relief. Because these soils are gently sloping to moderately steep, runoff is rapid and geologic erosion is active. Rainfall penetrates to only a limited depth, and the vegetation is therefore sparse. As a result, the factors of vegetation, time and climate can cause and sustain the formation of a soil that has only a thin profile over the beds of caliche.

The Randall soils are also affected by relief. They are somewhat poorly drained and are covered by water for long periods. Consequently, some of the minerals in those soils, especially iron and manganese, have been changed.

Time

Time is required for the formation of a soil. The amount of time required depends on the kind of parent material in which the soils has formed and on the environment; that is, on the climate, plant and animal life, and relief. An old soil is considered to be stable within its environment. It changes little with the passage of of time, because the environmental factors have already exerted their influence on the parent material. A young soil, on the other hand, is one in which climate, plant and animal life, and relief have only begun to alter the parent material. These factors are affecting the soil profile, but more time is needed for the soil to develop. Thus, the age of a soil is determined by the degree to which the parent material has been changed toward the full development of a soil profile that has its own unique set of characteristics.

Soils of the Pullman, Acuff, and Olton series have been in place long enough to have developed. They are deep and have pronounced horizon development. Free lime has been leached into the lower horizons, and much of the clay has moved out of the surface layer and into the subsoil. The A and B horizons of these soils are distinct. The Drake soils, on the other hand, are young. They have been in place such a short time that horizons have barely begun to form. There has been a slight movement of lime into the subsoil, and the surface layer has been darkened by vegetation.

Because the Randall soils have a clayey texture, time has had little influence on the development of a profile in those soils. The factors of parent material and relief have been dominant in their formation.

Irrigation has some effects on the formation of soils through changes it brings about in the climatic factors. No horizon changes in the soil profiles as a result of irrigation can yet be seen, although the supplies of plant nutrients and organic matter in the soils have been altered by irrigation.

The oldest soils in this county are the buried soils formed in the eolian mantle. The eolian material appears to have been deposited during different periods. After one deposition, soils formed at the surface for an extended period and were covered when the next layer of eolian material was deposited.

Processes of Horizon Differentiation

The processes involved in the formation of soil horizons in Swisher County are (1) accumulation of organic matter, (2) leaching of calcium carbonate and bases, (3) formation and translocation of silicate clay minerals, and (4) the slow horizon inversion of heavy clays. More than one of these processes has been active in most soils.

The accumulation of organic matter in the upper part of the profile has been important in the formation of an A1 horizon. Most of the soils in this county have a dark-colored A horizon that is more than 1 percent organic matter.

Nearly all of the soils of this county have been leached, to some degree, of carbonates and bases. Some soil scientists agree that the removal of bases precedes the translocation of silicate clay minerals. This leaching has contributed to the development of horizons. For example, Olton soils have been leached of most carbonates and show distinct horizons. In contrast, Drake soils have not been leached and do not show distinct horizons.

The translocation of clay minerals has also contributed to horizon development in Swisher County. The eluviated A horizon of most soils is lower in clay content than the B horizon. Leaching of carbonates and soluble salts and the translocation of silicate clays are among the more important processes in horizon differentiation in this county. Pullman, Lofton, Olton, and Acuff soils are examples of soils in which silicate clays have accumulated in the B horizon.

Particularly in Randall clay, and also to a lesser extent in Roscoe clay, a slow churning or horizon inversion is taking place. This is caused by soil material dropping down cracks during dry periods. The soil swells upon wetting, and parts of the profile are lifted upward. This causes uneven horizon boundaries and differences in horizon thickness.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics, assemble knowledge about them, see their relationship to one another and to the whole environment, and understand their behavior and their response to manipulation. First through classification, and then through use of the soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The current system of classification was adopted by the National Cooperative Soil Survey in 1965. The system has six categories. Beginning with the most inclusive, the categories are the order, the suborder, the great group, the subgroup, the family, and the series. The placement of some soil series in the current system, particularly in families, may change as more precise information becomes available. Readers interested in the development of the system should refer to the latest literature available (*4*, *6*). Table 6 shows the classification of the soils in this county according to the family, subgroup, and order.

General Nature of the County

This section briefly describes the climate, geology, and history and settlement of Swisher County. It also discusses livestock and transportation and markets.

Climate [4]

Swisher County has a dry, steppe climate marked by mild winters. Average annual precipitation is 17.24 inches, and approximately 79 percent of this amount falls during the warm season, May through October. Rains occur most frequently as thundershowers, and monthly and annual amounts are extremely variable. Annual extremes since 1949 range from 29.50 inches in 1960 to only 8.63 inches in 1956. Table 7 gives the precipitation and temperature data for Swisher County. The prevailing winds are southwesterly from October through April and southerly from May through September. Windspeed averages about 13.6 miles per hour. Average annual relative humidity is estimated to be 72 percent at 6:00 a.m., 44 percent at noon, and 40 percent at 6:00 p.m. The Tulia area receives approximately 74 percent of the total possible sunshine annually. Seasonal variations in both relative humidity and sunshine are small. Average annual lake evaporation is estimated to be 68 inches.

In winter, frequent surges of polar and arctic air masses bring strong northerly winds and rapid drops in temperature. However, cold spells are rather short, rarely lasting longer than 48 hours before sunshine and southwesterly winds bring rapid warming. Freezes occur almost every night, but days are usually sunny, and daily high temperature averages 54.1°F. The lowest temperature ever recorded in Texas, −23°, occurred at Tulia on February 12, 1899. This record was equaled on February 8, 1933 at Seminole, Texas. Winter is a dry season. Precipitation most often falls as light snow.

Spring is a season of frequent weather changes. Warm and cold spells follow each other in rapid succession throughout March and April. These are the windiest months of the year. Infrequently, strong, persistent southwesterly to northwesterly winds may produce duststorms in the area. Thunderstorms, which rarely occur in winter, increase in number through spring and reach a peak in May and June.

In summer, afternoon temperatures are sometimes hot, but most nights are pleasantly cool. The daily low temperature in summer averages 62.4°. Evaporative-type air conditioners operate efficiently in this relatively dry climate. The highest temperature on record at Tulia, 109°, occurred on June 26, 1902, and again on June 8, 1910. Fifty percent of the average annual precipitation falls during the three-month period of May through July. June is usually the wettest month. A few thunderstorms late in spring and early in summer are at times accompanied by damaging wind and hail. Thunderstorm activity gradually decreases throughout July and August. Thunderstorms occur an average of 46 days annually at Tulia.

[4] By Robert Orton, climatologist for Texas, National Weather Service, U.S. Department of Commerce.

Table 6.—*Classification of soil series*

Series	Family	Subgroup	Order
Acuff [1]	Fine-loamy, mixed, thermic	Aridic Paleustolls	Mollisols.
Berda	Fine-loamy, mixed, thermic	Aridic Ustochrepts	Inceptisols.
Bippus	Fine-loamy, mixed, thermic	Cumulic Haplustolls	Mollisols.
Drake	Fine-loamy, mixed (calcareous), thermic	Typic Ustorthents	Entisols.
Estacado	Fine-loamy, mixed, thermic	Calciorthidic Paleustolls	Mollisols.
Lipan	Fine, montmorillonitic, thermic	Entic Pellusterts	Vertisols.
Lofton	Fine, mixed, thermic	Torrertic Argiustolls	Mollisols.
Mansker	Fine-loamy, mixed, thermic	Aridic Calciustolls	Mollisols.
Olton	Fine, mixed, thermic	Aridic Paleustolls	Mollisols.
Potter [2]	Loamy, carbonatic, thermic, shallow	Ustollic Calciorthids	Aridisols.
Pullman	Fine, mixed, thermic	Torrertic Paleustolls	Mollisols.
Randall	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols.
Roscoe	Fine, montmorillonitic, thermic	Typic Pellusterts	Vertisols.
Tulia [3]	Fine-loamy, carbonatic, thermic	Calciorthidic Paleustalfs	Alfisols.

[1] A part of the acreage of the soils of Swisher County named for this series is a taxadjunct to the series because a Mollic epipedon is lacking. This difference does not alter its usefulness or behavior.

[2] A part of the acreage of the soils of Swisher County named for this series is outside the range of the series because the color of the surface layer is darker. This difference does not alter its usefulness or behavior.

[3] A part of the acreage of the soils of Swisher County named for this series in unit TuC is taxadjunct to the series because it lacks 40 percent carbonates within 40 inches of the surface. This difference does not alter its usefulness or behavior.

TABLE 7.—*Temperature and*

[Period of record, 1949–67; elevation,

Month	Temperature				Precipitation			
	Average daily maximum [1]	Average daily minimum [1]	Average maximum [1]	Average minimum [1]	Total	Probability, in percent, of receiving selected amounts during month		
						None or trace	0.50 inch or more	1.00 inch or more
	°F.	°F.	°F.	°F.				
January	52. 1	21. 5	72. 9	4. 5	0. 53	3	45	25
February	56. 3	24. 9	75. 9	8. 9	. 37	7	40	20
March	63. 1	30. 0	82. 4	13. 7	. 54	11	50	30
April	73. 2	40. 7	90. 7	26. 9	1. 16	1	75	50
May	81. 3	51. 1	95. 5	39. 1	2. 49	<1	95	88
June	89. 2	60. 5	100. 3	51. 3	3. 68	<1	89	75
July	91. 9	64. 2	99. 8	57. 5	2. 46	<1	83	69
August	91. 0	62. 4	99. 5	56. 2	1. 70	1	85	70
September	84. 1	55. 3	95. 9	44. 1	1. 77	3	80	59
October	75. 6	44. 1	90. 7	33. 1	1. 50	5	74	75
November	62. 6	31. 5	80. 1	17. 4	. 53	20	39	20
December	54. 0	24. 5	73. 4	9. 7	. 51	8	47	27
Year	72. 9	42. 6	88. 1	30. 2	17. 24			

[1] Length of record, 19 years.
[2] Length of record, 12 years.

In fall, cold fronts again push southward through the area. Rainfall decreases progressively from September through November. Mild, sunny days and crisp, cool nights characterize fall.

The growing season (freeze-free period) at Tulia averages 205 days. The average dates of the last occurrence of 32° in spring and the first in fall are April 10 and November 1, respectively.

Geology

The origin of the High Plains is significant in the geologic history of the area (*2*). During the Permian Period, roughly 200 million years ago, a large area that included nearly all of the present Panhandle of Texas, the eastern part of New Mexico, and the western part of Oklahoma was under a shallow sea. Sediment deposited in this sea formed what is known as Permian red beds. Later, as a result of movements inside the earth, this area rose above the level of the sea. Streams began to form on the exposed rocks of the red beds. Material was washed from the higher places and redeposited along the channels of the streams. The resulting formation is known as the Triassic red beds. Exposures of that formation can be seen along the lower part of Tule Canyon. They consist of reddish sandy shale and of grayish-brown sandstone ledges.

The uplift of the Rocky Mountains during the Pliocene Epoch was the next important geologic event. Swift streams flowing eastward from the mountains cut valleys and canyons through the red beds of Triassic age, and in some places, into the red beds of Permian age. When the mountains reached their maximum height, they began to erode more rapidly. At that time the climate was extremely wet, and rains carried coarse, gravelly material down the slopes and eastward out onto the plains. This material made up the first deposits of the Ogallala Formation, and it represents the present water-bearing material.

Finer textured sands and calcareous, loamy soil material were washed down after the coarse, gravelly material. They formed alluvial fans and outwash aprons over the Triassic red beds until the entire surface was finally covered. These deposits gradually built up to form a vast plain, the Ogallala Formation, which extends several hundred miles to the east of the Rockies. The Ogallala Formation in this county ranges from about 150 feet to 350 feet in thickness.

The next important event after the material of the Ogallala Formation was deposited was the formation of an eolian mantle that blankets the Ogallala Formation (*3*). This mantle was deposited about the middle of the Pleistocene Epoch. The climate by this time had reversed itself and had become dry, windy, and disiccating. The prevailing winds were from the southwest. During this period the Pecos and other rivers were forming to the west and south. As a result of the dry climate and winds, fine-textured sediment was blown out of the river bottoms and carried to the northeast. This sediment settled on the Ogallala outwash plain, and the eolian mantle it formed built up until it is now between 30 and 100 feet thick. Most of the soils of the High Plains formed in this mantle.

The most recent geologic formations in this county are the inextensive alluvial deposits along the streams and eolian dunes on the southeastern side of large playas. They are probably of late Wisconsin or more recent geologic age.

The source of most of the underground water used for irrigation is the saturated sand and gravel at the base *precipitation, Tulia, Tex.*

3,500 feet. The symbol < means less than]

Precipitation—Continued									
Probability, in percent, of receiving selected amounts during month—Continued					Average number of days with—			Snow and sleet	
2.00 inches or more	3.00 inches or more	4.00 inches or more	5.00 inches or more	6.00 inches or more	0.10 inch or more [2]	0.50 inch or more [2]	1.00 inch or more [2]	Average [3]	Maximum [3]
								Inches	*Inches*
6	1	<1	<1	<1	1	(4)	0	1. 5	7. 0
4	<1	<1	<1	<1	2	(4)	0	1. 6	----------
8	3	1	<1	<1	2	(4)	(4)	1. 0	9. 0
19	8	4	1	<1	3	1	(4)	0	0
63	43	30	20	8	4	1	(4)	0	0
54	34	21	11	10	6	3	2	0	0
43	22	11	8	5	4	2	1	0	0
44	28	12	8	5	4	1	1	0	0
35	21	11	7	3	4	1	1	0	0
33	20	11	6	3	3	1	(4)	0	0
6	2	1	<1	<1	2	(4)	(4)	0	0
8	3	1	<1	<1	2	(4)	(4)	. 8	3. 0
----------	----------	----------	----------	----------	37	10	5	4. 9	----------

[3] Length of record, 18 years.
[4] Less than one-half day.

of the Ogallala Formation. This water probably accumulated during the wet, humid period when the formation was being deposited, and the underlying impervious red beds kept the water from percolating to a greater depth. When the Ogallala Formation was cut off from the Rocky Mountains by the Pecos River, its source of recharge water was lost. At present, there seems to be little or no recharge from rainfall, and water is pumped out faster than it is restored.

At present, geologic forces are wearing away the edges of the High Plains tableland. The Red River, Brazos River, and Colorado River systems are encroaching by headward erosion from the east, the Canadian River is encroaching from the north, and tributaries of the Pecos River are encroaching from the west. In addition, a few streams have entrenched themselves across the High Plains, are cutting downward, and are gradually removing the deposits.

History and Settlement

Swisher County was established from Young and Bexar Counties in 1876 and organized in 1890. It was named for James G. Swisher.

Ranchers were the first settlers, and farmers settled later. The first railroad was built in 1906. By 1925 most of the virgin sod had been broken out.

A drought struck the Great Plains in the 1930's. Dust storms, lack of rainfall, and low market prices forced many farmers to leave the area. Only farmers that had enough financial backing remained.

The population began to increase again in the early 1940's. A series of wet years and irrigation brought prosperity to the county. Also, much had been learned during the drought period about how to farm the soils to control soil blowing. Irrigation, improved farming practices, and better outlets for farm products have been the main factors that have produced the stable farm economy of the present. Grain sorghum, wheat, and cotton are the main crops. About 80 percent of the county is farmed, mostly to irrigated crops.

Livestock

Livestock is an important source of income in Swisher County. The main kind of livestock is beef cattle, but there are a few hogs, sheep, milk cows, and saddle horses.

The fattening of beef cattle is an important enterprise. Several feedlots are located in the county. Locally grown grain sorghum and silage are the main feeds.

Transportation and Markets

The Santa Fe Railroad runs across the county north and south, connecting Lubbock and Amarillo. Interstate Highway 27 (U.S. Highway 87) parallels the railroad. State Highway 86 intersects Interstate 27 in Tulia and crosses the county from east to west. Numerous paved State and farm roads make all areas of the county accessible to traffic.

Tulia is the largest town and is the county seat. Happy is the commercial center for the northern part of the County, and Kress serves the southern part. Several grain elevators and cotton gins are located in the county. Livestock is sold in the local auction barn, shipped to nearby markets, or sold directly to slaughtering plants. Wheat is generally sold to local elevators. It is then transported to distant markets. Most of the grain sorghum, silage, and hay is fed locally to cattle and hogs.

Literature Cited

(1) American Association of State Highway Officials.
1961. standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v., illus.

(2) Frye, John C., and Leonard, A. Byron.
1957. studies of cenozoic geology along the eastern margin of texas high plains, armstrong to howard counties. Univ. of Texas, Bur. Econ. Geol. Rept. of Inv., No. 32, 66 pp., illus.

(3) Lotspeich, F. B., and Coover, J. R.
1962. soil forming factors on the llano estacado: parent material, time, and topography. Tex. Jour. of Sci., v. XIV, No. 1, pp. 7–17, illus.

(4) Simonson, Roy W.
1962. soil classification in the united states. Sci. 137: 1027–1034, illus.

(5) United States Department of Agriculture.
1951. soil survey manual. U.S. Dept. Agr. Handbook 18, 503 pp., illus. [Supplement issued in May 1962]

(6) ———
1960. soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued in March 1967 and in September 1968]

(7) United States Department of Defense.
1968. unified soil classification system for roads, airfields, embankments, and foundations. MIL–STD–619B, 30 pp., illus.

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.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils 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.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

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.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

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.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

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, and 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, released at high points, flows onto the field without controlled distribution.

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	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. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

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.

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 characteristic 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 primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are 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).

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

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.

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.

☆ U.S. GOVERNMENT PRINTING OFFICE 1974——563-368/61

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. The capability classification system is explained on pages 20 through 22. For general information about use of the soils for dryfarmed and irrigated crops, see pages 21 and 22; for windbreaks, see page 27; and for wildlife habitat, see page 28. Range sites are described on pages 25 and 27. Other information is given in tables as follows:

Acreage and extent, table 1, page 5.
Predicted yields, table 2, page 24.

Use of the soils in engineering, tables 4 and 5, pages 32 through 37.

Map symbol	Mapping unit	Described on page	Capability unit Dryland Symbol	Capability unit Irrigated Symbol	Range site Name
AcB	Acuff loam, 1 to 3 percent slopes	6	IIIe-2	IIIe-2	Deep Hardland
Bp	Bippus loam	7	IIe-1	IIe-1	Loamy Bottomland
Bu	Bippus loam, channeled	7	Vw-1	------	Loamy Bottomland
DrB	Drake loam, 1 to 3 percent slopes	8	IVe-9	IIIe-9	High Lime
DrC	Drake loam, 3 to 5 percent slopes	8	VIe-3	IIIe-9	High Lime
Lc	Lipan clay	10	IVs-1	IVs-1	Deep Hardland
Lo	Lofton clay loam	10	IIIe-5	IIs-1	Deep Hardland
MeA	Mansker and Estacado soils, 0 to 1 percent slopes	11	IIIe-6	IIe-1	Deep Hardland
MeB	Mansker and Estacado soils, 1 to 3 percent slopes	11	IIIe-2	IIIe-2	Deep Hardland
MeC	Mansker and Estacado soils, 3 to 5 percent slopes	12	IVe-6	IVe-3	Hardland Slopes
MtD	Mansker-Tulia complex, 5 to 8 percent slopes	12	VIe-2	------	Hardland Slopes
OlA	Olton clay loam, 0 to 1 percent slopes	13	IIIe-6	IIe-1	Deep Hardland
OlB	Olton clay loam, 1 to 3 percent slopes	13	IIIe-2	IIIe-2	Deep Hardland
Pt	Potter and Tulia soils	14	VIIs-1	------	Very Shallow
PuA	Pullman clay loam, 0 to 1 percent slopes	16	IIIe-5	IIs-1	Deep Hardland
PuB	Pullman clay loam, 1 to 3 percent slopes	16	IIIe-1	IIIe-1	Deep Hardland
Ra	Randall clay	17	VIw-1 (Not drained) IVs-1 (Drained)	------ IVs-1 (Drained)	1/
Ro	Roscoe clay	18	IVs-1	IVs-1	Deep Hardland
Ru	Rough broken land and Berda soils	18	VIIs-1	------	Rough Breaks
TlA	Tulia clay loam, 0 to 1 percent slopes	19	IVe-2	IIIe-6	Hardland Slopes
TlB	Tulia clay loam, 1 to 3 percent slopes	19	IVe-2	IIIe-6	Hardland Slopes
TuC	Tulia complex, 3 to 5 percent slopes	20	IVe-6	IVe-3	Hardland Slopes

1/ Randall clay is included in the range site of the surrounding soil.

Accessibility Statement

The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The USDA Target Center can convert USDA information and documents into alternative formats, including Braille, large print, video description, diskette, and audiotape. For more information, visit the TARGET Center's Web site (http://www.targetcenter.dm.usda.gov/) or call (202) 720-2600 (Voice/TTY).

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).