

SOIL SURVEY OF

Kaufman and Rockwall Counties, Texas



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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1963-71. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the counties in 1973. 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 Kaufman-Van Zandt Soil and Water Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

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 Kaufman and Rockwall Counties 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 counties in alphabetic order by map symbol and gives the capability classification, pasture and hayland group, and range site in which each soil has been placed. It shows the page where each soil is described and the page for each interpretive group in which the soil has been placed.

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 discussions of the capability units, the range sites, and the pasture and hayland groups.

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

Ranchers and others can find, under "Use of Soils for Range," 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.

Community planners and others can read about soil properties that affect the choice of sites for dwellings and industrial buildings in the section "Use of Soils in Town and Country Planning."

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 Soils."

Newcomers in Kaufman and Rockwall Counties 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 counties given at the beginning of the publication and in the section "Environmental Factors Affecting Soil Use."

Cover: Cattle grazing in a pasture of Coastal bermudagrass in an area of Axtell fine sandy loam, 1 to 4 percent slopes.

Contents

	Page		Page
Summary of tables	ii	Descriptions of the soils—Continued	
How this survey was made	1	Lewisville series	18
General soil map	2	LeB—Lewisville silty clay, 1 to 3 percent slopes	18
Deep, nearly level to strongly sloping soils of the prairies	2	LeC—Lewisville silty clay, 3 to 8 percent slopes	18
1. Crockett-Mabank association	3	Lufkin series	19
2. Houston Black-Heiden association	3	Lu—Lufkin-Rader complex	19
3. Wilson-Burleson association	3	Mabank series	19
4. Ferris-Altoga association	3	MaA—Mabank fine sandy loam, 0 to 1 percent slopes	20
Deep, nearly level to strongly sloping soils of the oak forests	3	MaB—Mabank fine sandy loam, 1 to 3 percent slopes	20
5. Axtell-Lufkin-Rader association	3	Normangee series	21
6. Konawa-Styx-Axtell association	4	NoC2—Normangee clay loam, 2 to 8 percent slopes, eroded	21
Deep, nearly level soils of the bottom lands	4	Rader series	21
7. Trinity-Kaufman association	4	Styx series	22
8. Aufco-Kemp association	4	StB—Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes	22
Descriptions of the soils	5	Trinity series	22
Altoga series	6	Te—Trinity clay, occasionally flooded	23
AtD2—Altoga silty clay, 3 to 12 percent slopes, eroded	6	Tf—Trinity clay, frequently flooded	23
Aquic Haplustalfs	7	Wilson series	24
Aufco series	7	WsA—Wilson silt loam, 0 to 1 percent slopes	24
Au—Aufco soils, frequently flooded	7	WsB—Wilson silt loam, 1 to 3 percent slopes	24
Axtell series	7	WsC2—Wilson clay loam, 2 to 5 percent slopes, eroded	24
AxB—Axtell fine sandy loam, 1 to 4 percent slopes	8	Use and management of the soils	24
AxC2—Axtell fine sandy loam, 2 to 5 percent slopes, eroded	8	Use of soils for crops	24
AxD—Axtell fine sandy loam, 5 to 12 percent slopes	8	Capability grouping	25
Burleson series	9	Estimated yields	29
BuA—Burleson clay, 0 to 1 percent slopes	10	Use of soils for pasture and hay	29
BuB—Burleson clay, 1 to 3 percent slopes	10	Pasture and hayland groups	30
Crockett series	10	Use of soils for range	33
CrB—Crockett fine sandy loam, 1 to 3 percent slopes	10	Range sites and condition classes	33
CrC2—Crockett fine sandy loam, 2 to 5 percent slopes, eroded	11	Descriptions of range sites	34
Ellis series	11	Use of soils for wildlife habitat	36
EsD—Ellis clay, 5 to 12 percent slopes	11	Elements of wildlife habitat	36
Ferris series	11	Kinds of wildlife	37
FeD2—Ferris clay, 5 to 12 percent slopes, eroded	12	Use of soils for recreational development	37
FhC—Ferris-Heiden complex, 2 to 5 percent slopes	12	Engineering uses of the soils	37
Gowen series	12	Engineering classification systems	41
Gc—Gowen clay loam, occasionally flooded	13	Estimated soil properties significant in engineering	41
Gf—Gowen clay loam, frequently flooded	13	Engineering interpretations	44
Haplustalfs, loamy	13	Use of soils in town and country planning	45
HaD—Haplustalfs, loamy, 5 to 12 percent slopes	13	Formation and classification of soils	49
Heiden series	13	Factors of soil formation	50
HeC—Heiden clay, 3 to 5 percent slopes	14	Climate	50
HeD—Heiden clay, 5 to 8 percent slopes	14	Living organisms	50
Houston Black series	14	Parent material	50
HoA—Houston Black clay, 0 to 1 percent slopes	15	Topography	50
HoB—Houston Black clay, 1 to 3 percent slopes	15	Time	50
HoC—Houston Black clay, 3 to 5 percent slopes	15	Processes of soil horizon differentiation	51
Kaufman series	15	Classification of soils	51
Ka—Kaufman clay, occasionally flooded	16	Environmental factors affecting soil use	52
Kb—Kaufman clay, frequently flooded	16	Climate	52
Kemp series	16	Relief and drainage	53
Ke—Kemp loam, occasionally flooded	17	Farming	53
Kf—Kemp loam, frequently flooded	17	Transportation and markets	53
Konawa series	17	Water supply	53
KoB—Konawa loamy fine sand, 1 to 3 percent slopes	18	Literature cited	53
KoC—Konawa loamy fine sand, 3 to 8 percent slopes	18	Glossary	54
		Guide to mapping units	Following 57

Summary of Tables

	Page
Descriptions of the Soils	
Approximate acreage and proportionate extent of the soils (Table 1) -----	5
Use and Management of the Soils	
Estimated average yields per acre of principal crops (Table 2) -----	30
Interpretations of the soils for elements of wildlife habitat and kinds of wildlife (Table 3) -----	38
Limitations of the soils for recreational development (Table 4) -----	40
Estimated soil properties significant in engineering (Table 5) -----	42
Interpretations of engineering properties of the soils (Table 6) -----	46
Limitations of the soils for town and country planning (Table 7) -----	48
Formation and Classification of Soils	
Classification of soil series (Table 8) -----	52
Environmental Factors Affecting Soil Use	
Temperature and precipitation data (Table 9) -----	54

SOIL SURVEY OF KAUFMAN AND ROCKWALL COUNTIES, TEXAS

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

KAUFMAN AND ROCKWALL COUNTIES are in the northeastern part of Texas (fig. 1). They have a total combined area of 616,960 acres, or 963 square miles.

Kaufman, the county seat of Kaufman County, is about 35 miles southeast of Dallas on U.S. Highway 175. The town serves a productive farming, ranching, and industrial area. In 1970, the population of the county was 32,393; it is gradually increasing.

Rockwall, the county seat of Rockwall County, is about 25 miles northeast of Dallas on Interstate Highway 30. The town serves a productive farming and industrial area. In 1970, the population of Rockwall County, the state's smallest county, was 7,046. Widespread urban developments near Lake Ray Hubbard have rapidly increased the population in recent years.

About 30 percent of the acreage of the two-county area is in crops and some idle cropland. Cotton and grain sorghum are the chief crops. In much of the acreage, the soils are subject to water erosion. About 60 percent of the acreage is used as grazing lands for livestock. Some of this is in introduced grasses and some is in native grasses. The remaining 10 percent of the area is urban land, but this is rapidly expanding.

Fishing and recreation as forms of economic land use contribute to the income of the area. Cedar Creek Lake and Lake Ray Hubbard provide many recreational facilities.

Kaufman and Rockwall Counties are in the Trinity River Watershed. The area is dissected by many small streams; most of them flow into the Trinity River or its tributaries. Elevation ranges from 390 to 620 feet. The area is divided into two major physiographic areas, the Texas Blacklands and the Texas Claypan area. The soils of these major areas are discussed in the section "General Soil Map."

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Kaufman and Rockwall Counties, where they are located, and how they can be used. The soil scientists went into the survey area 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 geographic fea-

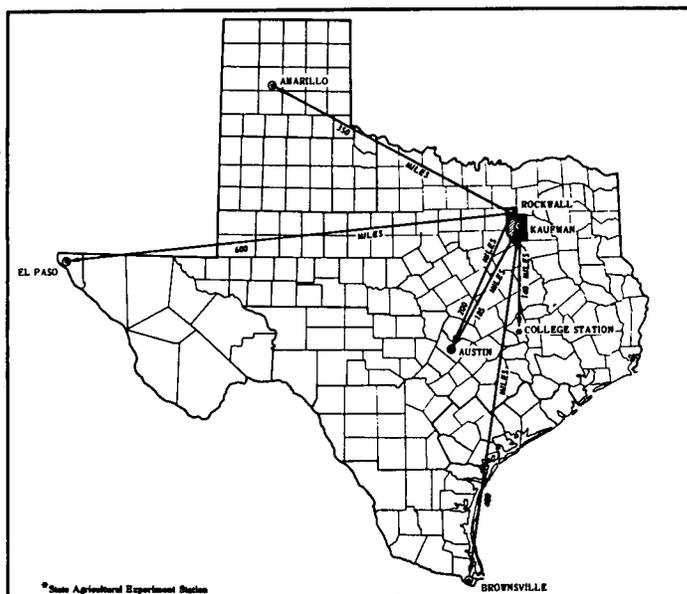


Figure 1.—Location of Kaufman and Rockwall Counties in Texas.

¹ Deceased.

ture near the place where a soil of that series was first observed and mapped. Axtell and Wilson, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

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, Burleson clay, 0 to 1 percent slopes, is one of two phases within the Burleson series in this survey area.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map 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 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 Kaufman and Rockwall Counties: 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. Lufkin-Rader complex 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. Aufco soils, frequently flooded, is an example.

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 and are given descriptive names. Haplustalfs, loamy, 5 to 12 percent slopes, is an example.

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 cultured plants, and as material for structures, foundations for structures, or cover-

ing 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 its high water table. They see that streets, road pavements, and foundations for houses are cracked on a particular 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 consultation. 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 Kaufman and Rockwall Counties. 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 the survey area, who want to compare different parts of the survey area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Kaufman and Rockwall Counties are discussed in the following pages.

The soil associations in this survey area have been grouped into three general kinds of landscapes for broad interpretative purposes. Each of the broad groups and their included soil associations are described in the following pages. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1, the word "loamy" refers to the texture of the surface layer.

Deep, Nearly Level to Strongly Sloping Soils of the Prairies

Most of the soils in this group are used for crops and pasture, but much of the land is being converted to urban uses. Some soil problems for urban uses are shrink-swell potential, corrosivity, and slow percolation for septic tank systems.

1. *Crockett-Maybank association*

Moderately well drained and somewhat poorly drained, very slowly permeable, noncalcareous loamy soils that have a clayey subsoil

This association is on broad, nearly level to gently sloping interstream divides and side slopes along natural drainageways.

This association makes up about 20 percent of the land area of the survey area. Crockett soils make up about 46 percent of the association, Mabank soils, 25 percent, and other soils, 29 percent. These other soils are in the Axtell, Burleson, Houston Black, and Normangee series.

Crockett soils have a surface layer of brown fine sandy loam about 8 inches thick. The subsoil, to a depth of 57 inches, is clay mottled in shades of red, brown, gray, yellow, and olive. The underlying material is pale-yellow, mottled loam.

Mabank soils have a surface layer of grayish-brown fine sandy loam about 7 inches thick. The subsoil, to a depth of 70 inches is clay. In sequence from the top, the upper 17 inches is very dark gray, the next 8 inches is gray, and the next 18 inches is light brownish gray, and the lower 20 inches is light-gray clay.

This association was once extensively farmed, but it is now used mostly as pasture and range. The soils in this association are well suited to these uses, and improved pasture grasses have been established in many old fields. This association is also well suited to habitat for open-land wildlife.

2. *Houston Black-Heiden association*

Moderately well drained and well drained, very slowly permeable, calcareous soils that are clayey throughout

This association is on broad, nearly level to sloping uplands.

This association makes up about 19 percent of the land area of the survey area. Houston Black soils make up 77 percent of the association, the closely similar Heiden soils, 15 percent, and other soils, 8 percent. These other soils are in the Burleson, Ferris, and Trinity series.

Houston Black soils have a surface layer of very dark gray clay about 14 inches thick. The next lower layer, to a depth of 72 inches, is dark-gray clay.

Heiden soils have a surface layer of dark grayish-brown clay about 27 inches thick. The next 21 inches is olive clay. The underlying material is mottled clay.

This association is used mostly for crops. The soils in this association are well suited to crops and pasture, and improved pastures have been established in some old fields. A few areas are used for range. This association is also well suited to habitat for open-land wildlife. Urban development is replacing agricultural land use near some towns and along Lake Ray Hubbard.

3. *Wilson-Burleson association*

Somewhat poorly drained, very slowly permeable, noncalcareous loamy or clayey soils that have a clayey subsoil and lower layers

This association is on broad, nearly level to gently sloping interstream divides.

This association makes up about 16 percent of the land area of the survey area. Wilson soils make up about 50 percent of the association, Burleson soils, about 25 percent,

and other soils, 25 percent. These other soils are the Mabank, Crockett, Heiden, and Houston Black series.

Wilson soils have a surface layer of very dark gray silt loam about 5 inches thick. The subsoil, to a depth of 65 inches, is silty clay. The upper part is very dark gray, and the lower part is grayish brown.

Burleson soils have a surface layer of very dark gray clay about 44 inches thick. The next layer to a depth of 65 inches, is clay. It is dark gray in the upper part and gray in the lower part.

This association was once extensively farmed, and although some areas are still used for crops, it is now used mostly as pasture or range. The soils of this association are suited to most locally grown crops. This association is also well suited to habitat for open-land wildlife.

4. *Ferris-Altoga association*

Well-drained, very slowly permeable to moderately permeable, calcareous soils that are clayey throughout

This association is on gently sloping to strongly sloping side slopes along deep, dissected drainageways.

This association makes up about 6 percent of the land area of the survey area. Ferris soils make up about 55 percent of the association, Altoga soils, 20 percent, and other soils, 25 percent. These other soils are in the Heiden, Houston Black, and Trinity series.

Ferris soils have a surface layer of grayish-brown clay about 6 inches thick. The lower layer, to a depth of 65 inches, is light yellowish-brown clay that is mottled in the lower part.

Altoga soils have a surface layer of grayish-brown silty clay about 5 inches thick. The lower layer, to a depth of 65 inches, is silty clay. It is light yellowish brown in the upper part and very pale brown in the lower part.

This association is used mostly for pasture or range. Most of the soils are too steep or eroded to use for crops. Urban development is rapidly replacing agricultural land use near towns and along Lake Ray Hubbard.

Deep, Nearly Level to Strongly Sloping Soils of the Oak Forests

Most of the soils in this group are used for pasture, but much of the land was cleared and farmed in the past. In some areas urban land use is rapidly expanding. Some soil problems for urban uses are corrosivity and slow percolation for septic tank systems.

5. *Axtell-Lufkin-Rader association*

Well-drained to somewhat poorly drained, very slowly permeable, noncalcareous loamy soils that have a loamy or clayey subsoil

This association is on broad, nearly level to strongly sloping, smooth plains, ridges, and side slopes to drainageways.

This association makes up about 19 percent of the land area of the survey area. Axtell soils make up about 30 percent of the association, Lufkin soils, 29 percent, Rader soils, 20 percent, and other soils, 21 percent. These other soils are in the Crockett, Mabank, and Wilson series.

Axtell soils have a surface layer of grayish-brown fine sandy loam about 6 inches thick. The subsoil is about 54 inches thick. The upper 8 inches is yellowish-red clay. The next 25 inches is mottled brown, yellowish-red, and grayish-brown clay loam. The lower 21 inches is light brownish-

gray, mottled sandy clay loam. The underlying material is pale-brown, mottled sandy clay loam.

Lufkin soils have a surface layer of fine sandy loam about 8 inches thick. The upper part is light brownish gray, and the lower part is light gray. The subsoil is clay about 48 inches thick. It is grayish brown in the upper part and light brownish gray in the lower part. The underlying material is light-gray clay and sandy clay loam.

Rader soils have a surface layer of brown fine sandy loam about 6 inches thick. The subsurface layer is 19 inches thick. The upper 13 inches is light-gray fine sandy loam, and the lower 6 inches is very pale brown fine sandy loam. The subsoil is about 52 inches thick. In sequence from the top, the upper 7 inches is light yellowish-brown sandy clay loam, the next 7 inches is light brownish-gray sandy clay, the next 13 inches is light-gray sandy clay, and the lower 25 inches is mottled sandy clay loam.

This association was once cleared and cultivated, and although a few small areas are still used for crops, it is now used mostly as pasture. The soils in this association are well suited to improved pasture grasses or range. This association is also suited to woodland and habitat for open-land wildlife.

Rock quarries in the limestone lentils of the Kincaid Formation (4, 9)² in eastern Kaufman County are the source of crushed rock for road construction.

6. *Konawa-Styx-Axtell association*

Well-drained and moderately well drained, moderately permeable to very slowly permeable, noncalcareous sandy or loamy soils that have a loamy or clayey subsoil.

This association is on nearly level to strongly sloping stream terraces and has areas of narrow ridges and side slopes.

This association makes up about 4 percent of the land area of the survey area. Konawa soils make up about 24 percent of the association, Styx soils, about 24 percent, Axtell soils, about 10 percent, and other soils, 42 percent. These other soils are Aquic Haplustalfs and soils in the Kemp, Lufkin, and Rader series.

Konawa soils have a surface layer of light yellowish-brown loamy fine sand about 11 inches thick. The subsoil is sandy clay loam about 39 inches thick. In sequence from the top, the upper 14 inches is red, the middle 17 inches is light red, and the lower 8 inches is reddish yellow. The underlying material is reddish-yellow fine sandy loam.

Styx soils have a surface layer of loamy fine sand about 18 inches thick. It is pale brown in the upper part and very pale brown in the lower part. The subsurface layer is very pale brown loamy fine sand about 15 inches thick. The subsoil, to a depth of 84 inches, is sandy clay loam. It is brownish yellow in the upper 9 inches and mottled in shades of gray, brown, yellow, and red below.

Axtell soils have a surface layer of grayish-brown fine sandy loam about 4 inches thick. The subsurface layer is light brownish-gray fine sandy loam about 2 inches thick. The subsoil is about 54 inches thick. In sequence from the top, the upper 8 inches is yellowish-red clay; the next 25 inches is clay loam mottled in shades of brown, red, yellow, and gray; and the lower 21 inches is sandy clay loam mottled in shades of brown, gray, and olive. The underlying material is pale-brown mottled sandy clay loam.

This association was once cleared and cultivated, and although a few small areas are still used for truck farming, it is now mostly used for pasture. These soils are well suited to improved permanent pasture and to urban development. Urban development is rapidly replacing agricultural land use.

Deep, Nearly Level Soils of the Bottom Lands

Most of the soils in this group are used for pasture and crops, for which they are well suited. Sand and gravel are mined in some places. Flooding is a hazard in unprotected areas; because of this hazard, these soils are not suited to urban uses.

7. *Trinity-Kaufman association*

Somewhat poorly drained, very slowly permeable, noncalcareous to calcareous soils that are clayey throughout

This association is on the nearly level flood plain of the major rivers and their tributaries.

This association makes up about 14 percent of the land area of the survey area. Trinity soils make up 61 percent of the association, the closely similar Kaufman soils, 19 percent, and other soils, 20 percent. These other soils are in the Gowen and Kemp series.

Trinity soils have a surface layer of dark-gray clay about 4 inches thick. The next layer is very dark gray clay about 56 inches thick. The next lower layer, to a depth of 72 inches, is dark-gray clay.

Kaufman soils have a surface layer of black clay about 18 inches thick. The next layer, to a depth of 75 inches, is clay. The upper part is very dark gray, and the lower part is dark gray.

The soils of this association are used mostly for crops and pasture. They are well suited to most locally grown crops. Crop areas are protected by a levee system. Unprotected areas are subject to flooding and are better suited to pasture, range, or habitat for wildlife than to other uses.

Sand and gravel are mined from subsurface deposits in some areas along the Trinity River.

8. *Aufco-Kemp association*

Moderately well drained and somewhat poorly drained, very slowly permeable to moderately permeable, noncalcareous soils that are clayey or loamy throughout.

This association is on the nearly level flood plains.

This association makes up about 2 percent of the land area of the survey area. Aufco soils make up about 48 percent of the association, Kemp soils, 20 percent, and other soils, 32 percent. These other soils are in the Gowen and Kaufman series.

Aufco soils have a surface layer of black clay about 5 inches thick. The next layer is clay loam 33 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next lower layer, to a depth of 75 inches, is dark grayish-brown clay with grayish and brownish mottles.

Kemp soils have a surface layer of brown loam about 18 inches thick. The next layer is grayish-brown fine sandy loam about 19 inches thick. The next layer, to a depth of 65 inches, is sandy clay loam. It is dark gray in the upper part and mottled in shades of brown, gray, and yellow in the lower part.

² Italic number in parentheses refer to Literature Cited, p. 53.

Most of the soils in this association are subject to frequent floods and are not suitable for cultivation. These soils are better suited to pasture, range, or habitat for wildlife than to other uses.

Descriptions of the Soils

This section describes the soil series and mapping units in Kaufman and Rockwall Counties. Each soil series is described in detail, and then, briefly, each mapping unit in that series is described. 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 soils. Color terms are for dry soil unless otherwise stated. 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 that series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Haplustalfs, loamy, for example, do not belong to a soil series. Nevertheless, they are listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol which identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and pasture and hayland group in which the mapping unit has been placed. The page for the description of each capability unit, and the range site, and pasture and hayland group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping

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

Soil	Kaufman County		Rockwall County		Total	
	Acres	Percent	Acres	Percent	Acres	Percent
Altoga silty clay, 3 to 12 percent slopes, eroded	4,000	0.8	3,800	4.0	7,800	1.3
Aufco soils, frequently flooded	5,700	1.1			5,700	.9
Axtell fine sandy loam, 1 to 4 percent slopes	13,000	2.5			13,000	2.1
Axtell fine sandy loam, 2 to 5 percent slopes, eroded	13,700	2.6			13,700	2.2
Axtell fine sandy loam, 5 to 12 percent slopes	12,100	2.3			12,100	2.0
Burleson clay, 0 to 1 percent slopes	8,300	1.6	960	1.0	9,260	1.5
Burleson clay, 1 to 3 percent slopes	18,600	3.6	4,200	4.5	22,800	3.7
Crockett fine sandy loam, 1 to 3 percent slopes	29,800	5.7	80	.1	29,880	4.9
Crockett fine sandy loam, 2 to 5 percent slopes, eroded	31,200	6.0	220	.2	31,420	5.1
Ellis clay, 5 to 12 percent slopes	1,450	.3			1,450	.2
Ferris clay, 5 to 12 percent slopes, eroded	12,000	2.3	5,800	6.2	17,800	2.9
Ferris-Heiden complex, 2 to 5 percent slopes	12,200	2.3	4,300	4.5	16,500	2.7
Gowen clay loam, occasionally flooded	6,100	1.2			6,100	1.0
Gowen clay loam, frequently flooded	12,800	2.5			12,800	2.1
Haplustalfs, loamy, 5 to 12 percent slopes	1,140	.2			1,140	.2
Heiden clay, 3 to 5 percent slopes	4,100	.7	11,000	11.8	15,100	2.5
Heiden clay, 5 to 8 percent slopes	1,900	.4	490	.5	2,390	.4
Houston Black clay, 0 to 1 percent slopes	14,800	2.8	3,000	3.2	17,800	2.9
Houston Black clay, 1 to 3 percent slopes	42,600	8.2	35,170	37.3	77,770	12.5
Houston Black clay, 3 to 5 percent slopes	2,170	.4	400	.4	2,570	.4
Kaufman clay, occasionally flooded	3,700	.7			3,700	.6
Kaufman clay, frequently flooded	13,600	2.7	620	.7	14,220	2.3
Kemp loam, occasionally flooded	1,200	.2			1,200	.2
Kemp loam, frequently flooded	11,000	2.1			11,000	1.8
Konawa loamy fine sand, 1 to 3 percent slopes	990	.2			990	.2
Konawa loamy fine sand, 3 to 8 percent slopes	4,900	.9			4,900	.8
Lewisville silty clay, 1 to 3 percent slopes	700	.1	320	.3	1,020	.2
Lewisville silty clay, 3 to 8 percent slopes	550	.1	40	(¹)	590	(¹)
Lufkin-Rader complex	62,048	11.8			62,048	10.1
Mabank fine sandy loam, 1 to 3 percent slopes	26,200	5.0	380	.4	26,580	4.3
Mabank fine sandy loam, 1 to 3 percent slopes	14,100	2.7	300	.3	14,400	2.3
Normangee clay loam, 2 to 8 percent slopes, eroded	4,000	.8			4,000	.7
Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes	9,400	1.8			9,400	1.5
Trinity clay, occasionally flooded	29,700	5.7	1,100	1.2	30,800	4.9
Trinity clay, frequently flooded	23,900	4.6	4,300	4.6	28,200	4.6
Wilson silt loam, 0 to 1 percent slopes	15,700	3.0	700	.8	16,400	2.6
Wilson silt loam, 1 to 3 percent slopes	31,200	5.9	3,200	3.4	34,400	5.6
Wilson clay loam, 2 to 5 percent slopes, eroded	10,100	1.9	700	.8	10,800	1.7
Total land area	510,648		81,080		591,728	
Water	12,232	2.3	13,000	13.8	25,232	4.1
Total	522,880	100.0	94,080	100.0	616,960	100.0

¹ Less than 0.05 percent.

unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (6).

Altoga Series

The Altoga series consists of deep, calcareous, clayey soils on old, high terraces. These gently sloping to strongly sloping soils formed in old calcareous sediments. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is grayish-brown, calcareous silty clay about 5 inches thick. The next 19 inches is light yellowish-brown, calcareous silty clay. The next 23 inches is very pale brown, calcareous silty clay with common calcium carbonate concretions and soft masses. The underlying material to a depth of 65 inches is very pale brown, calcareous silty clay.

Altoga soils are well drained. They have moderate permeability and high available water capacity.

Most of these soils are used for pasture or range. The soils are unsuitable for cultivated crops.

Representative profile of Altoga silty clay, 3 to 12 percent slopes, eroded, in a pasture; 75 feet south of Farm Road 740, 0.7 mile west, and 0.9 mile north of its junction with Interstate Highway 20 in Forney, Texas:

A1—0 to 5 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate, medium, subangular blocky structure; hard, firm; many roots; common wormcasts; calcareous; moderately alkaline; gradual, smooth boundary.

B2—5 to 24 inches, light yellowish-brown (10YR 6/4) silty clay, yellowish brown (10YR 5/4) moist; few fine, distinct, yellowish-brown (10YR 5/4) mottles; moderate, medium, subangular blocky structure; hard, firm; few roots; few wormcasts; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—24 to 47 inches, very pale brown (10YR 7/4) silty clay, light yellowish brown (10YR 6/4) moist; common fine, distinct, yellowish-brown (10YR 5/4) and grayish-brown (10YR 5/2) mottles; moderate, medium, subangular blocky structure; hard, firm; few roots; common soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—47 to 65 inches, very pale brown (10YR 7/4) silty clay, light yellowish brown (10YR 6/4) moist; common fine, distinct, yellowish-brown (10YR 5/4) and gray (10YR 5/1) mottles; massive; very hard, very firm; calcareous; moderately alkaline.

The solum is 35 to 55 inches thick. The A horizon is 4 to 8 inches thick. It is grayish brown or pale brown.

The B horizon is very pale brown, light brownish-gray, or light yellowish-brown clay loam or silty clay. Calcium carbonate concretions and soft masses range from few to many, and total carbonate content is 40 to 60 percent. Visible secondary carbonates are at a depth of 14 to 28 inches.

The C horizon is very pale brown or light yellowish brown. It contains few to common calcium carbonate concretions.

AtD2—Altoga silty clay, 3 to 12 percent slopes, eroded.

This gently sloping to strongly sloping soil is on escarpments of old, high terraces (fig. 2). Slopes are dominantly 5 to 12 percent. Most of the surface layer has been eroded away; all of it has been removed in places. Some areas are dissected by gullies 2 to 5 feet deep and 3 to 20 feet across. These oblong to elongated areas are 20 to 260 acres in size.

Included with this soil in mapping are small areas of Ferris soils near the tops of slopes and Lewisville soils in concave areas near the bottoms of slopes. Also included are small areas of Altoga soils with slopes as steep as 15 percent.

Runoff is rapid, and the hazard of erosion is severe.

Most areas of Altoga soils are used for native grass pasture, but urban development on these soils is rapidly increasing. This soil is too sloping and eroded for cultivated



Figure 2.—Landscape of Altoga silty clay, 3 to 12 percent slopes, eroded.

crops; it is better suited to grass. Capability unit VIe-3; pasture and hayland group 7D; Clay Loam range site.

Aquic Haplustalfs

Aquic Haplustalfs consist of deep, noncalcareous, sandy soils on old high terraces. These nearly level to gently sloping soils formed in sandy and loamy alluvial sediments under a hardwood forest.

In a representative profile the surface layer is pale-brown, strongly acid, loamy fine sand about 7 inches thick. The subsurface layer is very pale brown, medium acid, loamy fine sand 18 inches thick. The subsoil to a depth of 65 inches is mottled gray, brown, yellow, and red sandy clay loam. Reaction is strongly acid in the upper 11 inches of the subsoil and very strongly acid below.

These soils are moderately well drained. They have moderately slow permeability and medium available water capacity.

Most of these soils are used for pasture. A few areas are used for crops.

In Kaufman and Rockwall Counties, Aquic Haplustalfs are mapped only in complex with Styx soils.

Representative profile of Aquic Haplustalfs in an area of Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes, in a pasture; 0.3 mile south of Farm Road 148, 0.2 mile east of its junction with Farm Road 2613 at Lively, Texas:

Ap—0 to 7 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 4/3) moist; single grained; soft, loose; many roots; strongly acid; clear, smooth boundary.

A2—7 to 25 inches, very pale brown (10YR 8/3) loamy fine sand, pale brown (10YR 6/3) moist; single grained; soft, loose; few roots; medium acid; clear, smooth boundary.

B21t—25 to 36 inches, brownish-yellow (10YR 6/6) sandy clay loam, yellowish brown (10YR 5/6) moist; common medium, distinct, light-gray (10YR 7/2) and red (2.5YR 4/6) mottles; moderate, medium, blocky structure; very hard, friable; few roots; few quartz pebbles; few patchy clay films; strongly acid; gradual, smooth boundary.

B22t—36 to 48 inches, prominently mottled gray (10YR 6/1), strong-brown (7.5YR 5/8), and dark-red (2.5YR 3/6) sandy clay loam; moderate, medium, blocky structure; very hard, firm; few roots; few quartz pebbles; common clay films; very strongly acid; gradual, smooth boundary.

B23t—48 to 65 inches, prominently mottled gray (10YR 6/1), yellowish-brown (10YR 5/8), and dark-red (2.5YR 3/6) sandy clay loam; weak, medium, blocky structure; very hard, friable; few fine roots; common clay films; few quartz pebbles; very strongly acid; gradual, smooth boundary.

The solum is more than 50 inches thick. The A horizon is 20 to 27 inches thick. The Ap horizon ranges from brown to very pale brown. The A2 horizon ranges from light gray to very pale brown. Reaction is strongly acid to neutral.

The B2t horizon is sandy clay loam or clay loam mottled mainly in shades of gray, brown, yellow, and red. Reaction is very strongly acid to medium acid.

Aufco Series

The Aufco series consists of deep, noncalcareous, clayey soils on bottom lands. These nearly level soils formed in recent clayey to loamy alluvial sediments.

In a representative profile the surface layer is black, medium acid clay about 5 inches thick. The next layer is very strongly acid clay loam 33 inches thick. It is dark grayish brown in the upper part and grayish brown and mottled in the lower part. The next layer to a depth of 75 inches is dark grayish-brown, strongly acid mottled clay.

Aufco soils are somewhat poorly drained. They have

very slow permeability and high available water capacity. Runoff is slow.

Most of this soil is used for range. A few areas have been established to improved pasture grasses.

Representative profile of Aufco soils, frequently flooded; 10 feet south of Farm Road 1391, 3.25 miles east of its junction with U.S. Highway 175 in Kemp, Texas:

A11—0 to 5 inches, black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate, medium, blocky structure; extremely hard, very firm, very sticky; many roots; few pores and casts; few vertical cracks; medium acid; clear, smooth boundary.

A12g—5 to 24 inches, dark grayish-brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; common medium, distinct, light-gray (10YR 7/2) mottles; moderate, medium, subangular blocky structure; very hard, firm, sticky; few roots; few fine iron concretions; very strongly acid; diffuse, clear boundary.

A13g—24 to 38 inches, grayish-brown (10YR 5/2) clay loam, light brownish gray (10YR 6/2) dry; common fine and medium, faint and distinct, light-gray (10YR 7/2) and brown (10YR 4/3) mottles; moderate, medium, blocky structure; very hard, firm, sticky; few roots; very strongly acid; diffuse, smooth boundary.

A11b—38 to 56 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; common medium, distinct, light-gray (10YR 7/2) mottles; moderate, medium, blocky structure; extremely hard, very firm, very sticky; few roots; few fine iron concretions; few pressure faces on pedis; strongly acid; diffuse, smooth boundary.

A12b—56 to 75 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; common fine, faint and distinct, yellowish-brown (10YR 5/4) and gray (10YR 5/1) mottles; weak, medium, blocky structure; extremely hard, very firm, very sticky; few fine roots; few gypsum crystals; strongly acid.

The solum is more than 60 inches thick. The A11 horizon is 3 to 6 inches thick. It ranges from black to very dark grayish brown. Reaction is strongly acid to slightly acid.

The Ag horizon ranges from dark grayish brown or grayish brown to light brownish gray and has few to common mottles in shades of gray, brown, and yellow. It is clay loam, silty clay, or clay. Thin strata of loamy material are present in places. Reaction is extremely acid to strongly acid.

The Ab horizon is dark grayish brown or grayish brown. Reaction is very strongly acid to slightly acid.

The clay content at a depth of 10 to 40 inches is 35 to 50 percent.

Au—Aufco soils, frequently flooded. These nearly level soils are on the flood plain of Cedar Creek. Slopes are 0 to 1 percent.

The unit is about 70 percent Aufco soils and 30 percent other soils. Composition is variable; in some mapped areas the dark surface layer is absent, and in others it is extensive.

Included with this soil in mapping are small areas of Gowen and Kaufman soils on the outer edge of the flood plain near the mouths of smaller streams which drain the blackland prairies. Inclusions make up less than 10 percent of any one mapped area.

Areas are flooded more than once each year, and the rapidly flowing floodwaters cause scouring and leave sediment deposits. Most years the soil is saturated to a depth of 40 inches during the cool season.

Most of the acreage of these soils is in native hardwood timber. It is unsuitable for cultivated crops because of frequent, damaging flooding. A few areas have been cleared and established to improved pasture grasses. Capability unit Vw-1; pasture and hayland group 1B; Clayey Bottomland range site.

Axtell Series

The Axtell series consists of deep, noncalcareous, loamy soils on uplands. These gently sloping to strongly sloping soils formed in clay and sandy clay interbedded with

sandier materials. They developed mostly under a post oak forest.

In a representative profile the surface layer is grayish-brown, medium acid fine sandy loam about 4 inches thick. The subsurface layer is light brownish-gray, medium acid fine sandy loam 2 inches thick. The subsoil is about 54 inches thick. In sequence from the top, the upper 8 inches is yellowish-red, strongly acid mottled clay, the next 25 inches is mottled brown and yellowish-red, strongly acid clay loam, and the lower 21 inches is light brownish-gray, slightly acid mottled sandy clay loam. The underlying material to a depth of 75 inches is pale-brown, slightly acid mottled sandy clay loam.

Axtell soils are well drained to moderately well drained. They have very slow permeability and high available water capacity. Runoff is medium to rapid. The hazard of erosion is moderate to severe.

Most of the acreage of these soils is used for pasture.

Representative profile of Axtell fine sandy loam, 1 to 4 percent slopes, in a pasture; 50 feet south and 165 feet east of an oilfield road, 0.85 mile south of Farm Road 1391, 4.4 miles east of its junction with U.S. Highway 175 in Kemp, Texas:

- A1—0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; very hard, friable; few fine roots; medium acid; clear, smooth boundary.
- A2—4 to 6 inches, light brownish-gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; massive; very hard, friable; few fine roots; medium acid; abrupt, wavy boundary.
- B21t—6 to 14 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; common medium and coarse, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/4) mottles; moderate, medium and fine, blocky structure; extremely hard, very firm; few fine grass roots; few fine pores; distinct clay films on peds; vertical cracks partially filled with browner soil; few fine black concretions; strongly acid; gradual, wavy boundary.
- B22t—14 to 39 inches, distinctly and coarsely mottled brown (10YR 5/3) and yellowish-red (5YR 5/6) clay loam; many medium and coarse, distinct, grayish-brown (10YR 5/2), yellowish-brown (10YR 5/6), and strong-brown (7.5YR 5/6) mottles; moderate, medium and coarse, blocky structure; extremely hard, very firm; few fine pores; thin clay films on peds; few shiny pressure faces; cracks extend from horizon above; few fine and medium black concretions; strongly acid; gradual, smooth boundary.
- B3t—39 to 60 inches, light brownish-gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist; common medium, distinct, strong-brown (7.5YR 5/6) and olive-gray (5Y 5/2) mottles; weak, coarse, blocky structure; extremely hard, very firm; few thin clay films on peds; few fine and medium, black concretions; slightly acid; gradual, smooth boundary.
- C—60 to 75 inches, pale-brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist; common medium, distinct, yellowish-brown (10YR 5/6) and light-gray (2.5Y 7/2) mottles; massive; very hard, firm; few horizontal cleavage planes; few fine and medium, black and brown concretions; slightly acid.

The A horizon is 6 to 15 inches thick. The A1 horizon is brown, dark grayish brown, light gray, grayish brown, or very pale brown. The A2 horizon, where present, is slightly lighter in color than the A1 horizon. Reaction is slightly acid to strongly acid.

The B2t horizon is yellowish red, red, brown, light reddish brown, reddish yellow, strong brown, or reddish brown and has few to many mottles in shades of red, brown, yellow, and gray. Reaction in the upper part of the B2t horizon is strongly acid or very strongly acid. The lower part of the B2t horizon is strongly acid to neutral. The B2t horizon ranges from clay loam to clay, and clay content is 35 to 50 percent.

The B3t horizon is light brownish gray, pale brown, very pale brown, gray, or light olive brown and has yellow, gray, olive, and brown mottles. Reaction is medium acid to moderately alkaline.

The C horizon is pale brown, very pale brown, light brownish-gray, or yellowish-brown sandy clay loam to sandy clay. Reaction is slightly acid to moderately alkaline. Depth to the C horizon is 50 to 80 inches.

Calcium carbonate concretions are above a depth of 60 inches in some places.

AxB—Axtell fine sandy loam, 1 to 4 percent slopes. This gently sloping soil is on interstream divides and has a plane to convex surface. Soil areas are irregular in shape and vary from 5 to 120 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are Lufkin soils in small depressions and small areas of Rader soils on low ridges. These inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate.

Most of the acreage of this soil is used for pasture, and the soil is well suited to improved pasture. A few areas are used for crops and small grain for winter grazing. Capability unit IIIe-1; pasture and hayland group 8A; Claypan Savannah range site.

AxC2—Axtell fine sandy loam, 2 to 5 percent slopes, eroded. This gently sloping soil is on convex ridges and side slopes next to drainageways. Much of the surface layer has been eroded away (fig. 3); all of it has been removed in places. Soil areas are oblong in shape and range from 5 to 50 acres in size.

The surface layer is pale-brown fine sandy loam 6 inches thick. The subsoil is clay about 64 inches thick. It is mottled yellowish red, yellowish brown, red, and gray in the upper part and reddish brown with gray mottles in the lower part. The underlying material to a depth of 84 inches is mottled yellowish-brown and light brownish-gray sandy clay loam.

Included with this soil in mapping are Lufkin soils in small depressions and Rader soils on small, low ridges. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is severe.

Most of the acreage of this soil is used for pasture. Most areas were once farmed, and many have been abandoned to reseed naturally, while others have been established to improved pasture grasses. These soils are better suited to grass than to other crops. Capability unit IVe-1; pasture and hayland group 8A; Claypan Savannah range site.

AxD—Axtell fine sandy loam, 5 to 12 percent slopes. This sloping to strongly sloping soil occupies side slopes of deeply dissected drainageways and escarpments that parallel flood plains. About 30 percent of the total acreage is eroded. Eroded soils have a surface layer that averages 2 to 3 inches in thickness, and some gullies are present in most eroded areas. Areas of this soil range from 5 to 80 acres in size.

The surface layer is very pale brown fine sandy loam about 6 inches thick. Reaction is medium acid. The subsoil is clay about 32 inches thick. It is yellowish red with red and gray mottles in the upper part and red, yellow, brown, and gray mottles in the lower part. The next layer is light brownish-gray sandy clay loam 9 inches thick. The underlying material to a depth of 75 inches is mottled brown, yellow, and gray sandy clay loam.

Included with this soil in mapping are a few small areas of Konawa and Rader soils. Inclusions make up less than 15 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

Most of the acreage of this soil is used for pasture. About 40 percent is still in native timber. Some areas have been established to improved pasture. Capability unit VIe-1; pasture and hayland group 8B; Claypan Savannah range site.



Figure 3.—Area of Axtell fine sandy loam, 2 to 5 percent slopes, eroded, showing the effects of erosion on unprotected soil.

Burleson Series

The Burleson series consists of deep, clayey soils on uplands and ancient alluvial terraces. These nearly level to gently sloping soils formed in alkaline clays and shales. Undisturbed areas have a pronounced microrelief of alternating microbasins and microknolls. The native vegetation was tall prairie grasses.

In a representative profile the surface layer is very dark gray, moderately alkaline clay about 44 inches thick. The next 10 inches is dark-gray, moderately alkaline clay. The next layer is 11 inches of gray, calcareous clay that has common yellowish-brown and light olive-brown mottles. The underlying material to a depth of 75 inches is mottled olive-gray, light olive-brown, and yellowish-brown, calcareous shaly clay.

Burleson soils are moderately well drained. Water intake is rapid when the soil is dry and cracked, but these soils have very slow permeability when wet. Available water capacity is high. Runoff is slow to medium.

Most of the acreage of these soils is used for crops. A few areas are used for pasture or hay.

Representative profile of Burleson clay, 1 to 3 percent slopes, in a field; 100 feet north of Farm Road 1895, 1 mile east of its intersection with U.S. Highway 175 in Kemp, Texas:

- Ap—0 to 7 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, medium, subangular blocky structure; extremely hard, very firm; many fine roots; few pores; few quartz pebbles; moderately alkaline; gradual, smooth boundary.
- A11—7 to 39 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, medium, blocky structure; extremely hard, very firm; few fine roots; few fine, strongly cemented calcium carbonate concretions; common, grooved, intersecting slicken-

sides below a depth of 20 inches; few quartz pebbles; moderately alkaline; gradual, wavy boundary.

- A12—39 to 44 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; weak, medium, blocky structure; extremely hard; very firm; few fine roots; few weakly cemented calcium carbonate concretions; common, grooved, intersecting slickensides; moderately alkaline; gradual, wavy boundary.

- A13—44 to 54 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, medium, blocky structure; extremely hard, very firm; few fine roots; common weakly cemented calcium carbonate concretions; few quartz pebbles; few grooved, intersecting slickensides; moderately alkaline; gradual, wavy boundary.

- AC—54 to 65 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; common fine, distinct, yellowish-brown (10YR 5/4) and light olive-brown (2.5Y 5/4) mottles; weak, medium, blocky structure; extremely hard, very firm; few fine roots; few weakly cemented calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.

- C—65 to 75 inches, distinctly mottled olive-gray (5Y 5/2) light olive-brown (2.5Y 5/4), and yellowish-brown (10YR 5/6) shaly clay; extremely hard, extremely firm; contains approximately 10 percent calcium carbonate in the form of soft masses and concretions; calcareous; moderately alkaline.

Within a distance of about 5 to 15 feet, the thickness of the A horizon ranges from about 12 to 20 inches over the microknoll to about 24 to 60 inches over the microdepression. Elevation differences between microhighs and microlows is about 3 to 12 inches in undisturbed areas.

The A horizon is 6 to 60 inches thick. It is gray, very dark gray, or dark gray. Reaction is slightly acid to moderately alkaline.

The AC horizon is 10 to 30 inches thick. It is gray, grayish brown, dark gray, or light brownish gray and has mottles in shades of gray, yellow, brown, and olive in places.

The C horizon is olive gray or light brownish gray and has mottles in shades of olive, gray, brown, and yellow. Depth to the C horizon is 36 to 66 inches.

Reaction of the AC and C horizons is mildly alkaline to moderately alkaline. Concretions and soft masses of calcium carbonate in the AC and C horizons range from less than 1 to about 5 percent by volume.

Intersecting slickensides are common between depths of 20 and 40 inches.

BuA—Burlson clay, 0 to 1 percent slopes. This nearly level soil is on upland areas and old alluvial terraces and has a plane to slightly convex surface. Soil areas are oval in shape and vary from 10 to 120 acres in size.

The surface layer is very dark gray, slightly acid clay 21 inches thick. The next 22 inches is dark-gray, neutral clay. The next lower layer is gray, neutral clay 22 inches thick. The underlying material to a depth of 86 inches is light brownish-gray, calcareous clay with light yellowish-brown mottles.

Included with this soil in mapping are small areas of Houston Black, Mabank, and Wilson soils. Inclusions make up less than 15 percent of any one mapped area.

Runoff is slow. These soils are difficult to work, and a crust forms on the surface after rains. The hazard of erosion is slight.

Most of the acreage of this soil is used for crops. The rest is used for pasture and hay. Capability unit IIw-2; pasture and hayland group 7A; Blackland range site.

BuB—Burlson clay, 1 to 3 percent slopes. This gently sloping soil is on broad watershed divides and side slopes above drainageways. Soil areas are mainly oval in shape and vary from 10 to 300 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Heiden, Houston Black, and Wilson soils. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium. The hazard of erosion is moderate.

Most of the acreage of this soil is used for crops. It is suited to most locally grown crops. A few areas are used for pasture, hay, or range. Capability unit IIe-1; pasture and hayland group 7A; Blackland range site.

Crockett Series

The Crockett series consists of deep, noncalcareous, loamy soils on uplands. These gently sloping soils formed in alkaline marine clay and shale interbedded with sandier materials under a cover of tall prairie grasses.

In a representative profile the surface layer is brown, medium acid fine sandy loam about 8 inches thick. The subsoil is clay about 49 inches thick. In sequence from the top, the upper 8 inches is mottled reddish brown, brown, and dark red, and is medium acid; the next 14 inches is olive mottled in shades of gray, brown, red, and yellow and is slightly acid; the next 12 inches is pale olive mottled in shades of yellow, brown, and gray, and is neutral; and the lower 15 inches is mottled light brownish gray and pale olive, and is mildly alkaline. The underlying material to a depth of 73 inches is pale-yellow, moderately alkaline loam with mottles in shades of yellow and brown.

Crockett soils are moderately well drained. They have very slow permeability and high available water capacity. Runoff is medium.

Most of these soils are used for improved pasture. A few areas are used for crops. This soil is well suited to improved pasture or range.

Representative profile of Crockett fine sandy loam, 1 to 3 percent slopes, in a pasture; 250 feet east of Farm Road 986, 1.9 miles north of its intersection within Terrell, Texas:

Ap—0 to 8 inches, brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; very hard, friable; few wormcasts; medium acid; abrupt, wavy boundary.

B21t—8 to 16 inches, distinctly and coarsely mottled reddish-brown (5YR 4/4) and brown (10YR 4/3) clay, few fine and medium, prominent, dark-red (10R 3/6) mottles; moderate, fine and medium, blocky structure; extremely hard, very firm; few fine pores; distinct clay films and dark grayish-brown stains on ped; vertical cracks partially filled with darker soil; few fine black concretions; medium acid; diffuse, wavy boundary.

B22t—16 to 30 inches, olive (5Y 5/4) clay, olive (5Y 4/4) moist; common medium and coarse, distinct reddish-brown (5YR 5/4), yellow (10YR 7/6), and grayish-brown (10YR 5/2) mottles; moderate, medium, and coarse blocky structure; extremely hard, very firm; few fine pores; thin clay films on ped; few small pressure faces; vertical streaks of dark-brown soil that is less clayey; few fine black concretions; slightly acid; gradual, wavy boundary.

B23t—30 to 42 inches, pale-olive (5Y 6/4) clay, olive (5Y 5/4) moist; common medium, distinct, pale-yellow (5Y 7/4) and light brownish-gray (2.5Y 6/2) mottles; weak, coarse, blocky structure; extremely hard, very firm; thin patchy clay films; few black splotches or streaks on ped; few small pressure faces; few fine black concretions; neutral; gradual, wavy boundary.

B3t—42 to 57 inches, distinctly and coarsely mottled light brownish-gray (2.5Y 6/2) and pale-olive (5Y 6/4) clay; weak, coarse, blocky structure; extremely hard, very firm; few thin clay films; few pressure faces and cleavage plans; few black streaks along pressure faces and cleavage plains; few strongly cemented concretions and soft masses of calcium carbonate as much as ½ inch in diameter; few fine black concretions; mildly alkaline; abrupt, smooth boundary.

Cca—57 to 73 inches, pale-yellow (2.5Y 7/4) loam, light yellowish brown (2.5Y 6/4) moist; common medium, distinct, dark yellowish-brown (10YR 4/4) mottles; massive; extremely hard, very firm in places; friable; when broken contains about 25 percent, by volume, shale fragments; contains about 20 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; few fine roots; moderately alkaline.

The solum is 40 to 70 inches thick. The A horizon is 5 to 15 inches thick. It is brown, pale brown, dark brown, or light brown. Reaction is neutral through medium acid.

The B2t horizon is 28 to 53 inches thick. It ranges from clay loam to clay, and clay content is 35 to 50 percent. The dominant color and degree of mottling in the upper part of the B2t horizon are variable within distances of a few feet. Some parts have prominent mottles in shades of gray, yellow, red, brown, and olive; others have a matrix of reddish brown with few to common mottles. The lower part of the B2t horizon is mainly olive and yellowish brown with few to common mottles in shades of olive, gray, brown, and yellow. Reaction of the B2t horizon is medium acid or slightly acid in the upper part and mildly alkaline in the lower part.

The B3 horizon is mainly mottled in shades of gray, brown, yellow, and olive. It ranges from sandy clay loam to clay. Reaction is mildly alkaline to moderately alkaline.

The C horizon ranges from loam to clay and is commonly interbedded with shale. Visible carbonate bodies range from none to many. Reaction is mildly alkaline to moderately alkaline.

CrB—Crockett fine sandy loam, 1 to 3 percent slopes. This gently sloping soil is on broad, slightly convex areas on uplands. Soil areas are irregular to oval in shape and vary from 10 to 425 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are Mabank and Wilson soils in small depressions. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate. Most of the acreage of this soil is used for pasture or range. Most areas were once farmed, and a few small areas are still cultivated.

These soils are better suited to grass than to other crops. Capability unit IIIe-1; pasture and hayland group 8A; Claypan Prairie range site.

CrC2—Crockett fine sandy loam, 2 to 5 percent slopes, eroded. This gently sloping soil is on convex areas on uplands. Slopes are dominantly 2 to 4 percent. In a few places, all of the surface layer has been eroded away. Gullies that may be crossed by farm machinery are common. The soil areas are irregular in shape and range from 10 to 325 acres in size.

The surface layer is pale-brown, slightly acid fine sandy loam about 5 inches thick. The subsoil, to a depth of 55 inches, is clay. The upper 22 inches is mottled brown, red, olive, and gray; below that, it is light olive gray with yellowish-brown and light olive-brown mottles. The underlying material to a depth of 75 inches is pale-yellow sandy clay that contains common yellowish-brown mottles.

Included with this soil in mapping are Mabank and Wilson soils in small depressions. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate.

Most of the acreage of this soil is used for pasture or range. A few areas are still used for crops, and many areas have been established to improve pasture grasses. Capability unit IVe-5; pasture and hayland group 8A; Claypan Prairie range site.

Ellis Series

The Ellis series consists of moderately deep, noncalcareous clayey soils on uplands. These sloping to strongly sloping soils formed in alkaline marine shale under a cover of tall prairie grasses interspersed with trees.

In a representative profile the surface layer is dark grayish-brown, neutral clay about 4 inches thick. The next 18 inches is light yellowish-brown, neutral clay containing a few calcium carbonate concretions. The next 8 inches is light yellowish-brown, mildly alkaline shaly clay. The underlying material to a depth of 60 inches is light brownish-gray, moderately alkaline shale.

Ellis soils are well drained. They have very slow permeability and medium available water capacity.

Most of the acreage of these soils is used for pasture or range.

Representative profile of Ellis clay, 5 to 12 percent slopes, in a pasture; 50 feet west of a county road, 0.8 mile north and 0.7 mile west of U.S. Highway 175, 0.75 mile north of its junction with Texas Highway 98 in Mabank, Texas:

- A1—0 to 4 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate, fine and medium, blocky structure; extremely hard, very firm; many roots; few pores; neutral; gradual, smooth boundary.
- B2—4 to 22 inches, light yellowish-brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; moderate, medium, blocky structure; extremely hard, very firm; few roots; few strongly cemented calcium carbonate concretions; few small pressure faces; neutral; gradual, smooth boundary.
- B3—22 to 30 inches, light yellowish-brown (2.5Y 6/4) shaly clay, light olive brown (2.5Y 5/4) moist; common fine, distinct, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/4) mottles; moderate, medium, blocky structure; extremely hard, very firm; few roots; common shale fragments; mildly alkaline; gradual, smooth boundary.
- C—30 to 60 inches, light brownish-gray (2.5Y 6/2) shale, grayish brown (2.5Y 5/2) moist; massive; extremely hard, extremely firm; few fine roots; calcareous; moderately alkaline.

The solum is 20 to 40 inches thick. The A horizon is 3 to 6 inches thick. It is dark grayish brown to olive. Reaction is slightly acid to moderately alkaline.

The B horizon is 18 to 36 inches thick. It is olive gray to light yellowish brown, and the lower part contains mottles in shades of gray,

yellow, and brown. It is neutral to moderately alkaline and may be calcareous. This horizon contains a few weakly to strongly cemented calcium carbonate concretions.

The C horizon is light brownish-gray to olive shaly clay or shale. Reaction is neutral to moderately alkaline.

EsD—Ellis clay, 5 to 12 percent slopes. This sloping to strongly sloping soil is on escarpments above flood plains. Slopes are commonly 7 to 12 percent and have convex surfaces. Soil areas are elongated and vary from 20 to 150 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small bodies of Crockett and Normangee soils on narrow ridgetops. Inclusions make up less than 10 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

The acreage of this soil is used for pasture or range. The soil is not suited to cultivated crops. Capability unit VIe-2; pasture and hayland group 7B; Eroded Blackland range site.

Ferris Series

The Ferris series consists of deep, calcareous clay on uplands. These gently sloping to strongly sloping soils formed in calcareous marine clay and shale under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is grayish-brown, calcareous clay about 6 inches thick. The next lower layer is about 34 inches of light yellowish-brown, calcareous clay that contains soft masses and calcium carbonate concretions. The underlying material to a depth of 65 inches is light yellowish-brown, mottled shaly clay. It contains soft masses and calcium carbonate concretions.

Ferris soils are well drained. They have very slow permeability and high available water capacity. Runoff is rapid. Large cracks form in the soil during prolonged dry periods (fig. 4).

Most of the acreage of these soils is old abandoned fields, but a few areas have been established to improved pasture grasses.

Representative profile of Ferris clay, 5 to 12 percent slopes, eroded, in a pasture; 150 feet northwest of Farm Road 549, 1.75 miles northeast of its intersection with Farm Road 550, 1 mile north of Heath, Texas:

- Ap—0 to 6 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate, fine and medium, blocky structure; extremely hard, very firm; many roots; few pores; few fine calcium carbonate concretions; calcareous; moderately alkaline; gradual, smooth boundary.
- AC—6 to 40 inches, light yellowish-brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; moderate, medium, blocky structure; extremely hard, very firm; few roots; few soft masses and weakly cemented calcium carbonate concretions; common grooved, intersecting slickensides below a depth of 20 inches; calcareous; moderately alkaline; diffuse, wavy boundary.
- C—40 to 65 inches, distinctly mottled light yellowish-brown (2.5Y 6/4), light-gray (5Y 7/1), and yellowish-brown (10YR 5/8) shaly clay; massive; extremely hard, very firm; few fine roots; few soft masses and calcium carbonate concretions; few grooved, intersecting slickensides; common shale fragments; calcareous; moderately alkaline.

The solum is 30 to 65 inches thick. The clay content is 40 to 60 percent. Cracks extending to a depth of more than 20 inches remain open for 90 to 150 days in most years. Intersecting slickensides are common at depths below 20 inches. Calcium carbonate concretions range from few to common in most profiles.

The A horizon is grayish brown, dark grayish brown, or olive brown and is 3 to 12 inches thick.



Figure 4.—Surface of Ferris clay, 5 to 12 percent slopes, eroded, showing the deep, wide cracks common to these soils.

The AC horizon is light yellowish brown, yellowish brown, or pale olive and contains mottles in shades of gray, brown, olive, or yellow in places.

The C horizon is strongly weathered shaly clay to shale. It is light yellowish brown or yellowish brown and is mottled in shades of gray, yellow, and brown in places.

FeD2—Ferris clay, 5 to 12 percent slopes, eroded. This sloping to strongly sloping soil is on side slopes and narrow ridges. The landscape is a rolling prairie that is well dissected by drainageways. Gullies are common in most areas, and much of the surface layer has been eroded away. These oblong areas are 10 to 300 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Altoga and Heiden soils on foot slopes and Crockett soils on narrow ridgetops. Inclusions make up less than 15 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

All of the acreage of this soil is used for pasture or range. A few areas have been established to improved pasture grasses, and other areas have reseeded naturally. The soil is not suited to cultivated crops; it is better suited to grass. Capability unit VIe-3; pasture and hayland group 7B; Eroded Blackland range site.

FhC—Ferris-Heiden complex, 2 to 5 percent slopes.

The gently sloping soils in this mapping unit are on convex ridges and side slopes above natural drainageways. This unit is about 60 percent Ferris clay, 30 percent Heiden clay, and 10 percent other soils. These soils are so intermingled that they could not be shown separately at the scale mapped. Slopes average about 4 percent. Some areas have broad, shallow gullies that are easily crossed by farm machinery. The surface layer has been removed by sheet erosion in places. The soil areas are irregular in shape and vary from 10 to 200 acres in size.

The Ferris soil in this mapping unit has a surface layer of dark grayish-brown, calcareous clay about 10 inches thick. The next layer, to a depth of 64 inches, is calcareous clay that is light yellowish brown in the upper part and pale olive in the lower part.

The Heiden soil has a surface layer of dark grayish-brown, calcareous clay about 18 inches thick. The next lower layer is yellowish-brown calcareous clay about 30 inches thick. The underlying material to a depth of 75 inches is mottled gray, brown, and yellow, calcareous shaly clay.

Included with this unit in mapping are small areas of Crockett and Normangee soils on narrow ridgetops or at the crest of the slope.

Runoff is rapid, and the hazard of erosion is severe.

About 50 percent of the acreage of this unit is used for cultivated crops. The remaining 50 percent is used for pasture or range. Many areas are being established to improved pasture grasses. These soils are better suited to grass than to other crops. Capability unit IVE-4; pasture and hayland group 7A; Eroded Blackland range site.

Gowen Series

The Gowen series consists of deep, noncalcareous, loamy soils on bottom lands. These nearly level soils formed in loamy alluvial sediments. They are subject to flooding unless protected.

In a representative profile the upper part of the surface layer is dark grayish-brown clay loam about 6 inches thick. The lower part is dark-gray clay loam 19 inches thick. The underlying material to a depth of 60 inches is dark grayish-brown clay loam. Reaction is neutral throughout.

Gowen soils are well drained. They have moderate permeability and high available water capacity.

Most of the acreage of these soils is used for pasture, and a few areas are used for crops.

Representative profile of Gowen clay loam, frequently flooded, in a pasture; 300 feet west of a county road, 1 mile southwest and 1.4 miles southeast of U.S. Highway 175, 2.25 miles southeast of its junction with Texas Highway 34 in Kaufman, Texas:

A11—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, subangular blocky structure; hard, firm; many roots; common wormcasts; neutral; gradual, smooth boundary.

A12—6 to 25 inches, dark-gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; moderate, medium, subangular blocky structure; hard, firm; many roots; few wormcasts; neutral; diffuse, smooth boundary.

C—25 to 60 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; massive; hard, firm; few roots; few bedding planes; neutral.

The A horizon is from 24 to 40 inches thick. It is very dark grayish brown, dark gray, or brown. Reaction is neutral to moderately alkaline.

The C horizon is gray, very dark gray, dark grayish-brown, grayish-brown, or pale-brown clay loam to clay and contains thin strata of loam or sandy clay loam. Reaction is neutral to moderately alkaline.

Gc—Gowen clay loam, occasionally flooded. This nearly level soil is along the outer edges of the larger flood plains. Where it is not protected by a levee system, it is occasionally flooded. The soil areas are oblong to irregular in shape and range from 10 to 195 acres in size. Slopes are 0 to 1 percent.

The surface layer is dark grayish-brown, neutral clay loam about 8 inches thick. The next lower layer is very dark grayish-brown, neutral clay loam 25 inches thick. The underlying material to a depth of 60 inches is grayish-brown, mildly alkaline clay loam.

Included with this soil in mapping are small areas of Kaufman and Kemp soils. A few areas along stream channels are frequently flooded. Inclusions make up less than 15 percent of any one mapped area.

Runoff is slow. Brief flooding is likely in some years, but generally does not occur during the growing season, so crops are not damaged.

About 50 percent of the acreage of this soil is used for crops. The remaining acreage is used for pasture or pecan orchards. The soil is well suited to cultivated crops or grass. Capability unit I-1; pasture and hayland group 2A; Loamy Bottomland range site.

Gf—Gowen clay loam, frequently flooded. This nearly level soil is on flood plains of small local streams and natural levees along major streams. The surface is uneven, and in a few places it is cut by partly filled old stream channels. Water stands in these old channels for short periods after rains. Soil areas are oblong to irregular in shape and vary from 10 to 600 acres in size. Slopes are 0 to 1 percent.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Kaufman and Kemp soils. Inclusions make up less than 10 percent of any one mapped area.

Runoff is slow. This soil is flooded at least once each year. Flooding is of shallow depth, slow velocity, and short duration. Floods usually occur during the spring.

The acreage of this soil is used for pasture or range, and it is well suited to these uses. Frequent flooding makes it unsuited to cultivated crops. Some areas have been established to improved pasture grasses. A few areas are still in native vegetation. Capability unit Vw-2; pasture and hayland group 2A; Loamy Bottomland range site.

Haplustalfs, Loamy

Haplustalfs, loamy, consists of deep, noncalcareous, loamy soils on uplands. They formed in materials weathered from weakly cemented sandstone. They developed under tall prairie grasses interspersed with oak, elm, and hackberry trees.

In a representative profile the surface layer is dark grayish-brown, medium acid loam about 6 inches thick. The subsoil is neutral sandy clay loam about 38 inches thick. In sequence from the top, the upper 12 inches of the subsoil is light olive brown; the next 16 inches is olive yellow; and the lower 10 inches is yellow. The underlying material to a depth of 62 inches is yellow, weakly cemented sandstone.

Haplustalfs, loamy, are well drained. They have moder-

ate permeability and high available water capacity.

Most of the acreage of this soil is used for pasture. A few areas are still in native vegetation.

Representative profile of Haplustalfs, loamy, 5 to 12 percent slopes, in a pasture; 50 feet west of a fence, 0.25 mile south of the junction of U.S. Highway 175 and Texas Highway 243 in Kaufman, Texas:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, subangular blocky structure; slightly hard, very friable; many roots; few wormcasts; medium acid; clear, smooth boundary.

B21t—6 to 18 inches, light olive-brown (2.5Y 5/4) sandy clay loam, olive brown (2.5Y 4/4) moist; moderate, medium, subangular blocky structure; very hard, firm; few roots; clay films on ped; neutral; gradual, smooth boundary.

B22t—18 to 34 inches, olive-yellow (2.5Y 6/6) sandy clay loam, light olive brown (2.5Y 5/6) moist; weak, medium, blocky structure; very hard, firm; few roots; few clay films on ped; neutral; gradual, smooth boundary.

B3t—34 to 44 inches, yellow (2.5Y 7/6) sandy clay loam, olive yellow (2.5Y 6/6) moist; few strong-brown (7.5YR 5/6) and light brownish-gray (10YR 6/2) mottles; weak, coarse, blocky structure; hard, friable; few roots; neutral; gradual, smooth boundary.

C—44 to 62 inches, yellow (2.5Y 7/6) weakly cemented sandstone, olive yellow (2.5Y 6/6) moist; few prominent dark-brown (10YR 3/3) mottles; massive; very hard, firm; calcareous; moderately alkaline.

The solum is 40 to 60 inches thick. The A horizon is 4 to 10 inches thick. It is dark grayish brown or brown. Reaction is medium acid to mildly alkaline.

The B2t horizon is olive-yellow or light olive-brown sandy clay loam or clay loam. In its lower part in places, this horizon has few mottles in shades of red, brown, and yellow and concretions and soft masses of calcium carbonate. Reaction is medium acid to moderately alkaline.

The B3t horizon is yellow, brownish-yellow, or light olive-brown fine sandy loam to clay loam. It contains few to common mottles in shades of gray, yellow, and brown. Reaction is neutral to moderately alkaline.

The underlying material is yellow, reddish-yellow, or light yellowish-brown weakly cemented sandstone. Reaction is mildly alkaline to moderately alkaline.

HaD—Haplustalfs, loamy, 5 to 12 percent slopes. This sloping to strongly sloping soil is on escarpments above the flood plains. Slopes are commonly about 8 percent and have mostly convex surfaces. About 40 percent of the total acreage is eroded. In some areas the surface layer has been eroded away and the subsoil is exposed. These areas are dissected by a few shallow gullies. Soil areas are oblong to elongated in shape and vary from 22 to 180 acres in size.

Included with this soil in mapping are small areas of Axtell soils at the ridgecrests. Inclusions make up less than 10 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

Most of the acreage of this soil is used for pasture or range, and the soil is well suited to improved pasture grasses. A few areas are used for range. The use of these soils for urban development is increasing in the vicinity of Cedar Creek Lake and around the City of Kaufman. Capability unit VIe-4; pasture and hayland group 8D; Sandy Loam range site.

Heiden Series

The Heiden series consists of deep, calcareous, clayey soils on uplands. These soils formed in calcareous marine clays and shales under a cover of tall prairie grasses. Undisturbed areas have a microrelief of valleys and ridges that extend up and down the slopes.

In a representative profile the surface layer is dark grayish-brown, calcareous clay about 27 inches thick. The next

layer is olive, calcareous clay 21 inches thick. It contains very dark grayish-brown and olive-yellow mottles. The underlying material to a depth of 75 inches is mottled, calcareous shaly clay.

Heiden soils are well drained. They have very slow permeability and high available water capacity.

Most of the acreage of these soils is used for crops. A few areas are used for pasture or range.

Representative profile of Heiden clay, 3 to 5 percent slopes, in an old field; 200 feet south of Farm Road 549, 2.05 miles northeast of its junction with Farm Roads 550 and 740; 0.5 mile northeast of Heath, Texas:

- Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, subangular blocky structure; extremely hard, very firm; many roots; few pores; few fine, strongly cemented calcium carbonate concretions; calcareous; moderately alkaline; clear, wavy boundary.
- A1—7 to 27 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, medium, blocky structure; extremely hard, very firm; few roots; few pores; few fine, strongly cemented calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.
- AC—27 to 48 inches, olive (5Y 5/3) clay, olive (5Y 4/3) moist; common fine, distinct, very dark grayish-brown (10YR 3/2) and olive-yellow (2.5Y 6/6) mottles; moderate, medium, blocky structure; extremely hard, very firm; few roots; common medium, weakly cemented concretions and soft masses of calcium carbonate; few vertical cracks filled with material from above; common grooved, intersecting slickensides; calcareous; moderately alkaline; gradual, wavy boundary.
- C—48 to 75 inches, distinctly mottled light yellowish-brown (2.5Y 6/4), olive-yellow (2.5Y 6/8), and light-gray (10YR 7/1) shaly clay; massive; extremely hard, very firm; few slickensides in upper part; few soft masses and weakly cemented concretions of calcium carbonate; calcareous; moderately alkaline.

The soil is dry and cracked to depths greater than 20 inches for as long as 90 to 125 days in most years. The clay content is 40 to 60 percent. Grooved, intersecting slickensides are common below a depth of 20 inches.

Within a horizontal distance of 6 to 16 feet, the thickness of the A horizon ranges from 8 inches over the microknoll to 32 inches over the microdepression. The A horizon is dark grayish brown, dark olive brown, olive gray, dark gray, or grayish brown.

The AC horizon is yellowish brown, olive gray, or olive and contains mottles in shades of olive gray, brown, and yellow.

The C horizon is mainly mottled in shades of olive, gray, yellow, and brown. Depth to the C horizon is about 40 to 65 inches.

This soil contains few to common concretions and soft masses of calcium carbonate.

HeC—Heiden clay, 3 to 5 percent slopes. This gently sloping soil is on upland areas that slope to natural drainageways. Soil areas are oblong in shape and vary from 10 to 350 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Ferris soils on ridgetops and Houston Black soils on foot slopes. Inclusions make up less than 15 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is moderate.

Most of the acreage of this soil is used for crops. Some areas have been established to improved pasture grasses. A few old fields have reseeded naturally to native vegetation and are used for range. The soil is well suited to pasture or range. Capability unit IIIe-2; pasture and hayland group 7A; Blackland range site.

HeD—Heiden clay, 5 to 8 percent slopes. This sloping soil is on upland areas that slope to natural drainageways. Soil areas are oblong to irregular in shape and vary from 10 to 85 acres in size.

This soil is similar to the one described as representative of the series, but it has a thinner surface layer. The surface layer is dark grayish-brown, calcareous clay about 16 inches thick. The next lower layer is yellowish-brown, calcareous clay 28 inches thick. The underlying material to a depth of 60 inches is mottled gray, brown, and yellow shaly clay.

Included with this soil in mapping are small areas of Altoga soils on the lower slopes, Crockett soils on narrow ridgetops, and Ferris soils near the crest of the slope. Inclusions make up less than 15 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

Most of the acreage of this soil is used for range or pasture. This soil is well suited to grass. A few areas are used for crops. Capability unit IVe-2; pasture and hayland group 7B; Blackland range site.

Houston Black Series

The Houston Black series consists of deep, calcareous clayey soils on uplands. These nearly level to gently sloping soils formed in calcareous marine clay and shale under a cover of tall prairie grasses. Undisturbed areas have gilgai microrelief.

In a representative profile (fig. 5) the surface layer is very dark gray, calcareous clay about 14 inches thick. The next 46 inches is dark-gray calcareous clay. The next lower 12 inches is dark-gray calcareous clay containing yellowish-brown mottles. The underlying material to a depth of 84 inches is mottled light brownish-gray, gray, and yellowish-brown shaly clay.

Houston Black soils are moderately well drained. Water intake is rapid when the soil is dry and cracked, but the soils have very slow permeability when wet. Available water capacity is high.

Most of the acreage of these soils is used for crops. A few areas are used for pasture.

Representative profile of Houston Black clay, 1 to 3 percent slopes, in the center of a microdepression; 100 feet north of Farm Road 550, 0.8 mile northeast of its junction with Texas Highway 205; 6 miles southeast of Rockwall, Texas:

- A11—0 to 14 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, fine, blocky structure; very hard, very firm; many roots; few strongly cemented calcium carbonate concretions; calcareous; moderately alkaline; gradual, wavy boundary.
- A12—14 to 40 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, medium, blocky structure; extremely hard, very firm; few roots; few strongly cemented calcium carbonate concretions; few grooved, intersecting slickensides; calcareous; moderately alkaline; gradual, wavy boundary.
- A13—40 to 60 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, medium, blocky structure; extremely hard, very firm; few roots; few strongly and weakly cemented concretions and soft masses of calcium carbonate; few grooved intersecting slickensides; calcareous; moderately alkaline; gradual, wavy boundary.
- AC—60 to 72 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; common medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, coarse, blocky structure; extremely hard, very firm; few fine roots; common strongly and weakly cemented concretions and soft masses of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.
- C—72 to 84 inches, distinctly mottled light brownish-gray (2.5Y 6/2), gray (10YR 6/1), and yellowish-brown (10YR 5/6) shaly clay; massive; extremely hard, extremely firm; few soft masses of calcium carbonate; calcareous; moderately alkaline.

The soil is dry and cracked to depths greater than 20 inches for as long as 90 to 125 days in most years. The clay content is 40 to 60

percent. Grooved, intersecting slickensides are common below a depth of 20 inches. In undisturbed areas, gilgai microrelief is evident. The microknolls are 4 to 12 inches higher than the microdepressions. Distance between the microknolls is 10 to 20 feet.

The thickness of the A horizon ranges from 26 inches over the microknolls to 60 inches over the microdepressions. It is black, gray, dark gray, or very dark gray.

The AC horizon is dark grayish brown, dark gray, olive, yellow, or pale olive and has mottles in shades of brown or yellow.

The C horizon is light brownish-gray or very pale brown clay or shaly clay and has mottles in shades of gray, brown, olive, or yellow. The depth to the C horizon is 60 to about 90 inches.

HoA—Houston Black clay, 0 to 1 percent slopes. This nearly level soil is on broad ridgetops. Slopes are about 1 percent, and the surface is plane to slightly convex. Soil areas are oblong in shape and vary from 10 to 75 acres in size.

The surface layer is dark-gray, calcareous clay about 20 inches thick. The next lower layer is gray, calcareous clay about 26 inches thick. The next 11 inches is dark-gray, calcareous clay and has olive-yellow mottles. The next layer to a depth of 70 inches is mottled gray, brown, and yellow, calcareous clay.

Included with this soil in mapping are Wilson soils in small depressions. Inclusions make up less than 10 percent of any one mapped area.

Runoff is slow, and the hazard of erosion is slight.

Most of the acreage of this soil is used for crops, mostly cotton and grain sorghum. This soil is well suited to all locally grown crops. A few areas are improved permanent pasture. Capability unit IIw-2; pasture and hayland group 7A; Blackland range site.

HoB—Houston Black clay, 1 to 3 percent slopes. This gently sloping soil is on broad watershed divides. Slopes

are dominantly about 2 percent and have a slightly convex surface. Soil areas are oval to irregular in shape and vary from 25 to 1,700 acres in size but average about 300 acres.

This soil has the profile described as representative of the series.

Included with this soil in mapping are Ferris and Heiden soils on small ridgetops. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate.

Most of the acreage of this soil is used for farming. Cotton (fig. 6) and grain sorghum are the principal crops grown. This soil is well suited to all locally grown crops. A few areas are improved pasture. Capability unit IIe-1; pasture and hayland group 7A; Blackland range site.

HoC—Houston Black clay, 3 to 5 percent slopes. This gently sloping soil is on upland areas that slope to natural drainageways. Slopes are about 4 percent. Soil areas are oblong to elongated and vary in size from 5 to 35 acres.

The surface layer is very dark gray, calcareous clay about 42 inches thick. The next lower layer is dark grayish-brown, calcareous clay about 8 inches thick and contains yellowish-brown mottles. The underlying material to a depth of 60 inches is mottled gray, brown, and yellow, calcareous shaly clay.

Included with this soil in mapping are spots of Ferris and Heiden soils. Inclusions make up less than 10 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

Most of the acreage of this soil is used for range or pasture. It is well suited to grass. A few areas are used for crops. Capability unit IIIe-2; pasture and hayland group 7A; Blackland range site.

Kaufman Series

The Kaufman series consists of deep, noncalcareous clayey alluvial soils on bottom lands. These nearly level soils formed in clayey alluvial material interbedded with marl and chalk. They developed under a cover of elm, hackberry, oak, and locust with tall and mid grasses in open areas.

In a representative profile the surface layer is black, mildly alkaline clay about 18 inches thick. The next lower layer is very dark gray, neutral clay about 32 inches thick. The next lower layer extending to a depth of 75 inches is dark-gray, moderately alkaline clay.

Kaufman soils are somewhat poorly drained. They have very slow permeability and high available water capacity. Runoff is slow.

Most of these soils are used for pasture or range.

Representative profile of Kaufman clay, frequently flooded, in a pasture; 200 feet west of Farm Road 1388, 4.3 miles south of its intersection with Texas Highway 34 in Kaufman, Texas:

A11—0 to 18 inches, black (2.5Y N2/0) clay, black (2.5Y N2/0) moist; moderate, fine and medium, subangular blocky structure; extremely hard, very firm; many fine roots; few pores; common vertical cracks; mildly alkaline; diffuse, smooth boundary.

A12—18 to 50 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, coarse, subangular blocky structure; extremely hard, very firm; common fine roots; many grooved, intersecting slickensides; common vertical cracks; neutral; diffuse, wavy boundary.

A13—50 to 75 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, coarse, blocky structure; extremely hard, very firm; few fine roots; common grooved, intersecting slickensides; few vertical cracks; moderately alkaline.



Figure 5.—Road cut in a Houston Black clay showing the wavy boundary between the upper layers and the lower boundary.



Figure 6.—Cotton ready for harvest on Houston Black clay, 1 to 3 percent slopes.

The solum is 50 to 100 inches thick. Clay content is 60 to 80 percent. Grooved, intersecting slickensides are common below a depth of 20 inches. The A horizon is 40 to 78 inches thick. It is very dark gray, black, or dark gray. The C horizon, where present, is gray to grayish brown and has mottles of brown and olive.

Reaction is slightly acid to moderately alkaline.

Ka—Kaufman clay, occasionally flooded. This nearly level soil is on flood plains that are protected from flooding by levees. Runoff from bordering uplands occasionally floods some areas, but flooding is of shallow depth, slow velocity, and short duration. Soil areas vary from 20 to 1,200 acres in size. Slopes are 0 to 1 percent.

The surface layer is very dark gray, mildly alkaline clay about 30 inches thick. The next lower layer is dark-gray, moderately alkaline clay about 18 inches thick. The underlying material to a depth of 72 inches is gray, calcareous clay.

Included with this soil in mapping are small areas of Gowen and Kemp soils along foot slopes of adjoining uplands. Inclusions make up less than 10 percent of any one mapped area.

Most of the acreage of this soil has been cleared of timber and cultivated, but about 50 percent is now used for pasture. It is suited to most locally grown crops. Capability unit IIw-1; pasture and hayland group 1A; Clayey Bottomland range site.

Kb—Kaufman clay, frequently flooded. This nearly level soil is on flood plains that are not protected from flooding. The surface is uneven, and water stands in low places for long periods following floods. Soil areas vary from 20 to several thousand acres in size. Slopes are 0 to 1 percent.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Gowen and Kemp soils in deltas near the mouths of small streams and also along foot slopes of adjoining uplands. Inclusions make up less than 10 percent of any one mapped area.

Most of the acreage of this soil is used for pasture. A few large areas remain uncleared and are used for range. Frequent flooding makes this soil unsuited to cultivated crops. It is better suited to grass. Capability unit Vw-1; pasture and hayland group 1A; Clayey Bottomland range site.

Kemp Series

The Kemp series consists of deep, noncalcareous loamy soils on bottom lands. These nearly level soils formed in recent loamy alluvium. They developed under a native vegetation of hardwoods with mid and short grasses in open areas.

In a representative profile the surface layer is brown, medium acid loam 18 inches thick. The next layer, to a depth of 37 inches, is grayish-brown, slightly acid fine sandy loam. The next 15 inches is dark-gray, neutral sandy clay loam. The lower 13 inches is mottled strong-brown, light brownish-gray, and yellowish-brown, medium acid sandy clay loam.

Kemp soils are moderately well drained. They have moderate permeability and high available water capacity. Flooding is occasional to frequent, and runoff is slow. In some areas a perched water table is above a depth of 40 inches following periods of heavy rains in winter and in spring.

Most of these soils are used for pasture or range. A few areas are used for crops.

Representative profile of Kemp loam, frequently flooded, in a pasture; 200 feet west of unpaved service road on U.S. Highway 175; 0.65 mile northwest of its junction with Farm Road 1388 in Kaufman, Texas:

- A—0 to 18 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; hard, friable; many roots; common pores and wormcasts; medium acid; gradual, smooth boundary.
- C—18 to 32 inches, grayish-brown (10YR 5/2) fine sandy loam, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; hard, friable; many roots; common pores and wormcasts; few bedding planes and strata of fine sandy loam; slightly acid; gradual, smooth boundary.
- Ab—32 to 37 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; few fine, faint and distinct mottles of very dark gray (10YR 3/1), light brownish gray (10YR 6/2), and olive brown (2.5Y 4/4); weak, medium, subangular blocky structure; hard, friable; few roots; few pores and wormcasts; slightly acid; clear, smooth boundary.
- B2tb—37 to 52 inches, dark-gray (10YR 4/1) sandy clay loam, very dark gray (10YR 3/1) moist; few to common fine, distinct mottles of dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4); weak, medium, blocky structure; extremely hard, very firm; few roots; clay films on some peds; neutral; gradual, smooth boundary.
- B3b—52 to 65 inches, distinctly mottled strong-brown (7.5YR 5/6), light brownish-gray (10YR 6/2), and yellowish-brown (10YR 5/4) sandy clay loam; weak, coarse, blocky structure; very hard, very firm; few roots; few patchy clay films; medium acid.

The thickness of recent sediments over the buried soil ranges from 20 to 40 inches. Reaction of the recent alluvium is medium acid to neutral.

The A horizon is brown, dark grayish brown, or pale brown.

The C horizon is light-gray, brown, grayish-brown, or light yellowish-brown fine sandy loam to sandy clay loam. Mottles in shades of gray, brown, and yellow range from none to common. Bedding planes and strata of loamy textures are common.

The Ab horizon is not recognizable in all places. Where present, it is grayish-brown, dark grayish-brown, or brown fine sandy loam to sandy clay loam and has common mottles in shades of gray, olive, brown, and yellow. Reaction is slightly acid to mildly alkaline.

The Bb horizon is dark-gray, strong-brown, very dark gray, or pale-brown sandy clay loam to sandy clay and has few to many mottles in various shades of gray, brown, and yellow. Reaction is strongly acid to neutral.

Ke—Kemp loam, occasionally flooded. This nearly level soil is on flood plains that are protected from flooding. Soil areas are oblong to elongated bands along the foot slopes of adjoining uplands. They vary from 5 to 25 acres in size. Slopes are 0 to 1 percent.

The surface layer is brown, medium acid loam 36 inches thick. The next lower layer to a depth of 65 inches is grayish-brown, slightly acid sandy clay loam that has brown mottles.

Included with this soil in mapping are small bodies of Gowen soils. Inclusions make up less than 10 percent of any one mapped area.

Most of the acreage of this soil is used for pasture. Some areas have been established to improved pasture grasses. A few areas are used for crops. Cotton, grain sorghum, and small grains are grown. This soil is suited to crops or pasture. Capability unit IIw-3; pasture and hayland group 2A; Loamy Bottomland range site.

Kf—Kemp loam, frequently flooded. This nearly level soil is on flood plains of small local streams. It is subject to frequent and damaging overflow. Soil areas are continuous along some streams and vary from 5 to 200 acres in size. Slopes are 0 to 1 percent.

This soil has the profile described as representative of the series.

Included with this soil in mapping are spots of Gowen soils. Inclusions make up less than 15 percent of any one mapped area.

Most of the acreage of this soil is used for pasture. It is well suited to improved pasture or range. Capability unit Vw-2; pasture and hayland group 2A; Loamy Bottomland range site.

Konawa Series

The Konawa series consists of deep, noncalcareous sandy soils on stream terraces. These gently sloping to sloping soils formed in sandy and loamy sediments. The native vegetation consisted of oak, elm, pecan, and hickory with tall and mid grasses in open areas.

In a representative profile the surface layer is light yellowish-brown, slightly acid loamy fine sand about 11 inches thick. The subsoil is strongly acid sandy clay loam about 39 inches thick; it is red in the upper part, light red in the middle part, and reddish yellow in the lower part. The underlying material to a depth of 65 inches is reddish-yellow, medium acid fine sandy loam.

Konawa soils are well drained. They have moderate permeability and medium available water capacity.

Most of the acreage of these soils is used for pasture. A few areas are used for crops.

Representative profile of Konawa loamy fine sand, 3 to 8 percent slopes; 60 feet west of Farm Road 148, 0.45 mile south of its junction with Farm Road 3094; 3 miles south of Grays Prairie, Texas:

- A1—0 to 11 inches, light yellowish-brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) moist; weak, medium, subangular blocky structure; slightly hard, very friable; many roots; few pores; few quartz pebbles; slightly acid; clear, smooth boundary.
- B21t—11 to 25 inches, red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate, medium, subangular blocky structure; very hard, friable; common roots; few pores; clay films on faces of peds; strongly acid; gradual, smooth boundary.
- B22t—25 to 42 inches, light-red (2.5YR 6/8) sandy clay loam, red (2.5YR 5/8) moist; weak, medium, blocky structure; very hard, friable; few roots; few clay films on peds; strongly acid; gradual, smooth boundary.
- B3t—42 to 50 inches, reddish-yellow (5YR 6/8) sandy clay loam, yellowish red (5YR 5/8) moist; weak, coarse, blocky structure; hard, friable; few fine roots; strongly acid; gradual, smooth boundary.
- C—50 to 65 inches, reddish-yellow (7.5YR 6/8) fine sandy loam, strong brown (7.5YR 5/8) moist; massive; slightly hard, very friable; medium acid.

The solum is 48 to 72 inches thick. The A1 horizon is light yellowish brown, light brown, light brownish gray, or very pale brown. Where present, the A2 horizon is pink to light yellowish brown and is 8 to 18 inches thick. Reaction is medium acid to slightly acid.

The B2t horizon is red, light-red, or reddish-yellow sandy clay loam to clay loam 15 to 35 inches thick. Reaction is strongly acid to slightly acid.

The B3t horizon is light-red or reddish-yellow fine sandy loam or sandy clay loam 8 to 24 inches thick. Reaction is strongly acid to medium acid.

The C horizon is reddish-yellow or yellow fine sandy loam or loamy fine sand mottled in shades of gray, red, and yellow. Reaction is strongly acid to neutral.

KoB—Konawa loamy fine sand, 1 to 3 percent slopes.

This gently sloping soil is on ridgetops and side slopes. Soil areas are irregular to oblong in shape and vary from 5 to 100 acres in size.

The surface layer is light-brown, slightly acid loamy fine sand 16 inches thick. The subsoil is red, strongly acid sandy clay loam about 35 inches thick. The underlying material to a depth of 84 inches is reddish-yellow, strongly acid sandy clay loam.

Included with this soil in mapping are Styx soils in small areas along foot slopes. Inclusions make up less than 10 percent of any one mapped area.

Runoff is slow, and the hazard of erosion is moderate.

Most of the acreage of this soil is now used for pasture, although most areas were once cleared and farmed. A small acreage is used for crops. Some fields have been established to improved pasture grasses, to which the soil is well suited. Urban development on this soil is increasing. Capability unit IIIe-3; pasture and hayland group 9A; Sandy Loam range site.

KoC—Konawa loamy fine sand, 3 to 8 percent slopes.

This gently sloping to sloping soil is on side slopes of drainage ways and escarpments next to bottom lands. Slopes are mostly about 6 percent. About 40 percent of the soil of this unit is eroded. In places the surface layer has been removed and the subsoil is exposed. Shallow gullies are common in these areas. Soil areas are oblong to elongated in shape and vary from 10 to 85 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are spots of Axtell soils near ridgetops and Styx soils on foot slopes. Inclusions make up less than 10 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is severe.

Most of the acreage of this soil is used for pasture. Some areas have been established to improved pasture grasses. A few areas are still in native timber. This soil is better suited to grass than to other crops. Urban development on this soil is increasing. Capability unit IVe-6; pasture and hayland group 9A; Sandy Loam range site.

Lewisville Series

The Lewisville series consists of deep, calcareous clayey soils on old stream terraces. These gently sloping to sloping soils formed in old calcareous alluvium of ancient stream terraces under a native cover of tall prairie grasses.

In a representative profile the surface layer is very dark grayish-brown, calcareous, silty clay about 15 inches thick. The next 12 inches is light brownish-gray, calcareous silty clay. The next layer is pale-yellow, calcareous silty clay about 23 inches thick. The underlying material to a depth of 80 inches is pale-yellow, calcareous silty clay loam.

Lewisville soils are well drained. They have moderate permeability and high available water capacity.

About half the acreage of these soils is used for crops. The remainder is used for pasture or range.

Representative profile of Lewisville silty clay, 1 to 3 percent slopes, in an old field; 125 feet west of a paved county

road and 3 miles northwest of Farm Road 740; 0.25 mile northwest of its junction with Farm Road 460; 2.5 miles northwest of Forney, Texas:

Ap—0 to 5 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; strong, fine, granular to subangular blocky structure; hard, friable; many roots; common pores; few fine, strongly cemented calcium carbonate concretions; calcareous; moderately alkaline; clear, smooth boundary.

A1—5 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky structure; hard, friable; few roots; common pores; few strongly cemented calcium carbonate concretions; calcareous; moderately alkaline; gradual, smooth boundary.

B21—15 to 27 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; moderate, fine, subangular blocky structure; hard, friable; few roots; common pores; few weakly cemented calcium carbonate concretions; calcareous; moderately alkaline; gradual, smooth boundary.

B22ca—27 to 38 inches, pale-yellow (2.5Y 7/4) silty clay, light yellowish brown (2.5Y 6/4) moist; moderate, fine, subangular blocky structure; hard, friable; few roots; common soft masses and weakly cemented concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—38 to 50 inches, pale-yellow (2.5Y 7/4) silty clay, light yellowish brown (2.5Y 6/4) moist; common medium, distinct, yellowish-brown (10YR 5/4) mottles; moderate, medium, subangular blocky structure; hard, friable; few roots; common soft masses and weakly cemented concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—50 to 80 inches, pale-yellow (2.5Y 7/4) silty clay loam, light yellowish brown (2.5Y 6/4) moist; common medium, distinct, yellowish-brown (10YR 5/4) and light-gray (10YR 7/2) mottles; massive; hard, friable; few weakly cemented calcium carbonate concretions; calcareous; moderately alkaline.

The A horizon is 8 to 18 inches thick. It is very dark grayish brown, dark grayish brown, or brown.

The B horizons are light yellowish-brown, light brownish-gray, or pale-yellow clay loam to silty clay 25 to 48 inches thick. In the lower part of some profiles, mottles in shades of brown and gray are present. In the Bca horizon, soft masses and concretions of calcium carbonate make up about 2 to 15 percent of the soil material. The calcium carbonate equivalent ranges from 25 to about 40 percent.

Depth to the C horizon is 36 to about 70 inches. It is yellow or pale yellow and contains mottles of yellowish brown and light gray. Concretions and soft masses of calcium carbonate range from few to common.

LeB—Lewisville silty clay, 1 to 3 percent slopes. This gently sloping soil is on stream terraces. Soil areas are oblong in shape and vary from 10 to 125 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are Altoga soils in narrow bands near the slope crest. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate when the soil is cultivated.

Most of the acreage of this soil is used for crops; the remainder is used mainly for pasture. This soil is well suited to all locally grown crops. A few old fields have been established to improved pasture grasses. Capability unit IIe-2; pasture and hayland group 7C; Clay Loam range site.

LeC—Lewisville silty clay, 3 to 8 percent slopes. This gently sloping to sloping soil is on foot slopes along stream terraces. Slopes are commonly 4 to 6 percent and have a convex surface. Soil areas are oblong to elongated bands that vary from 10 to 75 acres in size.

This soil is slightly thinner than the one described as representative of the series. The surface layer is dark grayish-brown, calcareous silty clay 14 inches thick. The next lower layer is light yellowish-brown, calcareous silty clay 24 inches thick. The underlying material to a depth of 60 inches is pale-yellow, calcareous silty clay loam.

Included with this soil in mapping are small areas of Altoga and Heiden soils on the upper slopes. Inclusions make up less than 15 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

Most of the acreage of this soil is used for pasture. It is well suited to improved pasture or range. A few areas are still used for crops. Capability unit IVE-3; pasture and hayland group 7D; Clay Loam range site.

Lufkin Series

The Lufkin series consists of deep, noncalcareous loamy soils on uplands. These nearly level to gently sloping soils formed in acid to alkaline sediments under post oak savannah vegetation.

In a representative profile the surface layer is light brownish-gray, strongly acid fine sandy loam about 3 inches thick. The subsurface layer is light-gray, strongly acid fine sandy loam about 5 inches thick. The subsoil is very firm clay about 48 inches thick. It is grayish brown in the upper part and light brownish gray in the lower part. The upper 10 inches of the underlying material is light-gray clay. To a depth of 80 inches is light-gray sandy clay loam. Reaction is strongly acid in the upper part of the subsoil and medium acid in the lower part of the subsoil and in the underlying material.

Lufkin soils are somewhat poorly drained. They have very slow permeability and high available water capacity. A perched water table is at a depth of less than 12 inches after heavy rains in winter and spring.

Most of the acreage of these soils is used for pasture, and a few areas are used for crops.

Representative profile of Lufkin fine sandy loam in an area of Lufkin-Rader complex, in a wooded pasture; 100 feet south of an unpaved county road, 1.75 miles west of Farm Road 90, 1.85 miles north of its junction with Farm Road 1391, 7 miles east of Kemp, Texas:

- A1—0 to 3 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; very hard, friable; common roots; few pores; strongly acid; clear, smooth boundary.
- A2—3 to 8 inches, light-gray (10YR 7/1) fine sandy loam, gray (10YR 5/1) moist; massive; very hard, friable; few roots; few pores; strongly acid; abrupt, wavy boundary.
- B21tg—8 to 26 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; moderate, coarse, prismatic structure that parts to moderate, medium and coarse, blocky; extremely hard, very firm; few roots; few vertical cracks; distinct clay films on ped; strongly acid; gradual, smooth boundary.
- B22tg—26 to 44 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; weak, medium and coarse, blocky structure; extremely hard, very firm; few roots; few fine, black concretions; few vertical cracks; distinct clay films on ped; few small slickensides that do not intersect; medium acid; gradual, smooth boundary.
- B3tg—44 to 56 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; common medium, distinct, yellowish-brown (10YR 5/4) and light-gray (10YR 7/2) mottles; weak, coarse, blocky structure; extremely hard, very firm; few fine roots; few clay films on ped; few fine, black concretions; medium acid; gradual, smooth boundary.
- C1g—56 to 66 inches, light-gray (2.5Y 7/2) clay, light brownish gray (2.5Y 6/2) moist; few medium, distinct, yellowish-brown (10YR 5/4) mottles; massive; extremely hard, very firm; common fine, black concretions; few weakly cemented calcium carbonate concretions; medium acid; gradual, smooth boundary.
- C2g—66 to 80 inches, light-gray (2.5Y 7/2) sandy clay loam, light brownish gray (2.5Y 6/2) moist; common medium, distinct, strong-brown (7.5YR 5/6) mottles; massive; very hard, firm; few fine, black concretions; medium acid.

The solum is 40 to 60 inches thick. The A horizon is fine sandy loam or loam 6 to 12 inches thick. The A1 horizon is gray, light brownish gray, or brown, and the A2 horizon is light gray, grayish brown, or white. Reaction is slightly acid to strongly acid.

The Btg horizon is 30 to about 48 inches thick. It is grayish-brown, dark-gray, gray, or light brownish-gray clay loam or clay and has a clay content of 35 to 50 percent. Reaction is strongly acid to slightly acid in the upper part and strongly acid to mildly alkaline in the lower part.

The Cg horizon is grayish-brown or light-gray sandy clay loam to clay. Reaction is strongly acid to mildly alkaline.

Lu—Lufkin-Rader complex. The nearly level to gently sloping soils in this mapping unit are on broad upland areas that have mounded surfaces. This unit is about 55 percent Lufkin fine sandy loam on nearly level or slightly depressional areas; 35 percent Rader fine sandy loam on circular mounds 15 to 30 inches high and 30 to 125 feet in diameter; and 10 percent minor soils. These soils are so intermingled that they could not be shown separately at the scale mapped. Slope averages less than 1 percent but is as much as 2 percent in places. Areas are oval to irregular in shape and range from 15 to 1,000 acres in size but are commonly about 200 acres.

Runoff is slow, and the Lufkin soils are ponded at times during wet seasons.

This mapping unit is used mainly for pasture. Many old fields have been established to improved pasture grasses while some areas have been abandoned to reseed naturally. About 40 percent is still in native timber. A few small areas are used for crops. Capability unit IIIw-1; pasture and hayland group 8E; Claypan Savannah range site.

Mabank Series

Mabank series consists of deep, noncalcareous loamy soils on uplands. These nearly level to gently sloping soils formed in alkaline marine clays and shales under a cover of prairie grasses with scattered elm, hackberry, and bois d'arc trees.

In a representative profile the surface layer is grayish-brown slightly acid, fine sandy loam about 7 inches thick. The subsoil to a depth of 50 inches is clay. In sequence from the top, the upper 17 inches is mildly alkaline and very dark gray, the next 8 inches is moderately alkaline and gray, and the lower 18 inches is moderately alkaline and light brownish gray. The underlying material to a depth of 70 inches is moderately alkaline and light-gray clay.

Mabank soils are somewhat poorly drained. They have very slow permeability and high available water capacity. In some depressional areas a perched water table is at a depth of less than 12 inches for short periods during the winter and the spring.

Most of these soils are used for pasture. A few areas are used for crops.

Representative profile of Mabank fine sandy loam, 0 to 1 percent slopes, in a pasture; 250 feet south of a county road; 0.7 mile west of Farm Road 986, 3.5 miles north of its junction with U.S. Highway 80 in Terrell, Texas:

- Ap—0 to 7 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; very hard, friable; many roots; few fine iron concretions; slightly acid; abrupt, wavy boundary.
- B21tg—7 to 24 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, medium, blocky structure; extremely hard, very firm; few fine roots; patchy clay films; few pressure faces; few gypsum crystals; mildly alkaline; gradual, smooth boundary.



Figure 7.—Typical area of Mabank fine sandy loam, 0 to 1 percent slopes. It is on a broad, nearly level plain.

B22tg—24 to 32 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, medium, blocky structure; extremely hard, very firm; few fine roots; common clay films; few iron concretions; common strongly cemented calcium carbonate concretions; common masses of gypsum crystals; moderately alkaline; gradual, smooth boundary.

B23t—32 to 50 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; few fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak, medium, blocky structure; extremely hard, very firm; few fine roots; common clay films; few iron concretions; many strongly cemented calcium carbonate concretions; many gypsum crystals; moderately alkaline; gradual, smooth boundary.

B3—50 to 70 inches, light-gray (10YR 7/2) clay, light brownish gray (10YR 6/2) moist; weak, medium, blocky structure; extremely hard, very firm; few fine roots; common clay films; few iron concretions; many gypsum crystals; moderately alkaline.

The solum is about 60 to 80 inches thick. The A horizon is very dark gray or grayish brown and 5 to 11 inches thick. Reaction is medium acid to neutral.

The Btg horizon is very dark gray, dark-gray, gray, light brownish-gray, or grayish-brown clay loam or clay. Reaction is neutral to moderately alkaline.

The lower part of the B horizon is light brownish-gray, light-gray, or grayish-brown clay or shaly clay and contains few fine gray, brown, yellow, or olive mottles. Reaction is neutral to moderately alkaline.

MaA—Mabank fine sandy loam, 0 to 1 percent slopes.

This nearly level to slightly depressional soil is on broad, flat ridgetops and interstream divides (fig. 7). Slopes are commonly less than 0.5 percent. Soil areas are oval to elongated and vary from 10 to 350 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small circular

mounds of Crockett soils. Inclusions make up less than 15 percent of any one mapped area.

Runoff is slow, and ponding occurs in some areas during wet seasons. The soil surface becomes compacted after hard rains.

Most of the acreage of this soil is used for pasture. Many old fields have been abandoned to reseed naturally. Some areas have been established to improved pasture grasses. A few small areas are still used for crops. This soil is better suited to grass than to other crops. Capability unit IIIw-2; pasture and hayland group 8A; Claypan Prairie range site.

MaB—Mabank fine sandy loam, 1 to 3 percent slopes. This gently sloping soil is on broad, low, slightly convex ridges. Slopes are dominantly less than 2 percent. Soil areas are oval to irregular in shape and vary from 10 to 250 acres in size.

The surface layer is grayish-brown, slightly acid fine sandy loam about 7 inches thick. The subsoil is clay about 53 inches thick. It is very dark gray in the upper 29 inches and dark gray below.

Included with this soil in mapping are small areas of Crockett soils on ridgetops. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate if the soil is left bare and water concentrates on it. The soil surface becomes compacted after hard rains.

Most of the acreage of this soil is used for pasture. Some old fields have been established to improved permanent pasture. A few areas are still used for crops. This soil is better suited to grass than to other crops. Capability unit IIIe-1; pasture and hayland group 8A; Claypan Prairie range site.

Normangee Series

The Normangee series consists of deep, noncalcareous loamy soils on uplands. These gently sloping to sloping soils formed in alkaline marine clay and shale under a cover of tall prairie grasses.

In a representative profile the surface layer is yellowish-brown, medium acid clay loam about 2 inches thick. The subsoil to a depth of 36 inches is yellowish-brown and light yellowish-brown, slightly acid clay. The next lower layer is moderately alkaline clay mottled in shades of yellow, brown, olive, and gray about 21 inches thick. The underlying material to a depth of 80 inches is moderately alkaline, shaly clay mottled in shades of gray, brown, and yellow.

Normangee soils are moderately well drained. They have very slow permeability and high available water capacity. The soil cracks deeply when dry.

These soils are used for pasture or range.

Representative profile of Normangee clay loam, 2 to 8 percent slopes, eroded, in a pasture; 525 feet southwest of a county road; 0.5 mile west of Farm Road 987, 4.2 miles southeast of its junction with Farm Road 2578; 7 miles southwest of Terrell, Texas:

- Ap—0 to 2 inches, yellowish-brown (10YR 5/4) clay loam, brown (10YR 4/3) moist; massive; extremely hard, very firm; common roots; medium acid; abrupt, smooth boundary.
- B21t—2 to 24 inches, yellowish-brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; common fine, distinct, grayish-brown (10YR 5/2) and yellowish-red (5YR 5/6) mottles; moderate, medium, blocky structure; extremely hard, very firm; few roots; few calcium carbonate concretions; few vertical cracks; slightly acid; gradual, smooth boundary.
- B22t—24 to 36 inches, light yellowish-brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; common fine and medium, distinct, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/4) mottles; moderate, medium, blocky structure; extremely hard, very firm; few fine roots; few pressure faces; few calcium carbonate concretions, few vertical cracks; slightly acid; gradual, smooth boundary.
- B3—36 to 57 inches, distinctly mottled yellowish-brown (10YR 5/6), olive-gray (5Y 5/2), and brown (10YR 4/3) clay; weak, medium, blocky structure; extremely hard, very firm; few fine roots; few pressure faces; few calcium carbonate concretions; moderately alkaline; gradual, smooth boundary.
- C—57 to 80 inches, distinctly mottled dark-gray (5Y 4/1), yellowish-brown (10YR 5/6), and brown (10YR 5/3) shaly clay; massive; extremely hard, extremely firm; moderately alkaline.

The solum is 40 to 60 inches thick. The Ap horizon is dark grayish brown or yellowish brown and 2 to 4 inches thick. Reaction is medium acid or slightly acid.

The B2t horizon is clay to light olive-brown clay and contains mottles in shades of gray, red, yellow, or brown. Clay content is 40 to 55 percent. Reaction is medium acid to moderately alkaline.

The B3 horizon is clay or shaly clay mottled in shades of olive, red, gray, brown, or yellow. Reaction is mildly alkaline or moderately alkaline.

The C horizon is shaly clay or shale mottled in shades of red, olive, gray, brown, or yellow. Reaction is neutral to moderately alkaline. Calcium carbonate concretions range from few to common below a depth of 15 inches.

NoC2—Normangee clay loam, 2 to 8 percent slopes, eroded. This gently sloping to sloping soil is on uplands. Slopes are dominantly about 6 percent and are convex. In most places the surface layer has been eroded away and the subsoil is exposed. Shallow gullies are common in about 40 percent of the areas. Soil areas are mostly oblong to elongated in shape and vary from 10 to 100 acres in size.

Included with this soil in mapping are small areas of Crockett soils on the lower slopes and Ellis soils near the slope crests. Inclusions make up less than 15 percent of any one mapped area.

Runoff is rapid, and the hazard of erosion is severe.

All of the acreage of this soil is used for pasture or range. A few areas have been established to improved pasture grasses. Many areas have been abandoned to reseed naturally and have been invaded by mesquite trees. This soil is suited only to pasture or range. Capability unit VIe-2; pasture and hayland group 7I; Claypan Prairie range site.

Rader Series

The Rader series consists of deep, noncalcareous loamy soils on uplands. These nearly level to gently sloping soils formed in slightly acid to mildly alkaline sediments under a post oak savannah type of vegetation.

In a representative profile the surface layer is brown, strongly acid fine sandy loam 6 inches thick. The subsurface layer is 19 inches thick. It is light-gray, strongly acid fine sandy loam in the upper 13 inches and very pale brown, very strongly acid fine sandy loam below. The subsoil is about 52 inches thick. In sequence from the top, the upper 7 inches is separated bodies of light yellowish-brown, very strongly acid, mottled sandy clay loam. These bodies are separated by coatings of light-gray, very strongly acid fine sandy loam. The next 7 inches is strongly acid light brownish-gray sandy clay; the next lower 13 inches is light-gray sandy clay; the next lower 25 inches is neutral, mottled sandy clay loam.

Rader soils are moderately well drained. They have very slow permeability and high available water capacity. In some areas a perched water table is at a depth of 20 to 40 inches following heavy rains during the winter and the spring.

Most of these soils are used for pasture. A few areas are used for crops.

In Kaufman and Rockwall Counties, Rader soils are mapped only in complex with Lufkin soils.

Representative profile of Rader fine sandy loam, in an area of Lufkin-Rader complex, 3.0 miles northeast of Kaufman, Texas to intersection of State Highway 34 and Farm Road 2728, 3.15 miles north on State Highway 34, 2.95 miles southwest on country road, 0.1 mile south on private road and 100 feet west in wooded pasture:

- A1—0 to 6 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; weak, fine and medium, subangular blocky structure; slightly hard, very friable; common roots; few pores; strongly acid; gradual, smooth boundary.
- A21—6 to 19 inches, light-gray (10YR 7/2) fine sandy loam, brown (10YR 5/3) moist; weak, fine and medium, subangular blocky structure; slightly hard, very friable; common roots; few pores; strongly acid; gradual, smooth boundary.
- A22—19 to 25 inches, very pale brown (10YR 7/3) fine sandy loam, yellowish brown (10YR 5/4) moist; weak, medium, blocky structure; slightly hard, very friable; few roots; few pores; very strongly acid; clear, wavy boundary.
- Bt&A2—25 to 32 inches, discrete bodies of light yellowish-brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist, most of these bodies are coated with light-gray (10YR 7/1) fine sandy loam; common fine, faint and distinct mottles of yellowish brown (10YR 5/6), dark red (2.5YR 3/6), and grayish brown (10YR 5/2) in ped interiors; weak, medium, subangular blocky structure; hard, friable; common pockets of friable, structureless, light-gray (10YR 7/1) fine sandy loam; very strongly acid; clear, wavy boundary.
- B21t—32 to 39 inches, light brownish-gray (10YR 6/2) sandy clay, grayish brown (10YR 5/2) moist; moderate, coarse, prismatic structure parting to moderate, coarse, blocky; extremely hard, very firm; few prism faces in upper part are coated with light-gray (10YR 7/1) fine sandy loam; few roots on prism faces; common clay films; very strongly acid; gradual, smooth boundary.

- B22t—39 to 52 inches, light-gray (2.5Y 7/2) sandy clay, light brownish gray (2.5Y 6/2) moist; common fine and medium, distinct, strong-brown (7.5YR 5/6) and olive-yellow (2.5Y 6/6) mottles; moderate, coarse, prismatic structure parting to moderate, coarse, blocky; extremely hard, very firm; few roots on prism faces; common clay films; few pressure faces 1 to 3 inches across; few black concretions; strongly acid; gradual, smooth boundary.
- B23t—52 to 67 inches, distinctly mottled yellowish-brown (10YR 5/8), light-gray (2.5Y 7/2), and strong-brown (7.5YR 5/6) sandy clay loam; coatings of gray (10YR 6/1) and pale olive (5Y 6/3) on ped faces; moderate, coarse, prismatic structure parting to weak, coarse, blocky; extremely hard, very firm; few roots on prism faces; common clay films; common black stains along root channels, few threads and films of neutral salts; neutral; gradual, smooth boundary.
- B3—67 to 77 inches, distinctly mottled light brownish-gray (2.5Y 6/2), olive-yellow (2.5Y 6/6), and yellowish-brown (10YR 5/6) sandy clay loam; coatings of grayish brown (10YR 5/2) on ped faces; moderate, coarse, prismatic structure parting to weak, coarse, blocky; very hard, firm; few roots along prism faces; few black concretions; few threads and films of neutral salts; common black stains along root channels; moderately alkaline.

The solum is 60 to 100 inches thick. The A horizon is fine sandy loam or loam; reaction is very strongly acid to slightly acid. The A1 horizon is light brownish gray or brown. The A2 horizon is light gray or very pale brown.

The Bt&A2 horizon is about 70 to 85 percent, by volume, bodies of Bt material that is yellowish-brown, light yellowish-brown, or strong-brown sandy clay loam or loam. It contains mottles in shades of yellow, brown, red, and gray. The A2 material of this horizon is light-gray, white, or very pale brown fine sandy loam or loam; it exists as coatings and pockets intermingled with the Bt material. Reaction is very strongly acid to medium acid.

The upper part of the B2t horizon is light brownish-gray, yellowish-brown, light-gray, or brown sandy clay loam to sandy clay and contains mottles in shades of gray, olive, red, yellow, and brown. Reaction is very strongly acid or strongly acid.

The lower part of the B horizon is sandy clay loam mainly mottled in shades of gray, yellow, olive, and brown. Reaction is neutral to moderately alkaline.

Styx Series

The Styx series consists of deep, noncalcareous sandy soils on uplands and old, high terraces. These nearly level to gently sloping soils formed in sandy and loamy alluvial sediments under a cover of post oak, blackjack oak, red oak, elm, hickory, and hackberry.

In a representative profile the surface layer is medium acid loamy fine sand about 18 inches thick. It is pale brown in the upper 5 inches and very pale brown below. The sub-surface layer is very pale brown, slightly acid loamy fine sand 15 inches thick. The subsoil is about 51 inches thick. The upper 9 inches is brownish-yellow sandy clay loam. Below that, it is sandy clay loam mottled in shades of gray, brown, yellow, and red. Reaction is medium acid in the upper 22 inches of the subsoil and strongly acid below that.

Styx soils are well drained. They have moderate permeability and medium available water capacity. These soils have a seasonal water table at a depth of 40 to 50 inches during the winter and the spring.

Most of these soils are used for pasture. A few areas are used for crops.

Representative profile of Styx loamy fine sand in an area of Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes, in a pasture; 500 feet south of a county road; 0.75 mile southwest of Farm Road 2451, 1 mile northwest of its junction with Texas Highway 34; 11.6 miles southwest of Kaufman, Texas:

- Ap—0 to 5 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 4/3) moist; single grained; soft, loose; many roots; medium acid; clear, smooth boundary.

- A1—5 to 18 inches, very pale brown (10YR 7/3) loamy fine sand, brown (10YR 5/3) moist; single grained; soft, loose; few roots; medium acid; gradual, smooth boundary.
- A2—18 to 33 inches, very pale brown (10YR 8/3) loamy fine sand, pale brown (10YR 6/3) moist; single grained; slightly hard, very friable; few roots; slightly acid; clear, wavy boundary.
- B21t—33 to 42 inches, brownish-yellow (10YR 6/6) sandy clay loam, yellowish brown (10YR 5/6) moist; moderate, medium, subangular blocky structure; very hard, friable; few roots; few patchy clay films; few uncoated sand grains; few strongly cemented iron concretions; medium acid; gradual, smooth boundary.
- B22t—42 to 65 inches, prominently mottled light brownish-gray (10YR 6/2), brownish-yellow (10YR 6/6), and red (2.5YR 4/8) sandy clay loam; moderate, medium, blocky structure; very hard, friable; few fine roots; common clay films; few uncoated sand grains; few strongly cemented iron concretions; medium acid; gradual, smooth boundary.
- B3t—65 to 84 inches, distinctly mottled brownish-yellow (10YR 6/6) and yellowish-brown (10YR 5/6) sandy clay loam; weak, coarse, prismatic structure; very hard, friable, few fine roots; few patchy clay films; 5 to 10 percent light-gray uncoated sand grains; few iron concretions; strongly acid.

The solum is 60 to more than 84 inches thick. The A horizon is 20 to 40 inches thick. Reaction is strongly acid to neutral. The A1 horizon is pale brown, very pale brown, grayish brown, or yellowish brown. The A2 horizon is light brownish gray or very pale brown.

The B2t horizons are sandy clay loam or clay loam with an average clay content of 25 to 35 percent. The upper part is reddish yellow, brownish yellow, or yellowish brown. The lower part is mottled in shades of gray, red, yellow, and brown. Reaction is strongly acid to slightly acid.

The B3t horizon is mottled in shades of gray, white, red, brown, or yellow. It contains pockets and coatings of uncoated sand grains.

StB—Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes. This mapping unit is made up of deep sandy soils on old stream terraces. They form a landscape that has a mixed concave and convex surface. Soil areas are oval to elongated in shape and vary from 10 to 180 acres in size.

This unit is about 65 percent Styx soils on broad, low ridges or mounds, 20 percent Aquic Haplustalfs in concave positions, and 15 percent other soils. These soils are so intermingled that they could not be shown separately at the scale mapped.

Runoff is slow, and the hazard of erosion is moderate.

Most of the acreage of these soils is used for pasture. Most areas were once cleared and cultivated, but very few areas are now farmed. Some areas have been established to improved pasture grasses. The use of these soils for urban development is increasing. Capability unit IIIs-1; pasture and hayland group 9A; Sandy range site.

Trinity Series

The Trinity series consists of deep, calcareous, clayey soils on bottom lands. These nearly level soils formed in recent calcareous clayey alluvium under a cover of mixed hardwoods with tall and mid grasses in open areas.

In a representative profile the surface layer is dark-gray, calcareous clay about 4 inches thick. The next lower layer is calcareous clay about 68 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The underlying material to a depth of 84 inches is gray calcareous clay that has a few brown mottles.

Trinity soils are somewhat poorly drained. They have very slow permeability and high available water capacity. These soils have a perched water table at a depth of 0 to 15 inches in some areas during the winter and spring.

Most of these soils are used for pasture or range (fig. 8). Some areas are used for crops.

Representative profile of Trinity clay, occasionally flooded, in a field; 100 feet west of Farm Road 740, 6.5



Figure 8.—A good pasture of common bermudagrass on Trinity clay, frequently flooded.

miles southwest of its junction with U.S. Highway 80 in Forney, Texas:

- Ap—0 to 4 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, fine and medium, subangular blocky structure; extremely hard, very firm; many roots; calcareous; moderately alkaline; clear, smooth boundary.
- A11—4 to 36 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, medium, blocky structure; extremely hard, very firm; few fine roots; calcareous; moderately alkaline; diffuse, smooth boundary.
- A12—36 to 60 inches, very dark gray (2.5Y N3/0) clay, black (2.5Y N2/0) moist; weak, coarse, blocky structure; extremely hard, very firm; few roots; few grooved slickensides that intersect; calcareous; moderately alkaline; gradual, smooth boundary.
- A13—60 to 72 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, coarse, blocky structure; extremely hard, very firm; few fine roots; few shiny pressure faces on peds; calcareous; moderately alkaline; gradual, smooth boundary.
- C—72 to 84 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; few fine, distinct, brown (10YR 5/3) mottles; massive; extremely hard, very firm; few strongly cemented calcium carbonate concretions; calcareous; moderately alkaline.

The solum is over 50 inches thick. The soil is calcareous throughout. It is of 60 to 80 percent clay. The A horizon is black, very dark gray, or dark gray and has a few olive and brown mottles in places. The C horizon is very dark gray, gray, or grayish brown and has mottles in shades of yellow and brown. Calcium carbonate concretions range from none to common. Below a depth of 20 inches, grooved, intersecting slickensides range from few to common.

Te—Trinity clay, occasionally flooded. This nearly level soil is on flood plains that are protected from flooding by a levee system. Runoff from bordering uplands occa-

sionally floods some areas, but flooding is shallow and of short duration. Soil areas are elongated and continuous within the levee districts. Slopes are 0 to 1 percent.

This soil has the profile described as representative of the series.

Runoff is slow, and small areas are ponded for short periods.

About 50 percent of the acreage of this soil is cultivated. Some fields have been established to improved pasture grasses. This soil is well suited to all locally grown crops or improved pasture. Capability unit IIw-1; pasture and hayland group 1A; Clayey Bottomland range site.

Tf—Trinity clay, frequently flooded. This nearly level soil is on flood plains that are subject to frequent and damaging floods. The surface is uneven, and water stands in low places for long periods following floods. Slopes are 0 to 1 percent.

The surface layer is dark-gray, calcareous clay about 6 inches thick. The next lower layer is very dark gray, calcareous clay about 55 inches thick. The underlying material to a depth of 78 inches is grayish-brown, calcareous clay.

Most of the acreage of this soil is used for pasture or range. Some areas are still in native vegetation of mixed hardwoods. The soil is unsuited to cultivation. It is better suited to grasses than to other crops. Capability unit Vw-1; pasture and hayland group 1A; Clayey Bottomland range site.

Wilson Series

The Wilson series consists of deep, noncalcareous loamy soils on uplands. These nearly level to gently sloping soils formed in alkaline clayey sediments under a cover of tall prairie grasses.

In a representative profile the surface layer is very dark gray, slightly acid silt loam about 5 inches thick. The subsoil is silty clay about 60 inches thick. It is very dark gray and slightly acid in the upper 27 inches and grayish brown and mildly alkaline below. The underlying material to a depth of 90 inches is olive-gray, calcareous silty clay.

Wilson soils are somewhat poorly drained. They have very slow permeability and high available water capacity. Some areas have a perched water table at a depth of less than 12 inches for short periods in the winter and the spring.

Most of these soils are used for pasture or range. A few areas are used for crops.

Representative profile of Wilson silt loam, 0 to 1 percent slopes, in a field; 150 feet southwest of a county road; 0.15 mile northeast and 0.2 mile southeast of intersection of county road and U.S. Highway 175, 4 miles southeast of its intersection with Texas Highway 34 in Kaufman, Texas:

Ap—0 to 5 inches, very dark gray (10YR 3/1) moist silt loam, gray (10YR 5/1); weak fine granular structure; very hard, friable; slightly acid; abrupt, wavy boundary.

B21tg—5 to 32 inches, very dark gray (10YR 3/1) moist silty clay, gray (10YR 5/1); moderate, medium, blocky structure; extremely hard, very firm; few fine pores; continuous thin clay films are 1/2 unit of value darker than interiors of peds; vertical cracks filled with material from Ap horizon; slightly acid; gradual, wavy boundary.

B22tg—32 to 50 inches, grayish-brown (2.5Y 5/2) moist silty clay, light brownish gray (2.5Y 6/2); moderate, medium, blocky structure; extremely hard, very firm; few fine pores; continuous thin clay films on peds; few small pressure faces; vertical cracks partly filled with material from above; few fine gypsum crystals; few fine, strongly cemented calcium carbonate concretions; mildly alkaline; diffuse, wavy boundary.

B3tg—50 to 65 inches, grayish-brown (2.5Y 5/2) moist silty clay, light brownish gray (2.5Y 6/2); weak, coarse, blocky structure; extremely hard, very firm; patchy clay films on peds; common fine gypsum crystals; few soft masses of calcium carbonate; mildly alkaline; gradual, smooth boundary.

C—65 to 90 inches, olive-gray (5Y 5/2) moist silty clay, light gray (5Y 7/2); massive; extremely hard, very firm; few soft masses of calcium carbonate; few small shale fragments; calcareous; moderately alkaline.

The solum is 40 to 75 inches thick. The A horizon is dark-gray, very dark gray, very dark grayish-brown, dark grayish-brown, or grayish-brown loam, silt loam, silty clay loam, or clay loam 5 to 10 inches thick but averages about 8 inches in thickness. Reaction is medium acid to mildly alkaline.

The Btg horizon is black, gray, dark-gray, grayish-brown, olive-gray, light olive-gray, very dark gray, or light brownish-gray silty clay, clay loam, or clay. It has mottles in shades of olive, brown, and yellow in places. Reaction is medium acid to mildly alkaline in the upper part and mildly alkaline or moderately alkaline in the lower part.

The C horizon is gray, olive-gray, or brown silty clay or clay. Reaction is mildly alkaline or moderately alkaline. It is calcareous in places.

WsA—Wilson silt loam, 0 to 1 percent slopes. This nearly level to slightly depressional soil is on broad upland plains. Slopes are mainly less than 0.5 percent. Soil areas are oval to elongated in shape and vary from 10 to 150 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small circular

mounds of Crockett and Mabank soils. Inclusions make up less than 15 percent of any one mapped area.

Runoff is slow. Water is ponded in some areas during wet seasons.

Most of the acreage of this soil is used for pasture or range. A few areas are used for crops, but this soil is better suited to grass. Capability unit IIIw-2; pasture and hayland group 8A; Claypan Prairie range site.

WsB—Wilson silt loam, 1 to 3 percent slopes. This gently sloping soil is on broad, low, slightly convex ridges and side slopes. Slopes are dominantly less than 2 percent. Soil areas are oval to irregular in shape and vary from 10 to 250 acres in size.

The surface layer is dark-gray, mildly alkaline clay loam about 9 inches thick. The subsoil is very dark gray, moderately alkaline clay about 53 inches thick. The underlying material to a depth of 70 inches is grayish-brown, moderately alkaline clay.

Included with this soil in mapping are small spots of Crockett and Mabank soils. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate.

Most of the acreage of this soil is used for pasture or range. Some old fields have been established to improved pasture grasses. A few areas are still used for crops, but this soil is better suited to grass. Capability unit IIIe-1; pasture and hayland group 8A; Claypan Prairie range site.

WsC2—Wilson clay loam, 2 to 5 percent slopes, eroded. This gently sloping soil is on slightly convex areas of uplands. Slopes are dominantly less than 3 percent. In a few places the surface layer has been eroded away and the subsoil is exposed. Broad, shallow gullies are common. Soil areas are oblong to irregular in shape and vary from 5 to 110 acres in size.

The surface layer is dark grayish-brown, medium acid clay loam about 5 inches thick. The subsoil is dark-gray, moderately alkaline clay about 47 inches thick. The underlying material to a depth of 80 inches is gray clay.

Included with this soil in mapping are small bodies of Crockett and Normangee soils. Inclusions make up less than 15 percent of any one mapped area.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used for pasture or range. Some areas have been established to improved pasture grasses; others have been abandoned to reseed naturally. Capability unit IVe-5; pasture and hayland group 7H; Claypan Prairie range site.

Use and Management of the Soils

This section explains the capability grouping of soils. Management of the soils by capability unit is described, and estimated yields of crops are given for a high level of management. A brief discussion of general soil management practices is included. Use of the soils for pasture and hayland, range, wildlife habitat, recreation, and engineering purposes also are discussed.

Use of Soils for Crops

About 30 percent of the survey area is in crops. Approximately 80 percent of this is in Kaufman County, and the remainder is in Rockwall County.

The principal crops grown are cotton, grain sorghum, and small grain. A limited acreage of the sandy and loamy soils is used for truck crops and orchards.

In Kaufman and Rockwall Counties, management is needed mainly for control of erosion and maintenance of soil tilth and fertility. In the following paragraphs, the main management practices used in the counties are discussed.

Use of crop residues.—A sufficient amount of residue left on or near the soil surface helps maintain organic matter and soil tilth. It also aids in controlling erosion and conserving moisture. All soils in Kaufman and Rockwall Counties used for crops benefit from proper use of plant residue.

Terraces farmed on the contour.—If terraces are farmed on the contour, they help to control water erosion. This practice is most beneficial on soils that have slopes of more than 1 percent.

Use of cover crops.—Crops that cover the soil will furnish protection against erosion during the interval between the time of harvest and the time of planting the next crop. Among crops suitable for most soils in the counties are small grain, sweetclovers, and mixtures of annual grasses and legumes.

Maintenance of soil fertility.—In Kaufman and Rockwall Counties, crops respond to additions of fertilizers. If good practices of soil management are used and proper amounts of fertilizer are applied, fertility can be maintained. The amount and type of fertilizer needed will vary according to kind of soil, crop to be grown, production desired, and previous land use or cropping history. Therefore, the use of commercial fertilizers should be based on crop needs determined by soil tests. Information on soil testing and fertilizer application can be obtained from the Soil Conservation Service or the Texas Agricultural Extension Service.

Capability grouping

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

In the capability system, all 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. 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, woodland, or wildlife.

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

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, range, woodland, or wildlife. (There are no class VII soils in the survey area.)

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. (There are no class VIII soils in the survey area.)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, 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, IIe-2 or IIIe-3. 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.

In the following pages the capability units in Kaufman and Rockwall Counties are described, and suggestions for the use and management of the soils are given.

CAPABILITY UNIT I-1

Gowen clay loam, occasionally flooded, is the only soil in this unit. This deep, well-drained, nearly level loamy soil is on bottom lands. The surface layer and lower layers are loamy. Permeability is moderate, and available water capacity is high.



Figure 9.—Young cotton in a terraced field of Houston Black clay, 1 to 3 percent slopes, in capability unit IIe-1.

This soil is well suited to all locally grown crops. Most of the cultivated acreage is used for cotton and grain sorghum.

Good management practices help maintain fertility and tilth. A suitable cropping system includes crops that produce large amounts of residue. Crop residue should be left on or near the soil surface.

CAPABILITY UNIT IIe-1

This unit consists of deep, moderately well drained, gently sloping clay soils on uplands. The surface layer and lower layers are clayey. Available water capacity is high. Permeability is very slow. When dry, these soils crack to a depth of more than 30 inches. Because of their gentle slope, these soils are moderately susceptible to erosion.

Most of the acreage of these soils is cultivated. The main crops are cotton (fig. 9), grain sorghum, and small grain.

Good management practices help control erosion and maintain soil fertility and tilth. Terracing, using grassed waterways, and contour farming help control erosion. A suitable cropping system provides crops that produce large amounts of residue. Crop residue should be left on or near the soil surface.

CAPABILITY UNIT IIe-2

Lewisville silty clay, 1 to 3 percent slopes, is the only

soil in this unit. This deep, well-drained, gently sloping soil is on old stream terraces. The surface layer and lower layers are clayey. Available water capacity is high, and the hazard of erosion is moderate. Permeability is moderate.

This soil is well suited to all locally grown crops. Most of the cultivated acreage is planted to cotton, grain sorghum, forage sorghum, and small grain.

Good management practices help control erosion and maintain soil fertility and tilth. Terracing, contour farming, and using grassed waterways are necessary for row crops. A suitable cropping system provides crops that produce large amounts of residue. Crop residue should be left on or near the soil surface.

CAPABILITY UNIT IIw-1

This unit consists of deep, somewhat poorly drained, nearly level clayey soils on bottom lands. The surface layer and lower layers are clayey. Available water capacity is high. Permeability is very slow.

Most of the cultivated acreage of these soils is planted to cotton and grain sorghum. Some alfalfa and small grains are grown.

Good management practices help maintain fertility and tilth. A suitable cropping system includes crops that produce large amounts of residue. Crop residue should be left on or near the soil surface to help maintain tilth. In some

areas diversion terraces are essential to protect the soil from runoff from higher areas.

CAPABILITY UNIT IIw-2

This unit consists of deep, moderately well drained, nearly level clayey soils on uplands. The surface layer and lower layers are clayey. When dry, these soils crack to depths of more than 30 inches. Available water capacity is high. Permeability is very slow.

Most of the acreage of these soils is cultivated. The main crops are cotton, grain sorghum, and small grains.

Good management practices remove water, help maintain fertility, and improve tilth. Row direction and shallow drains may be needed for drainage. A suitable cropping system provides deep-rooted plants and crops that produce large amounts of residue. Crop residue should be left on or near the soil surface.

CAPABILITY UNIT IIw-3

Kemp loam, occasionally flooded, is the only soil in this unit. This deep, moderately well drained, nearly level soil is on bottom lands. The surface layer and lower layers are loamy. Available water capacity is high. Permeability is moderate. A perched water table is at a depth of about 2 feet for short periods after heavy rains.

Most of the cultivated acreage of this soil is planted to cotton, grain sorghum, and small grains.

Good management practices help maintain soil fertility and tilth and control excess water. A suitable cropping system provides crops that produce large amounts of residue. Crop residue should be left on or near the soil surface to help maintain tilth. Diversion terraces are needed in some places to protect the soil from runoff from higher areas.

CAPABILITY UNIT IIIe-1

This unit consists of deep, gently sloping, well-drained to somewhat poorly drained loamy soils on uplands. The surface layer is loamy, and the lower layers are loamy to clayey. Available water capacity is high, and the hazard of water erosion is moderate. Permeability is very slow.

Most of the cultivated acreage of these soils is planted to cotton, forage sorghum, small grain, and vetch. These soils are better suited to cool-season crops that mature early than to other crops.

Good management practices help control erosion and maintain fertility and tilth. Terracing, using grassed waterways, and contour farming are needed to help control erosion. A suitable cropping system should provide frequent planting of crops that produce large amounts of residue. Crop residue should be left on or near the soil surface to help conserve soil moisture and to improve tilth.

CAPABILITY UNIT IIIe-2

This unit consists of deep, moderately well drained to well drained, gently sloping clayey soils on uplands. The surface layer and lower layers are clayey. When dry, these soils crack to a depth of 30 inches or more. Available water capacity is high, and the hazard of water erosion is moderate or severe. Permeability is very slow.

The cultivated acreage of these soils is primarily planted to cotton, grain sorghum, and small grains.

Good management practices help control erosion and maintain fertility and tilth. Terracing, contour farming, and using grassed waterways are needed to help control

erosion. A suitable cropping system provides crops that produce large amounts of residue. Effective use of crop residue helps maintain soil tilth.

CAPABILITY UNIT IIIe-3

The only soil in this unit is Konawa loamy fine sand, 1 to 3 percent slopes. This is a deep, well-drained, gently sloping soil on stream terraces. The surface layer is sandy, and the lower layers are loamy. Available water capacity is medium, and the hazard of water erosion is moderate. Permeability is moderate.

The cultivated acreage of these soils is small. The principal crops grown are forage sorghums, small grain, and vegetables.

Good management practices help control erosion, prevent leaching, and maintain fertility and tilth. A suitable cropping system provides frequent planting of cover crops and other crops that produce large amounts of residue. Proper use of crop residue helps control erosion and improve the available water capacity of the soil. Agricultural lime may be needed in some areas.

CAPABILITY UNIT IIIw-1

Only the Lufkin-Rader complex is in this unit. These are deep, moderately well drained to somewhat poorly drained, nearly level to gently sloping loamy soils on uplands. The surface layer is loamy, and the lower layers are loamy to clayey. Available water capacity is high. Permeability is very slow.

The cultivated acreage of these soils is small. The main crops grown are small grains, forage sorghums, and vegetables.

Good management practices help remove water and maintain soil fertility and tilth. Row direction and shallow drains are necessary for drainage in some places. A suitable cropping system provides frequent planting of crops that produce large amounts of residue. Crop residue should be left on or near the soil surface. Agricultural lime may be needed in some places.

CAPABILITY UNIT IIIw-2

This unit consists of deep, somewhat poorly drained, nearly level loamy soils on uplands. The surface layer is loamy and the lower layers are clayey. Available water capacity is high. Permeability is very slow.

Most of the cultivated acreage of these soils is planted to cotton, grain sorghum, forage sorghums, and small grain.

Good management practices help maintain fertility and tilth and control excess surface water in level areas. Row direction and shallow drains are desirable to remove excess water in level areas. A suitable cropping system provides frequent planting of crops that produce large amounts of residue. Crop residue should be left on or near the soil surface.

CAPABILITY UNIT IIIe-1

Only the Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes, is in this unit. These are deep, well drained to moderately well drained, nearly level to gently sloping soils on stream terraces. The surface layer is sandy, and the lower layers are loamy. Available water capacity is medium,

and the hazard of erosion is moderate. Permeability is moderate to moderately slow.

The cultivated acreage of these soils is small. The principal crops grown are forage sorghums, small grain, and vegetables.

Good management practices help control erosion, prevent leaching, and maintain fertility and tilth. A suitable cropping system provides frequent planting of cover crops and other crops that produce large amounts of residue. Proper use of crop residue helps control erosion and helps improve the available water capacity of the soils. Agricultural lime may be needed in some areas.

CAPABILITY UNIT IVe-1

Axtell fine sandy loam, 2 to 5 percent slopes, eroded, is the only soil in this unit. This soil is deep, well drained to moderately well drained, and gently sloping. The surface layer is loamy, and the lower layers are clayey or loamy. Available water capacity is high, and the hazard of water erosion is severe. Permeability is very slow. Much of the surface layer has been removed by erosion, and small gullies and thin spots are common.

Most areas of this soil are in pasture, but a few areas are planted to small grain and vetch.

Good management practices help control erosion and improve soil fertility and tilth. A combination of terracing, contour farming, and grassed waterways helps control erosion and conserve moisture. A suitable cropping system includes crops that produce large amounts of residue. All crop residue should be left on or near the surface.

CAPABILITY UNIT IVe-2

Heiden clay, 5 to 8 percent slopes, is the only soil in this unit. This deep, well-drained, sloping soil is on uplands. The surface layer and lower layers are clay. When dry, this soil cracks deeply. Available water capacity is high, and the hazard of erosion is severe. Permeability is very slow.

The cultivated acreage of this soil is planted to cotton, grain sorghum, and small grain.

Good management practices help control erosion and maintain fertility and tilth. A suitable cropping system provides crops that produce large amounts of residue. Crop residue left on the surface helps protect these soils against erosion and helps maintain tilth. Terracing, contour farming, and using grassed waterways are necessary in cultivated areas.

CAPABILITY UNIT IVe-3

Lewisville silty clay, 3 to 8 percent slopes, is the only soil in this unit. This deep, well-drained, gently sloping to sloping soil is on old stream terraces. The surface layer and lower layers are clayey. Available water capacity is high, and the hazard of water erosion is severe. Permeability is moderate.

Most of the cultivated acreage of this soil is planted to cotton, grain sorghum, forage sorghums, and small grains.

Good management practices help control erosion and maintain soil fertility and tilth. Contour farming, terracing, and using grassed waterways are necessary for row crops. A suitable cropping system provides either a continuous cover of vegetation or crops that produce large amounts of residue. Crop residue left on or near the soil surface helps protect against erosion and maintain soil tilth.

CAPABILITY UNIT IVe-4

This unit consists of Ferris-Heiden complex, 2 to 5 percent slopes. These deep, well-drained, gently sloping clayey soils are on uplands. The surface layer and lower layers are clayey. When dry, these soils crack deeply. Runoff is rapid. Available water capacity is high, and the hazard of water erosion is severe. Permeability is very slow.

Most of the acreage of these soils is planted to cotton, grain sorghum, and small grain.

Good management practices help control erosion and improve fertility and tilth. Terracing, contour farming, and using grassed waterways are necessary for row crops. A suitable cropping system provides crops that produce large amounts of residue. Crop residues should be left on or near the soil surface to help control erosion and improve tilth.

CAPABILITY UNIT IVe-5

This unit consists of deep, moderately well drained and somewhat poorly drained, gently sloping loamy soils on uplands. The surface layer is loamy and the lower layers are clayey. Available water capacity is high, and the hazard of water erosion is moderate to severe. Permeability is very slow. Erosion has removed much of the surface layer, and small gullies are common in some places.

Most of the acreage of these soils is used for pasture or range. A few areas are planted to small grain and vetch.

Good management practices help control erosion and improve fertility and tilth. A combination of contour farming, terracing, and using grassed waterways helps control erosion. A suitable cropping system provides either a continuous cover of vegetation or crops that produce large amounts of residue. Crop residue should be left on or near the soil surface.

CAPABILITY UNIT IVe-6

Konawa loamy fine sand, 3 to 8 percent slopes, is the only soil in this unit. This deep, well-drained, gently sloping to sloping sandy soil is on uplands. The surface layer is sandy, and the lower layers are loamy. Available water capacity is medium, and the hazard of water erosion is severe. Permeability is moderate. Some areas have been damaged by erosion.

Most of the acreage of this soil is used for pasture. A few areas are planted to forage sorghums and vegetables.

Good management practices help control erosion and maintain or improve fertility and tilth. A suitable cropping system provides either a continuous cover of vegetation or crops that produce large amounts of residue. Crop residue should be left on or near the soil surface to help control erosion and improve soil tilth. Agricultural lime may be needed in some places.

CAPABILITY UNIT Vw-1

This unit consists of deep, nearly level, somewhat poorly drained clayey soils on bottom lands. The surface layer is clayey, and the lower layers are loamy to clayey. Available water capacity is high. Permeability is very slow. Frequent flooding is likely; during floods new soil material is deposited.

The acreage of these soils is used mainly for pasture, range, or wildlife habitat. Good management practices help improve fertility and maintain soil cover.

CAPABILITY UNIT Vw-2

This unit consists of deep, nearly level, moderately well drained and well drained loamy soils on bottom lands. The surface layer and lower layers are loamy. Available water capacity is high. Permeability is moderate. These soils are subject to frequent overflow.

The acreage of these soils is used for pasture, range, or wildlife habitat.

Good management practices help maintain fertility and improve soil cover.

CAPABILITY UNIT VIe-1

Axtell fine sandy loam, 5 to 12 percent slopes, is the only soil in this unit. This deep, well drained to moderately well drained, sloping to strongly sloping soil is on uplands. The surface layer is loamy, and the lower layers are clayey to loamy. Available water capacity is high, and the hazard of water erosion is severe. Permeability is very slow.

The acreage of this soil is used mainly for pasture. It is too steep for cultivation.

Good management practices help improve fertility and maintain continuous soil cover to control erosion.

CAPABILITY UNIT VIe-2

This unit consists of moderately deep to deep, moderately well drained to well drained, gently sloping to strongly sloping, loamy to clayey soils on uplands. The surface layer is loamy to clayey, and the lower layers are clayey. Available water capacity is medium to high, and the hazard of water erosion is severe. Permeability is very slow.

The acreage of these soils is too eroded or too steep for cultivation. Most areas were once cultivated, but are now in native grasses or improved pasture.

Good management practices help improve fertility and maintain continuous soil cover to control further erosion.

CAPABILITY UNIT VIe-3

This unit consists of deep, well-drained, gently sloping to strongly sloping clayey soils on uplands. The surface layer and lower layers are clayey. Available water capacity is high, and the hazard of water erosion is severe. Permeability is moderate to very slow. Erosion has removed most of the surface layer, and the lower layer is exposed in many places. Gullied areas are common.

Most of the acreage of these soils is used for pasture or range. The soils are too eroded or too steep for cultivation.

Good management practices help improve fertility and maintain soil cover to control further erosion.

CAPABILITY UNIT VIe-4

Haplustalfs, loamy, 5 to 12 percent slopes, is the only soil in this unit. This deep, well-drained, sloping to strongly sloping, loamy soil is on uplands. The surface layer and lower layers are loamy. Available water capacity is high, and the hazard of water erosion is severe. Permeability is moderate. Erosion has removed some of the surface layer, and the subsoil is exposed in some places.

The acreage of this soil is too steep and too eroded for cultivation. Most areas are in pasture.

Good management practices help control erosion, improve fertility, and maintain soil cover.

Estimated yields

Table 2 lists estimated yields of the principal crops grown in the counties. The predictions are based on estimates made by farmers, soil scientists, and others who have knowledge of yields in the counties, and on information taken from research data. The estimated yields are average yields per acre that can be expected by good commercial farmers at the level of management which tends to produce the highest economic returns.

The yields are given for dryland soils.

Crops other than those shown in table 2 are grown in the counties, but their estimated yields are not included because their acreage is small or reliable data on yields are not available.

The predicted yields given in table 2 can be expected if the following management practices are used:

1. Rainfall is effectively used and conserved.
2. Surface and/or subsurface drainage systems are installed.
3. Crop residue is managed to maintain soil tilth.
4. Minimum but timely tillage is used.
5. Insect, disease, and weed control measures are consistently used.
6. Fertilizer is applied according to soil test and crop needs.
7. Adapted crop varieties are used at recommended seeding rates.

Use of Soils for Pasture and Hay

The livestock industry is important to the economy of Kaufman and Rockwall Counties. It is presently the main agricultural enterprise.

In this section the major management practices for productive pasture and hayland are discussed.

The soils of the two counties have been placed into 14 pasture and hayland groups. These groups are described, and the principles of management for each group are discussed.

Present pastures in Kaufman and Rockwall Counties are mainly warm-season grasses and cool-season legumes. Some acreage is also used for cool-season perennial grasses. Common bermudagrass and coastal bermudagrass are the most widely used grasses. These grasses are well suited to most of the soils. Some grazing programs on wet or bottom land soil include fescue and clover to be used for winter grazing. Lovegrasses are planted on many soils and used chiefly for cool-season grazing. The most commonly used legumes are vetch, crimson clover, and burclover. These are overseeded on established stands of bermudagrass.

The major management practices needed on pasture are fertilization, weed control, and controlled grazing. Fertilizers should be applied according to plant needs, the level of production desired, and the results of soil tests. Weeds can be controlled by mechanical means such as mowing or shredding, or by the use of herbicides. Weed control is less of a problem on well managed pastures than it is on over-used, poorly managed pastures. A good stand of well managed grass will tend to crowd out weeds. A pasture grass should not be grazed below its optimum recovery height.

Temporary pasture is often used to supplement permanent pasture or to produce hay. Sudangrass, johnsongrass, and sorghum-sudangrasses make good supplemental

TABLE 2.—*Estimated average yields per acre of principal crops*

[Absence of entry indicates that the crop is not suited to the soil or that it is not commonly grown]

Soil	Cotton (lint)	Grain sorghum	Corn	Wheat	Tame pasture
	<i>Lbs</i>	<i>Lbs</i>	<i>Bu</i>	<i>Bu</i>	<i>AUM</i> ¹
Altoga silty clay, 3 to 12 percent slopes, eroded					4.0
Aufco soils, frequently flooded					7.0
Axtell fine sandy loam, 1 to 4 percent slopes	250	2,250	35	20	6.0
Axtell fine sandy loam, 2 to 5 percent slopes, eroded	150	1,750	20	12	5.0
Axtell fine sandy loam, 5 to 12 percent slopes					5.0
Burleson clay, 0 to 1 percent slopes	450	4,750	50	25	7.0
Burleson clay, 1 to 3 percent slopes	400	4,500	45	30	7.0
Crockett fine sandy loam, 1 to 3 percent slopes	350	3,000	35	20	7.0
Crockett fine sandy loam, 2 to 5 percent slopes, eroded	200	2,500	30	20	5.0
Ellis clay, 5 to 12 percent slopes					4.0
Ferris clay, 5 to 12 percent slopes, eroded					4.0
Ferris-Heiden complex, 2 to 5 percent slopes	350	3,000	40	25	5.0
Gowen clay loam, occasionally flooded	550	4,250	60	35	10.0
Gowen clay loam, frequently flooded					10.0
Haplustals, loamy, 5 to 12 percent slopes					5.5
Heiden clay, 3 to 5 percent slopes	375	4,000	50	25	6.0
Heiden clay, 5 to 8 percent slopes		2,000		25	4.0
Houston Black clay, 0 to 1 percent slopes	500	5,000	60	30	8.0
Houston Black clay, 1 to 3 percent slopes	450	4,750	55	30	8.0
Houston Black clay, 3 to 5 percent slopes	400	4,250	50	25	7.0
Kaufman clay, occasionally flooded	500	5,500	60	30	8.0
Kaufman clay, frequently flooded					8.0
Kemp loam, occasionally flooded	475	4,500	50	25	10.0
Kemp loam, frequently flooded					10.0
Konawa loamy fine sand, 1 to 3 percent slopes					7.0
Konawa loamy fine sand, 3 to 8 percent slopes					5.5
Lewisville silty clay, 1 to 3 percent slopes	500	4,500	40	30	7.5
Lewisville silty clay, 3 to 8 percent slopes					6.5
Lufkin-Rader complex					6.5
Mabank fine sandy loam, 0 to 1 percent slopes	350	3,000	40	25	6.0
Mabank fine sandy loam, 1 to 3 percent slopes	300	2,500	35	25	6.0
Normangee clay loam, 2 to 8 percent slopes, eroded					4.5
Styx-Aquic Haplustals complex, 0 to 3 percent slopes					7.0
Trinity clay, occasionally flooded	500	5,500	60	30	8.0
Trinity clay, frequently flooded					8.0
Wilson silt loam, 0 to 1 percent slopes	350	3,000	45	25	5.5
Wilson silt loam, 1 to 3 percent slopes	300	2,500	35	20	5.5
Wilson clay loam, 2 to 5 percent slopes, eroded				20	5.0

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

summer pastures. Small grains provide good supplemental winter forage.

A well managed pasture generally has one main grass, which may be overseeded with an adapted legume for cool-season grazing. It is amply supplied with water, free of weeds, and well fertilized. It is stocked according to the amount of forage available and is grazed only to a height that allows the plants to remain vigorous.

A well managed hay meadow is well fertilized, weeds are controlled, and forage is cut at proper heights and at proper intervals to obtain high quality hay and maintain plant vigor. Hay should be cut at a height that has been proven best for the grass being used. Normally, sod-forming grasses, such as bermudagrass, can be mowed lower than bunchgrasses, such as bluestems. Cutting too close or too often damages haylands in the same way that overgrazing damages pastures. Mowing when the soil is wet tends to pack the surface soil, and this causes excessive runoff and poor plant growth. Weeds can be controlled the same way they are controlled in pastures.

Pasture and hayland groups

The soils are placed in pasture and hayland groups according to their suitability for the production of forage. The soils in each group are enough alike to be suited to the same grasses, to have similar limitations and hazards, to require similar management, and to have similar productivity and other responses to management. The pasture and hayland groups in Kaufman and Rockwall Counties are identified by numerals and uppercase letters, for example, 7A. The numbers are assigned locally but are a part of a statewide system. Not all the groups in the system are represented in Kaufman and Rockwall Counties, so the numbers are not consecutive.

The group in which each soil has been placed can be found in the "Guide to Mapping Units" at the back of this survey.

PASTURE AND HAYLAND GROUP 1A

This group consists of clayey, nearly level soils on bottom lands. Some of the soils in this group are frequently

flooded. These soils crack and take water rapidly when dry, but they expand and absorb water very slowly when wet. They are somewhat poorly drained, and permeability is very slow. These soils have high available water capacity, but the plant-soil-moisture relationship is fair to poor.

Seedbeds are difficult to prepare on these soils. Grazing when the soil is wet results in puddling on the surface. Because these nearly level soils are subject to overflow and seasonal winter wetness, this group is better suited to warm-season grazing. Nitrogen and phosphorous fertilizer is needed for sustained high production.

Some grasses and legumes adapted to these soils are improved bermudagrass, fescuegrass, dallisgrass, johnsongrass, burclover, black medic, and singletary peas.

PASTURE AND HAYLAND GROUP 1B

Aufco soils, frequently flooded, are the only soils in this group. These are clayey, nearly level soils on bottom lands and are subject to frequent flooding. This soil cracks and takes water readily when dry, but it swells and absorbs water very slowly when wet. It is somewhat poorly drained, and permeability is very slow. This soil has high available water capacity, but the plant-soil-moisture relationship is poor.

Seedbeds are difficult to prepare on this soil because the soil is wet for long periods. Grazing when the soil is wet results in severe puddling on the surface. A complete nitrogen, phosphorous, and potassium fertilizer is needed mostly for sustained high production of forage.

Some grasses and legumes adapted to these soils are improved bermudagrass, fescuegrass, dallisgrass, johnsongrass, white clover, burclover, and singletary peas.

PASTURE AND HAYLAND GROUP 2A

This group consists of loamy, nearly level soils on bottom lands. Some of the soils are subject to flooding. They absorb water at moderate rates. They are moderately well drained to well drained, and permeability is moderate. The plant-soil-moisture relationship is good.

Light summer rains provide quick forage production response. Soils in this group are mostly fertile, but a complete nitrogen, phosphorous, and potassium fertilizer is needed for sustained high production of forage.

Some grasses and legumes adapted to these soils are improved bermudagrass, common bermudagrass, fescuegrass, dallisgrass, johnsongrass, white clover, burclover, and singletary peas.

PASTURE AND HAYLAND GROUP 7A

This group is made up of nearly level to gently sloping, clayey soils on uplands. These soils crack and take water rapidly when dry, but they expand and absorb water very slowly when wet. They are moderately well drained and well drained, and permeability is very slow. These soils have high available water capacity, but the plant-soil-moisture relationship is fair to poor.

Seedbeds are difficult to prepare on these soils. Grazing when the soil is wet results in puddling on the surface. Nitrogen and phosphorous fertilizer is needed for sustained high production.

Some grasses and legumes adapted to these soils are improved bermudagrass, fescuegrass, johnsongrass, kleingrass, burclover, black medic, and singletary peas.

PASTURE AND HAYLAND GROUP 7B

This group consists of sloping to strongly sloping, clayey soils on uplands. These soils crack deeply and take water rapidly when dry, but they swell and absorb water very slowly when wet. They are well drained, and permeability is very slow. Available water capacity is medium to high, but the plant-soil-moisture relationship is fair to poor. The hazard of erosion is severe.

Seedbeds are difficult to prepare. Grazing when the soil is wet results in soil packing and surface sealing. This increases runoff. Nitrogen and phosphorous fertilizer is needed for sustained production.

Some grasses and legumes adapted to these soils are improved bermudagrass, johnsongrass, king ranch bluestem, burclover, black medic, and singletary peas.

PASTURE AND HAYLAND GROUP 7C

Lewisville silty clay, 1 to 3 percent slopes, is the only soil in this group. It is a gently sloping, friable clayey soil on old stream terraces. It is well drained, and permeability is moderate. The soil has high available water capacity, and the plant-soil-moisture relationship is fair.

Nitrogen and phosphorous fertilizer is needed for sustained high production.

Some grasses and legumes adapted to this soil are improved bermudagrass, kleingrass, King Ranch bluestem, lovegrass, black medic, and singletary peas.

PASTURE AND HAYLAND GROUP 7D

This group consists of friable, clayey, gently sloping to strongly sloping soils on stream terraces. The soils absorb water at a moderate rate. These soils are well drained, and permeability is moderate. They have high available water capacity, and the plant-soil-moisture relationship is fair.

Seedbeds are difficult to prepare on these soils because of gullies or steepness. Nitrogen and phosphorous fertilizer is needed for sustained forage production.

Some grasses and legumes adapted to these soils are improved bermudagrass, lovegrass, King Ranch bluestem, black medic, and vetch.

PASTURE AND HAYLAND GROUP 7H

The only soil in this group is Wilson clay loam, 2 to 5 percent slopes, eroded. This is a gently sloping loamy soil on uplands. It absorbs water very slowly as a result of surface sealing and the clayey subsoil. The soil is somewhat poorly drained, and permeability is very slow. The plant-soil-moisture relationship is poor.

Seedbeds are difficult to prepare on these soils because of clayey texture and rapid change in surface moisture conditions. Grasses are also difficult to establish because of surface crusting. A complete nitrogen, phosphorous, and potassium fertilizer is needed for sustained production.

Some grasses and legumes adapted to these soils are improved bermudagrass, lovegrass, King Ranch bluestem, kleingrass, and burclover.

PASTURE AND HAYLAND GROUP 7I

Normangee clay loam, 2 to 8 percent slopes, eroded, is the only soil in this group. This is a gently sloping to sloping, eroded soil on uplands. It absorbs water very slowly as a result of surface sealing and clayey subsoil. Some areas are so eroded that shaping is necessary before grass can be planted. The plant-soil-moisture relationship is poor.



Figure 10.—Ermelo lovegrass pasture on Wilson silt loam, 0 to 1 percent slopes.

Seedbeds are difficult to prepare because of the texture and rapid change in surface moisture conditions. Grasses are also difficult to establish because of surface crusting and rapid drying. A complete nitrogen, phosphorous, and potassium fertilizer is needed for sustained production.

Some grasses and legumes adapted to this soil are improved bermudagrass, lovegrass, King Ranch bluestem, and burclover.

PASTURE AND HAYLAND GROUP 8A

This group consists of loamy, nearly level to gently sloping soils on uplands. These soils absorb water at moderate rates. They are somewhat poorly drained to well drained, and permeability is very slow. The plant-soil-moisture relationship is poor. These soils are seasonally wet or seasonally droughty.

A complete fertilizer is needed for sustained high forage production.

Some grasses and legumes adapted to these soils are improved bermudagrass, bahiagrass, lovegrass (fig. 10), crimson clover, vetch, and singletary peas.

PASTURE AND HAYLAND GROUP 8B

Axtell fine sandy loam, 5 to 12 percent slopes, is the only soil in this group. It is a sloping to strongly sloping loamy soil on uplands.

This soil is well drained to moderately well drained, and permeability is very slow. The soil absorbs water at a moderate rate, but the plant-soil-moisture relationship is poor. The hazard of erosion is severe, and a few areas are eroded.

Seedbeds are difficult to prepare because of slope. The soils should be without plant cover only for short periods. A complete nitrogen, phosphorous, and potassium fertilizer is needed for sustained production.

Some grasses and legumes adapted to these soils are improved bermudagrass, lovegrass, bahiagrass, crimson clover, vetch, and singletary peas.

PASTURE AND HAYLAND GROUP 8D

Haplustalfs, loamy, 5 to 12 percent slopes, are the only soils in this group. This is a sloping to strongly sloping, well-drained loamy soil on uplands. It absorbs water at moderate rates, and permeability is moderate. The plant-soil-moisture relationship is good. The hazard of erosion is severe.

Seedbeds are difficult to prepare because of past erosion and slope. A complete nitrogen, phosphorous, and potassium fertilizer is needed for sustained high production.

Some grasses and legumes adapted to this soil are improved bermudagrass, bahiagrass, lovegrass, vetch, and crimson clover.

PASTURE AND HAYLAND GROUP 8E

Only the Lufkin-Rader complex is in this group. These are nearly level to gently sloping loamy soils on uplands. They are moderately well drained to somewhat poorly drained. They absorb water at moderate to slow rates, and permeability is very slow. The soil surface is saturated in places for long periods during the year, and surface drainage may be needed in some areas. The plant-soil-moisture relationship is poor.

Seedbeds are difficult to prepare on these soils. A complete nitrogen, phosphorous, and potassium fertilizer is needed for sustained forage production. Agricultural lime may be needed in some areas.

Some grasses and legumes adapted to these soils are improved bermudagrass, bahiagrass, fescuegrass, dallisgrass, and singletary peas.

PASTURE AND HAYLAND GROUP 9A

This group consists of nearly level to sloping sandy soils on old, high stream terraces. They are moderately well drained to well drained. They absorb water rapidly, and permeability is moderate to moderately slow. The plant-soil-moisture relationship is fair. Light summer rains provide quick forage production response.

It is difficult to establish vegetation on a clean seedbed because of the cutting action of blowing sand and the looseness of the sand. Low fertility makes it desirable to apply a complete fertilizer at planned intervals during the growing season. Agricultural lime may be needed in some areas.

Some grasses and legumes adapted to these soils are improved bermudagrass, lovegrass, vetch, and crimson clover.

Use of Soils for Range ³

Range is land on which the native (climax or natural potential) vegetation is dominated by grasses, grasslike plants, forbs, and shrubs. It is suitable for grazing and is present in sufficient quantity to justify grazing use. Included as range are natural grasslands, savannahs, many wetlands, and certain forb and shrub communities.

About 15 percent of the survey area is in native vegetation and is managed as range for livestock production.

When Kaufman and Rockwall Counties were first settled in about 1840, they were part of a grassy, nearly treeless prairie interrupted by strips of hardwoods along the streams. The uplands were dotted with isolated areas and belts of post oak savannah growing on the loamy and sandy soils. Big bluestem, indiagrass, little bluestem, tall dropseeds, silver bluestem, and buffalograss dominated the prairie vegetation. The prairies were an excellent range for cattle, and cattle raising was the principal industry at first.

The prairie was initially broken out and put under cultivation with the introduction of barbed wire and the coming of the railroad about 1872-74. Almost all suitable land was cultivated by 1900. The production of prairie hay, however, continued to be important, especially in the vicinity of Forney, until 1915.

Ranching and livestock farming are still important agricultural enterprises in Kaufman and Rockwall Counties.

Cash receipts for farm marketing of livestock and livestock products exceeded 9.3 million dollars in 1969. That same year, approximately 46,500 mature cows and their calves grazed on the grasslands of the survey area.

The principal source of forage in the survey area is tame pasture. These pastures receive regular fertilization, weed control, and overseeding with legumes and winter grasses to ensure high production. Native grazing lands, nevertheless, contribute significantly to the total forage needs of livestock and big game animals. These native grazing lands receive no cultural treatment.

The composition and production of forage plants depends primarily upon kind of soil, soil moisture, overstory canopy, grazing management, and past use.

Vegetation, both native and introduced, is produced mainly in two distinct growth periods. Approximately two-thirds of the annual growth is produced in April, May, and June, when rainfall and temperatures are most favorable for growth of warm-season plants. A secondary growth period occurs during September and October. Short droughts are common in midsummer, and lengthy droughts occur about one year in five.

Range sites and condition classes

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kinds and amounts of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of range that differ in their capacity to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation, the stabilized plant community that reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable decreaser plants are reduced by close grazing. They are commonly shorter than decreasers and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is less than 25.

³ By DON T. PENDLETON, range conservationist, Soil Conservation Service.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods under the supervision of a careful manager may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of range sites

In the following pages, the range sites of Kaufman and Rockwall Counties are described, and the climax plants and principal invaders on each site are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

BLACKLAND RANGE SITE

The soils in this site are nearly level to sloping. Undisturbed areas often have microridges and valleys extending up and down slope, and flatter areas have a microrelief of knolls and depressions. These deep clayey soils crack when dry. They have very slow permeability and high available water capacity. Under a good grass cover, the soils favor air and water movement and root growth.

In climax condition, this range site is a tall grass prairie. The approximate species composition, by weight, is 35 percent big bluestem and indiangrass; 15 percent eastern grama; 15 percent little bluestem; 5 percent dropseed; 5 percent Texas wintergrass; 5 percent longspike tridens; 5 percent silver bluestem; and 5 percent buffalograss. Hackberry, elm, osageorange, and honeylocust trees grow along draws. These and other woody plants make up about 5 percent of the plant community. Indigenous perennial forbs, such as englemann Daisy, Maximilian sunflower, hairy sunflower, buttonsnakeroot, gayfeather, coneflower, Indianplantain bundleflower, and prairieclover make up about 5 percent.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 4,000 to 7,000 pounds, depending on rainfall and growing conditions. About 95 percent of this production is palatable to cattle.

Abandoned cropland is dominated by Texas wintergrass, meadow dropseed, and silver bluestem. The climax plant community may deteriorate to buffalograss and Texas wintergrass under prolonged, continuous overgrazing by cattle. Mesquite trees often invade.

CLAY LOAM RANGE SITE

The soils in this site are deep, clayey, gently sloping to

strongly sloping soils on old stream terraces. They have moderate permeability and high available water capacity.

The climax plant community is a tall grass prairie. Large pecan, hackberry, and elm trees are widely scattered on the site. A combination of big bluestem, indiangrass, and switchgrass dominates the site. The approximate species composition, by weight, is about 40 percent big bluestem, indiangrass, and switchgrass; 25 percent little bluestem; 5 percent side-oats grama; 5 percent silver bluestem; 5 percent meadow dropseed; 5 percent wildrye; 5 percent Texas wintergrass; and 5 percent buffalograss. Trees, shrubs, and forbs make up about 5 percent of the production; these include pecan, hackberry, elm, sumac species, bumelia, osageorange, honeylocust, possumhaw, englemann Daisy, Maximilian sunflower, gayfeather, buttonsnakeroot, cobaea penstemon, prairieclover, and bundleflower.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 4,000 to 5,000 pounds, depending on rainfall and growing conditions. About 90 percent of this production is palatable to cattle.

Decades of overgrazing by cattle have reduced much of this site to buffalograss, Texas wintergrass, Texas grama, annual brome grasses, and legumes.

CLAYPAN PRAIRIE RANGE SITE

The soils in this unit are deep and nearly level to sloping. They have a loamy surface layer. Permeability is very slow, and available water capacity is high.

The climax plant community is dominated by tall grasses. Elm, hackberry, osageorange, honeylocust, and pricklyash are sparse woody inhabitants. Large, mature oak trees are widely spaced over the site, but once they are removed from the site, they generally do not reestablish. The approximate species composition, by weight, of the plant community is 30 percent indiangrass and big bluestem; 25 percent little bluestem; 5 percent tall dropseeds; 10 percent Texas wintergrass, wildrye, and sedges; 5 percent longspike tridens and Florida paspalum; 5 percent silver bluestem; 5 percent low panicums; and 5 percent woody plants. Climax forbs make up about 10 percent; these include englemann Daisy, Maximilian sunflower, gayfeather, sensitivebrier, bundleflower, neptunia, prairieclover, scurfpea, and groundplum.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 3,000 to 6,000 pounds, depending on rainfall and growing conditions. About 90 percent of this production is palatable to cattle.

Abandoned cropland is dominated by broomsedge bluestem and low panicums at first. As plant succession progresses, these are replaced by Texas wintergrass, meadow dropseed, and silver bluestem. Mesquite trees are aggressive invaders.

ERODED BLACKLAND RANGE SITE

The soils in this site are deep to moderately deep, sloping to strongly sloping clays. They have very slow permeability, and available water capacity is medium to high. The hazard of erosion is severe.

The climax plant community is a tall grass prairie. The approximate species composition, by weight, is 25 percent indiangrass; 25 percent big bluestem; 25 percent little bluestem; 5 percent meadow dropseed; 5 percent Texas wintergrass; and 5 percent Carolina jointtail. Forbs and woody

plants make up about 10 percent of the plant community; these include englemann daisy, Maximilian sunflower, Indian plantain, Texas parsley, buttons nakeroot, sensitive brier, groundplum, sumac, bumelia, hackberry, coralberry, coral honeysuckle, and pricklyash.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 3,000 to 5,000 pounds, depending on rainfall and growing conditions. About 85 percent of this production is palatable to cattle.

Prolonged overgrazing by cattle causes a decrease in big bluestem, indiagrass, little bluestem, wildrye, and palatable forbs. These are replaced by meadow dropseed, Texas wintergrass, silver bluestem, buffalograss, and less palatable forbs.

CLAYPAN SAVANNAH RANGE SITE

In this site are deep, nearly level to strongly sloping loamy soils on uplands. These soils have very slow permeability and high available water capacity.

The climax plant community is a post oak-blackjack oak savannah. Associated woody plants include red oak, hickory, hackberry, elm, hawthorns, yaupon, American beautyberry, greenbrier, grapevines, and berryvines. Tall and mid grasses dominate the understory. The approximate species composition, by weight, of the plant community is 25 percent little bluestem; 20 percent indiagrass and big bluestem; 10 percent beaked panicum; 10 percent longleaf uniola; 5 percent purpletop; 5 percent low paspalums and panicums; 20 percent woody plants; and 5 percent forbs. Indigenous forbs include lespedezas, tickclover, snoutbeans, tephrosia, milkpea, butterflypea, and sensitive brier.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 2,500 to 5,000 pounds, depending on overstory canopy, leaf and litter build-up, rainfall, and other growing conditions. About 70 percent of this production is palatable to cattle.

The plant-soil-moisture relationship and acid reaction of these soils favor growth of woody vegetation. When this site is in climax condition, the dense growth of grass and forbs, together with periodic fires, discourage the growth of woody plants and maintain the savannah aspect of the site. When herbaceous plants are weakened and thinned by prolonged heavy grazing by cattle, they can no longer compete with woody species for space, light, moisture, and minerals. As woody species increase, the likelihood of destructive grass fires decreases, and the site begins to resemble a hardwood forest. Shade-tolerant grasses and forbs, such as longleaf uniola, low panicums, and sedges, increase with the thickening canopy until the shade becomes too dense. Under such a dense canopy, production by all herbaceous species is severely restricted.

SANDY RANGE SITE

Only Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes is in this range site. The soils are deep and nearly level to gently sloping on old, high stream terraces. They have a sandy surface layer. These soils have moderate to moderately slow permeability, and available water capacity is medium.

In climax condition this is a post oak-blackjack oak savannah. Associated woody plants are hickory, red oak, elm, hackberry, American beautyberry, yaupon, sassafras, greenbrier, peppervine, grapevine, and berry vines. The

approximate species composition, by weight, is 25 percent little bluestem; 10 percent indiagrass; 10 percent big bluestem; 10 percent beaked panicum; 5 percent purpletop, sand lovegrass, and longleaf uniola; 5 percent low panicums and paspalums; 20 percent woody plants; and 15 percent forbs. Native forbs include lespedezas, tickclover, snoutbeat, vetch, tephrosia, milkpea, butterflypea, partridgepea, spiderwort, dayflower, bullnettle, and croton.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 3,000 to 5,000 pounds, depending on overstory canopy, leaf and mulch buildup, rainfall, and other growing conditions. As much as 1,200 pounds of the annual yield is woody plants. About 85 percent of this production is palatable to cattle.

The plant-soil-moisture relationship, acid reaction, and low fertility of these soils favor growth of woody vegetation.

When the site is in climax condition, the dense herbaceous understory, together with periodic fires, discourage the growth of woody plants and maintain the savannah aspect of the site. When the herbaceous understory is weakened and thinned by prolonged heavy grazing by cattle, these plants can no longer successfully compete with the woody vegetation for space, light, moisture, and minerals. As woody species increase, the likelihood of destructive grass fires decreases. Consequently, trees, shrubs, and woody vines increase and invade to form dense thickets. Red lovegrass, yankeeweed, bullnettle, sandbur, and splitbeard bluestem dominate the site in a deteriorated condition.

SANDY LOAM RANGE SITE

In this site are deep, gently sloping to strongly sloping, sandy to loamy soils on uplands and stream terraces. They have moderate permeability and medium to high available water capacity.

The climax plant community is a post oak-blackjack oak savannah. Associated woody plants include red oak, elm, hackberry, hickory, American beautyberry, yaupon, hawthorns, greenbrier, grape, and berryvines. Tall and mid grasses dominate the understory. The approximate species composition, by weight, is 30 percent indiagrass and big bluestem; 20 percent little bluestem; 10 percent beaked panicum; 10 percent longleaf uniola; 5 percent purpletop; 20 percent woody plants; and 5 percent forbs. Native forbs include lespedezas, tickclovers, snoutbean, tephrosia, butterflypea, milkpea, wildbean, partridgepea, sensitive brier, and goldenrod.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 2,500 to 4,000 pounds, depending on overstory canopy, leaf and litter buildup, rainfall, and other growing conditions. As much as 1,500 pounds of the yield is woody plants. About 70 percent of this production is palatable to cattle.

These soils favor growth of woody vegetation. When this site is in climax condition, the dense herbaceous understory, together with periodic fires, discourage the growth of woody plants and maintain the savannah aspect of the site. When the site is subjected to prolonged heavy grazing, big and little bluestem, indiagrass, and beaked panicum decrease in the plant community. As these and other herbaceous plants are weakened and thinned, they can no longer compete with woody plants for space, light, moisture, and minerals. As woody species increase, the likelihood of destructive grass fires decreases. Consequently,

oaks, elms, hickory, hawthorns, American beautyberry, and associated woody species generally increase, and the site begins to resemble hardwood forest. Shade-tolerant herbaceous plants, such as longleaf uniola, sedges, and low panicums, increase along with the thickening canopy until the shade becomes too dense. Under a dense canopy, production by all herbaceous species is severely restricted.

CLAYEY BOTTOMLAND RANGE SITE

The soils in this site are deep, nearly level clayey soils on bottom lands. They have very slow permeability and high available water capacity.

The climax plant community is a savannah of oak species. Associated plants include elm, hackberry, sycamore, cottonwood, ash, and willow. Underbrush includes hawthorns, plums, Texas sophora, Alabama supplejack, peppervine, trumpetcreeper, grapevines, and greenbrier. The herbaceous understory is dominated by sedges and Virginia wildrye. The approximate species composition, by weight, is 35 percent sedges and wildrye; 10 percent switchgrass; 10 percent beaked panicum; 10 percent eastern gama; 10 percent combinations of buffalograss, nimblewill, redtop, and low panicums; 20 percent woody plants; and 5 percent forbs. Native forbs include ironweed, blood ragweed, white crownbeard, lespedezas, and tickclover.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 4,000 to 7,500 pounds, depending on overstory canopy, overflow, rainfall, and other growing conditions. As much as 1,500 pounds of the annual yield is woody species. About 80 percent of this production is palatable to cattle.

Because of the palatable and nutritious forage produced on the site, the presence of water, and its proximity to water, this site is a preferred grazing area. Consequently, it is one of the first to be heavily grazed. As range condition deteriorates, trees and shrubs increase to form a dense canopy. When this happens, the shade-tolerant woods grasses become more prominent. Bermudagrass and buffalograss often occupy closely grazed open areas. Bushy and broomsedge bluestem, cocklebur, smallhead sneezeweed, white crownbeard, blood ragweed, fogfruit, cone-flower, and sumpweed are likely to dominate this site in a deteriorated condition.

LOAMY BOTTOMLAND RANGE SITE

The soils in this site are deep, nearly level loamy soils on bottom lands. These soils have moderate permeability and high available water capacity.

The climax plant community is a savannah of pecan, oaks, hackberry, elm, cottonwood, sycamore, black willow, and ash trees. Underbrush includes hawthorn, Alabama supplejack, Texas sophora, greenbrier, grapevines, peppervine, trumpetcreeper, and honeysuckle. Virginia wildrye and sedges dominate the herbaceous understory. The approximate species composition, by weight, is 25 percent sedges and wildrye; 10 percent switchgrass; 10 percent eastern gama; 10 percent beaked panicum; 5 percent switchcane; 5 percent plumegrass; 5 percent low panicums; 5 percent buffalograss; 20 percent woody plants; and 5 percent forbs. Indigenous forbs include ironweed, blood ragweed, white crownbeard, tickclover, lespedezas, wildbean, and gayfeather.

The approximate total annual yield of air-dry herbage per acre on range in excellent condition ranges from 4,000 to 7,000 pounds, depending on overstory canopy, overflow,

rainfall, and other growing conditions. As much as 1,500 pounds of the annual yield is woody plants. About 80 percent of this production is palatable to cattle.

Because of the palatable and nutritious forage produced on the site, the presence of large shade trees, and the proximity of the site to water, it is a preferred grazing area. Consequently, it is one of the first to be overgrazed. As range condition deteriorates, trees, shrubs, and woody vines increase and invade to form a dense canopy. As the shade thickens, shade-tolerant species make up a higher percentage of the herbaceous production, until the shade becomes too dense. As the overstory continues to close in, production by herbaceous plants is reduced proportionately.

Use of Soils for Wildlife Habitat

Soils directly influence the kinds and amounts of vegetation and amounts of water available in an area, and in this way they indirectly influence the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are thickness of soil useful to crops, surface texture, available water capacity to a depth of 40 inches, wetness, surface stoniness or rockiness, flood hazard, slope, and permeability of the soil to air and water.

In table 3 soils of this survey area are rated for producing six elements of wildlife habitat and for three groups, or kinds, of wildlife. The ratings indicate relative suitability for various elements. A rating of good means the element of wildlife habitat and habitat generally are easily created, improved, and maintained. Few or no limitations affect management in this category, and satisfactory results are expected when the soil is used for the prescribed purpose.

A rating of fair means the element of wildlife habitat and habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention may be required for satisfactory results, however.

A rating of poor means that limitations for the designated use are rather severe. Habitats can be created, improved, or maintained in most places, but management is difficult and requires intensive effort.

A rating of very poor means that limitations are very severe and that unsatisfactory results are to be expected. It is either impossible or impractical to create, improve, or maintain habitats on soils in this category.

Elements of wildlife habitat

Each soil is rated in table 3 according to its suitability for producing various kinds of plants and other elements that make up wildlife habitats. The ratings take into account mainly the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and people. For this reason, selection of a site for development as a habitat for wildlife requires inspection at the site.

Grain and seed crops are annual grain-producing plants, such as corn, sorghum, millet, and soybeans.

Grasses and legumes are domestic grasses and legumes that are established by planting. They provide food and cover for wildlife. Grasses include bahiagrass, ryegrass, and panicgrass; legumes include annual lespedeza, shrub lespedeza, and other clovers.

Wild herbaceous plants are native or introduced perennial grasses, forbs, and weeds that provide food and cover for upland wildlife. Beggarweed, perennial lespedeza, wild bean, pokeweed, and cheatgrass are typical examples. On range, typical plants are bluestem, grama, perennial forbs, and legumes.

Hardwood trees and shrubs are nonconiferous trees, shrubs, and woody vines that produce wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants commonly grow in their natural environment, but they may be planted and developed through wildlife management programs. Typical species in this category are oak, hackberry, hickory, dogwood, maple, viburnum, grape, honeysuckle, greenbrier, and silverberry.

Wetland food and cover plants are annual and perennial herbaceous plants that grow wild on moist and wet sites. They furnish food and cover mostly for wetland wildlife. Typical examples of these plants are smartweed, wild millet, spikerush, and other rushes, sedges, burreed, tear-thumb, and aneilema. Submerged and floating aquatic plants are not included in this category.

Shallow-water developments are impoundments or excavations for controlling water, generally not more than five feet deep, to create habitats that are suitable for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments that grow submersed aquatic plants.

Kinds of wildlife

Table 3 rates soils according to their suitability as habitat for the three kinds of wildlife in the counties—openland, rangeland, and wetland wildlife. These ratings are related to ratings made for the elements of habitat. For example, soils rated very poor for shallow water developments are rated very poor for wetland wildlife.

Openland wildlife are birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, doves, meadowlarks, field sparrows, cottontail rabbits, and foxes are typical examples of openland wildlife.

Rangeland wildlife are birds and mammals that normally live in rangeland areas of hardwood trees and shrubs. Woodcocks, thrushes, wildturkeys, deer, squirrels, and raccoons are typical examples of rangeland wildlife.

Wetland wildlife are birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, rails, herons, and snakes are typical examples of wetland wildlife.

Use of Soils for Recreational Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 4 the soils of Kaufman and Rockwall Counties are rated according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable, and limitations are so minor that they can easily be overcome. A *moderate* limitation can be overcome or modified by planning, design, or special maintenance. A *severe* limitation means that costly

soil reclamation, special design, and intense maintenance, or a combination of these, is required.

Camp areas are used intensively for tents and small camp trailers. Little site preparation is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Picnic areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increases cost of leveling sites or of building access roads.

Playgrounds are used intensively for organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Engineering Uses of the Soils ⁴

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slopes. These properties, in various degrees and combination, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.

⁴ JOE T. ROGERS, civil engineer, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Interpretations of the soils for*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs
Altoga: AtD2	Poor	Fair	Fair	Fair
Aquic Haplustalfs Mapped only in complex with Styx soils.	Fair	Fair	Good	Good
Aufco: Au	Poor	Fair	Fair	Good
Axtell: AxB, AxC2	Fair	Good	Good	Good
AxD	Poor	Fair	Good	Good
Burleson: BuA, BuB	Good	Good	Fair	Fair
Crockett: CrB, CrC2	Fair	Good	Good	Good
Ellis: EsD	Poor	Fair	Fair	Fair
Ferris: FeD2	Poor	Fair	Fair	Fair
FhC For Heiden part, see Heiden series.	Fair	Good	Fair	Fair
Gowen: Gc	Good	Good	Good	Good
Gf	Poor	Fair	Fair	Good
Haplustalfs, loamy: HaD	Poor	Fair	Good	Good
Heiden: HeC, HeD	Fair	Good	Fair	Fair
Houston Black: HoA, HoB	Good	Good	Fair	Fair
HoC	Fair	Good	Fair	Fair
Kaufman: Ka	Fair	Good	Fair	Good
Kb	Poor	Fair	Fair	Good
Kemp: Ke	Good	Good	Good	Good
Kf	Very poor	Poor	Fair	Good
Konawa: KoB, KoC	Fair	Good	Good	Good
Lewisville: LeB	Good	Good	Fair	Fair
LeC	Fair	Good	Fair	Fair
Lufkin: Lu For Rader part, see Rader series.	Fair	Fair	Good	Good
Mabank: MaA, MaB	Fair	Good	Good	Fair
Normangee: NoC2	Poor	Fair	Fair	Good
Rader Mapped only in complex with Lufkin soils.	Fair	Fair	Good	Good
Styx: StB For the Aquic Haplustalfs part, see Aquic Haplustalfs.	Fair	Good	Good	Good
Trinity: Te	Fair	Good	Fair	Good
Tf	Poor	Fair	Fair	Good
Wilson: WsA, WsB	Fair	Good	Good	Good
WsC2	Fair	Good	Good	Good

- Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
- Predict the trafficability of soils for cross-country

- movement of vehicles and construction equipment.
- Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5 and 6, which show, respectively, several estimated

elements of wildlife habitat and kinds of wildlife

Elements of wildlife habitat— <i>Continued</i>		Kinds of wildlife		
Wetland food and cover	Shallow-water developments	Openland wildlife	Rangeland wildlife	Wetland wildlife
Poor -----	Very poor -----	Fair -----	Fair -----	Very poor.
Poor -----	Poor -----	Fair -----	Good -----	Poor.
Fair -----	Fair -----	Fair -----	Fair -----	Fair.
Poor -----	Very poor -----	Good -----	Good -----	Very poor.
Poor -----	Very poor -----	Fair -----	Good -----	Very poor.
Poor -----	Poor -----	Good -----	Fair -----	Poor.
Poor -----	Very poor -----	Good -----	Good -----	Very poor.
Very poor -----	Very poor -----	Fair -----	Fair -----	Very poor.
Very poor -----	Very poor -----	Fair -----	Fair -----	Very poor.
Poor -----	Very poor -----	Good -----	Good -----	Very poor.
Poor -----	Very poor -----	Fair -----	Fair -----	Very poor.
Very poor -----	Very poor -----	Fair -----	Good -----	Very poor.
Poor -----	Very poor -----	Fair -----	Fair -----	Very poor.
Poor -----	Poor -----	Good -----	Fair -----	Poor.
Poor -----	Very poor -----	Fair -----	Fair -----	Very poor.
Poor -----	Fair -----	Fair -----	Fair -----	Poor.
Poor -----	Fair -----	Fair -----	Fair -----	Poor.
Fair -----	Fair -----	Good -----	Good -----	Fair.
Fair -----	Fair -----	Poor -----	Fair -----	Fair.
Poor -----	Very poor -----	Good -----	Good -----	Very poor.
Poor -----	Very poor -----	Good -----	Fair -----	Very poor.
Poor -----	Very poor -----	Fair -----	Fair -----	Very poor.
Fair -----	Fair -----	Fair -----	Good -----	Fair.
Fair -----	Fair -----	Good -----	Fair -----	Fair.
Poor -----	Poor -----	Fair -----	Fair -----	Poor.
Poor -----	Poor -----	Fair -----	Good -----	Poor.
Poor -----	Very poor -----	Good -----	Good -----	Very poor.
Poor -----	Very poor -----	Good -----	Good -----	Very poor.
Poor -----	Fair -----	Fair -----	Fair -----	Poor.
Poor -----	Fair -----	Fair -----	Fair -----	Poor.
Poor -----	Poor -----	Good -----	Good -----	Poor.
Poor -----	Very poor -----	Good -----	Good -----	Very poor.

soil properties significant in engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 4 and 6, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially those that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially small ones, is needed because

TABLE 4.—*Limitations of the soils for recreational development*

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe" and other terms used to rate soils]

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Altoga: AtD2 -----	Severe: too clayey -----	Severe: too clayey -----	Severe: too clayey; slope --	Severe: too clayey.
Aquic Haplustalfs ----- Mapped only in complex with Styx soils.	Moderate: too sandy -----	Moderate: too sandy -----	Moderate: too sandy -----	Moderate: too sandy.
Aufco: Au -----	Severe: floods; too clayey; wetness.	Severe: floods; too clayey --	Severe: floods; too clayey; wetness.	Severe: floods; too clayey.
Axtell: AxB, AxC2 ----- AxD -----	Severe: percs slowly ----- Severe: percs slowly -----	Slight ----- Moderate: slope -----	Severe: percs slowly ----- Severe: percs slowly; slope.	Slight. Slight.
Burleson: BuA, BuB -----	Severe: percs slowly; too clayey.	Severe: too clayey -----	Severe: percs slowly; too clayey.	Severe: too clayey.
Crockett: CrB, CrC2 -----	Severe: percs slowly -----	Slight -----	Severe: percs slowly -----	Slight.
Ellis: EsD -----	Severe: percs slowly; too clayey.	Severe: too clayey -----	Severe: percs slowly; too clayey; slope.	Severe: too clayey.
Ferris: FeD2 -----	Severe: percs slowly; too clayey.	Severe: too clayey -----	Severe: too clayey; percs slowly; slope.	Severe: too clayey.
FhC ----- For Heiden part, see Heiden series.	Severe: percs slowly; too clayey.	Severe: too clayey -----	Severe: percs slowly; too clayey.	Severe: too clayey.
Gowen: Gc ----- Gf -----	Severe: floods ----- Severe: floods -----	Moderate: floods ----- Severe: floods -----	Moderate: floods ----- Severe: floods -----	Moderate: too clayey. Severe: floods.
Haplustalfs, loamy: HaD -----	Moderate: slope -----	Moderate: slope -----	Severe: slope -----	Slight.
Heiden: HeC, HeD -----	Severe: percs slowly; too clayey.	Severe: too clayey -----	Severe: percs slowly; too clayey.	Severe: too clayey.
Houston Black: HoA, HoB, HoC.	Severe: percs slowly; too clayey.	Severe: too clayey -----	Severe: percs slowly; too clayey.	Severe: too clayey.
Kaufman: Ka ----- Kb -----	Severe: too clayey; wet- ness; floods. Severe: too clayey; wet- ness; floods.	Severe: too clayey ----- Severe: too clayey; floods --	Severe: too clayey; wetness. Severe: too clayey; wet- ness; floods.	Severe: too clayey. Severe: too clayey; floods.
Kemp: Ke ----- Kf -----	Severe: floods ----- Severe: floods -----	Moderate: floods ----- Severe: floods -----	Moderate: floods ----- Severe: floods -----	Slight. Severe: floods.
Konawa: KoB, KoC -----	Moderate: too sandy -----	Moderate: too sandy -----	Moderate: too sandy; slope.	Moderate: too sandy.
Lewisville: LeB, LeC -----	Severe: too clayey -----	Severe: too clayey -----	Severe: too clayey -----	Severe: too clayey.
Lufkin: Lu ----- For Rader part, see Rader series.	Severe: percs slowly; wetness.	Moderate: wetness -----	Severe: percs slowly; wetness.	Moderate: wetness.
Mabank: MaA, MaB -----	Severe: percs slowly; wetness.	Moderate: wetness -----	Severe: percs slowly; wetness.	Moderate: wetness.
Normangee: NoC2 -----	Severe: percs slowly -----	Moderate: too clayey -----	Severe: percs slowly -----	Moderate: too clayey.
Rader ----- Mapped only in complex with Lufkin soils.	Severe: percs slowly -----	Moderate: wetness -----	Severe: percs slowly -----	Slight.
Styx: StB ----- For Aquic Haplustalfs part, see Aquic Haplustalfs.	Moderate: too sandy -----	Moderate: too sandy -----	Moderate: too sandy -----	Moderate: too sandy.
Trinity: Te ----- Tf -----	Severe: too clayey; wetness. Severe: too clayey; wet- ness; floods.	Severe: too clayey ----- Severe: too clayey; floods --	Severe: too clayey; wetness. Severe: too clayey; wet- ness; floods.	Severe: too clayey. Severe: too clayey; floods.
Wilson: WsA, WsB, WsC2 -----	Severe: percs slowly; wetness.	Moderate: wetness -----	Severe: percs slowly; wetness.	Moderate: wetness.

many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning in soil science but are not known to all engineers. The Glossary defines many of these terms commonly used in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (8) used by SCS engineers, Department of Defense, and others, and the AASHTO system adopted by the American Association of State Highway and Transportation Officials (2).

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

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated AASHTO classification, without group index numbers, is given in table 5 for all soils mapped in the survey area.

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.

Estimated soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 5.

Hydrologic Soil Groups give the runoff potential from rainfall. Four major soil groups are used. The soils are classified on the basis of intake of water at the end of long-duration storms after prior wetting and opportunity for swelling and without the protective effects of vegetation.

The major soil groups are:

A. (Low runoff potential). Soils having high infiltra-

tion rates even when thoroughly wetted. These consist chiefly of deep, well-drained to excessively drained sands or gravels. These soils have a high rate of water transmission; water readily passes through them.

B. Soils having moderate infiltration rates when thoroughly wetted. These consist chiefly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse texture. These soils have a moderate rate of water transmission.

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

D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted. These consist chiefly of clay soil with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Depth to bedrock was not estimated for the soils of Kaufman and Rockwall Counties because all but the Ellis soils are deep. Ellis soils are 20 to 40 inches deep over shale.

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5.

Permeability is the quality of a soil that enables it to transmit water or air. It is estimated on basis of soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

TABLE 5.—Estimated soil properties

[Absence of data indicates that the soil is too variable to be rated or that no estimate was made. An asterisk in the first column indicates that at least and for this reason it is necessary to follow carefully the instructions for referring to another series

Soil series and map symbols	Hydrologic group	Depth to seasonal high water table	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
					Unified	AASHTO	
		<i>Inches</i>	<i>Inches</i>				<i>Percent</i>
Altoga: AtD2 -----	C	>60	0-24 24-65	Silty clay ----- Silty clay -----	CL or CH CL	A-6 or A-7-6 A-6 or A-7-6	
Aquic Haplustalfs ----- Mapped only in complex with Styx soils.	C	>60	0-25 25-65	Loamy fine sand ----- Sandy clay loam -----	SM-SC or SM SC or CL	A-2-4 or A-4 A-6	
Aufco: Au -----	D	20-40	0-5 5-38 38-75	Clay ----- Clay, clay loam ----- Clay -----	CH CL CH, CL	A-7-6 A-6 or A-7-6 A-7-6	
Axtell: AxB, AxC2, AxD -----	D	>60	0-6 6-39 39-75	Fine sandy loam ----- Clay, clay loam ----- Sandy clay loam -----	SM, SM-SC, ML, CL-ML CL or CH CL or SC	A-2-4 or A-4 A-7-6 A-6 or A-7-6	0-2 0-2
Burleson: BuA, BuB -----	D	>60	0-54 54-75	Clay ----- Clay, shaly clay -----	CH CH	A-7-6 A-7-6	
Crockett: CrB, CrC2 -----	D	>60	0-8 8-57 57-73	Fine sandy loam ----- Clay ----- Loam -----	ML, CL-ML, CL-SM, SC, SM-SC CH or CL CL	A-2, A-4, or A-6 A-6 or A-7-6 A-6 or A-7-6	0-2
Ellis: EsD -----	D	>60	0-30 30-60	Clay, shaly clay ----- Shale -----	CH CH	A-7-6 A-7-6	0-5
*Ferris: FeD2, FhC ----- For Heiden part of FhC, see Heiden series.	D	>60	0-65	Clay, shaly clay -----	CH	A-7-6	
Gowen: Gc, Gf -----	B	>60	0-25 25-60	Clay loam ----- Clay loam -----	CL CL	A-6 A-6 or A-4	
Haplustalfs, loamy: HaD -----	B	>60	0-6 6-44 44-62	Loam ----- Sandy clay loam ----- Weakly cemented sand- stone.	SM, SM-SC, SC, CL, ML, CL-ML SC, CL	A-4 or A-6 A-4 or A-6	
Heiden: HeC, HeD -----	D	>60	0-75	Clay, shaly clay -----	CH	A-7-6	
Houston Black: HoA, HoB, HoC.	D	>60	0-84	Clay, shaly clay -----	CH	A-7-6	
Kaufman: Ka, Kb -----	D	>60	0-75	Clay -----	CH	A-7-6	
Kemp: Ke, Kf -----	C	20-40	0-37 37-65	Fine sandy loam, loam ----- Sandy clay loam -----	SM-SC, SC, CL-ML, CL CL	A-4 or A-6 A-6 or A-7-6	
Konawa: KoB, KoC -----	B	>60	0-11 11-50 50-65	Loamy fine sand ----- Sandy clay loam ----- Fine sandy loam -----	SM SC, CL SC, SM, CL or ML, SM-SC, CL-ML	A-2 or A-4 A-4 or A-6 A-2 or A-4	
Lewisville: LeB, LeC -----	B	>60	0-15 15-50 50-80	Silty clay ----- Silty clay ----- Silty clay loam -----	CL or CH CL or CH CL or CH	A-7-6 A-7-6 or A-6 A-7-6 or A-6	
*Lufkin: Lu ----- For Rader part, see Rader series.	D	0-12	0-8 8-66 66-80	Fine sandy loam ----- Clay ----- Sandy clay loam -----	CL, ML, SM or SC, CL-ML, SM-SC CH CH, CL, or SC	A-4 A-7-6 A-7-6	0-5
Mabank: MaA, MaB -----	D	0-12	0-7 7-70	Fine sandy loam ----- Clay -----	CL, ML, SM, SC, CL-ML, SM-SC CL or CH	A-4 A-7-6	

significant in engineering

one mapping unit in the series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, in the first column of this table. The symbol > means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permea- bility	Available water capacity	Reaction	Shrink- swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
100	95-100	85-95	80-95	40-51	20-31	0.6-2.0	0.15-0.18	7.9-8.4	High -----	Moderate --	Low.
100	95-100	85-95	75-80	30-48	20-25	0.6-2.0	0.15-0.18	7.9-8.4	Moderate --	Moderate --	Low.
100	100	70-95	20-40	<20	NP-5 ¹	2.0-6.0	0.07-0.11	5.1-7.3	Low -----	Low -----	Low to moderate.
100	100	80-95	40-60	25-40	11-25	0.2-0.6	0.12-0.17	4.5-6.0	Low -----	Moderate --	Moderate to high.
100	100	90-100	75-95	51-60	30-40	<0.06	0.12-0.18	5.1-6.5	High -----	High -----	Low.
100	100	90-100	70-80	30-45	15-30	0.2-0.6	0.15-0.20	4.0-5.5	High -----	High -----	High.
100	100	90-100	75-95	45-60	25-40	<0.06	0.12-0.18	4.5-6.5	High -----	High -----	Moderate.
90-100	80-100	75-90	30-60	<25	NP-4 ¹	0.6-2.0	0.11-0.15	5.1-6.5	Low -----	Low -----	Moderate.
90-100	75-100	75-100	51-75	45-60	25-40	<0.06	0.13-0.18	4.5-7.3	High -----	High -----	Moderate.
85-100	75-100	75-90	36-88	35-45	25-35	0.06-0.2	0.13-0.18	5.6-8.4	Moderate --	High -----	Low.
99-100	98-100	85-100	80-95	51-75	30-55	<0.06	0.15-0.18	6.1-8.4	High -----	High -----	Low.
95-100	90-100	75-95	70-95	55-85	40-55	<0.06	0.15-0.18	7.4-8.4	High -----	High -----	Low.
95-100	95-100	95-100	35-95	15-35	3-15	0.6-2.0	0.11-0.15	5.6-7.3	Low -----	Low -----	Low.
90-100	80-100	75-100	65-91	40-60	20-38	<0.06	0.14-0.18	5.6-7.8	High -----	High -----	Low.
95-100	95-100	90-100	65-90	30-45	11-25	0.06-0.2	0.15-0.20	7.4-8.4	Moderate --	High -----	Low.
95-100	95-100	90-100	90-100	51-70	25-40	<0.06	0.12-0.18	6.1-8.4	Very high --	High -----	Low.
95-100	95-100	95-100	90-100	65-100	40-65	<0.06	<0.05	6.6-8.4	Very high --	High -----	Low.
95-100	95-100	80-95	75-95	51-70	35-50	<0.06	0.15-0.18	7.9-8.4	Very high --	High -----	Low.
100	100	85-100	60-80	30-40	11-25	0.6-2.0	0.15-0.20	6.6-8.4	Moderate --	Moderate --	Low.
100	100	85-100	55-80	25-40	10-25	0.6-2.0	0.15-0.20	6.6-8.4	Moderate --	Moderate --	Low.
95-100	95-100	85-95	36-70	15-30	3-15	0.6-2.0	0.14-0.17	5.6-7.8	Low -----	Low -----	Low.
95-100	95-100	80-90	36-80	22-40	8-20	0.6-2.0	0.14-0.18	5.6-8.4	Moderate --	Moderate --	Low.
95-100	95-100	80-95	75-95	55-80	40-50	<0.06	0.15-0.20	7.9-8.4	Very high --	High -----	Low.
95-100	95-100	95-100	85-100	58-90	35-65	<0.06	0.15-0.20	7.9-8.4	Very high --	High -----	Low.
100	100	95-100	90-95	70-85	40-55	<0.06	0.15-0.20	6.1-8.4	Very high --	High -----	Low.
100	100	90-100	40-80	20-35	7-20	0.6-2.0	0.13-0.20	5.6-7.8	Low -----	Moderate --	Moderate.
100	100	85-95	51-80	25-50	11-30	0.6-2.0	0.12-0.18	5.1-7.3	Moderate --	High -----	Moderate.
100	100	50-90	30-49	20	NP-3 ¹	2.0-6.0	0.07-0.09	5.6-6.5	Very low ---	Low -----	Moderate.
100	100	90-100	40-60	20-30	8-15	0.6-2.0	0.12-0.16	5.1-6.5	Low -----	Moderate --	Moderate.
100	100	90-100	30-60	10-26	3-10	2.0-6.0	0.09-0.13	5.1-7.3	Low -----	Low -----	Moderate.
100	98-100	70-90	70-85	41-65	25-40	0.6-2.0	0.16-0.20	7.9-8.4	High -----	Moderate --	Low.
100	95-100	65-90	65-85	35-55	20-35	0.6-2.0	0.16-0.20	7.9-8.4	High -----	High -----	Low.
100	95-100	65-90	70-90	35-55	20-35	0.6-2.0	0.16-0.20	7.9-8.4	High -----	High -----	Low.
90-100	80-100	80-100	40-85	<30	NP-10 ¹	0.6-2.0	0.11-0.18	5.1-6.5	Low -----	High -----	Moderate.
90-100	90-100	90-100	70-95	51-65	30-45	<0.06	0.14-0.18	5.1-7.8	High -----	High -----	Moderate.
70-100	70-100	55-100	44-90	45-86	25-55	<0.06	0.10-0.14	5.1-7.8	Moderate --	High -----	Moderate.
95-100	95-100	80-95	40-70	<30	NP-10 ¹	0.6-2.0	0.11-0.15	5.6-7.3	Low -----	Moderate --	Moderate.
95-100	95-100	95-100	70-85	42-65	25-40	<0.06	0.12-0.16	6.6-8.4	High -----	High -----	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Hydrologic group	Depth to seasonal high water table	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
					Unified	AASHTO	
		<i>Inches</i>	<i>Inches</i>				<i>Percent</i>
Normangee: NoC2 -----	D	>60	0-2 2-80	Clay loam ----- Clay, shaly clay -----	CL CL or CH	A-6 A-7-6	----- -----
Rader ----- Mapped only in complex with Lufkin soils.	D	20-40	0-25	Fine sandy loam -----	ML, CL, CL-ML, SM, SM-SC, SC	A-2-4 or A-4	-----
			25-32 32-52 52-77	Sandy clay loam ----- Sandy clay ----- Sandy clay loam -----	SC, CL CL, CH SC, CL	A-6 A-6 or A-7-6 A-6 or A-7-6	----- ----- -----
Styx: StB ----- For Aquic Haplustalfs part, see Aquic Haplustalfs.	A	40-60	0-33 33-84	Loamy fine sand ----- Sandy clay loam -----	SM-SC or SM CL, SC	A-2-4 or A-4 A-6	----- -----
Trinity: Te, Tf -----	D	0-15	0-84	Clay -----	MH or CH	A-7-6	-----
Wilson: WsA, WsB, WsC2 -----	D	0-12	0-5 5-32 32-90	Silt loam, clay loam ----- Silty clay ----- Silty clay -----	CL-ML, CL CL or CH CL or CH	A-4 or A-6 A-7-6 A-7-6	----- ----- -----

¹ NP = Nonplastic.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5 and on the experience of engineers and soil scientists with the soils of Kaufman and Rockwall Counties. In table 6, ratings are used to summarize suitability of the soils as sources of topsoil and road fill; limitations to use of the soils as pond reservoir areas and in dikes, levees, and other embankments; and soil features affecting drainage for crops and pasture, grassed waterways, and terraces and diversions.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special designs, or intensive maintenance is required. For some uses, the rating of severe is divided to obtain ratings of severe and very severe.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or its response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage, and the relative ease of excavating the material at borrow areas.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Dikes, levees, and other embankments require soil material resistant to seepage and piping and of favorable sta-

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permea- bility	Available water capacity	Reaction	Shrink- swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				<i>Percent</i>		<i>Inches per hour</i>	<i>Inches per inch of soil</i>	<i>pH</i>			
100	100	90-100	70-80	30-40	11-25	0.06-0.2	0.15-0.18	5.6-6.5	Moderate	High	Low.
100	100	90-100	75-90	45-70	30-50	<0.06	0.14-0.18	5.6-8.4	High	High	Low.
95-100	95-100	80-100	30-60	18-25	3-10	2.0-6.0	0.11-0.15	4.5-6.5	Low	High	High.
90-100	90-100	80-100	36-55	26-40	11-20	0.2-0.6	0.15-0.17	4.5-6.0	Moderate	High	High.
90-100	90-100	85-100	51-85	36-55	20-40	<0.06	0.12-0.18	4.5-5.5	High	High	High.
90-100	90-100	80-100	36-55	30-48	11-25	0.06-0.2	0.12-0.17	4.5-8.4	Moderate	High	Moderate.
100	100	70-95	20-40	<20	NP-5 ¹	2.0-6.0	0.09-0.11	5.1-7.3	Low	Low	Low.
100	100	80-95	40-60	25-40	11-22	0.6-2.0	0.12-0.17	4.5-6.5	Low	Moderate	Moderate.
100	98-100	95-100	85-98	61-78	26-45	<0.06	0.18-0.20	7.9-8.4	High	High	Low.
95-100	85-100	80-100	60-85	25-35	7-20	0.2-0.6	0.15-0.20	5.6-7.8	Low	High	Low.
90-100	80-100	80-100	65-90	41-55	25-35	<0.06	0.14-0.20	5.6-7.8	High	High	Low.
95-100	95-100	90-100	70-90	41-55	25-35	<0.06	0.12-0.15	5.6-8.4	High	High	Low.

bility, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among unfavorable factors.

Drainage for crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope, stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Grassed waterways are used to carry off excess water from terraced fields and other areas. Soils that are shallow to sandstone or shale are poorly suited as sites for waterways because these soils are droughty and vegetation is difficult to establish.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff, and vegetation is not difficult to establish.

Use of Soils in Town and Country Planning

The estimated interpretations in table 7 are based on the engineering properties of soils shown in table 5, on available test data, and on the experience of engineers and soil scientists with the soils of Kaufman and Rockwall Counties. In table 7, ratings are used to summarize limitations of the soils for sewage disposal systems, foundations for buildings, and local roads and streets.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use, or in other words, limi-

tations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special designs, or intensive maintenance is required.

Following are explanations of some of the columns in table 7.

Septic tank filter fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties that affect the pond floor and the embankment are considered. Those that affect the pond floor are permeability, organic matter, and slope, and if the floor needs to be leveled, depth to bedrock is important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, com-

TABLE 6.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soils in such mapping in the first column of this table. "Peres slowly" and some of the other terms that describe restrictive soil features are

Soil series and map symbols	Sutiability as a source of—		Degree of limitation and soil features affecting—
	Topsoil	Road fill	Pond reservoir areas
Altoga: AtD2 -----	Poor: too clayey -----	Poor: shrink-swell -----	Moderate: seepage -----
Aquic Haplustalfs ----- Mapped only in complex with Styx soils.	Poor: too sandy -----	Poor: low strength -----	Moderate: seepage -----
Aufco: Au -----	Poor: too clayey -----	Poor: shrink-swell -----	Slight -----
Axtell: AxB, AxC2 ----- AxD -----	Poor: thin layer ----- Poor: thin layer -----	Poor: shrink-swell ----- Poor: shrink-swell -----	Moderate: seepage ----- Moderate: seepage -----
Burleson: BuA -----	Poor: too clayey -----	Poor: shrink-swell -----	Slight -----
BuB -----	Poor: too clayey -----	Poor: shrink-swell -----	Slight -----
Crockett: CrB ----- CrC2 -----	Fair: thin layer ----- Poor: thin layer -----	Poor: shrink-swell ----- Poor: shrink-swell -----	Slight ----- Slight -----
Ellis: EsD -----	Poor: too clayey -----	Poor: shrink-swell -----	Slight -----
*Ferris: FeD2 ----- FhC ----- For Heiden part, see Heiden series.	Poor: too clayey ----- Poor: too clayey -----	Poor: shrink-swell ----- Poor: shrink-swell -----	Slight ----- Slight -----
Gowen: Gc ----- Gf -----	Fair: too clayey ----- Fair: too clayey -----	Poor: low strength ----- Poor: low strength -----	Moderate: seepage ----- Moderate: seepage -----
Haplustalfs, loamy: HaD -----	Poor: thin layer -----	Fair: low strength -----	Moderate: depth to rock -----
Heiden: HeC ----- HeD -----	Poor: too clayey ----- Poor: too clayey -----	Poor: shrink-swell ----- Poor: shrink-swell -----	Slight ----- Slight -----
Houston Black: HoA, HoB, HoC -----	Poor: too clayey -----	Poor: shrink-swell; low strength -----	Slight -----
Kaufman: Ka, Kb -----	Poor: too clayey -----	Poor: shrink-swell -----	Slight -----
Kemp: Ke ----- Kf -----	Good ----- Good -----	Poor: low strength ----- Poor: low strength -----	Moderate: seepage ----- Moderate: seepage -----
Konawa: KoB ----- KoC -----	Poor: too sandy ----- Poor: too sandy -----	Good ----- Good -----	Severe: seepage ----- Severe: seepage -----
Lewisville: LeB ----- LeC -----	Poor: too clayey ----- Poor: too clayey -----	Poor: shrink-swell ----- Poor: shrink-swell -----	Moderate: seepage ----- Moderate: seepage -----
*Lufkin: Lu ----- For the Rader part, see Rader series.	Fair: thin layer -----	Poor: shrink-swell -----	Slight -----
Mabank: MaA, MaB -----	Poor: thin layer -----	Poor: shrink-swell; low strength -----	Slight -----
Normangee: NoC2 -----	Poor: too clayey -----	Poor: shrink-swell; low strength -----	Slight -----
Rader ----- Mapped only in complex with Lufkin soils.	Good -----	Poor: shrink-swell; low strength -----	Slight -----
Styx: StB -----	Poor: too sandy -----	Good -----	Moderate: seepage -----
Trinity: Te, Tf -----	Poor: too clayey -----	Poor: shrink-swell -----	Slight -----
Wilson: WsA ----- WsB ----- WsC2 -----	Poor: thin layer ----- Poor: thin layer ----- Poor: too clayey -----	Poor: shrink-swell ----- Poor: shrink-swell ----- Poor: shrink-swell -----	Slight ----- Slight ----- Slight -----

engineering properties of the soils

units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to another series defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

Degree of limitation and soil features affecting— <i>Continued</i>	Soil features affecting—		
	Dikes, levees, and other embankments	Drainage for crops and pasture	Grassed waterways
Moderate: compressible ----- Moderate: piping -----	Not needed ----- Not needed -----	Slope; erodes easily ----- Droughty -----	Slope; erodes easily. Erodes easily.
Moderate: unstable fill -----	Floods -----	Wetness -----	Not needed.
Moderate: compressible ----- Moderate: compressible -----	Not needed ----- Not needed -----	Droughty ----- Droughty -----	Percs slowly; erodes easily. Slope; percs slowly; erodes easily.
Moderate: unstable fill; hard to pack. Moderate: unstable fill; hard to pack.	Percs slowly ----- Not needed -----	Percs slowly ----- Percs slowly -----	Percs slowly. Percs slowly.
Moderate: compressible ----- Moderate: compressible -----	Not needed ----- Percs slowly -----	Percs slowly ----- Percs slowly -----	Percs slowly, erodes easily. Percs slowly, erodes easily.
Moderate: compressible -----	Not needed -----	Slope; erodes easily -----	Slope; erodes easily.
Moderate: unstable fill ----- Moderate: unstable fill -----	Not needed ----- Not needed -----	Slope; erodes easily ----- Erodes easily -----	Slope; erodes easily. Erodes easily.
Moderate: compressible ----- Moderate: compressible ----- Moderate: thin layer -----	Not needed ----- Floods ----- Not needed -----	Favorable ----- Favorable ----- Slope; erodes easily -----	Favorable. Floods. Slope; erodes easily.
Moderate: unstable fill ----- Moderate: unstable fill -----	Not needed ----- Not needed -----	Percs slowly ----- Slope -----	Percs slowly. Slope.
Moderate: compressible; un- stable fill.	Percs slowly -----	Percs slowly -----	Percs slowly.
Moderate: compressible, un- stable fill.	Percs slowly -----	Percs slowly -----	Percs slowly.
Moderate: piping; compressible ----- Moderate: piping; compressible -----	Not needed ----- Floods -----	Favorable ----- Favorable -----	Not needed. Not needed.
Moderate: piping ----- Moderate: piping -----	Not needed ----- Not needed -----	Droughty; erodes easily ----- Slope; droughty; erodes easily -----	Erodes easily. Slope; erodes easily.
Moderate: compressible ----- Moderate: compressible ----- Moderate: compressible -----	Not needed ----- Not needed ----- Percs slowly; wetness -----	Favorable ----- Slope ----- Percs slowly; wetness -----	Favorable. Slope. Percs slowly; wetness.
Moderate: compressible; un- stable fill.	Percs slowly; wetness -----	Percs slowly -----	Percs slowly; erodes easily.
Moderate: unstable fill -----	Not needed -----	Percs slowly; erodes easily -----	Slow intake; percs slowly; erodes easily.
Moderate: compressible -----	Percs slowly; wetness -----	Percs slowly -----	Percs slowly; wetness.
Moderate: piping ----- Moderate: compressible -----	Not needed ----- Percs slowly; wetness -----	Droughty; erodes easily ----- Percs slowly; wetness -----	Too sandy; erodes easily. Percs slowly; wetness.
Moderate: compressible ----- Moderate: compressible ----- Moderate: compressible -----	Percs slowly; wetness ----- Not needed ----- Not needed -----	Percs slowly; wetness ----- Droughty; percs slowly ----- Droughty; percs slowly -----	Percs slowly; erodes easily. Percs slowly; erodes easily. Slope; percs slowly; erodes easily.

TABLE 7.—*Limitations of the soils for town and country planning*

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe" and other terms used to rate soils]

Soil series and map symbols	Septic tank filter fields	Sewage lagoons	Sanitary landfills (trench type)	Dwellings without basements	Light industries	Local roads and streets
Altoga: AtD2 ----	Moderate: percs slowly; slope.	Severe: slope ----	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell; slope.	Severe: shrink-swell.
Aquic Haplustalfs. Mapped only in complex with Styx soils.	Severe: percs slowly.	Moderate: seepage.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: low strength.
Aufco: Au -----	Severe: floods; percs slowly.	Severe: floods ----	Severe: floods; too clayey; wetness.	Severe: floods; wetness.	Severe: floods; wetness.	Severe: floods; shrink-swell.
Axtell: AxB, AxC2 -----	Severe: percs slowly.	Moderate: slope --	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
AxD -----	Severe: percs slowly.	Severe: slope ----	Severe: too clayey.	Severe: shrink-swell; slope.	Severe: shrink-swell; slope.	Severe: shrink-swell.
Burleson: BuA -----	Severe: percs slowly.	Slight -----	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell; low strength.
BuB -----	Severe: percs slowly.	Moderate: slope --	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell; low strength.
Crockett: CrB, CrC2.	Severe: percs slowly.	Moderate: slope --	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell; low strength.
Ellis: EsD -----	Severe: percs slowly.	Severe: slope ----	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell; slope.	Severe: shrink-swell; low strength.
Ferris: FeD2 -----	Severe: percs slowly.	Severe: slope ----	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell; slope.	Severe: shrink-swell; low strength.
FhC ----- For Heiden part, see Heiden series.	Severe: percs slowly.	Moderate: slope --	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell; low strength.
Gowen: Gc, Gf ----	Severe: floods ----	Severe: floods ----	Severe: floods ----	Severe: floods ----	Severe: floods ----	Severe: floods.
Haplustalfs, loamy: HaD.	Moderate: slope; depth to rock.	Severe: slope ----	Moderate: seepage; depth to rock.	Moderate: slope; low strength.	Severe: slope ----	Moderate: low strength.
Heiden: HeC, HeD.	Severe: percs slowly.	Moderate: slope --	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell; low strength.
Houston Black: HoA -----	Severe: percs slowly.	Slight -----	Severe: too clayey.	Severe: shrink-swell; low strength.	Severe: shrink-swell; low strength.	Severe: shrink-swell; low strength.
HoB, HoC -----	Severe: percs slowly.	Moderate: slope --	Severe: too clayey.	Severe: shrink-swell; low strength.	Severe: shrink-swell; low strength.	Severe: shrink-swell; low strength.
Kaufman: Ka, Kb.	Severe: floods; percs slowly.	Severe: floods ----	Severe: too clayey; floods.	Severe: floods ----	Severe: floods ----	Severe: floods; low strength.
Kemp: Ke, Kf ----	Severe: floods; wetness.	Severe: floods; wetness.	Severe: floods; wetness.	Severe: floods ----	Severe: floods ----	Severe: floods.
Konawa: KoB -----	Slight -----	Severe: seepage --	Moderate: seepage.	Slight -----	Slight -----	Slight.
KoC -----	Slight -----	Severe: seepage --	Moderate: seepage.	Slight -----	Moderate: slope --	Slight.
Lewisville: LeB, LeC.	Moderate: percs slowly.	Moderate: seepage.	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Lufkin: Lu ----- For Rader part, see Rader series.	Severe: percs slowly; wetness.	Slight -----	Severe: too clayey; wetness.	Severe: shrink-swell; wetness.	Severe: shrink-swell; wetness.	Severe: shrink-swell.

TABLE 7.—*Limitations of the soils for town and country planning—Continued*

Soil series and map symbols	Septic tank filter fields	Sewage lagoons	Sanitary landfills (trench type)	Dwellings without basements	Light industries	Local roads and streets
Mabank: MaA, MaB.	Severe: percs slowly; wetness.	Slight -----	Severe: too clayey; wetness.	Severe: shrink-swell; low strength; wetness.	Severe: shrink-swell; low strength; wetness.	Severe: shrink-swell; low strength.
Normangee: NoC2.	Severe: percs slowly.	Moderate: slope --	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell; low strength.
Rader ----- Mapped only in complex with Lufkin soils.	Severe: percs slowly; wetness.	Moderate: seepage.	Severe: wetness --	Severe: wetness --	Severe: wetness --	Severe: shrink-swell; wetness.
Styx: StB ----- For Aquic Haplustalfs part, see Aquic Haplustalfs.	Moderate: percs slowly; wetness.	Moderate: seepage; wetness.	Severe: wetness --	Slight -----	Slight -----	Slight.
Trinity: Te, Tf ----	Severe: percs slowly; floods; wetness.	Severe: floods ----	Severe: floods; too clayey; wetness.	Severe: floods; shrink-swell; low strength.	Severe: floods; shrink-swell; low strength.	Severe: floods; shrink-swell; low strength.
Wilson: WsA -----	Severe: percs slowly; wetness.	Slight -----	Severe: too clayey; wetness.	Severe: shrink-swell; wetness.	Severe: shrink-swell; low strength; wetness.	Severe: shrink-swell; low strength; wetness.
WsB, WsC2 -----	Severe: percs slowly.	Slight -----	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell; low strength.	Severe: shrink-swell; low strength.

pacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 7 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Dwellings without basements referred to in table 7 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Ratings for light industries are for the undisturbed soils that are used to support building foundations. Emphasis is on foundations, ease of excavation for underground utilities, and corrosion potential of uncoated steel pipe. The undisturbed soil is rated for spread footing foundations for buildings less than three stories high or foundation loads not in excess of that weight. Features affecting load-supporting capacity and settlement under load are wetness, flooding, texture, plasticity, density, and shrink-swell be-

havior. Features affecting excavation are wetness, flooding, slope, and depth to bedrock. Properties affecting corrosion of buried uncoated steel pipe are wetness, texture, total acidity, and electrical resistivity.

Local roads and streets have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Formation and Classification of Soils

This section consists of three main parts. The first part briefly discusses the five major factors of soil formation in terms of their effect on the soils of Kaufman and Rockwall Counties. The second part discusses the processes of soil horizon differentiation. The third part discusses the comprehensive system of soil classification and classifies the soil series.

Factors of Soil Formation

Soil is the product of the interaction of the five major factors of soil formation. These factors are climate, living organisms (especially vegetation), parent material, topography, and time (3).

The interrelationship among the five factors is complex, and the effect of any one factor is difficult to isolate. Each factor is discussed separately in the paragraphs that follow, but it is the interaction of all these factors, rather than their simple sum, that determines the nature of the soil.

Climate

The climate of Kaufman and Rockwall Counties is humid subtropical with hot summers. Presumably, the present climate is similar to that which existed when the soils were formed. Climate is uniform throughout the counties, but its effects have been modified locally by relief and runoff. The high temperatures and adequate rainfall favor plant growth and chemical activity and encourage micro-organism activity. As a result many deep soils formed in the area.

Living organisms

Plants, man, animals, insects, bacteria, worms, and fungi are important in the formation of soils. Living organisms cause gains in organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in soil structure and porosity. In the Texas Blacklands and claypan prairies, tall prairie grasses had more influence on soil formation than other plants. These tall grasses provided litter that protected the surface and added organic matter to soils such as those in the Houston Black series and the Lewisville series. Minerals and organic matter were distributed throughout the soil profile as these plants died and decomposed. The decomposed plant roots left channels that increased water intake and aeration of the soil. Earthworms and other soil organisms fed on the decomposed roots. The borings of earthworms also increased the movement of air and water through the soil.

Rodents played an important part in the formation of the Axtell, Rader, and Styx soils. Burrowing animals help mix the soil layers and distribute the organic materials in the soil.

In the past 100 years, man has also influenced soil formation. He cleared much of the forest, plowed up the prairies, and planted crops. This increased runoff and erosion and reduced the amount of organic matter in the soil. Tillage compacted the clayey soils, reduced aeration, infiltration, and permeability, and destroyed soil organisms.

Parent material

Parent material is the unconsolidated mass from which a soil is formed. It determines the limits of the chemical and mineral composition of the soil. The soils of Kaufman and Rockwall Counties formed from parent materials ranging from Upper Cretaceous to Recent in age.

Rocks forming the parent material consist mainly of clay, sand, marl, shale, and sandstone which crop out in north-south-trending belts. The oldest stratigraphic unit is exposed between the Trinity River and the East Fork of the Trinity River on the western margin of Kaufman County. Younger bedrock units are exposed in sequence to-

ward the east. Alluvium and terrace deposits are composed of sand, silt, clay, and gravel materials which overlap bedrock units in the vicinity of streams and rivers.

The Upper Cretaceous marine deposits include formations of the Taylor and Navarro groups (1). Formations of the Taylor Group crop out in the western portion of the survey area and are comprised of, in the order of outcrop from west to east, the Ozan, Wolfe City, Pecan Gap Chalk, and Marlbrook Marl. The calcareous clay and shale strata weather readily to form dark clayey soils such as Heiden and Houston Black soils. Axtell, Crockett, and Wilson soils formed in sandstone. The Navarro Group, located in the central portion of the survey area, consists of the Neylandville, Nacatoch Sand, Corsicana Marl, and Kemp Clay Formations. The Neylandville, Corsicana Marl, and Kemp Clay are composed mostly of calcareous clay, marl, and shale which weather to form Burleson, Crockett, Mabank, and Wilson soils. The Nacatoch Sand is a narrow band of fine-grained, glauconitic sand, extending from near the city of Kaufman northward into Hunt County. Axtell, Lufkin, and Rader soils formed in areas where the sand is exposed.

The Kincaid and Wills Point Formations of the Midway Group (4) (Eocene Series) crop out in a 10-mile-wide belt extending across eastern Kaufman County in a north-south direction. Materials of these formations consist of interbedded sand and clay. The glauconitic sand weathered to form Axtell, Lufkin, and Rader soils. Crockett, Mabank, and Wilson soils formed in the clayey materials.

Along the major streams are Quaternary terrace deposits that were laid down chiefly during the Pleistocene Epoch. Some of these deposits are smooth and are the parent material of Burleson, Houston Black, and Wilson soils. Others are sloping and are the parent material of Altoga and Lewisville soils.

Alluvium is of Recent age and is deposited along the Trinity River and East Fork of the Trinity River and many of the smaller stream valleys in the area. Examples of soils formed in these materials are Aufco and Trinity soils.

Topography

Topography, or relief, affects soil formation through its influence on drainage, erosion, plant cover, and soil temperature. In much of Kaufman and Rockwall Counties the soils slope less than 3 percent. The topography ranges from nearly level along flood plains and broad interstream divides to strongly sloping on side slopes above streams.

Erosion affected soil formation on the more sloping, unprotected soils. The Altoga and Lewisville soils formed in similar parent materials. Generally the Altoga soils are more sloping and eroded than Lewisville soils. Erosion has kept the surface layer of Altoga soils thin and light colored. Lewisville soils, in contrast, have a dark surface layer.

Soil temperature varies slightly according to position of the slopes. During summer, soil slopes facing north are slightly cooler than those facing south, and they generally produce more vegetation.

Time

Generally, a long time is required for formation of soils that have distinct horizons. The length of time that parent materials have been in place is commonly reflected in the degree of development of the soil horizons.

The soils in Kaufman and Rockwall Counties range from young to old. The young soils have very little horizon de-

velopment, and the older soils have well expressed soil horizons.

Gowen soils are an example of young soils having little horizon development. The soil horizons of Gowen soils still show the evidence of stratification, and there has been little change from the original stream-deposited alluvium. Rader soils are an example of old soils that have well expressed soil horizons. The parent materials of Rader soils have been in place for a long period of time. They have developed distinct A and Bt horizons that bear little resemblance to the original parent material.

Processes of Soil Horizon Differentiation

Several processes were involved in the formation of soil horizons in the soils of Kaufman and Rockwall Counties. The three main processes are accumulation of organic matter, leaching of calcium carbonates and bases, and formation and translocation of silicate clay minerals. In most soils more than one of these processes has been active in the development of horizons.

Accumulation of organic matter in the upper part of the surface layer has been important in the formation of an A1 horizon. The organic-matter content of the soils in Kaufman and Rockwall Counties ranges from low to medium.

Some leaching of carbonates has occurred in nearly all soils. Leaching of bases in soils precedes translocation of silicate clay minerals. Some calcium carbonate has been leached from the upper horizons of all the soils of the survey area but those of the Blackland Prairie. This has contributed to the development of distinct horizons. The amount of rainfall has not been great enough to leach all the carbonates from the soil. Some soils have a layer in which calcium carbonates have accumulated.

In several soils of Kaufman and Rockwall Counties, the downward translocation of clay minerals has also contributed to horizon development. Axtell, Crockett, Konawa, Styx, and Wilson soils are examples of soils in which translocated silicate clays have accumulated in the Bt horizon. The Bt horizon of these soils contains appreciably more silicate clay than the A horizon. These soils were probably leached of carbonates and soluble salts to a considerable extent before translocation of silicate clays took place. Leaching of bases and translocation of silicate clays are among the more important processes in horizon differentiation in the soils of Kaufman and Rockwall Counties.

Classification of Soils

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

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes

to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (7). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (5).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8, the soil series of Kaufman and Rockwall Counties are placed in three categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates.

Five orders are recognized in Kaufman and Rockwall Counties. Alfisols have a light-colored surface layer low in organic matter, a clay-enriched B horizon, an accumulation of aluminum and iron, and a base saturation of more than 35 percent. Entisols have little or no evidence of development of pedogenic horizons. Inceptisols have a light-colored surface layer low in organic matter, but they lack a clay-enriched B horizon. Mollisols have a dark-colored surface layer high in organic matter, and they have a base saturation of more than 50 percent. Vertisols are clayey soils that have deep, wide cracks part of each year in most years.

SUBORDER. Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP. Suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and surface horizons that are thick and dark colored. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like.

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order.

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Altoga	Fine-silty, carbonatic, thermic	Typic Ustochrepts	Inceptisols.
Aufco	Fine, mixed, acid, thermic	Aeric Fluvaquents	Entisols.
Axtell	Fine, montmorillonitic, thermic	Udertic Paleustalfs	Alfisols.
Burleson	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols.
Crockett	Fine, montmorillonitic, thermic	Udertic Paleustalfs	Alfisols.
Ellis	Fine, montmorillonitic, thermic	Vertic Ustochrepts	Inceptisols.
Ferris	Fine, montmorillonitic, thermic	Udorthentic Chromusterts	Vertisols.
Gowen	Fine-loamy, mixed, thermic	Cumulic Hapludolls	Mollisols.
Heiden	Fine, montmorillonitic, thermic	Udic Chromusterts	Vertisols.
Houston Black	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols.
Kaufman	Very-fine, montmorillonitic, thermic	Typic Pelluderts	Vertisols.
Kemp	Fine-loamy, mixed, nonacid, thermic	Aquic Udifluvents	Entisols.
Konawa	Fine-loamy, mixed, thermic	Ultic Haplustalfs	Alfisols.
Lewisville	Fine-silty, mixed, thermic	Typic Calcicustolls	Mollisols.
Lufkin	Fine, montmorillonitic, thermic	Vertic Albaqualfs	Alfisols.
Mabank	Fine, montmorillonitic, thermic	Vertic Albaqualfs	Alfisols.
Normangee	Fine, montmorillonitic, thermic	Vertic Haplustalfs	Alfisols.
Rader	Fine-loamy, mixed, thermic	Aquic Paleustalfs	Alfisols.
Styx	Loamy, mixed, thermic	Arenic Paleustalfs	Alfisols.
Trinity	Very-fine, montmorillonitic, thermic	Typic Pelluderts	Vertisols.
Wilson	Fine, montmorillonitic, thermic	Vertic Ochraqualfs	Alfisols.

engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Environmental Factors Affecting Soil Use

This section provides information about environmental factors that affect the use of soils. It discusses briefly the climate, relief and drainage, farming, transportation and markets, and water supplies in the survey area.

Climate⁵

The climate of Kaufman, Texas, is humid subtropical with hot summers. The Gulf of Mexico plays a dominant role in the climate of the area during the spring, summer, and fall months, while modified polar and arctic air masses contribute significantly to the winter climate. The range in temperature from winter to summer is considerable, and air mass changes occur frequently during the cool season of the year. Rainfall is adequate for most water needs, averaging 38.67 inches annually. Prevailing winds vary from south to southeast throughout the year, although northerly winds are frequent during the winter months.

Winter temperatures are mild. On an average, the daily maximum fails to rise above freezing only about four days each year. Arctic or cold polar air masses plunging rapidly southward out of Canada bring sharp drops in temperature, but ordinarily, cold spells are short. Cloudiness is more prevalent in winter, but the area continues to receive about 50 percent of the total possible sunshine during this season. Strong northerly winds accompany a vigorous cold front at times, but windspeeds decrease rapidly after the frontal passage. The lowest temperature ever recorded at Kaufman (since 1900) was -3° F in January 1940.

Daytime temperatures are hot in summer, particularly in July and August. Except for an occasional thunder-shower, there is little variation in the day-to-day weather in summer. Air-conditioning is needed for maximum comfort indoors. The highest temperature ever recorded at Kaufman (since 1900) was 113° F in August 1936.

Temperatures in the spring and fall are the most pleasant, and during these seasons there is sufficient variation in the weather to make it stimulating.

Precipitation falls mostly in thundershowers. While rainfall is fairly evenly distributed, monthly totals are largest in April and May. High intensity rains of short duration producing rapid runoff may occur during any season. In July 1962, 12.75 inches fell within a single 24-hour period. Slow general rains are more common in winter. The predominantly anticyclonic atmospheric circulation over Texas in summer and the exclusion of cold fronts from the area result in a relatively dry period in midsummer. Monthly and seasonal rainfall totals are quite variable. The driest year on record (since 1902) was 1910, with 22.79 inches of rain. The wettest year was 1926, when 58.33 inches fell.

Mean annual snowfall is 2.8 inches; however, mean values are misleading. A few exceptionally heavy snowfalls create a bias in the mathematical mean for long periods of years so that the statistic is a poor estimate of expected snowfall. Almost as frequent as snow storms are ice storms that cause considerable damage to trees, shrubs, and utility lines, and make travel hazardous for a few hours at a time.

The growing season (freeze-free period) at Kaufman averages 248 days. The average date of the last freeze in the spring is March 18, and the average date of the first freeze in the fall is November 21. Low temperatures are very sensitive to variations in topography, air drainage, plant cover, and soil conditions; therefore, significant departures from these mean values are likely to be found, not only in the surrounding rural area, but within the city limits of Kaufman.

Average annual relative humidity is about 81 percent at 6:00 a.m., 56 percent at noon, and 52 percent at 6:00 p.m., Central Standard Time. Seasonal averages vary only

⁵ By ROBERT B. ORTON, climatologist for Texas, National Weather Service, U.S. Department of Commerce.

slightly. The area receives about 65 percent of the total possible sunshine annually. Mean annual lake evaporation is estimated at 55 inches. A summary of the climate for Kaufman and Rockwall Counties is given in table 9.

Relief and Drainage

Kaufman and Rockwall Counties are on the divide between two large rivers, the Trinity and the Sabine. The drainage system is completely developed, and the inter-stream divides are low and rounded. The elevation of the upland areas range from 390 feet above sea level at Mabank, in southeastern Kaufman County, to 620 feet above sea level at Fate, in northern Rockwall County. Except for a small area in northern Kaufman County and eastern Rockwall County which drains into the Sabine River, all of the two-county area drains into the Trinity River or its tributaries. The general upland plain extends as a broad, undulating expanse over the northern three-fourths of the survey area.

In southwestern Kaufman County there is a series of low-lying stream terraces, embracing about 75 square miles, which grade into the undulating uplands. None of these terraces has a regional drainage system, and water stands in some places for long periods after heavy rains.

Most of the soils in the survey area slope less than 3 percent. The areas of greatest relief occur as distinct escarpments along the larger streams. The nearly level soils are confined largely to stream terraces and flood plains, but some soils on the uplands are nearly level and somewhat poorly drained.

Farming

The early agriculture, beginning with the first settlement about 1840, included cattle grazing on ranches on the prairies and scattered pioneer farming on the forested lands. This type of ranching and farming soon was replaced by the cash-crop system of cotton farming.

In the earlier period the prairies were an excellent range for cattle, and small streams provided adequate water. There was no practical way of fencing the prairies. The clayey soils were difficult to work using draft animals and tillage implements available at that time. Farm products had to be hauled in wagons to distant markets since railroad transportation was not available. The soils of the prairies, therefore, were not farmed, but were more valuable as ranch land. Cattle were easily driven to market. The forested soils, almost worthless for grazing, furnished a supply of wood for buildings, fuel, and fences. This forested land, once cleared, was easily cultivated, and it produced food crops for home use.

When the railroads were built and barbed wire was introduced, the prairies began to be placed in cultivation. Most of the soils well suited to crops in the survey area were in cultivation by 1900. By 1929 about 280,000 acres were planted to cotton. Since that time the acreage used for crops has steadily decreased. Currently there are about 180,000 acres in crops in the survey area; cotton and sorghums are the main crops grown.

The decrease in acreage used for crops has been accompanied by an increase in pasture. Beef cattle are the principal livestock and account for most of the agricultural income. Most of the cattle are sold at local auctions for commercial and domestic use. Herds are mostly cow-calf

operations and are kept year-round. Sales are usually direct from herds; few animals are finished in feedlots.

Transportation and Markets

Kaufman and Rockwall Counties are adequately served by highways and railroads. In Kaufman County Interstate 20 is the principal east-west highway. It parallels U.S. Highway 80, another major east-west highway, and serves Forney and Terrell. These highways connect Dallas and Longview. U.S. Highway 175 runs diagonally across the southern part of Kaufman County and serves Crandall, Kaufman, Kemp, and Mabank. Texas Highways 34 and 205 are the principal north-south highways. In Rockwall County Interstate 30 is the principal east-west highway. It connects Dallas and Texarkana. Texas Highway 205 is the main north-south highway. It connects Rockwall and Terrell.

Numerous farm to market roads connect all of the towns and communities of the two-county region.

There are three railroads in the two counties. The M.K.T. railroad serves Rockwall, the Texas and Pacific serves Terrell and Forney, and the Southern Pacific serves Crandall, Kaufman, Kemp, and Mabank.

The city-owned airport in Terrell has facilities for small aircraft, including paved runways, hangar space, and fuel service.

The principal markets for livestock are the local weekly livestock auctions.

The metropolitan markets of nearby Dallas and Fort Worth are easily reached by railroad or highway.

Water Supply

The most valuable resource to Kaufman and Rockwall Counties is the surface water that is in or nearby the area. Nine reservoirs in or near the area serve the two counties.

The lack of adequate water was once a common problem. The only water available in rural areas was rainwater caught in cisterns or ponds. Where well water is available, it is generally of poor quality, and most wells are uneconomical to pump because they are too deep. As a result of this situation, rural water supply systems have been developed. These systems provide adequate water to about 90 percent of the farms and ranches in the area.

Numerous watershed lakes and other private lakes greater than 5 acres in size provide water for livestock and can be developed for recreational uses. Nearly all water for livestock is provided by small ponds. Most soils in the survey area are suitable for pond construction.

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TABLE 9.—*Temperature*
[Data from Kaufman, elevation 448 feet. Period of record, except

Month	Temperature				Precipitation				
	Mean daily maximum	Mean monthly highest maximum	Mean daily minimum	Mean monthly lowest minimum	Mean total	Probability, in percent, of receiving selected amounts during month			
						0 or trace	0.50 inch or more	1.00 inch or more	2.00 inches or more
	° F	° F	° F	° F	Inches				
January	54.3	75.3	32.8	14.4	2.63	<1	93	84	60
February	58.9	77.6	36.9	21.6	3.02	<1	96	90	65
March	66.7	83.3	42.4	26.7	2.78	<1	96	90	65
April	75.9	88.1	52.6	36.5	4.99	<1	99	94	80
May	83.2	93.1	61.3	48.5	4.63	<1	99	95	85
June	91.0	98.2	69.2	60.2	3.79	5	90	80	60
July	96.1	103.1	72.5	66.6	2.75	<1	80	70	43
August	97.1	104.3	71.9	64.5	2.11	1	80	70	40
September	90.4	100.8	65.4	52.4	2.81	1	85	75	55
October	80.7	92.3	54.5	38.3	2.90	<1	85	85	55
November	66.9	83.1	42.2	26.8	3.29	<1	90	78	60
December	57.7	76.3	35.7	20.3	2.97	<1	95	86	65
Year	76.6		53.1		38.67				

¹ Length of record, 11 years.

² Less than one-half day.

³ Trace, an amount too small to measure.

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- (9) University of Texas. 1972. Geologic atlas of Texas, Dallas sheet map with explanation.

Glossary

This glossary defines those terms most frequently needed in soil survey reports. It can be used to check glossaries prepared by authors, or to compile a glossary at an author's request. If additional definitions are really necessary, you can obtain them from the Desk Glossary or from the Yearbooks of Agriculture and other references in the Editorial Section. Generally, authors who compile their own glossaries provide more definitions than are needed.

ABC soil. A soil that has a complete profile, including an A, B, and C horizon.

AC soil. A soil that has an A horizon and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

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

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

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.

Badlands. Areas of rough, irregular land where most of the surface is occupied by ridges, gullies, and deep channels. Land hard to traverse.

Base saturation. The degree to which material that has base-exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.

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

California bearing ratio. The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California, and abbreviated CBR. A soil with a CBR of 16 will support 16 percent of the load that would be supported by the standard crushed limestone, per unit area and with the same degree of distortion.

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.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

Compressible. The soil is relatively soft and decreases excessively in volume when a load is applied.

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.

and precipitation data

where noted, is 1937-66. The symbol < means less than]

Precipitation—Continued									
Probability, in percent, of receiving selected amounts during month—Continued				Mean number of days with ¹			Snow, sleet		
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	0.50 inch or more	1.00 inch or more	Mean total	Maximum monthly	Greatest depth ¹
							Inches	Inches	Inches
38	25	15	9	4	2	1	1.6	8.0	7
45	31	21	10	5	2	1	.6	4.0	3
44	28	16	8	4	1	(²)	.2	2.2	0
62	45	30	15	7	4	2	(³)	(³)	0
68	58	40	20	6	3	1	0	0	0
45	30	20	15	5	3	1	0	0	0
30	19	10	7	3	2	1	0	0	0
30	19	10	5	3	2	1	0	0	0
37	27	17	12	4	2	2	0	0	0
40	25	19	11	4	2	1	0	0	0
40	30	20	10	5	2	1	.3	8.0	0
50	35	20	12	5	2	1	.1	1.0	3
				55	27	13	2.8	8.0	7

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Decreaser. Any of the climax range plants most heavily grazed. Because they are the most palatable, they are first to be destroyed by overgrazing.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock is so near the surface that it affects specified use of the soil.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

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 available water 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 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.

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

Favorable. Features of the soil are favorable for the intended use.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

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

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gilgai. Typically, the microrelief of Vertisols—clayey soils that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Gypsum. Calcium sulphate.

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.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Increases. Species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing; increases commonly are shorter than decreases, and some are less palatable to livestock.

Invaders. On range, plants that come in and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface. (Most weeds are "invaders.")

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Low strength. The soil has inadequate strength to support loads.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common, and many*; size—*fine, medium, and coarse*; and contrast—*faint, distinct, and prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Peres slowly. Water moves through the soil slowly, affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid*.

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 series, 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.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Piping. The soil is susceptible to the formation of tunnels or pipelike cavities by moving water.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semi-solid to a plastic state.

Poor outlets. Surface or subsurface drainage outlets are difficult or expensive to install.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condi-

tion classes generally recognized are—*excellent, good, fair, and poor*. The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind of climax vegetation.

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.

Rill. A steep-sided channel resulting from accelerated erosion. A rill normally is a few inches in depth and width and is not large enough to be an obstacle to farm machinery.

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.

Seepage. Water moves through the soil so quickly that it affects the specified use.

Sequum. A sequence consisting of an alluvial horizon and the overlying eluvial horizon. If two sequa are present in a single soil profile, it is said to have a bisequum.

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.

Shrink-swell. Soil expands on wetting and shrinks on drying, which may cause damage to roads, dams, building foundations, or other structures.

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.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Slow intake. Water infiltrates slowly into the soil.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life 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 grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

- Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.
- Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.
- Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.
- Terrace (geological).** An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.
- 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."
- Thin layer.** Suitable soil material is not thick enough for use as borrow material or topsoil.
- Tilth, soil.** The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.
- Topsoil.** A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress road-banks, lawns, and gardens.
- Unstable fill.** Banks of fill likely to cave in or slough.
- 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.
- Well-graded soil.** A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.
- Wilting point** (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read the description of the mapping unit and the description of the soil series of which it is a part. When referring to a capability unit, pasture and hayland suitability group, or range site, read the introduction of its section for general management information. Dashes indicate that the soil was not placed in a particular grouping.

Map symbol	Mapping unit	De-scribed on page	Capability unit		Pasture and hayland group	Range site
			Symbol	Page	Number	Name
AtD2	Altoga silty clay, 3 to 12 percent slopes, eroded-----	6	VIe-3	29	7D	Clay Loam
Au	Aufco soils, frequently flooded-----	7	Vw-1	28	1B	Clayey Bottomland
AxB	Axtell fine sandy loam, 1 to 4 percent slopes-----	8	IIIe-1	27	8A	Claypan Savannah
AxC2	Axtell fine sandy loam, 2 to 5 percent slopes, eroded-----	8	IVe-1	28	8A	Claypan Savannah
AxD	Axtell fine sandy loam, 5 to 12 percent slopes-----	8	VIe-1	29	8B	Claypan Savannah
BuA	Burleson clay, 0 to 1 percent slopes-----	10	IIw-2	27	7A	Blackland
BuB	Burleson clay, 1 to 3 percent slopes-----	10	IIE-1	26	7A	Blackland
CrB	Crockett fine sandy loam, 1 to 3 percent slopes-----	10	IIIe-1	27	8A	Claypan Prairie
CrC2	Crockett fine sandy loam, 2 to 5 percent slopes, eroded-----	11	IVe-5	28	8A	Claypan Prairie
EsD	Ellis clay, 5 to 12 percent slopes-----	11	VIe-2	29	7B	Eroded Blackland
Fed2	Ferris clay, 5 to 12 percent slopes, eroded-----	12	VIe-3	29	7B	Eroded Blackland
FhC	Ferris-Heiden complex, 2 to 5 percent slopes-----	12	IVe-4	28	7A	Eroded Blackland
Gc	Gowen clay loam, occasionally flooded-----	13	I-1	25	2A	Loamy Bottomland
Gf	Gowen clay loam, frequently flooded-----	13	Vw-2	29	2A	Loamy Bottomland
HaD	Haplustalfs, loamy, 5 to 12 percent slopes--	13	VIe-4	29	8D	Sandy Loam
HeC	Heiden clay, 3 to 5 percent slopes-----	14	IIIe-2	27	7A	Blackland
HeD	Heiden clay, 5 to 8 percent slopes-----	14	IVe-2	28	7B	Blackland
HoA	Houston Black clay, 0 to 1 percent slopes---	15	IIw-2	27	7A	Blackland
HoB	Houston Black clay, 1 to 3 percent slopes---	15	IIE-1	26	7A	Blackland
HoC	Houston Black clay, 3 to 5 percent slopes---	15	IIIe-2	27	7A	Blackland
Ka	Kaufman clay, occasionally flooded-----	16	IIw-1	26	1A	Clayey Bottomland
Kb	Kaufman clay, frequently flooded-----	16	Vw-1	28	1A	Clayey Bottomland
Ke	Kemp loam, occasionally flooded-----	17	IIw-3	27	2A	Loamy Bottomland
Kf	Kemp loam, frequently flooded-----	17	Vw-2	29	2A	Loamy Bottomland
KoB	Konawa loamy fine sand, 1 to 3 percent slopes-----	18	IIIe-3	27	9A	Sandy Loam
KoC	Konawa loamy fine sand, 3 to 8 percent slopes-----	18	IVe-6	28	9A	Sandy Loam
LeB	Lewisville silty clay, 1 to 3 percent slopes-----	18	IIE-2	26	7C	Clay Loam
LeC	Lewisville silty clay, 3 to 8 percent slopes-----	18	IVe-3	28	7D	Clay Loam
Lu	Lufkin-Rader complex-----	19	IIIw-1	27	8E	Claypan Savannah
MaA	Mabank fine sandy loam, 0 to 1 percent slopes-----	20	IIIw-2	27	8A	Claypan Prairie
MaB	Mabank fine sandy loam, 1 to 3 percent slopes-----	20	IIIe-1	27	8A	Claypan Prairie
NoC2	Normangee clay loam, 2 to 8 percent slopes, eroded-----	21	VIe-2	29	7I	Claypan Prairie
StB	Styx-Aquic Haplustalfs complex, 0 to 3 percent slopes-----	22	IIIs-1	27	9A	Sandy
Te	Trinity clay, occasionally flooded-----	23	IIw-1	26	1A	Clayey Bottomland
Tf	Trinity clay, frequently flooded-----	23	Vw-1	28	1A	Clayey Bottomland
WsA	Wilson silt loam, 0 to 1 percent slopes-----	24	IIIw-2	27	8A	Claypan Prairie
WsB	Wilson silt loam, 1 to 3 percent slopes-----	24	IIIe-1	27	8A	Claypan Prairie
WsC2	Wilson clay loam, 2 to 5 percent slopes, eroded-----	24	IVe-5	28	7H	Claypan Prairie

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