United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with Texas Agricultural Experiment Station and Texas State Soil and Water Conservation Board

Soil Survey of Van Zandt County, Texas

How to Use This Soil Survey

General Soil Map

The general soil map, which is a color map, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

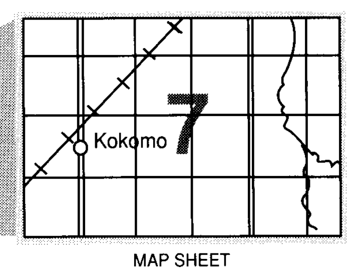
Detailed Soil Maps

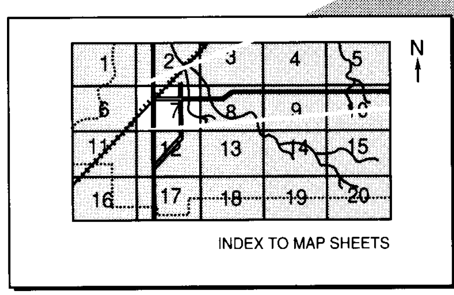
The detailed soil maps can be useful in planning the use and management of small areas.

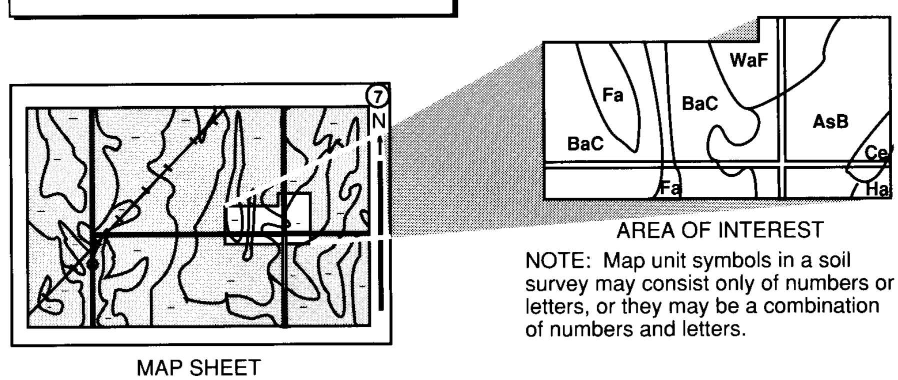
To find information about your area of interest, locate that area on the **Index to Map Sheets**. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.







This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1991. Soil names and descriptions were approved in 1994. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1991. This survey was made cooperatively by the Natural Resources Conservation Service, the Texas Agricultural Experiment Station, and the Texas State Soil and Water Conservation Board. The survey is part of the technical assistance furnished to the Kaufman-Van Zandt Soil and Water Conservation District and the Trinity-Neches Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: The main farm enterprise in Van Zandt County is raising livestock. About 66 percent of the county is used primarily for grazing. Livestock are also grazed on many areas managed for woodland.

Contents

Issued March 1998

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that affects land use planning in this survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations that affect various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

John P. Burt
State Conservationist
Natural Resources Conservation Service

Soil Survey of
Van Zandt County, Texas

By Billy R. Stringer, Natural Resources Conservation Service

Fieldwork by Billy R. Stringer, Natural Resources Conservation Service

United States Department of Agriculture, Natural Resources Conservation Service,
in cooperation with
the Texas Agricultural Experiment Station and the Texas State Soil and Water
Conservation Board

VAN ZANDT COUNTY is in the northeast part of Texas (fig. 1). The total area, including water, is 549,964 acres, or about 860 square miles. The county is irregular in shape and is about 60 miles from the northwest corner to the southeast corner. The elevation ranges from 573 feet above sea level in the central part of the county to about 421 feet in the southeast corner. The topography is mainly gently undulating to rolling.

Van Zandt County is in the Western Coastal Plain, Texas Claypan Area, and Texas Blackland Prairie Major Land Resource Areas. The soils that formed under timber and savannah are generally lighter in color and more sandy than soils formed under prairie grasses.

The county is drained by numerous creeks and streams that generally flow away from the central part of the county. Streams north of Canton and Wills Point flow northward to the Sabine River. Streams west of Wills Point and Canton flow southwesterly to the Trinity River. Streams in the southeastern part of the county flow to the Neches River.

About 54 percent of the county is used for improved pasture and for hayland. About 13 percent is managed for woodland and about 8 percent of the county that was originally woodland has been cleared and is now being used as native pasture (fig. 2). Less than 10 percent is used for cropland, and only about one-fifth of that is in row crops and truck crops. About 4 percent is used for rangeland. The remaining 11 percent of the county is in towns, roads, railroads, water, and other miscellaneous uses.

This soil survey updates the survey of Van Zandt County, Texas, published in 1928 *(10)*. It provides additional information and has larger maps, which show the soils in greater detail.

General Nature of the County

This section gives general information concerning Van Zandt County. It discusses settlement and population, agriculture, natural resources, and climate.

Settlement and Population

Van Zandt County, named for Republic of Texas leader Isaac Van Zandt, was created from Henderson County in 1848.

A few Caddo Indians were in the area now known as Van Zandt County when the first Europeans visited the area in the eighteenth century. Tawakoni Indians also hunted in the area. From about 1819 to 1839, a band of Cherokee Indians lived along the Sabine River. The first documented Mexican settler obtained a land title in 1834, but never lived in the county. By 1850, there were 1348 settlers who were mainly of Anglo origin *(5)*. Most of them came from the southern states.

Canton, the county seat, had a population of 2,937 in 1990. Other towns in the county are Edgewood, Edom, Fruitvale, Grand Saline, Van, and Wills Point. The county population in 1990 was 39,433 *(8)*.

Agriculture

Raising beef cattle is the main agricultural enterprise in Van Zandt County. Other livestock raised in significant numbers are dairy cattle, hogs, and horses. Other

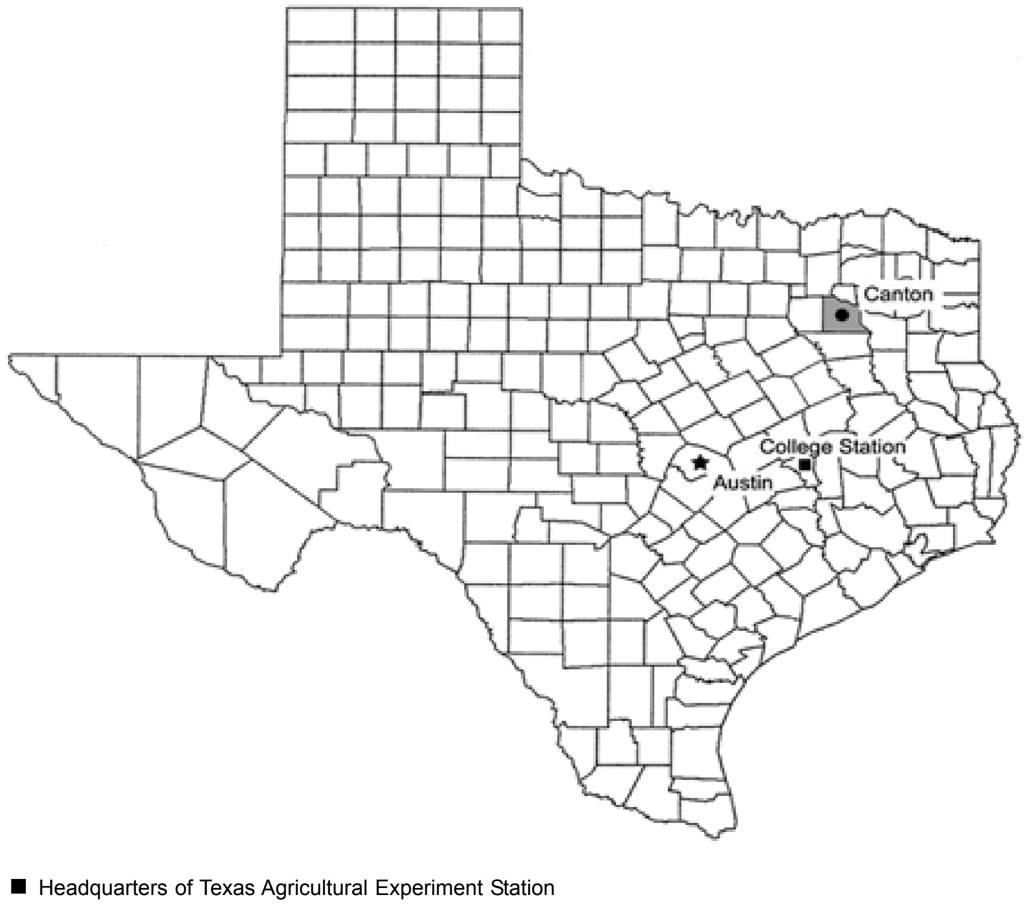


Figure 1.—Location of Van Zandt County in Texas.

agricultural enterprises include hay, cultivated crops, and timber.

Crop production prior to World War II was dominantly cotton and corn. The agriculture of the county has changed drastically since that time. The amount of land used for crops has decreased and the major crops are now hay and forage. Small grains, sweet potatoes, cotton, tomatoes, watermelons, and nursery stock are also grown.

Some commercial tracts of timber, both pine and hardwood trees, in Van Zandt County. Pine is sold for pulpwood, posts, crossties, and other wood products. Mature stands are sold for saw timber. Hardwood trees are cut mainly for firewood, crossties, and pulpwood.

Natural Resources

Soil is the most important natural resource in the county. The livelihood of many people depends on the soil to produce forage and hay for livestock, which is a major source of income.

Water is a very important natural resource and Van Zandt County has an abundant supply. Lake Tawakoni, partly in Van Zandt County along the northern boundary, provides water, flood control, fishing, and other recreational activities. The Sabine River, Neches River, and numerous smaller creeks and lakes are also an abundant source of water. Farm ponds are numerous. Most of the county has ample supplies of good quality underground water for industrial, recreational, agricultural, and domestic uses.

Salt, another important natural resource, is mined from a huge salt dome at Grand Saline. The salt dome is only a few hundred feet below the surface. Natural springs in the area created a salt marsh, which was a source of salt for the Indians and for wildlife.

Oil and gas production is also a major source of income and jobs. Several oil and gas fields are in the county.

Iron ore occurs as deposits in the Weches Formation and was mined in the past. Lignite, a form of soft coal, occurs as deposits in the Wilcox geological group. Brick clay is also available in the county.

Tourism is also an important resource. One of the better-known attractions is Canton's First Monday Trade's Day. People travel hundreds of miles to attend this monthly event. Other attractions are the salt palace and salt festival in Grand Saline and Purtis Creek State Park.

Climate

Prepared by the Water and Climate Center, Natural Resource Conservation Service, Portland, Oregon

Table 1 gives data on temperature and precipitation for the survey area as recorded at Wills Point in the period 1961 to 1990. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 45 degrees F and the average daily minimum temperature is 34 degrees. The lowest temperature on record, which occurred on December 24, 1989, is -2 degrees. In summer, the average temperature is 82 degrees and the average daily maximum temperature is 93 degrees. The highest recorded temperature, which occurred on August 18, 1909, is 115 degrees.

Growing degree days are shown in table 3. They are equivalent to “heat units.” During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 43 inches. Of this, 22 inches, or 52 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 9 inches. The heaviest 1-day rainfall during the period of record was 7.08 inches on June 12, 1945. Thunderstorms occur on about 46 days each year, and most occur in May.

The average seasonal snowfall is about 3.7 inches. The greatest snow depth at any one time during the period of record was 7 inches.

The average relative humidity in midafternoon is about 56

Figure 2.—A typical area of a well managed native pasture on Woodtell loam, 5 to 12 percent slopes.

percent. Humidity is higher at night, and the average at dawn is about 82 percent. The sun shines 74 percent of the time possible in summer and 56 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in March.

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The descriptions, names, and delineations of the soils in this survey area do not fully agree with those of the soils in adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in series concepts, or variations in the intensity of mapping or in the extent of the soils in the survey areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The components of one map unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soils of the Woodlands

These soils make up about 65 percent of Van Zandt County. The Cuthbert, Elrose, Freestone, Kirvin, Oakwood, Pickton, Redsprings, Wolfpen, and Woodtell soils are the major soils in this group. These soils developed in sandy, loamy, and clayey sediments of the Claiborne and Wilcox Geological Groups. The landscapes range from broad, gently sloping areas to moderately steep scarps. Native grasses are mainly bluestems, uniola, panicums, purpletop, and indiangrass. Trees are dominantly oak, sweetgum, elm, hickory, and pine.

1. Woodtell-Freestone

Very gently sloping to strongly sloping, well drained to moderately well drained, loamy soils

In this map unit, the landscape is typically broad, smooth ridges and divides. The soils formed in interbedded shale and loamy materials.

This map unit makes up about 39 percent of the county. It is about 39 percent Woodtell soils, 25 percent Freestone soils, and about 36 percent soils of minor extent.

Typically, the surface layer of the Woodtell soil is very dark grayish brown and grayish brown loam about 8 inches thick. The clayey subsoil becomes less clayey with depth. It extends from a depth of 8 inches to a depth of 54 inches. It is red or dark red with mottles in the upper part and is dark yellowish brown with mottles in the lower part. The underlying material, from a depth of 54 to 80 inches, is stratified shale and loamy material in shades of gray and brown. This soil is strongly acid except for the underlying material, which is slightly acid.

Typically, the surface layer of the Freestone soil is dark brown and brown fine sandy loam about 16 inches thick. The subsoil extends to a depth of more than 80 inches. The upper part is brownish sandy clay loam with mottles in shades of red and gray. The next part is grayish or brownish clay. The lower part is clay loam mottled in shades of gray and brown. The surface layer is slightly acid. The upper parts of the subsoil are strongly acid and the lower part is moderately acid.

Of minor extent in this map unit are the Bernaldo, Cuthbert, Derly, Gallime, Kirvin, Leagueville, Lufkin, Manco, Nahatche, Oakwood, Pickton, Rader, Raino, and Wolfpen soils. The Bernaldo and Gallime soils are on stream terraces. The Cuthbert, Kirvin, and Oakwood soils are on stream divides and side slopes of drainageways. The Derly-Raino soils and the Lufkin-Rader soils are on old stream terraces. The Leagueville, Pickton, and Wolfpen soils have a sandy surface layer. The Leagueville soils are wetter. The loamy Manco and Nahatche soils are on flood plains.

The Woodtell and Freestone soils formed under a woodland canopy of post oak, red oak, blackjack oak, hickory, sweetgum, and elm.

This map unit is used mainly for pasture. The main grasses are improved bermudagrass, common bermudagrass, and bahiagrass with an overseeding of clover or vetch. A few areas have been planted to pine trees. These soils were once used for growing cotton, corn, and sorghums. The small areas in cropland are currently used for growing corn, tomatoes, peas, sweet potatoes, beans, and small grain. These soils are highly erodible and conservation management practices are needed to reduce erosion. The major limitations affecting urban development are very slow permeability, high shrink-swell potential, low strength, and wetness.

2. Wolfpen-Pickton

Gently sloping to moderately steep, well drained, sandy soils

In this map unit, the landscape is typically broad, sandy ridges and divides. The soils formed in loamy sediments.

This map unit makes up about 17 percent of the county. It is about 37 percent Wolfpen soils, 29 percent Pickton soils, and about 34 percent soils of minor extent.

Typically, the surface layer of the Wolfpen soil is dark brown loamy fine sand about 5 inches thick. The subsurface layer is pale brown loamy fine sand about 13 inches thick. The sandy clay loam subsoil extends from a depth of 28 inches to a depth of more than 80 inches. The upper part is yellowish brown with mottles in shades of brown and red. The lower part is mottled in shades of gray, red, and brown. The soil is slightly acid or moderately acid.

Typically, the surface layer of the Pickton soil is brown fine sand about 7 inches thick. The subsurface layer is yellowish brown fine sand about 53 inches thick. The sandy clay loam subsoil extends from a depth of 60 inches to a depth of more than 80 inches. The upper part is yellowish brown with mottles in shades of brown. The lower part is mottled in shades of gray, red, and brown. The soil is slightly acid except for the lower part of the subsoil which is strongly acid.

Of minor extent in this map unit are the Bernaldo, Cuthbert, Derly, Freestone, Kirvin, Leagueville, Manco, Nahatche, Oakwood, Raino, Tenaha, Tonkawa, and Woodtell soils. The loamy Bernaldo, Derly, Freestone, and Raino soils are on stream terraces. The loamy Cuthbert, Kirvin, and Oakwood soils are on divides and side slopes of drainageways. The sandy Leagueville soils are on terraces and are wetter. The loamy Manco and Nahatche soils are on flood plains of streams. The sandy Tenaha soils are on side slopes of drainageways. The Tonkawa soils are on interstream divides and are fine sand to a depth of more than 80 inches. The loamy Woodtell soils are on broad divides.

Wolfpen and Pickton soils formed under a woodland canopy of red oak, post oak, blackjack oak, sandjack oak, hickory, elm, sweetgum, and pine.

This map unit is used mainly for pasture. The main grasses are improved bermudagrass, common bermudagrass, bahiagrass and lovegrass with some overseeding of clovers and vetch. Some areas are in woodland and some former cropland has been planted to pine trees. The small areas in cropland are used for growing peas, watermelons, roses, sweet potatoes, tomatoes, and corn. Droughtiness and erosion are the main limitations affecting cropland use. These soils are generally suited to most urban uses.

3. Cuthbert-Oakwood-Kirvin

Gently sloping to moderately steep, well drained and moderately well drained, loamy soils

In this map unit, the landscape is typically narrow divides, ridges, side slopes, and narrow drainageways. The soils formed in unconsolidated or weakly consolidated sandstone and interbedded shale and loamy materials.

This map unit makes up about 8 percent of the county. It is about 38 percent Cuthbert soils, 19 percent Oakwood and closely similar soils, 10 percent Kirvin soils, and 33 percent soils of minor extent.

Typically, the surface layer of the Cuthbert soils is dark brown and yellowish brown fine sandy loam about 10 inches thick. The subsoil extends from a depth of 10 inches to a depth of 36 inches. The upper part is red clay. The lower part is red sandy clay loam. The underlying material, from a depth of 36 to 60 inches, is sandstone interbedded with shale. The surface layer is moderately acid. The upper part of the subsoil is strongly acid and the lower part is very strongly acid. The underlying material is extremely acid.

Typically, the surface layer of the Oakwood soil is dark brown and light yellowish brown fine sandy loam about 15 inches thick. The subsoil extends from a depth of 15 inches to a depth of more than 80 inches. The upper part is yellowish brown or brownish yellow sandy clay loam with mottles in shades of red. The lower part is grayish brown clay loam with mottles in shades of red and yellow. The surface layer is slightly acid. The subsoil is moderately acid or strongly acid.

Typically, the surface layer of the Kirvin soil is dark brown and pale brown fine sandy loam about 11 inches thick. The subsoil extends from a depth of 11 inches to a depth of 55 inches. The upper part is red clay with mottles in shades of brown. The lower part is yellowish red clay loam with red and brown mottles. The underlying material is red and brown stratified sandy clay loam and gray shale. The surface layer is moderately acid or strongly acid. The subsoil and underlying material are very strongly acid.

The Bernaldo, Elrose, Freestone, and Gallime soils are closely similar to the Oakwood soils. The Bernaldo and Gallime soils are on old stream terraces. The Elrose soils are more red than the Oakwood soils, and the Freestone soils have a more clayey subsoil.

Of minor extent in this map unit are the Leagueville, Manco, Pickton, Redsprings, Tenaha, and Wolfpen soils. The Leagueville soils, in narrow drainageways, toe slopes, and depressional areas, are more sandy and wetter. The Manco soils are on flood plains of small streams. The Pickton, Tenaha, and Wolfpen soils are more sandy. The

Redsprings soils have a very gravelly surface layer and overlie glauconitic material.

The soils of this map unit formed under a woodland canopy of red oak, post oak, hickory, sweetgum, and pine trees.

This map unit is used mainly as woodland. Loblolly and shortleaf pines are grown for pulpwood, and oak trees are sold for firewood. Most areas of this map unit are too rough for growing crops; although a few acres are in corn and vegetables. Some of the smoother areas are in pastures of improved bermudagrass, common bermudagrass, and clovers and vetches. These soils are highly erodible and conservation management practices are needed to reduce erosion. These soils are suited to most urban uses. The limitations affecting urban development are slow permeability, slope, and low strength.

4. Redsprings-Elrose

Gently sloping to moderately steep, well drained, loamy soils

In this map unit, the landscape is typically narrow ridges and side slopes. The soils formed in loamy glauconite of marine origin.

This map unit makes up about 1 percent of the county. It is about 40 percent Redsprings soils, 23 percent Elrose soils, and 37 percent soils of minor extent.

Typically, the surface layer of the Redsprings soil is dark reddish brown very gravelly fine sandy loam about 6 inches thick. The subsoil extends from a depth of 6 inches to a depth of 48 inches. It is red clay with ironstone fragments. The underlying material is loamy glauconite. The surface layer is moderately acid. The subsoil is strongly acid in the upper part and very strongly acid in the lower part. The underlying material is very strongly acid.

Typically, the surface layer of the Elrose soil is reddish brown and yellowish red fine sandy loam about 12 inches thick. The subsoil extends to a depth of more than 80 inches, and is reddish sandy clay loam or clay loam. The surface layer is strongly acid. The subsoil is moderately acid in the upper part and strongly acid in the lower part.

Of minor extent in this map unit are the Cuthbert, Kirvin, Manco, Oakwood, Pickton, and Wolfpen soils. The Cuthbert soils are on side slopes with the Redsprings soils. The Kirvin and Oakwood soils are on ridge crests and toe slopes. The Manco soils are on flood plains of drainageways. The Pickton and Wolfpen soils are sandy and on smoother hilltops.

The soils of this map unit formed under a woodland canopy of red oak, post oak, sweetgum, hickory, and pine trees.

This map unit is used mainly for woodland and wildlife habitat. Loblolly and shortleaf pines are grown for pulpwood, and oak trees are sold for firewood. A few small areas are in pastures of improved bermudagrass, common bermudagrass, and bahiagrass. Most areas are too gravelly or too steep for pastures. Only a few very small areas are used for growing corn, tomatoes, peas, sweet potatoes, and squash. The ironstone gravels are mined in places for use as construction materials. These soils are suited to urban uses. The limitations affecting urban development are slope and low strength.

Soils of the Prairies and Savannahs

These soils make up about 22 percent of the county. The Crockett and Edge soils are the dominant soils in this group. These soils developed in loamy and clayey, mostly alkaline sediments of the Midway and Wilcox Geological Groups. The landscape ranges from areas that are broad and nearly level to those that are strongly sloping or rolling. Native grasses are mainly bluestems, indiangrass, switchgrass, grama, and paspalum. Trees are dominantly oak, elm, hackberry, and mesquite.

5. Crockett

Nearly level and gently sloping, moderately well drained, loamy soils

In this map unit, the landscape is typically broad, smooth, and low ridges. The soils formed in alkaline clay and shale.

This map unit makes up about 16 percent of the county. It is about 78 percent Crockett soils and closely similar soils, and about 22 percent soils of minor extent.

Typically, the surface layer of the Crockett soil is dark brown loam about 6 inches thick. The clay subsoil extends from a depth of 6 inches to a depth of 56 inches. The upper part is mottled in shades of brown and red. The next part is olive with mottles in shades of brown, yellow, and gray. The lower part is mottled in shades of gray and olive. The underlying material is yellowish brown and yellow clay loam. The surface layer is moderately acid. The subsoil is slightly acid in the upper part, grading to slightly alkaline in the lower part. The underlying material is moderately alkaline.

The Edge and Normangee soils are closely similar to the Crockett soils. Edge soils have a more red subsoil and are more acid. Normangee soils have a clay loam surface layer and are on side slopes of small drainageways.

Of minor extent in this map unit are the Bazette, Freestone, Lufkin, Nahatche, Sandow, Whitesboro, and Wilson soils. The Bazette soils are on side slopes of small drains. The Freestone soils are in positions similar to Crockett and Edge soils. The Lufkin and Wilson soils are in lower landscape positions. The Nahatche, Sandow, and Whitesboro soils are on the flood plains of streams.

The Crockett soils formed under a tall grass prairie.

Some of the minor soils, especially those on flood plains, developed under mixed hardwoods.

This map unit is used mainly for pasture. The main grasses are improved bermudagrass and common bermudagrass. Although once used for growing crops such as cotton, corn, and sorghums, only small areas of these soils are still used for this purpose. These soils are highly erodible and conservation management practices are needed to reduce erosion.

The limitations affecting urban development are the very slow permeability, high shrink-swell potential, and low strength.

6. Edge

Gently sloping to strongly sloping, well drained, loamy soils

In this map unit, the landscape is typically broad, smooth ridges and divides. The soils formed in interbedded soft sandstone and shale.

This map unit makes up about 6 percent of the county. It is about 59 percent Edge soil and closely similar soils, and 41 percent soils of minor extent.

Typically, the surface layer of the Edge soil is dark brown and pale brown fine sandy loam about 8 inches thick. The subsoil extends from a depth of 8 inches to a depth of 60 inches. The upper part is yellowish red clay. The next part is mottled brownish and reddish clay. The lower part is light grayish brown clay loam with mottles in shades of brown and yellow. The underlying material is interbedded shale and sandstone. The surface layer is moderately acid. The subsoil is very strongly acid in the upper part, grading to slightly acid in the lower part. The underlying material is slightly alkaline.

The Crockett soils are closely similar to the Edge soils. They are in similar landscape positions, but have a less acid and less red subsoil.

Of minor extent in this map unit are the Aufco, Bazette, Derly, Freestone, Gladewater, Lufkin, Nahatche, Rader, Raino, Sandow, Wilson, and Wolfpen soils. The Aufco, Gladewater, Nahatche, and Sandow soils are on flood plains of streams. The Bazette soils are on side slopes of small drains. The Derly, Freestone, Lufkin, Rader, Raino, and Wilson soils are in lower, smoother areas. The Wolfpen soils are in slightly higher sandy areas.

The Edge soils formed under a savannah of tall grasses and post oak trees.

The soils of this map unit are used mainly for pasture. The main grasses are improved bermudagrass and common bermudagrass. Although once used for growing crops such as cotton, corn, and sorghums, only small areas are still used for this purpose. These soils are highly erodible and conservation management practices are needed to reduce erosion. The limitations affecting urban development are very slow permeability, high shrink-swell potential, and low strength.

Soils of the Flood Plains

These soils make up about 12 percent of the county. The Aufco, Gladewater, Manco, Nahatche, Sandow, and Whitesboro soils are the dominant soils in this group. These soils developed in loamy and clayey sediments of Recent Geological Age. The landscape is nearly level flood plains of rivers and streams. Native grasses are bluestem, switchgrass, gamagrass, panicum, uniola, wildrye, and paspalum, as well as sedges. Trees are mainly oak, elm, ash, cottonwood, sweetgum, and pecan.

7. Nahatche-Manco

Nearly level, somewhat poorly drained, loamy soils

In this map unit, the landscape is nearly level flood plains of streams that drain woodlands. The soils formed in recent loamy sediments.

This map unit makes up about 8 percent of the county. It is about 46 percent Nahatche soils, 24 percent Manco soils, and about 30 percent soils of minor extent.

Typically, the surface layer of the Nahatche soils is dark brown loam about 8 inches thick. The subsoil is loam, sandy clay loam, or clay loam. It is shades of brown or gray and is mottled. The surface layer is moderately acid. The subsoil is moderately acid in the upper part, grading to slightly alkaline in the lower part.

Typically, the surface layer of the Manco soil is dark brown loam about 12 inches thick. The subsoil extends from a depth of 12 inches to a depth of 64 inches. The upper part is brownish loam. The lower part is grayish or brownish loam mottled in shades of brown and gray. The soil is very strongly acid throughout.

Of minor extent in this map unit are the Cuthbert, Elrose, Freestone, Gladewater, Kirvin, Nahatche, Oakwood, Pickton, Sandow, Wolfpen, and Woodtell soils. The Cuthbert, Elrose, Freestone, Kirvin, Oakwood, Pickton, Wolfpen, and Woodtell soils are on uplands along the edges of flood plains. The Gladewater, Sandow and Nahatche soils are saline. The Gladewater soils are lower on the landscape and Sandow soils are higher. Also included are areas of Salt flats.

This map unit is used for pasture and for woodland. The main plants are bahiagrass, dallisgrass, tall fescue, and white clover. Trees include water oak, willow oak, and sweetgum. The understory plants are grazed by livestock and wildlife. Flooding and wetness limit the use of these soils for cropland and for urban development.

8. Sandow-Whitesboro-Aufco

Nearly level, moderately well drained and somewhat poorly drained, clayey and loamy soils

In this map unit, the landscape is nearly level flood plains of streams draining the prairies and savannahs. Most streams flow southwestward to the Trinity River, except in the northern part of the county where some flow to the Sabine River. Where the Aufco and the Sandow soils occur on the same flood plain, the Aufco soils are in lower positions. Whitesboro soils are on higher positions than Aufco soils, but lower than Sandow soils. All are subject to flooding. The soils formed in recent clayey and loamy sediments.

This map unit makes up about 2 percent of the county. It is about 38 percent Sandow soils, 22 percent Whitesboro soils, 15 percent Aufco soils, and 25 percent soils of minor extent.

Typically, the surface layer of the Sandow soil is dark brown loam about 8 inches thick. From a depth of 8 inches to a depth of 63 inches, the subsoil is grayish or brownish stratified loam, sandy clay loam, or clay loam. The surface layer is neutral, and the subsoil is slightly acid or neutral.

Typically, the surface layer of the Whitesboro soil is very dark grayish brown loam about 56 inches thick. The subsoil, from a depth of 56 inches to a depth of 80 inches, is dark yellowish brown, dark brown, or dark grayish brown loam. The soil is neutral throughout.

Typically, the surface layer of the Aufco soil is black clay about 5 inches thick. The subsoil, from a depth of 5 inches to a depth of 76 inches, is dark grayish brown or grayish brown clay loam or clay. Mottles are in shades of brown or gray. The surface layer is moderately acid. The subsoil is strongly acid.

Of minor extent in this map unit are the Crockett, Edge, Nahatche, Normangee and Wilson soils. The Crockett, Edge, Normangee, and Wilson soils are on uplands along the outer edges of the flood plains. The Nahatche soils are lower on the landscape and wetter than Sandow soils.

The soils of this map unit are used for pasture and for woodland. Pasture plants include common and improved bermudagrass, bahiagrass, tall fescue, white clover, and singletary peas. Trees include water oak, willow oak, overcup oak, ash, elm, and cottonwood. The understory plants are grazed by livestock and wildlife. Flooding and wetness limit the use of these soils for cropland and for urban development.

9. Gladewater

Nearly level, somewhat poorly drained, clayey soils

In this map unit, the landscape typically is nearly level flood plains of the Sabine River. The soils formed in recent clayey sediment from sources outside the county. The sediment is mainly from soils formed in Cretaceous limestone and marl with small amounts of other material.

This map unit makes up about 2 percent of the county. It is about 83 percent Gladewater soils and 17 percent soils of minor extent.

Typically, the surface layer of the Gladewater soil is black clay about 8 inches thick. The subsoil, from a depth of 8 inches to a depth of 63 inches, is gray or dark gray clay. The surface layer is slightly acid, and the subsoil is moderately acid or slightly acid.

Of minor extent in this map unit are the Nahatche and Sandow soils. These soils are mainly near the mouth of local streams where less clayey sediment has been deposited on the river flood plain. These soils are generally slightly higher on the landscape than the Gladewater soils.

The soils of this map unit are mainly used for woodland. A few areas are used for pasture. Trees include water oak, willow oak, elm, sweetgum, and ash. The understory plants are grazed by livestock and wildlife. Pasture plants are common bermudagrass, bahiagrass, tall fescue, and white clover. Flooding, wetness, high shrink-swell potential, restricted permeability, and the clayey texture limit the use of these soils for cropland and for urban development.

Detailed Soil Map Units

The map units delineated on the detailed maps at the back of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information about each map unit is given under the heading “Use and Management of the Soils.”

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some “included” areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Crockett loam, 0 to 1 percent slopes, is a phase of the Crockett series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Derly-Raino complex, 0 to 1 percent slopes is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Cuthbert and

Redsprings soils, graded, 3 to 8 percent slopes is an undifferentiated group in this survey area.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Salt flats is an example.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see “Summary of Tables”) give properties of the soils and the limitations, capabilities, and potentials for many uses. The “Glossary” defines many of the terms used in describing the soils or miscellaneous areas.

Au—Aufco clay, frequently flooded. This soil is on nearly level flood plains of large streams. Surfaces are mainly smooth or concave and slopes are 0 to 1 percent. Areas are oblong and are a few hundred feet to about 0.5 mile wide. They range from about 100 to several hundred acres in size.

Typically, the surface layer is moderately acid, black clay about 5 inches thick. The upper part of the subsoil, from a depth of 5 to 20 inches, is strongly acid, dark grayish brown clay loam. The next part, from a depth of 20 to 54 inches, is strongly acid, dark grayish brown clay with light gray and dark brown mottles. The lower part, from a depth of 54 to 76 inches, is strongly acid, dark grayish brown clay with yellowish brown and gray mottles.

This soil is somewhat poorly drained. Surface runoff is low. Permeability is very slow, and the available water capacity is high. The hazard of erosion is slight. A perched water table is within a depth of 2 to 3 feet during the winter and spring. Flooding generally occurs two or three times a year, usually during the months of November through May, for a duration of 2 to 4 days.

Included with this soil in mapping are small areas of Whitesboro and Sandow soils that are less clayey and are in slightly higher positions on the landscape. Also included are some areas of clayey soils covered by 3 to 6 inches of loamy overwash. The included soils make up less than 15 percent of the map unit.

This Aufco soil is mostly in hardwood forests. A few areas have been cleared and planted in pasture grasses.

Water oak and overcup oak are the dominant trees. Other common trees are elm, willow oak, and ash. Water oak and overcup oak are sometimes commercially harvested to produce crossties. This soil is not suited to pine production because of flooding and wetness.

Common bermudagrass and coastal bermudagrass are suitable warm-season grasses. Tall fescue and white clover are adapted cool-season plants. Flooding and wetness limit forage production on this soil. Applications of fertilizer and lime can help maintain a higher level of production.

This soil is not suited to crops because of frequent flooding.

This soil is not suitable for urban uses because of flooding and wetness.

This soil is in capability subclass Vw and in the Clayey Bottomland range site. The woodland ordination symbol is 4W.

BaD—Bazette clay loam, 5 to 12 percent slopes. This strongly sloping soil is on uplands. Areas are irregular in shape and range from 25 to 100 acres in size.

Typically, the surface layer is neutral, very dark grayish brown clay loam about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 14 inches, is neutral, olive brown clay loam. The next part, from a depth of 14 to 24 inches, is neutral, light olive brown clay. The lower part, from a depth of 24 to 38 inches, is moderately alkaline, light olive brown clay loam. The underlying material, from a depth of 38 to 60 inches, is moderately alkaline, light yellowish brown and grayish brown clay loam.

This soil is well drained. Surface runoff is rapid, and permeability is slow. The available water capacity is moderate. The hazard of erosion is severe.

Included with this soil in mapping are areas of Crockett, Edge, and Normangee soils in similar positions on the landscape. The Crockett and Edge soils have an abrupt textural change between the surface and subsoil. The Normangee soils have a more clayey subsoil. The included soils make up less than 20 percent of the map unit.

This Bazette soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding adapted clovers or vetches into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil is not suited to crops because of the slope and hazard of erosion.

This soil has severe limitations for most urban uses. Shrinking and swelling and slope are limitations affecting dwellings. Slow permeability and slope restrict use of this soil for septic tank absorption fields. Low strength is a limitation that affects streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass VIe and in the Claypan Savannah range site.

BeB—Bernaldo fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on stream terraces. Surfaces are mainly smooth or slightly convex. Areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, The surface layer is slightly acid, brown fine sandy loam about 7 inches thick. The subsurface layer is moderately acid, pale brown fine sandy loam about 9 inches thick. The upper part of the subsoil, from a depth of 16 to 52 inches, is strongly acid, yellowish brown sandy clay loam with red mottles. The lower part, from a depth of 52 to 80 inches, is very strongly acid, mottled yellowish brown, red, and light brownish gray sandy clay loam.

This soil is well drained. Surface runoff is very low. Permeability is moderate and the available water capacity is high. The hazard of water erosion is slight. A perched water table is at a depth of 4 to 6 feet, mainly during the winter.

Included with this soil in mapping are small areas of Bernaldo soil with slopes of more than 3 percent. Also included are areas of Freestone, Gallime, and Wolfpen soils. The Freestone soils are in concave positions on the landscape and have a sandy clay subsoil. The Gallime and Wolfpen soils have a surface layer 20 to 40 inches thick and are in similar positions on the landscape. The Wolfpen soils have a loamy fine sand surface layer. The included soils make up less than 15 percent of the map unit.

This Bernaldo soil is used mainly for pasture or woodland. Some small areas are used for cropland.

Grasses that are well suited to this soil are coastal bermudagrass, common bermudagrass, lovegrass, and bahiagrass. Overseeding legumes, such as crimson clover, arrowleaf clover, or vetch, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil is well suited to woodland. The main commercial trees are loblolly and shortleaf pines. Plantations of these pines are in some areas that were once cropland. This soil has no major limitations for timber production; however, good woodland management practices can increase production.

This soil is well suited to crops. Corn, small grains, and vegetables grow well. Applications of fertilizer and lime are needed to maintain a higher level of production. Good management practices, such as using crop residues and cover crops, help maintain soil tilth and reduce erosion. Farming on the contour and terraces also reduce erosion.

This soil is suited to most urban uses. Wetness and seepage can affect sanitary facilities, and wetness and moderate shrink-swell potential are limitations affecting building sites. Low strength is a limitation affecting streets and roads. Good design and careful installation can overcome these limitations.

This soil is in capability subclass IIe. The woodland ordination symbol is 10A.

BeD—Bernaldo fine sandy loam, 5 to 8 percent slopes. This moderately sloping soil is on side slopes of drainageways. Surfaces are mainly smooth or slightly convex. Areas are long and narrow and range from 10 to 40 acres in size.

Typically, The surface layer is slightly acid, brown fine sandy loam about 6 inches thick. The subsurface layer is moderately acid, yellowish brown fine sandy loam about 7 inches thick. The upper part of the subsoil, from a depth of 13 to 40 inches, is strongly acid, yellowish brown sandy clay loam. The next part, from a depth of 40 to 52 inches, is very strongly acid, brownish yellow sandy clay loam that has red mottles. The lower part, from a depth of 52 to 80 inches, is very strongly acid, mottled brown, red, and light brownish gray sandy clay loam.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is high. The hazard of water erosion is severe. A water table is at a depth of 4 to 6 feet during the winter.

Included with this soil in mapping are small areas of a Bernaldo soil with slopes of less than 5 percent. Also included are areas of Gallime and Wolfpen soils. The Gallime and Wolfpen soils have a surface layer 20 to 40 inches thick. The surface layer of the Wolfpen soils is sandy. The included soils make up less than 15 percent of the map unit.

This Bernaldo soil is used mainly for pasture or woodland.

The main pasture grasses are coastal bermudagrass, common bermudagrass, bahiagrass, and lovegrass. Overseeding legumes, such as clover or vetch, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime help to maintain a higher level of production.

This soil is well suited to woodland production. It has no major limitations for this use. Loblolly and shortleaf pines are the main commercial trees.

This soil can be used for crops. Erosion is a hazard, so good management practices, such as using cover crops, terraces, and contour farming, are needed.

This soil is suited to most urban uses, although wetness and seepage can affect sanitary facilities. Wetness and moderate shrink-swell potential are limitations affecting building sites. Low strength is a limitation affecting streets and roads. Good design and careful installation can overcome these limitations.

This soil is in capability subclass IVe. The woodland ordination symbol is 10A.

CrA—Crockett loam, 0 to 1 percent slope. This nearly level soil is on uplands in slightly depressional areas. Surfaces are smooth to slightly concave. Areas are irregular in shape and range from 10 to 40 acres in size.

Typically, The surface layer is moderately acid, dark brown loam about 6 inches thick. The subsoil extends to a depth of 56 inches. From a depth of 6 to 15 inches, it is slightly acid, mottled reddish brown and dark brown clay; from a depth of 15 to 28 inches, it is neutral, pale olive clay with reddish brown, yellow, and grayish brown mottles. From a depth of 28 to 40 inches, the subsoil is neutral, pale olive clay with pale yellow and light brownish gray mottles; and from a depth of 40 to 56 inches, it is slightly alkaline, mottled light brownish gray and pale olive clay. The upper part of the underlying material, from a depth of 56 to 70 inches, is moderately alkaline, pale yellow loam with dark yellowish brown mottles. The lower part, from a depth of 70 to 80 inches, is moderately alkaline, pale yellow loam and light olive brown shale.

This soil is moderately well drained. Surface runoff is low, and permeability is very slow. The available water capacity is moderate. The hazard of erosion is slight.

Included with this soil in mapping are areas of Lufkin and Wilson soils that are more gray and are in lower positions on the landscape. The included soils make up less than 10 percent of the map unit.

This Crockett soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding adapted clovers or vetches into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

Areas of this soil that are in cropland are used mainly for small grains and cotton. Applications of fertilizer help to maintain a higher level of production.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength is a limitation affecting streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass IIIs and in the Claypan Prairie range site.

CrB—Crockett loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. Surfaces are smooth to convex. Areas are mainly broad and extensive and include large stream divides. They range from 20 to more than a thousand acres in size.

Typically, the surface layer is moderately acid, dark brown loam about 6 inches thick. The subsoil extends to a depth of 56 inches. From a depth of 6 to 15 inches, it is slightly acid, mottled reddish brown and dark brown clay; from a depth of 15 to 28 inches, it is neutral, olive clay with reddish brown, yellow, and grayish brown mottles. From a depth of 28 to 40 inches, the subsoil is neutral, olive clay with pale yellow and light brownish gray mottles; and from a depth of 40 to 56 inches, it is slightly alkaline, mottled light brownish gray and pale olive clay. The upper part of underlying material, from a depth of 56 to 70 inches, is moderately alkaline, light yellowish brown clay loam with dark yellowish brown mottles. The lower part, from a depth of 70 to 80 inches, is moderately alkaline, pale yellow clay loam with light olive brown mottles.

This soil is moderately well drained. Surface runoff is medium, and permeability is very slow. The available water capacity is moderate. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Edge, Lufkin, and Wilson soils. The Edge soils are in similar positions on the landscape but have a red clayey subsoil. The Lufkin and Wilson soils are more gray and are in lower positions. The included soils make up 5 to 15 percent of the map unit.

This Crockett soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding adapted clovers or vetches into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

Areas of this soil that are in cropland are used mainly for small grains and cotton. Erosion is a hazard. Good management practices, such as farming on the contour, terracing, and using cover crops and green manure crops, are needed to reduce erosion and maintain fertility. Applications of fertilizer help maintain a higher level of production.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength is a limitation affecting streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass IIIe and in the Claypan Prairie range site.

CrC—Crockett loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. Surfaces are smooth to convex. Areas are along side slopes of small drainageways. They are narrow and irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is moderately acid, dark brown loam about 5 inches thick. The subsoil extends to a depth of 54 inches. From a depth of 5 to 13 inches, it is slightly acid, mottled reddish brown and dark brown clay; from a depth of 13 to 26 inches, it is neutral, pale olive clay with reddish brown, yellow, and grayish brown mottles. From a depth of 26 to 38 inches, the subsoil is neutral, pale olive clay with pale yellow and light brownish gray mottles; and from a depth of 38 to 54 inches, it is slightly alkaline, mottled light brownish gray and pale olive clay. The upper part of the underlying material, from a depth of 54 to 66 inches, is moderately alkaline, pale yellow loam with dark yellowish brown mottles. The lower part, from a depth of 66 to 80 inches, is moderately alkaline, pale yellow loam with 40 percent shale.

This soil is moderately well drained. Surface runoff is high, and permeability is very slow. The available water capacity is moderate. The hazard of erosion is severe.

Included with this soil in mapping are areas of Bazette, Edge, and Normangee soils. The Bazette and Normangee soils are in similar positions on the landscape. The Edge soils are in similar positions but have a red clayey subsoil. Also included are Crockett soils with slopes of less than 3 percent and a Crockett soil that is eroded. The included soils make up less than 10 percent of this map unit.

The Crockett soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding adapted clovers or vetches into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

Areas of this soil that are in cropland are used mainly for small grains and cotton. The droughty nature of the soil is a limitation, and erosion is a hazard. Good management practices, such as farming on the contour, terracing, and using cover crops and green manure crops, can help to reduce erosion and maintain fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength is a limitation affecting streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass IVe and in the Claypan Prairie range site.

CrC2—Crockett loam, 2 to 5 percent slopes, eroded. This gently sloping soil is on uplands along side slopes of small drainageways. Areas are mainly narrow and irregular in shape. Hills and shallow gullies are in most areas. The gullies are 10 to 75 feet wide, 1 to 3 feet deep, and at 75 to 300 feet intervals; most can be crossed with farm machinery. Areas range from 20 to 300 acres in size.

Typically, the surface layer is moderately acid, dark brown loam about 3 inches thick. The subsoil extends to a depth of 53 inches. From a depth of 3 to 12 inches, it is slightly acid, mottled reddish brown and dark brown clay; from a depth of 12 to 25 inches, it is neutral, pale olive clay with reddish brown, yellow, and grayish brown mottles. From a depth of 25 to 37 inches, the subsoil is neutral, pale olive clay with pale yellow and light brownish gray mottles; and from a depth of 37 to 53 inches, it is slightly alkaline, mottled light brownish gray and pale olive clay. The upper part of the underlying material, from a depth of 53 to 67 inches, is moderately alkaline, pale yellow loam with dark yellowish brown mottles. The lower part, from a depth of 67 to 80 inches, is moderately alkaline, pale yellow loam with 45 percent shale.

This soil is moderately well drained. Surface runoff is high, and permeability is very slow. The available water capacity is moderate. The hazard of erosion is severe.

Included with this soil in mapping are areas of Bazette, Edge, and Normangee soils. The Bazette and Normangee soils are in similar positions on the landscape. The Edge soils are in similar positions, but have a red clayey subsoil. Also included, in similar positions, is a Crockett soil that is not eroded. The included soils make up less than 10 percent of the map unit.

This Crockett soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding adapted clovers or vetches into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil is poorly suited to crops because of the slope, hazard of erosion, and past erosion.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength is a limitation affecting streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass IVe and in the Claypan Prairie range site.

CuE—Cuthbert fine sandy loam, 8 to 20 percent slopes. This strongly sloping to moderately steep soil is on uplands. Surfaces are mainly smooth or convex. Areas are long and narrow and generally follow breaks into drainageways. Areas range from 10 to 700 acres in size.

Typically, the surface layer is moderately acid, dark brown fine sandy loam about 5 inches thick. The subsurface layer is moderately acid, yellowish brown fine sandy loam about 5 inches thick. The upper part of the subsoil, from a depth of 10 to 16 inches, is strongly acid, red clay. The next part, from a depth of 16 to 28 inches, is very strongly acid, red clay with yellow mottles. The lower part, from a depth of 28 to 36 inches, is very strongly acid, red sandy clay loam and light gray shale. The underlying material, from a depth of 36 to 60 inches, is extremely acid, mottled yellowish red, red, and yellowish brown soft sandstone interbedded with light gray and red shale.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow and the available water capacity is moderate. The hazard of erosion is severe.

Included with this soil in mapping are small areas of Kirvin, Redsprings, and Tenaha soils. The Kirvin soils are similar, but more deeply developed and are near the top of hillslopes above drainageways. Redsprings soils are in higher positions on the landscape and are more deeply developed. The Tenaha soils have a sandy surface layer 20 to 40 inches thick. Also included are small areas of an eroded and gravelly Cuthbert soil. The included soils make up less than 20 percent of the map unit.

This Cuthbert soil is used mainly for woodland. Some areas have been cleared and planted in pasture grasses.

Loblolly and shortleaf pines are the main commercial trees produced for timber. Slope and the clayey subsoil are limitations affecting timber production.

Areas used as pasture are planted mainly in coastal bermudagrass or bahiagrass. Overseeding legumes, such as clover or vetch, into the grasses provides additional forage and improves soil fertility. Adequate applications of fertilizer and lime can help to maintain a higher level of production. Using a good grazing management program can help to reduce erosion.

This soil has severe limitations for most urban uses. Low strength and steep slopes are limitations affecting streets and roads, and slope and shrink-swell properties are limitations for building sites. Some of these limitations can be overcome by good design and careful installation.

This soil is in capability subclass VIe. The woodland ordination symbol is 8C.

CvE—Cuthbert gravelly fine sandy loam, 8 to 20 percent slopes. This strongly sloping to moderately steep soil is on side slopes of uplands. Surfaces are mainly smooth or slightly convex. Areas are oblong in shape, either following breaks into drainageways or occupying entire steep hills. Areas range from 10 to 250 acres in size.

Typically, the surface layer is moderately acid, dark brown gravelly fine sandy loam about 4 inches thick. The subsurface layer is moderately acid, brown gravelly fine sandy loam about 5 inches thick. The upper part of the subsoil, from a depth of 9 to 16 inches, is very strongly acid, red clay. The lower part, from a depth of 16 to 30 inches, is very strongly acid, red clay loam with thin strata of yellowish loamy material and soft sandstone. The underlying material, from a depth of 30 to 65 inches, is very strongly acid, interbedded yellowish and reddish sandy clay loam and fine sandy loam and gray shale.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Redsprings and Tenaha soils. Also included are areas of a Cuthbert soil with about 10 percent of the surface covered with stones. The stony Cuthbert soil is in steeper, narrow areas along upper slopes. The Redsprings soils are on more gentle, higher-lying slopes. The Tenaha soils have a thick, sandy surface layer and are in positions on the higher-lying landscape similar to the Cuthbert soil. The included soils make up less than 10 percent of the map unit.

This Cuthbert soil is used mainly for woodland or wildlife habitat.

Loblolly and shortleaf pines are the major commercial trees. Most trees are used for pulpwood in paper production rather than for lumber because of their smaller size. Most areas are inaccessible to vehicles because of slope and ironstone fragments on the surface. Timber stands are better managed with natural reproduction of trees. Areas of this soil are a natural refuge for deer and other wildlife.

This soil is not suited to crops or pasture, mainly because of slope, the hazard of erosion, and fragments of ironstone on the surface.

This soil is poorly suited to most urban uses; however, some areas do provide homesites with scenic views. Slope, ironstone fragments, and shrink-swell potential are the main limitations.

This soil is in capability subclass VIe. The woodland ordination symbol is 8C.

CwF—Cuthbert fine sandy loam, 8 to 25 percent slopes, very stony. This strongly sloping to steep soil is on uplands in areas leading down to major drainageways. Surfaces are mainly smooth or slightly convex. Areas are oblong and narrow. Fragments of ironstone are on the surface or embedded in the surface layer. The fragments range from 3 inches to 6 feet in diameter but most are about 10 to 24 inches across. Fragments cover 3 to 10 percent of the soil surface. Areas are 10 to 60 acres in size.

Typically, the surface layer is moderately acid, dark brown stony fine sandy loam about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 17 inches, is strongly acid red clay. The lower part, from a depth of 17 to 32 inches, is strongly acid, red clay with thin strata of yellowish red loamy material and soft sandstone. The underlying material, from a depth of 32 to 60 inches, is very strongly acid, interbedded yellowish red and reddish yellow sandy clay loam and fine sandy loam and gray shale.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of

Redsprings and Tenaha soils. Also included are areas of Cuthbert gravelly fine sandy loam. The Redsprings soils are on more gentle, higher-lying slopes. The Tenaha soils have a thick, sandy surface layer and are in positions on the landscape similar to the Cuthbert soil. The gravelly Cuthbert soils are in less steep areas along upper slopes. The included soils make up less than 5 percent of the map unit.

This Cuthbert soil is used mainly for woodland or wildlife habitat.

Loblolly and shortleaf pines are the major commercial trees. Most trees are used for pulpwood in paper production rather than for lumber because of their smaller size. Areas are inaccessible to vehicles because of slope and stone fragments on the surface. Timber stands are better managed with natural reproduction of trees. Areas of this soil are a natural refuge for deer and other wildlife.

This soil is not suited to crops or pasture because of slope, the hazard of erosion, and fragments of ironstone on the surface.

This soil is poorly suited to urban uses; however, some areas do provide homesites with scenic views. Slope, ironstone fragments, and shrink-swell potential are the main limitations.

This soil is in capability subclass VIIs. The woodland ordination symbol is 7X.

CxC—Cuthbert and Redsprings soils, graded, 3 to 8 percent slopes. These gently sloping to moderately sloping soils are on uplands. Areas are mainly on ridges in the highest positions on the landscape. Surfaces are slightly convex. Areas are irregular in shape and range from 10 to 100 acres in size.

This map unit averages about 40 percent Cuthbert soil, 40 percent Redsprings soil, and 20 percent other soils. Some areas are mostly Cuthbert soil, some are mostly Redsprings soil, and some are both soils.

These soils have been surface-mined for ironstone gravel. The removal of topsoil makes soil reclamation and revegetation difficult. Most areas have sparse stands of grasses, weeds, and trees; some areas are barren.

Typically, the surface layer of the Cuthbert soil is very strongly acid, yellowish red gravelly clay loam about 2 inches thick. The upper part of the subsoil, from a depth of 2 to 8 inches, is very strongly acid, red clay with mottles in shades of yellow. The lower part, from a depth of 8 to 20 inches, is very strongly acid, red clay with yellowish brown mottles. The underlying material, from a depth of 20 to 60 inches, is extremely acid, light gray shale with red mottles.

The surface layer of the Redsprings soil is moderately acid, reddish brown very gravelly clay loam about 2 inches thick. The upper part of the subsoil, from a depth of 2 to 40 inches, is strongly acid, red clay with yellowish brown mottles below a depth of 24 inches. The lower part, from a depth of 40 to 50 inches, is very strongly acid, red clay loam with yellowish brown mottles. The underlying material, from a depth of 50 to 60 inches, is very strongly acid, yellowish brown weathered glauconitic material with red mottles.

These soils are well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is moderate.

Included with these soils in mapping are areas of Elrose and Kirvin soils, as well as Cuthbert and Redsprings soils that have slopes of more than 8 percent. Also included are similar, but thinner soils. The included soils make up about 20 percent of the map unit.

Most areas of these Cuthbert and Redsprings soils are idle. A few areas are used for improved pasture or woodland.

Bahiagrass, common bermudagrass, and coastal bermudagrass are suited to this soil. Because of the removal of topsoil, good management practices, along with proper applications of fertilizer and lime are needed for establishment and maintenance of pasture grasses.

A few areas of Cuthbert and Redsprings soils have been planted to loblolly pine and some areas have reseeded naturally. The timber is of low quality, mainly because of high seedling mortality rates and droughtiness.

These soils are not suited to cultivation because of the severe hazard of erosion.

These soils are suitable for most urban uses. Low strength and moderate shrink-swell potential are limitations that can be overcome by good design and proper installation.

This map unit is in capability subclass VIe. The woodland ordination symbol for the Cuthbert soils is 5C and is 6C for the Redsprings soil.

DrA—Derly-Raino complex, 0 to 1 percent slopes. These nearly level soils are on high stream terraces that have flats, shallow depressions, and scattered mounds on the surface. Areas are irregular in shape and range from 10 to more than a thousand acres in size.

This map unit consists of Derly soils in the flats and depressional areas, and Raino soils on mounds that are 2 to 4 feet higher than the flats. The mounds are mainly circular and are 50 to 300 feet across. In some areas, Raino soils are on ridges that meander through the flat areas of Derly soils.

This map unit is about 50 percent Derly soil, 40 percent Raino soil, and 10 percent other soils. Areas of these soils are so intricately mixed that separation is not practical at the scale mapped.

Typically, the Derly soil has a surface layer that is moderately acid, dark grayish brown silt loam about 3 inches thick. The subsurface layer is very strongly acid, light brownish gray silt loam with light yellowish brown mottles. It is about 6 inches thick. The subsoil extends to a depth of 80 inches or more. From a depth of 9 to 16 inches, it is very strongly acid, grayish brown clay loam that has streaks of white silt loam; from a depth of 16 to 44 inches, it is very strongly acid, dark grayish brown clay loam. From a depth of 44 to 50 inches, the subsoil is strongly acid, grayish brown clay loam; from a depth of 50 to 68 inches, it is slightly acid, grayish brown clay loam; and from a depth of 68 to 80 inches, it is slightly acid, light gray and light brownish gray clay loam with brownish yellow mottles.

The Derly soil is poorly drained. Surface runoff is negligible, and permeability is very slow. The available water capacity is moderate. Water ponds on this soil during periods of heavy rainfall, and a perched water table is at a depth of 1 foot or less during winter and spring.

Typically, the Raino soil has a surface layer that is strongly acid, dark yellowish brown loam about 6 inches thick. The subsurface layer is moderately acid to strongly acid, yellowish brown and light yellowish brown loam about 20 inches thick. The subsoil extends to a depth of 84 inches. From a depth of 26 to 36 inches, it is strongly acid, strong brown loam with yellowish red and light brownish gray mottles; from a depth of 36 to 44 inches, it is strongly acid, mottled yellowish brown, red, and light brownish gray clay and light gray sand and silty materials. From a depth of 44 to 60 inches, the subsoil is strongly acid, gray clay with red, light brownish gray, and yellowish brown mottles; from a depth of 60 to 72 inches, it is strongly acid, mottled brownish yellow, light gray, and red clay; and from a depth of 72 to 84 inches, it is moderately acid, light gray, sandy clay loam with yellowish brown mottles.

The Raino soil is moderately well drained. Surface runoff is low and permeability is very slow. The available water capacity is high. A perched water table is at a depth of 24 to 42 inches during the winter and spring.

Included in mapping are small areas of Bernaldo soils that are on higher parts of the mounds and are well drained. The included soils make up less than 10 percent of the map unit.

These Derly and Raino soils are mainly in hardwood forest. Some areas are used as improved pasture.

Loblolly pine and sweetgum are suited to the Raino soil; however, the dominant trees on the wet, poorly drained Derly soil are water oak and willow oak. Loblolly pine is the main commercial tree. Wetness is a limitation affecting pine production and it makes harvesting difficult.

Common bermudagrass, fescue, and bahiagrass are adapted pasture grasses for these soils. Legumes, such as white clover or singletary peas, can be overseeded into the grasses to provide additional cool-season forage and improve soil fertility. Applications of lime and fertilizer are needed to maintain a higher level of production.

This map unit is too wet in most years for the cultivated crops most commonly grown in the survey area.

This map unit has severe limitations for most urban uses. Wetness, shrinking and swelling, and very slow permeability are limitations affecting septic tank absorption fields, building sites, streets, and roads. Proper design and installation are needed to overcome these limitations.

The Derly soil is in capability subclass IVw, and the Raino soil is in capability subclass IIIs. The woodland ordination symbol for the Derly soil is 4W and is 9W for the Raino soil.

EdC—Edge fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on uplands. Surfaces are mainly smooth or convex. Areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is moderately acid, dark brown, fine sandy loam about 6 inches thick. The subsurface layer is moderately acid, pale brown fine sandy loam about 2 inches thick. The upper part of the subsoil, from a depth of 8 to 18 inches, is very strongly acid, yellowish red clay. The next part, from a depth of 18 to 34 inches, is very strongly acid, mottled pale brown, brown, red, and strong brown clay. The lower part, from a depth of 34 to 60 inches, is slightly acid, light brownish gray clay loam that has dark yellowish brown and brownish yellow mottles. The underlying material, from a depth of 60 to 80 inches, is slightly alkaline, brown sandy clay loam interbedded with light gray shale and light gray and yellowish brown soft sandstone.

This soil is well drained. Surface runoff is medium. Permeability is very slow and the available water capacity is moderate. The hazard of erosion is moderate.

Included with this soil in mapping are small areas of Crockett, Freestone, and Rader soils. The Crockett soils are in similar positions on the landscape, but do not significantly decrease in clay within a depth of 35 inches. The Freestone and Rader soils are in slightly lower positions on the landscape. Also included are small areas of eroded and gravelly Edge soils. The included soils make up less than 15 percent of the map unit.

This Edge soil is used mostly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding legumes, such as crimson clover, arrowleaf clover, or vetch, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

Areas of this soil that are in cropland are used mainly for small grains and vegetables. The droughty nature of the soil is a limitation, and erosion is a hazard. Good management practices, such as farming on the contour, terracing, and using cover crops and green manure crops can help reduce erosion and maintain soil fertility.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength is a limitation affecting streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass IVe and in the Claypan Savannah range site. The woodland ordination symbol is 6C.

EdD—Edge fine sandy loam, 5 to 12 percent slopes. This strongly sloping soil is on uplands along drainageways above streams. Surfaces range from smooth to convex. Areas are mainly long and narrow, irregular in shape, and range from 15 to 200 acres in size.

Typically, the surface layer is moderately acid, brown fine sandy loam about 4 inches thick. The subsurface layer is moderately acid, pale brown fine sandy loam about 2 inches thick. The upper part of the subsoil, from a depth of 6 to 17 inches, is very strongly acid, red clay that has brownish yellow mottles. The next part, from a depth of 17 to 31 inches, is strongly acid, brownish yellow clay that has yellowish red, red, and gray mottles. The lower part, from a depth of 31 to 50 inches, is moderately acid, yellowish brown clay loam that has gray mottles. The underlying material, from a depth of 50 to 76 inches, is slightly acid, yellowish brown sandy clay loam with strata of gray loamy material.

This soil is well drained. Surface runoff is very high. Permeability is very slow and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are areas of Bazette, Crockett, and Normangee soils that are in similar positions on the landscape. These soils have thicker layers of clay in the subsoil. Also included are small areas of Edge soils that are eroded. The included soils make up less than 10 percent of the map unit.

This Edge soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding legumes, such as crimson clover, arrowleaf clover, or vetch, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil not suited to crops because of the slope and hazard of erosion.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability and slope restrict use of this soil for septic tank absorption fields. Low strength is a limitation affecting streets and roads. Good design and careful installation are needed to overcome these limitations.

This soil is in capability subclass VIe, and in the Claypan Savannah range site. The woodland ordination symbol is 6C.

ErB—Elrose fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. Surfaces are mainly smooth or slightly convex. Areas are irregular in shape and range from 10 to 350 acres in size.

Typically, the surface layer is strongly acid, reddish brown fine sandy loam about 6 inches thick. The subsurface layer is strongly acid, yellowish red fine sandy loam about 6 inches thick. The subsoil extends to a depth of 80 inches or more. From a depth of 12 to 21 inches, it is moderately acid, dark red sandy clay loam; from a depth of 21 to 38 inches, it is moderately acid, red sandy clay loam. From a depth of 38 to 56 inches, the subsoil is strongly acid, red clay loam; and from a depth of 56 to 80 inches, it is strongly acid, red sandy clay loam with about 10 percent brownish yellow fragments.

This soil is well drained. Surface runoff is very low. Permeability is moderate, and the available water capacity is moderate. The hazard of water erosion is slight.

Included with this soil in mapping are small areas of Cuthbert, Oakwood, and Redsprings soils. The Cuthbert and Redsprings soils have a clayey subsoil. The Oakwood soils have a yellowish subsoil. The included soils make up less than 15 percent of the map unit.

This Elrose soil is mainly used for pasture or for smaller areas of woodland. A few small areas are used as cropland.

Coastal bermudagrass, common bermudagrass, and bahiagrass are well suited to this soil. Overseeding legumes, such as crimson clover, arrowleaf clover, and vetch, into the grasses provides additional forage and improves soil fertility. When good management practices are used, forage production is high. Applications of fertilizer and lime are essential to maintain a high level of production.

Loblolly and shortleaf pines are the main commercial trees. A few old cropland fields have been planted to loblolly or slash pine for timber production. This is one of the better soils in the area for timber production; it has no major limitations.

Corn and truck crops such as tomatoes, peas, sweet potatoes, and squash, are well adapted to this soil. Good management practices, such as constructing terraces and farming on the contour, can help reduce erosion.

This soil is suited to most urban uses. Seepage is a limitation for sewage lagoons and low strength is a limitation affecting roads and streets. With good design and careful installation, these limitations can be overcome.

This soil is in capability subclass IIe. The woodland ordination symbol is 10A.

ErE—Elrose fine sandy loam, 8 to 12 percent slopes. This strongly sloping soil is on upland foot slopes above drainageways. Surfaces are smooth or slightly convex. Areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is moderately acid, reddish brown fine sandy loam about 5 inches thick. The subsurface layer is moderately acid, yellowish red fine sandy loam about 5 inches thick. The upper part of the subsoil, from a depth of 10 to 37 inches, is moderately acid, red sandy clay loam. The next part, from a depth of 37 to 58 inches, is strongly acid, red clay loam. The lower part, from a depth of 58 to 80 inches, is strongly acid, red sandy clay loam.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is moderate. The hazard of water erosion is moderate.

Included with this soil in mapping are small areas of Cuthbert and Redsprings soils that have a clayey subsoil. The included soils make up less than 15 percent of the map unit.

This Elrose soil is used mainly for pasture or woodland.

Bahiagrass, common bermudagrass, and coastal bermudagrass are well suited to this soil. Crimson clover, arrowleaf clover, and vetch are well adapted legumes. Under good management, forage production is high. Applications of fertilizer and lime are needed to maintain a higher level of production.

Some areas are in mixed pine and hardwood trees. Loblolly and shortleaf pines are the main commercial trees. A few old cropland fields have been planted to loblolly pine or slash pine. This soil is well suited to timber production; it has no major limitations.

This soil is suited to most urban uses. Seepage is a limitation affecting sewage lagoons. Slope is a limitation affecting septic tank absorption fields, and low strength is a limitation for streets and roads. With good design and careful installation these limitations can be overcome.

This soil is in capability subclass VIe. The woodland ordination symbol is 9A.

FrB—Freestone fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on old high stream terraces. Surfaces are mainly smooth. Areas are irregular in shape and range from 10 to 400 acres in size.

Typically, the surface layer is slightly acid, dark brown fine sandy loam about 5 inches thick. The subsurface layer is slightly acid, brown fine sandy loam about 11 inches thick. The subsoil extends to a depth of 84 inches. From a depth of 16 to 32 inches, it is strongly acid, strong brown sandy clay loam with red mottles or it is strongly acid, yellowish brown sandy clay loam with red and grayish brown mottles; from a depth of 32 to 46 inches, it is strongly acid, light gray clay with red and yellowish brown mottles. From a depth of 46 to 60 inches, the subsoil is moderately acid, light gray clay with yellowish brown and dark red mottles; from a depth of 60 to 72 inches, it is slightly acid, grayish brown clay with yellowish red and yellowish brown mottles; and from a depth of 72 to 84 inches, it is moderately acid, mottled light gray, yellowish brown, and dark brown clay loam.

This soil is moderately well drained. Surface runoff is low. Permeability is slow and the available water capacity is high. A water table is perched at a depth of 2 to 3 feet during the winter and spring. The hazard of erosion is slight.

Included with this soil in mapping are small areas of Bernaldo, Derly, Raino, Wolfpen, and Woodtell soils. The Bernaldo soils do not have a clayey layer in the lower part of the subsoil. The Derly soils have a clayey subsoil and are wetter. The Raino and Woodtell soils have a clayey layer that is closer to the surface. The Wolfpen soils have a sandy surface layer 20 to 40 inches thick. The included soils make up less than 15 percent of the map unit.

This Freestone soil is used mainly for pasture (fig. 3). A few small areas have been planted to loblolly pine and small areas are in cropland.

Coastal bermudagrass, common bermudagrass, and bahiagrass are well suited to this soil. Overseeding legumes, such as clover or vetch, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime are needed to maintain a higher level of production.

Red oak, post oak, elm, and sweetgum are the dominant trees in wooded areas. Loblolly pine is well suited to commercial timber production.

Corn and vegetable crops, such as tomatoes, peas, sweet potatoes, and beans, are well suited to this soil. Applications of lime and fertilizer are essential to maintain a higher level of production. Good management practices, such as constructing terraces and farming on the contour can help reduce erosion.

This soil has several limitations for urban uses. Wetness and slow permeability are limitations affecting sanitary facilities, such as septic tank absorption fields and sanitary landfills. Wetness and low strength are limitations when this soil is used for building sites, streets, and roads. With good design and careful installation most of these limitations can be overcome.

This soil is in capability subclass IIe. The woodland ordination symbol is 8W.

Figure 3.—An area of coastal bermudagrass on Freestone fine sandy loam, 1 to 3 percent slopes.

GaB—Gallime fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping soil is on terraces above drainageways. Surfaces are mainly smooth or slightly convex. Areas are irregular in shape and range from 10 to 250 acres in size.

Typically, the surface layer is moderately acid, brown fine sandy loam about 8 inches thick. The subsurface layer is slightly acid, light yellowish brown fine sandy loam about 18 inches thick. The upper part of the subsoil, from a depth of 26 to 48 inches, is moderately acid, yellowish brown sandy clay loam with red mottles. The next part, from a depth of 48 to 68 inches, is strongly acid, yellowish brown sandy clay loam with yellowish red and yellow mottles. The lower part, from a depth of 68 to 80 inches, is very strongly acid, mottled red, light gray, and yellow sandy clay loam.

This soil is well drained. Surface runoff is negligible. Permeability is moderate and the available water capacity is moderate. The hazard of water erosion is moderate. A water table is within a depth of 4 to 6 feet during the winter.

Included with this soil in mapping are small areas of Bernaldo, Pickton, and Wolfpen soils. The Bernaldo soils have a thinner surface layer. The Pickton and Wolfpen soils have a sandy surface layer. The included soils make up less than 15 percent of the map unit.

This Gallime soil is used mainly for pasture or woodland. A few small areas are used for cropland.

Bahiagrass, bermudagrass, crimson clover, arrowleaf clover, and vetch are well suited pasture grasses and legumes. Forage production is high under good management. Applications of fertilizer and lime are essential to maintain a higher level of production.

Loblolly and shortleaf pines are the main commercial trees. A few old cropland fields have been planted to loblolly pine or slash pine. This is one of the better soils in the area for timber production; it has no major limitations.

Corn, roses, and vegetables, such as peas, tomatoes, sweet potatoes, and beans, are well suited to this soil. Applications of lime and fertilizer are essential to maintain a higher level of production. Good management practices, such as planting cover crops and farming on the contour, can help reduce erosion.

This soil is suited to most urban uses. Seepage is a limitation for sewage lagoons and area sanitary landfills. Wetness is a limitation affecting septic tank absorption fields and trench sanitary landfills. These limitations can be overcome with good design and careful installation.

This soil is in capability subclass IIe. The woodland ordination symbol is 9A.

Gw—Gladewater clay, frequently flooded. This nearly level soil is on the flood plain of the Sabine River in the northern part of the county. Slopes are 0 to 1 percent. This map unit consists of one soil area many acres in size.

Typically, the surface layer is slightly acid, black clay about 8 inches thick. The upper part of the subsoil, from a depth of 8 to 22 inches, is slightly acid, gray clay with yellowish brown mottles. The next part, from a depth of 22 to 42 inches, is moderately acid, gray clay with yellowish brown mottles. The lower part, from a depth of 42 to 63 inches, is slightly acid, dark gray clay with dark yellowish brown mottles.

This soil is somewhat poorly drained. Surface runoff is negligible. Permeability is very slow, and the available water capacity is high. The hazard of water erosion is slight. Flooding occurs at least once in most years for a duration of 7 days or more. A water table is within a depth of 3.5 feet during winter and spring.

Included with this soil in mapping are small areas of loamy Sandow and Nahatche soils that are on alluvial fans at the mouth of tributary creeks. The included soils make up less than 15 percent of the map unit.

This Gladewater soil is mostly in hardwood forests. A few areas have been cleared and planted in pasture grasses.

Water oak and willow oak are the dominant trees. Other common trees are elm, sweetgum, and ash. In some areas, water and willow oak have been commercially harvested, mainly to produce crossties. Because of flooding and wetness, this soil is not suited to pine production.

Common bermudagrass and bahiagrass are suitable warm-season grasses. Tall fescue and white clover are adapted cool-season plants. Flooding and wetness limit forage production on this soil. Applications of fertilizer and lime help to maintain a higher level of production.

This soil is not suited to crops because of frequent flooding.

This soil is not suited to urban uses because of flooding and wetness.

This soil is in capability subclass Vw. The woodland ordination symbol is 6W.

KfC—Kirvin fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on uplands. Surfaces are mainly convex. Areas are oval to oblong ridges or stream divides and range from 10 to 150 acres in size.

Typically, the surface layer is moderately acid, dark brown fine sandy loam about 6 inches thick. The subsurface layer is strongly acid, pale brown fine sandy loam about 5 inches thick. The upper part of the subsoil, from a depth of 11 to 34 inches, is very strongly acid, red clay with strong brown mottles. The lower part, from a depth of 34 to 55 inches, is very strongly acid, yellowish red clay loam with red and strong brown mottles. The underlying material, from a depth of 55 to 70 inches, is stratified, very strongly acid, red and strong brown sandy clay loam and gray shale.

This soil is well drained. Surface runoff is low. Permeability is moderately slow, and the available water capacity is moderate. The hazard of water erosion is moderate.

Included with this soil in mapping are small areas of Bernaldo, Freestone, and Wolfpen soils. The Bernaldo soils have a yellow loamy subsoil. The Freestone soils are wetter and have gray mottles in the upper part of the subsoil. The Wolfpen soils have a sandy surface layer 20 to 40 inches thick. Also included are areas of a Kirvin soil with a gravelly surface layer. The included soils make up less than 20 percent of the map unit.

This Kirvin soil is used mainly for pasture or woodland. A few small areas are used as cropland.

Pasture grasses, such as coastal bermudagrass, bahiagrass, and common bermudagrass, are well suited to this soil. Legumes, such as crimson clover, arrowleaf clover, or vetch, are often overseeded into the grasses to provide additional forage and to improve soil fertility. Good management practices and applications of fertilizer and lime are essential to maintain a higher level of production.

Shortleaf and loblolly pines are the main commercial trees. Good woodland management practices can increase timber production. This soil has no major limitations for woodland use.

Corn and vegetable crops grow well in this soil. Applications of fertilizer and lime are essential to maintain a higher level of production. Good management practices, such as planting cover crops, constructing terraces, and farming on the contour, can help reduce erosion.

This soil is suitable for most urban uses. Permeability is a limitation for septic tank absorption fields. Low strength is a limitation affecting roads and streets. These limitations can be overcome by good design and careful installation.

This soil is in capability subclass IIIe. The woodland ordination symbol is 8A.

KgC—Kirvin very gravelly fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on uplands. Surfaces are mainly convex. Areas are generally oval ridges and stream divides and range from 5 to 150 acres in size.

Typically, the surface layer is moderately acid, yellowish brown very gravelly fine sandy loam about 7 inches thick. The subsurface layer is strongly acid, brownish yellow very gravelly fine sandy loam about 4 inches thick. The upper part of the subsoil, from a depth of 11 to 26 inches, is very strongly acid, red clay. The next part, from a depth of 26 to 42 inches, is very strongly acid, yellowish red clay with strong brown mottles. The lower part, from a depth of 42 to 50 inches, is very strongly acid, mottled red and yellowish red sandy clay loam. The underlying material, from a depth of 50 to 72 inches, is stratified; extremely acid; red, strong brown, and gray; loamy, sandy, and shaly materials.

This soil is well drained. Surface runoff is low. Permeability is moderately slow and the available water capacity is moderate. The hazard of water erosion is moderate.

Included with this soil in mapping are small areas of Bernaldo and Wolfpen soils. The Bernaldo soils have a yellow, loamy subsoil. The Wolfpen soils have a sandy surface layer 20 to 40 inches thick. Also included are areas of Kirvin soils that do not have a gravelly surface layer. The included soils make up less than 20 percent of the map unit.

This Kirvin soil is used mainly as woodland. Some areas are used for pasture and a few small areas are used as cropland.

Loblolly and shortleaf pines are the main commercial trees on this soil. The gravel on the surface is a limitation, but production can be increased with proper woodland management.

Bahiagrass, common bermudagrass, and coastal bermudagrass are suitable pasture plants. Legumes, such as crimson clover, arrowleaf clover, or vetch, are often overseeded into the grasses to provide additional forage and improve soil fertility. Applications of fertilizer and lime can help to maintain a higher level of production.

The hazard of erosion limits the use of this soil for cropland. Good management practices, such as using cover crops, terraces, and contour farming, are needed to reduce erosion.

This soil is suited to most urban uses. Moderately slow permeability is a limitation for septic tank absorption fields, and low strength is a limitation affecting streets and roads. With good design and installation, these limitations can be overcome.

This soil is in capability subclass IVe. The woodland ordination symbol is 8F.

LgB—Leagueville loamy fine sand, 0 to 3 percent slopes. This nearly level to very gently sloping soil is along narrow drainageways, on toe slopes, and in depressional areas on uplands. Surfaces are mainly smooth or concave. Areas are long and narrow and range from 10 to 300 acres in size.

Typically, the surface layer is about 14 inches thick. The upper part is strongly acid, very dark grayish brown loamy fine sand with brown mottles. The lower part is very strongly acid, dark grayish brown loamy fine sand with brown mottles. The subsurface layer is about 16 inches thick. It is very strongly acid, pale brown loamy fine sand with brown mottles. The upper part of the subsoil, from a depth of 30 to 50 inches, is very strongly acid, gray sandy clay loam with yellowish brown and reddish brown mottles. The lower part, from a depth of 50 to 80 inches, is very strongly acid, light gray sandy clay loam with reddish brown and yellowish brown mottles.

This soil is poorly drained. Surface runoff is negligible. Permeability is moderate, and the available water capacity is moderate. The hazard of erosion is slight. A water table is at a depth of 6 to 18 inches during the winter and spring.

Included with this soil in mapping are small areas of Pickton and Wolfpen soils. The Pickton soils have a sandy surface layer 40 to 72 inches thick. The Wolfpen soils have a yellowish subsoil. The included soils make up less than 10 percent of the map unit.

This Leagueville soil is used mainly for pasture or woodland.

Bahiagrass, common bermudagrass, and fescue are suited to this soil. A high water table and wetness are factors that make pastures difficult to establish. Applications of fertilizer and lime can help to maintain a higher level of production.

Areas of woodland are mainly hardwood trees. Water oak, willow oak, and sweetgum are dominant. A few loblolly pines are in some areas. Equipment limitations, seedling mortality, and severe plant competition make commercial timber production difficult.

This soil is poorly suited to cropland. Wetness is the main limitation.

This soil is not suited to urban uses because of wetness.

This soil is in capability subclass IVw. The woodland ordination symbol is 8W.

Lk—Lufkin loam, 0 to 1 percent slopes. This nearly level soil is on high stream terraces. Areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is moderately acid, dark grayish brown loam about 7 inches thick. The subsurface layer is moderately acid, light brownish gray loam about 5 inches thick. The upper part of the subsoil, from a depth of

12 to 22 inches, is slightly acid, dark grayish brown clay that has streaks of light brownish gray silt loam. The next part, from a depth of 22 to 30 inches, is slightly acid, grayish brown clay with yellowish brown and strong brown mottles. The next part, from a depth of 30 to 44 inches, is moderately acid, dark grayish brown clay with yellowish brown mottles. The lower part, from a depth of 44 to 72 inches, is neutral, gray clay with red, yellow, and brownish yellow mottles.

This soil is moderately well drained. Surface runoff is low, and permeability is very slow. The available water capacity is moderate. The surface layer of this soil may be saturated for periods of a few days to a few weeks after heavy rains. In some cases, this soil has shallow depressions that are ponded for short periods, mostly during winter and spring.

Included in mapping are small areas of Crockett, Rader, and Wilson soils. The Crockett soils have brown and red colors in the subsoil. The Rader soils are not as clayey. The Wilson soils do not have an abrupt texture change between the surface and subsoil. The included soils make up less than 20 percent of the map unit.

This Lufkin soil is used mostly for pasture. A few small areas are used as cropland.

Coastal bermudagrass, common bermudagrass, and tall fescue are adapted pasture grasses for this soil. Legumes, such as white clover and singletary peas, can be overseeded into the grasses to provide additional cool-season forage and also to improve soil fertility. Applications of lime and fertilizer are needed to maintain a higher level of production.

Delays may occur during the planting season in most years for the cultivated crops most commonly grown in the survey area.

This soil has severe limitations for most urban uses. Shrinking and swelling and very slow permeability are limitations affecting septic tank absorption fields, building sites, streets and roads. Wetness is a limitation in ponded areas. Proper design and installation are needed to overcome these limitations.

This soil is in capability subclass IIIw and in the Claypan Savannah range site.

Lu—Lufkin-Rader complex, 0 to 1 percent slopes. These nearly level soils are on high stream terraces that have flats, shallow depressions, and scattered mounds on the surface. Areas are irregular in shape and range from 20 to more than a thousand acres in size.

This map unit is about 50 percent Lufkin soil, 35 percent Rader soil, and 15 percent other soils. The Lufkin soil is in the flats and depressional areas, and the Rader soil is on mounds that are about 1 to 2 feet higher than the flats. The mounds are mainly circular and are 25 to 200 feet across. In some areas, the Rader soil is on ridges that meander through flats of the Lufkin soils. Areas of these soils are so intricately mixed that separation in mapping is not practical.

Typically, the Lufkin soil has a surface layer that is strongly acid, dark grayish brown loam about 5 inches thick. The subsurface layer is strongly acid, grayish brown loam about 3 inches thick. The upper part of the subsoil, from a depth of 8 to 22 inches, is strongly acid, dark grayish brown clay loam. The next part, from a depth of 22 to 42 inches, is slightly acid, dark grayish brown clay loam with yellowish brown and strong brown mottles. The lower part, from a depth of 42 to 80 inches, is slightly alkaline, gray clay loam.

The Lufkin soil is moderately well drained. Surface runoff is negligible, and permeability is very slow. The available water capacity is moderate. The surface layer may be saturated for periods of a few days to a few weeks after heavy rains. The shallow depressions are ponded for short periods, mostly during winter and spring.

Typically, the Rader soil has a surface layer that is moderately acid, dark brown fine sandy loam about 5 inches thick. The subsurface layer is strongly acid, light brownish gray or very pale brown fine sandy loam about 19 inches thick. The subsoil extends to a depth of 80 inches or more. From a depth of 24 to 30 inches, it is very strongly acid, mottled yellowish brown, strong brown, and grayish brown sandy clay loam; from a depth of 30 to 38 inches, it is very strongly acid, grayish brown sandy clay with red and yellowish red mottles. From a depth of 38 to 50 inches, the subsoil is very strongly acid, yellowish brown sandy clay with strong brown, grayish brown, and olive yellow mottles; from a depth of 50 to 66 inches, it is strongly acid, mottled light brownish gray, strong brown, and yellowish red sandy clay loam; and from a depth of 66 to 80 inches, it is slightly acid, mottled grayish brown, red, and yellowish red sandy clay loam.

This Rader soil is moderately well drained. Surface runoff is very low. Permeability is very slow and the available water capacity is moderate. A water table is at a depth of 2 to 5 feet during the winter.

Included in mapping are small areas of Crockett, Edge, and Wilson soils. The Crockett and Edge soils have a brown and red subsoil and do not have a water table within 6 feet of the surface. The Wilson soils have darker colors and do not have an abrupt textural change between the surface and subsoil. The included soils make up 5 to 15 percent of the map unit.

These Lufkin and Rader soils are used mainly for pasture.

Coastal bermudagrass, common bermudagrass, and tall fescue are adapted pasture grasses. Legumes, such as white clover or singletary peas, can be overseeded into the grasses to provide additional cool-season forage and to improve soil fertility. Applications of lime and fertilizer are needed to maintain a higher level of production.

In most years, delays may occur during the planting season for the cultivated crops most commonly grown in this survey area.

These soils have severe limitations for most urban uses. Shrinking and swelling and very slow permeability are limitations affecting septic tank absorption fields, building sites, and streets and roads. Wetness is a limitation in ponded areas. Proper design and installation are needed to overcome these limitations.

The Lufkin soil is in capability subclass IIIw, and the Rader soil is in capability subclass IIw. The Lufkin soil is in the Claypan Savannah range site and the Rader soil is in the Sandy Loam range site.

Ma—Manco loam, frequently flooded. This soil is on nearly level flood plains of streams. Surfaces are mainly smooth or slightly concave, and slopes are 0 to 1 percent. Areas follow the meander of streams. They range from about 200 feet to 0.5 mile wide and are about 20 to several hundred acres in size.

Typically, the surface layer is very strongly acid dark brown or mottled brown, grayish brown, and yellowish brown loam about 12 inches thick. The subsoil extends to a depth of 64 inches. From a depth of 12 to 17 inches, it is very strongly acid, mottled grayish brown, brown, and dark yellowish brown loam; from a depth of 17 to 22 inches, it is very strongly acid, grayish brown loam with dark yellowish brown mottles. From a depth of 22 to 30 inches, the subsoil is very strongly acid, mottled light brownish gray, yellowish brown, and grayish brown loam; from a depth of 30 to 48 inches, it is very strongly acid, grayish brown loam with yellowish red and strong brown mottles; and from a depth of 48 to 64 inches, it is very strongly acid, gray loam with strong brown and yellowish red mottles.

This soil is somewhat poorly drained. Surface runoff is negligible. Permeability is moderate and the available water capacity is high. The hazard of erosion is slight. Flooding occurs once or twice a year. In most areas, the duration is usually for periods of 7 to 10 days during November through May. A water table is within a depth of 12 to 18 inches during the winter and spring.

Included with this soil in mapping are areas of Gladewater soils. The Gladewater soils are usually in a slightly lower position on the landscape and are more clayey throughout. The included soils make up less than 20 percent of the map unit.

This Manco soil is used mainly for woodland or pasture.

Woodland areas, which provide excellent wildlife habitat, are mainly hardwood. Water oak, willow oak, and sweetgum are the dominant trees. Flooding and wetness severely limit pine timber production.

The main pasture grasses are bahiagrass, dallisgrass, and cool-season tall fescue. Overseeding legumes, such as white clover, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime are essential to maintain a higher level of production.

This soil is not suited to cultivation because of frequent flooding.

This soil is not suited to urban uses because of frequent flooding and wetness.

This soil is in capability subclass Vw. The woodland ordination symbol is 8W.

Na—Nahatche loam, frequently flooded. This soil is on nearly level flood plains. Surfaces are mainly smooth or slightly concave and slopes are 0 to 1 percent. Areas follow the meander of streams. They are about 200 feet to 0.5 mile wide, and range from about 20 acres to several thousand acres in size.

Typically, the surface layer is moderately acid, dark brown loam with grayish brown and yellowish brown mottles. It is about 8 inches thick. The subsoil extends to a depth of 66 inches. From a depth of 8 to 18 inches, it is moderately acid, grayish brown clay loam; from a depth of 18 to 30 inches, it is moderately acid, light brownish gray loam with brown and grayish brown mottles; from a depth of 30 to 48 inches, it is moderately acid, light brownish gray clay loam with strong brown mottles. From a depth of 48 to 52 inches, the subsoil is slightly acid, mottled gray and strong brown sandy clay loam; and from a depth of 52 to 66 inches, it is slightly alkaline, dark gray clay loam with strong brown and yellowish brown mottles.

This soil is somewhat poorly drained. Surface runoff is negligible. Permeability is moderate and the available water capacity is high. The hazard of erosion is slight. Flooding occurs once or twice a year for a duration of 1 to 7 days. Flooding is most likely to occur during November through May. A water table is within a depth of 18 inches during the winter.

Included with this soil in mapping are areas of Gladewater, Manco, and Sandow soils. The Gladewater soils are more clayey and are in lower positions on the landscape. The Manco soils are more acid in the lower part of the subsoil. The Sandow soils are better drained in the subsoil. The included soils make up less than 30 percent of the map unit.

This Nahatche soil is used mainly for woodland or pasture.

Woodland areas, which provide excellent wildlife habitat, are mainly hardwood. Water oak, willow oak, and sweetgum are the dominant trees. Flooding and wetness severely limit pine timber production.

The main pasture grasses suited to this soil are bahiagrass, dallisgrass, and the cool-season tall fescue. Overseeding legumes, such as white clover, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime are essential to maintain a higher level of production.

This soil is not suitable for cropland because of frequent flooding.

This soil is not suited to urban uses because of frequent flooding and wetness.

This soil is in capability subclass Vw. The woodland ordination symbol is 6W.

Nh—Nahatche loam, saline, frequently flooded. This soil is on the nearly level flood plain of Grand Saline Creek near the salt flats. Slopes are 0 to 1 percent. Areas follow the meander of Grand Saline Creek and range from about 200 to several hundred feet wide. This map unit consists of one area of 2,173 acres.

Typically, the surface layer is moderately acid, dark brown loam with grayish brown and yellowish brown mottles and salt crystals. It is about 7 inches thick. The upper part of the subsoil, from a depth of 7 to 35 inches, is moderately acid, grayish brown loam or light brownish gray loam with brown and dark grayish brown mottles. The next part, from a depth of 35 to 48 inches, is moderately acid, mottled gray, light brownish gray, and strong brown clay loam. The lower part, from a depth of 48 to 63 inches, is slightly acid, mottled gray and strong brown sandy clay loam.

This soil is somewhat poorly drained. Surface runoff is negligible. Permeability is moderate, and the available water capacity is moderate. The hazard of erosion is slight. The salinity content, which is moderate, is caused by natural artesian springs in the area of a salt dome. Flooding occurs on the average of once or twice a year; the duration is for a period of 2 to 7 days, most likely during November through May. A water table is within a depth of 18 inches during the winter.

Included with this soil in mapping are areas of Gladewater soils and small areas of salt flats. The Gladewater soils are more clayey and are in lower areas near the Sabine River. The salt flats are in areas where the soils are wetter and more saline. The included soils make up less than 5 percent of the map unit.

This Nahatche soil is used mainly for woodland or pasture.

Woodland areas, which provide excellent wildlife habitat, are mainly hardwoods. Water oak, willow oak, willow, and sweetgum are the dominant trees. The saline properties of the soil inhibit the growth of some hardwood species. Flooding, wetness, and salinity severely limit pine timber production.

The main pasture grasses are bahiagrass, dallisgrass, and the cool-season tall fescue. Overseeding legumes, such as white clover, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are essential to maintain a higher level of production.

This soil is not suitable for cropland because of frequent flooding and salinity.

This soil is not suitable for urban uses because of frequent flooding and wetness.

This soil is in capability subclass Vw. The woodland ordination symbol is 6W.

NoC2—Normangee clay loam, 3 to 8 percent slopes, severely eroded. This gently sloping to moderately sloping soil is on uplands along side slopes of small drainageways. Most areas have rills and shallow gullies that are 10 to 75 feet wide and 1 to 3 feet deep. They occur at 75 to 300 feet intervals. Most can be crossed with farm machinery. Areas are irregular in shape and range from 10 to 150 acres in size.

Typically, the surface layer is slightly acid, very dark grayish brown clay loam about 4 inches thick. The upper part of the subsoil, from a depth of 4 to 12 inches, is slightly acid, dark brown clay. The next part, from a depth of 12 to 26 inches, is neutral, dark brown clay. The lower part, from a depth of 26 to 41 inches, is moderately alkaline, light olive brown clay. The underlying material, from a depth of 41 to 72 inches, is stratified light olive brown, yellowish brown, and dark gray clay interbedded with strata of weathered shale.

This soil is moderately well drained. Surface runoff is high and permeability is very slow. The available water capacity is moderate. The hazard of erosion is severe.

Included with this soil in mapping are areas of Bazette, Crockett, and Edge soils. The Bazette soils are in similar positions on the landscape but do not have as clayey a subsoil. The Crockett and Edge soils have an abrupt textural change between the surface and subsoil. The included soils make up less than 20 percent of the map unit.

This Normangee soil is used mainly for pasture.

The main pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding adapted clovers or vetches into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

The slope, hazard of erosion, and past erosion severely limit this soil for use as cropland.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength affects streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass VIe and in the Claypan Prairie range site.

OkB—Oakwood fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on upland interstream divides. Surfaces are mainly smooth or slightly convex. Areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is slightly acid, dark brown, fine sandy loam about 7 inches thick. The subsurface layer is slightly acid, light yellowish brown fine sandy loam about 8 inches thick. The upper part of the subsoil, from a depth of 15 to 34 inches, is strongly acid, yellowish brown sandy clay loam with yellowish red mottles. The next part, from a depth of 34 to 72 inches, is moderately acid, brownish yellow sandy clay loam with red mottles. The lower part, from a depth of 72 to 80 inches, is strongly acid, grayish brown clay loam with red and brownish yellow mottles.

This soil is moderately well drained. Surface runoff is very low. Permeability is moderately slow and the available water capacity is moderate. The hazard of water erosion is moderate. A water table is at a depth of 3.5 to 5 feet during winter and spring.

Included with this soil in mapping are small areas of Freestone, Raino, and Wolfpen soils. The Freestone and Raino soils have a clayey layer in the lower part of the subsoil. The Wolfpen soils have a sandy surface layer 20 to 40 inches thick. The included soils make up less than 15 percent of the map unit.

This Oakwood soil is used mainly for pasture or woodland. Some small areas are used as cropland.

Coastal bermudagrass, common bermudagrass, and bahiagrass are well suited grasses on this soil. Overseeding legumes, such as arrowleaf clover, crimson clover or vetch, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime are needed to maintain a higher level of production.

Areas of woodland are mainly hardwood with some pine. The dominant hardwood trees are southern red oak, post oak, and sweetgum. Loblolly and shortleaf pines are the main commercial trees. This soil has no major limitations for timber production. Proper woodland management practices can increase timber production.

Crops, such as corn, roses, and vegetables, are suited to this soil. Fertilizer and lime are essential to maintain a higher level of production. Good management practices, such as using cover crops, green manure crops, terraces, and contour farming, can help reduce erosion and improve fertility.

This soil is suited to most urban uses. Wetness and permeability are limitations for septic tank absorption fields. Corrosivity is a limitation affecting uncoated steel and concrete, and low strength is a limitation affecting streets and roads. These limitations can be overcome with good design and installation.

This soil is in capability subclass IIe. The woodland ordination symbol is 9A.

OkD—Oakwood fine sandy loam, 5 to 8 percent slopes. This moderately sloping soil is on uplands. Surfaces are mainly smooth or slightly convex. Areas are mainly long and narrow and generally follow breaks into drainageways. Areas range from 15 to 150 acres in size.

Typically, the surface layer is slightly acid, brown fine sandy loam about 6 inches thick. The subsurface layer is slightly acid, light yellowish brown fine sandy loam about 4 inches thick. The upper part of the subsoil, from a depth of 10 to 18 inches, is moderately acid, dark yellowish brown sandy clay loam. The next part, from a depth of 18 to 26 inches, is very strongly acid, yellowish brown sandy clay loam. The lower part, from a depth of 26 to 80 inches, is very strongly acid, yellowish brown sandy clay loam that has red and light brownish gray mottles.

This soil is moderately well drained. Surface runoff is medium. Permeability is moderately slow and the available water capacity is moderate. The hazard of water erosion is severe. A water table is within a depth of 3.5 to 5 feet during winter and spring.

Included with this soil in mapping are small areas of Cuthbert and Wolfpen soils. The Cuthbert soils have a reddish, clayey subsoil. The Wolfpen soils have a sandy surface layer 20 to 40 inches thick. The included soils make up less than 15 percent of the map unit.

This Oakwood soil is used mainly for woodland or pasture.

Areas of woodland consist of mixed hardwoods and some pines. The dominant hardwood trees are southern red oak, post oak, and sweetgum. Loblolly and shortleaf pines are the main commercial trees. This soil has no major limitations for timber production, and good woodland management practices can increase timber production.

Coastal bermudagrass, common bermudagrass, and bahiagrass are pasture grasses well suited to this soil. Overseeding legumes, such as arrowleaf clover, crimson clover, or vetch, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime can help to maintain a higher level of production.

Erosion is a major limitation when this soil is used as cropland; however, terraces and farming on the contour can help reduce erosion.

This soil is suited to most urban uses. Wetness and permeability are limitations for septic tank absorption fields. Corrosivity is a limitation affecting uncoated steel and concrete, and low strength is a limitation affecting streets and roads. These limitations can be overcome with good design and installation.

This soil is in capability subclass IVe. The woodland ordination symbol is 9A.

PkC—Pickton fine sand, 1 to 5 percent slopes. This gently sloping soil is on broad upland interstream divides. Surfaces are mainly slightly convex. Soil areas are irregular in shape and range from 10 to 2,500 acres in size.

Typically, the surface layer is slightly acid, brown fine sand about 7 inches thick. The subsurface layer is slightly acid, light yellowish brown fine sand about 53 inches thick. The upper part of the subsoil, from a depth of 60 to 72 inches, is slightly acid, yellowish brown sandy clay loam. The lower part, from a depth of 72 to 80 inches, is strongly acid, mottled light gray, strong brown, and red sandy clay loam.

This soil is well drained. Surface runoff is very low and permeability is moderate. The available water capacity is low. The hazard of water erosion is slight. During wet periods in the winter and spring a water table is at a depth of 4 to 6 feet.

Included with this soil in mapping are areas of Tonkawa and Wolfpen soils. The Tonkawa soils are sandy to a depth of more than 80 inches. The Wolfpen soils have a surface layer 20 to 40 inches thick. The included soils make up less than 20 percent of the map unit.

This Pickton soil is used mainly for pasture. Some areas are in woodland and small areas are in cropland.

Coastal bermudagrass and lovegrass are well suited to this soil. Overseeding a legume, such as vetch, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are essential to maintain a higher level of production. Low available water capacity is the main limitation.

Woodland areas consist mainly of hardwoods with some loblolly and shortleaf pines. Red oak, post oak, blackjack oak, and hickory are the main hardwood trees. Loblolly and shortleaf pines are the main commercial trees. Plantations of loblolly and slash pines are on some old cropland fields. Droughtiness limits the growth of trees and decreases the survival rate of seedlings.

Watermelons, roses, peas, and sweet potatoes are crops suited to this soil (fig. 4). Low natural fertility and droughtiness are the major limitations. Applications of fertilizer and lime are essential to maintain a high level of production. Growing high residue crops and green manure crops will help to maintain fertility and increase the water holding capacity.

This soil is suited to most urban uses. Seepage is a limitation affecting most sanitary facilities.

This soil is in capability subclass IIIs. The woodland ordination symbol is 8S.

PkE—Pickton fine sand, 5 to 15 percent slopes. This moderately sloping to moderately steep soil is on side slopes along drainageways. Areas are commonly long and narrow and range from 10 to 500 acres in size.

Typically, the surface layer is slightly acid, brown fine sand about 6 inches thick. The subsurface layer is slightly acid, very pale brown fine sand about 36 inches thick. The upper part of the subsoil, from a depth of 42 to 56 inches, is strongly acid, reddish yellow sandy clay loam. The lower part, from a depth of 56 to 80 inches, is strongly acid, mottled light brownish gray and reddish yellow sandy clay loam.

This soil is well drained. Surface runoff is low and permeability is moderate. The available water capacity is low and the hazard of water erosion is moderate. During wet periods in the winter, a water table is at a depth of 4 to 6 feet.

Included with this soil in mapping are areas of Cuthbert, Tenaha, Tonkawa, and Wolfpen soils. The Cuthbert soils have a loamy surface layer. The Tenaha and Wolfpen soils have a surface layer 20 to 40 inches thick. The Tonkawa soils are sandy to a depth of more than 80 inches. The included soils make up less than 20 percent of the map unit.

This Pickton soil is used mainly as woodland. Some areas have been cleared and planted in pasture grasses.

Most woodland areas consist of hardwood trees, mainly red oak, post oak, and hickory. Shortleaf and loblolly pines are in some areas. Droughtiness is the main limitation; however, good management practices can help to increase timber production.

Coastal bermudagrass and weeping lovegrass are well suited to this soil. Applications of lime and fertilizer at frequent intervals are essential to maintain a higher level of production. The low available water capacity is a limitation that also affects production.

Slope is a major limitation and erosion is a hazard when this soil is used as cropland.

This soil has limitations for most urban uses. Seepage and slope are limitations affecting sanitary facilities. Slope is the main limitation for such uses as dwellings, streets, and roads. These limitations can be overcome with good design and careful installation.

This soil is in capability subclass VIe. The woodland ordination symbol is 8S.

Pt—Pits. This map unit consists of areas where soils, and often the underlying strata, have been removed. Pits range from about 5 to 100 acres in size. Most pits in the county are clay, rock, or sand.

Figure 4.—A field of sweet potatoes growing on Pickton fine sand, 1 to 5 percent slopes.

Most of the clay pits are in areas of Crockett, Edge, and Woodtell soils along Interstate 20 and U. S. Highway 80. The clay was used as fill material in highway construction. Clay pits average about 5 feet in depth and range up to about 100 acres in size.

The rock pits are in the extreme northwestern part of the county in areas of Crockett, Edge, Lufkin, Rader, and Wilson soils. The rock is used mainly for construction. Rock pits average 20 to 70 feet in depth and range up to about 100 acres in size. After rock is removed, the pits contain water most of the year.

Sand pits are throughout the county in sandy areas. Sand pits average about 5 feet in depth and range up to about 100 acres in size. Sand pits are mostly in Pickton, Tonkawa, and Wolfpen soils. The sand is used for building, fill, and road building material.

No capability subclass, range site, or woodland ordination symbol is assigned.

RdC—Redsprings very gravelly fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on narrow interstream divides or low foot slopes on uplands. Surfaces are mainly convex, and areas are irregular in shape. Areas range from 10 to 300 acres in size.

Typically, the surface layer is moderately acid, dark reddish brown, very gravelly fine sandy loam about 7 inches thick. The upper part of the subsoil, from a depth of 7 to 27 inches, is moderately acid, red clay. The middle part, from a depth of 27 to 42 inches, is strongly acid, red clay with glauconitic material and shale fragments. The lower part, from a depth of 42 to 50 inches, is strongly acid, red clay with 30 percent weathered glauconite and 10 percent shale fragments. The underlying material, from a depth of 50 to 71 inches, is strongly acid, red loamy glauconitic material.

This soil is well drained. Surface runoff is low. Permeability is moderately slow and the available water capacity is moderate. The hazard of water erosion is moderate.

Included with this soil in mapping are small areas of Cuthbert, Elrose, and Kirvin soils. The Cuthbert and Kirvin soils lack glauconitic material in the subsoil. The Elrose soils have a loamy subsoil. Also included are areas of a Redsprings soil with up to 5 percent of the surface covered with stones. The included soils make up less than 20 percent of the map unit.

This Redsprings soil is used mainly for pasture or woodland. Small areas are used for cropland.

Woodland areas are mainly mixed hardwood and some pine trees. Shortleaf and loblolly pines are the main commercial trees. The gravel on the surface reduces the available water capacity and limits timber production; however, the use of good woodland management practices can help to maintain a higher level of production.

Pasture grasses adapted to this soil are bahiagrass, common bermudagrass, and coastal bermudagrass. Legumes, such as crimson clover, arrowleaf clover, or vetch, are often overseeded into the grasses to provide additional forage and improve soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

The very gravelly surface layer, moderate available water capacity, and hazard of erosion are the main limitations for use of this soil as cropland.

This soil is suited to most urban uses; although low strength is a limitation affecting streets and roads, and moderately slow permeability is a limitation for septic tank absorption fields. With good design and careful installation, these limitations can be overcome.

This soil is in capability subclass IIIe. The woodland ordination symbol is 8F.

RdE—Redsprings very gravelly fine sandy loam, 5 to 15 percent slopes. This strongly sloping to moderately steep soil is on side slopes of uplands. Surfaces are mainly smooth or slightly convex. Areas are oblong, either following breaks into drainageways or occupying entire steep hills. Areas are 10 to 300 acres in size.

Typically, the surface layer is moderately acid, dark reddish brown, very gravelly fine sandy loam about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 36 inches, is strongly acid, red clay with some ironstone fragments. The lower part, from a depth of 36 to 48 inches, is very strongly acid, red clay with some glauconite, ironstone, and shale fragments. The underlying material, from a depth of 48 to 66 inches, is very strongly acid, strong brown, weathered glauconite of sandy clay loam texture.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Cuthbert soils. The Cuthbert soils lack glauconitic materials in the subsoil. Also included are areas of a Redsprings soil with up to 10 percent of the surface covered with stones. The included soils make up less than 15 percent of the map unit.

This Redsprings soil is used mainly for woodland or wildlife habitat. Some areas are used for pasture.

The woodland areas are mainly mixed hardwoods and some pines. Shortleaf and loblolly pines are the main commercial trees. The gravel on the surface of this soil reduces the available water capacity and limits tree growth. Slope limits accessibility of harvesting equipment. Timber stands are better managed with natural reproduction of trees. These woodland areas are a natural refuge for deer and other wildlife.

Pasture grasses adapted to this soil are bahiagrass, common bermudagrass, and coastal bermudagrass. Legumes, such as crimson clover, arrowleaf clover, or vetch, are often overseeded into the grasses to provide additional forage and improve soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil is not suited to crops, mainly because of slopes, hazard of erosion, and fragments of ironstone on the surface.

This soil is moderately suited to most urban uses. Low strength and slope are limitations affecting streets and roads. Moderately slow permeability is a limitation for septic tank absorption fields and slope and shrink-swell potential are limitations for homesites. However, some areas feature homesites with scenic views.

This soil is in capability subclass VIe. The woodland ordination symbol is 8F.

Sa—Salt flats. These areas are on the southeast edge of Grand Saline, Texas, southeast of the junction of U.S. Highway 80 and Farm Road 314.

The areas, caused by natural artesian springs, are mainly clayey with very high levels of sodium chloride. The flats are mostly barren or ponded with water 3 to 7 times during most years for periods of 2 to 10 days. The vegetation around the perimeter of the barren areas is dominately seashore saltgrass.

No capability subclass, range site or woodland ordination symbol is assigned.

Sd—Sandow loam, occasionally flooded. This nearly level soil is on flood plains. Surfaces are mainly smooth or concave, and slopes are 0 to 1 percent. Areas are long and narrow and range from 10 to 400 acres in size.

Typically, the surface layer is neutral, brown loam about 10 inches thick. The subsoil extends to a depth of 63 inches. From a depth of 10 to 29 inches, it is slightly acid, pale brown loam; from a depth of 29 to 36 inches, it is slightly acid, dark brown loam with very dark gray and olive brown mottles. From a depth of 36 to 56 inches, the subsoil is neutral, dark gray clay loam with dark yellowish brown and yellowish brown mottles; and from a depth of 56 to 63 inches, it is neutral, mottled strong brown, light brownish gray, and yellowish brown sandy clay loam.

This soil is moderately well drained. Surface runoff is negligible. Permeability is moderately slow and the available water capacity is high. The hazard of erosion is slight. Flooding occurs on the average of once every 2 to 5 years for a duration of 2 to 7 days. A water table is within a depth of 3.5 to 6 feet during the winter.

Included with this soil in mapping are areas of Whitesboro and Nahatche soils. The Whitesboro soils are darker and more alkaline. The Nahatche soils are in lower positions on the landscape and are wetter. The included soils make up less than 20 percent of the map unit.

This Sandow soil is used mainly for pasture or woodland.

The main pasture grasses suited to this soil are common bermudagrass, bahiagrass, and fescue. Overseeding legumes, such as white clover or singletary peas, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime are essential to maintain a higher level of production.

Crops, such as sorghums and small grains, are suited to this soil. Good management practices, such as using cover crops and green manure crops, help reduce erosion. Wetness can be a problem when this soil is used as cropland.

Woodland areas consist of hardwood trees that provide excellent wildlife habitat.

Occasional flooding and wetness can limit the use of this soil for urban uses.

This soil is in capability subclass IIw and in the Loamy Bottomland range site.

Sf—Sandow loam, frequently flooded. This nearly level soil is on flood plains. Surfaces are mainly smooth or concave and slopes are 0 to 1 percent. Areas are long and narrow and range from 50 to 450 acres in size.

Typically, the surface layer is neutral, dark brown loam about 8 inches thick. The subsoil extends to a depth of 63 inches. From a depth of 8 to 28 inches, it is slightly acid, dark grayish brown loam with thin stratified layers of fine sandy loam; from a depth of 28 to 34 inches, it is slightly acid, dark brown loam with olive brown mottles. From a depth of 34 to 56 inches, the subsoil is neutral, dark grayish brown clay loam with yellowish brown and dark yellowish brown mottles; and from a depth of 56 to 63 inches, it is neutral, mottled strong brown, light brownish gray, and yellowish brown sandy clay loam.

This soil is moderately well drained. Surface runoff is negligible. Permeability is moderately slow and the available water capacity is high. The hazard of erosion is slight. Flooding generally occurs two to five times a year for a duration of 1 to 3 days, most likely during December through May. A water table is within a depth of 3.5 to 6 feet during the winter.

Included with this soil in mapping are areas of Whitesboro and Nahatche soils. The Whitesboro soils are darker and more alkaline. The Nahatche soils are in lower positions on the landscape and are wetter. The included soils make up less than 20 percent of the map unit.

This Sandow soil is used for pasture or woodland.

The main pasture grasses suited to this soil are common bermudagrass, bahiagrass, and fescue. Overseeding legumes, such as white clover or singletary peas, into the grasses provides additional forage and improves soil fertility. Good management practices and applications of fertilizer and lime are essential to maintain a higher level of production.

Woodland areas consist of hardwood trees, which provide excellent wildlife habitat.

This soil is not suited to cropland because of flooding.

Flooding and wetness makes this soil unsuitable for urban uses.

This soil is in capability subclass Vw and in the Loamy Bottomland range site.

TeE—Tenaha loamy fine sand, 8 to 20 percent slopes. This strongly sloping to moderately steep soil is on uplands above drainageways. Surfaces range from smooth to slightly convex. Areas are mainly long and narrow and range from 25 to 250 acres in size.

Typically, the surface layer is moderately acid, dark grayish brown loamy fine sand about 5 inches thick. The subsurface layer is about 27 inches thick. From a depth of 5 to 20 inches, it is moderately acid, light yellowish brown loamy fine sand with pale brown and brownish yellow mottles. From a depth of 20 to 32 inches, it is moderately acid, yellowish brown loamy fine sand. The upper part of the subsoil, from a depth of 32 to 38 inches, is very strongly acid, mottled yellowish red and strong brown fine sandy loam. The lower part, from a depth of 38 to 50 inches, is very strongly acid, mottled red, yellowish red, and strong brown sandy clay loam. The underlying material, from a depth of 50 to 68 inches, is very strongly acid, red, gray and yellow soft sandstone.

This soil is well drained. Surface runoff is low and permeability is moderately slow. The hazard of water erosion is severe. The available water capacity is moderate.

Included with this soil in mapping are areas of Cuthbert and Redsprings soils. The Cuthbert and Redsprings soils have a loamy surface layer. The included soils make up less than 5 percent of the map unit.

This Tenaha soil is mostly in woodland. Small areas are in improved pasture.

Woodland areas are mainly mixed hardwood and pine. Loblolly and shortleaf pines are the main commercial trees. High seedling mortality and slope are the main limitations for timber production.

Coastal bermudagrass, common bermudagrass, and bahiagrass are the main pasture grasses. Overseeding legumes, such as clover or vetch, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil is not suited to crops, mainly because of slope and the hazard of erosion.

This soil is suited to some urban uses, although slope and seepage affect most uses. Good design and careful installation are needed to overcome these limitations.

This soil is in capability subclass VIe. The woodland ordination symbol is 9S.

ToB—Tonkawa fine sand, 1 to 3 percent slopes. This very gently sloping soil is on broad interstream divides. Surfaces are mainly smooth or convex. Areas are irregular in shape and range from 20 to 400 acres in size.

Typically, the surface layer is moderately acid, brown fine sand about 7 inches thick. The upper part of the underlying material, from a depth of 7 to 56 inches, is strongly acid, pale brown fine sand. The lower part, from a depth of 56 to 80 inches, is strongly acid, light yellowish brown fine sand.

This soil is excessively drained. Surface runoff is negligible and permeability is rapid. The available water capacity is low. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Pickton and Wolfpen soils that have a loamy subsoil. The included soils make up less than 15 percent of this map unit.

This Tonkawa soil is used mainly for pasture or woodland. A small area is used for cropland.

Coastal bermudagrass and lovegrass are suitable pasture grasses for this soil. A good management program and applications of fertilizer and lime are needed to maintain a higher level of production. Droughtiness is the main limitation.

Woodland areas are mainly hardwoods, dominately sandjack oak, hickory, and post oak. Scattered shortleaf and loblolly pines are in some areas. Droughtiness and the low available water capacity affect pine growth. High seedling mortality is the main limitation for planting pine trees on this soil.

This soil is poorly suited to most cultivated crops; however, watermelons grow well. Crop residues and green manure crops are needed to maintain soil tilth. Droughtiness and the low available water capacity are the main limitations for crop production.

This soil is suited to most urban uses. Seepage and rapid permeability are limitations for sanitary facilities. Slippage or cutbanks caving are limitations affecting shallow excavations.

This soil is in capability subclass IVs. The woodland ordination symbol is 6S.

Wh—Whitesboro loam, frequently flooded. This soil is on nearly level flood plains of large streams. Surfaces are mainly smooth or concave and slopes are 0 to 1 percent. Areas are oblong and are a few hundred feet to about 0.5 mile wide. Areas range from about 100 to several hundred acres in size.

Typically, the surface layer is neutral, very dark grayish brown loam about 12 inches thick. The subsurface layer, from a depth of 12 to 56 inches, is neutral, very dark gray or dark brown clay loam. The subsoil, from a depth of 56 to 80 inches, is neutral, dark yellowish brown loam.

This soil is moderately well drained. Surface runoff is negligible. Permeability is moderate and the available water capacity is high. Flooding occurs at least once in most years during November through May for a duration of 3 to 7 days. A water table is within a depth of 2 to 4 feet during the winter and spring.

Included with this soil in mapping are small areas of Aufco and Sandow soils. The Aufco soils are more clayey and are in slightly lower positions on the landscape. The Sandow soils are of lighter color and are in slightly higher positions. The included soils make up less than 15 percent of any mapped area.

This Whitesboro soil is mainly used for pasture and wildlife habitat.

The main pasture grasses suited to this soil are common bermudagrass, bahiagrass, and fescue. Overseeding legumes, such as white clover or singletary peas, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are essential to maintain a higher level of production.

This soil is not suited to cropland because of flooding.

Flooding and wetness make this soil unsuitable for urban uses.

This soil is in capability subclass Vw and in the Loamy Bottomland range site.

Wn—Wilson silt loam, 0 to 1 percent slopes. This nearly level soil is on terraces in slightly depressional upland areas. Surfaces are smooth to slightly concave. Areas are oval in shape and range from 10 to 300 acres in size.

Typically, the surface layer is slightly acid, dark gray silt loam about 6 inches thick. The subsoil extends to a depth of 80 inches or more. From a depth of 6 to 22 inches, it is slightly acid, very dark gray silty clay; from a depth of 22 to 32 inches, it is slightly alkaline, dark grayish brown silty clay. From a depth of 32 to 54 inches, the subsoil is slightly alkaline, grayish brown silty clay; and from a depth of 54 to 80 inches, it is moderately alkaline, olive gray silty clay with few fine soft masses of calcium carbonate.

This soil is moderately well drained. Surface runoff is low and permeability is very slow. The available water capacity is moderate. The hazard of erosion is slight.

Included with this soil in mapping are areas of Crockett soils that are in slightly higher positions on the landscape. The included soils make up less than 10 percent of the map unit.

This Wilson soil is used mostly for pasture.

The main pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding adapted clovers or vetches into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

Areas of cropland are mainly small grains and cotton. Applications of fertilizer can help to maintain a higher level of production.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. The very slow permeability will restrict use of this soil for septic tank absorption fields. Low strength is a limitation affecting streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in the capability subclass IIIw and in the Claypan Prairie range site.

WoC—Wolfpen loamy fine sand, 1 to 5 percent slopes. This gently sloping soil is on broad interstream divides on uplands. Surfaces are mainly slightly convex. Areas are irregular in shape and range from 10 to 2,000 acres in size.

Typically, the surface layer is moderately acid, dark brown loamy fine sand about 5 inches thick. The subsurface layer is slightly acid, pale brown loamy fine sand about 23 inches thick. The subsoil extends to a depth of 80 inches or more. From a depth of 28 to 35 inches, it is slightly acid, yellowish brown sandy clay loam with yellowish brown and dark yellowish brown mottles; from a depth of 35 to 42 inches, it is moderately acid, yellowish brown sandy clay loam with strong brown, grayish brown, and yellowish red mottles. From a depth of 42 to 65 inches, the subsoil is slightly acid, yellowish brown sandy clay loam with red mottles; and from a depth of 65 to 80 inches, it is slightly acid, mottled light gray, red, and yellowish brown sandy clay loam.

This soil is well drained. Surface runoff is very low. Permeability is moderate and the available water capacity is moderate. The hazard of water erosion is slight. A water table is at a depth of 4 to 6 feet during winter and spring.

Included with this soil in mapping are small areas of Bernaldo and Leagueville soils. The Bernaldo soils are on toe slopes and have a loamy surface layer. The Leagueville soils are wetter and in concave depressions. The included soils make up less than 15 percent of the map unit.

This Wolfpen soil is used mainly for pasture or cropland.

The main pasture grasses are coastal bermudagrass, common bermudagrass, and bahiagrass. Some areas are overseeded with legumes, such as arrowleaf clover, crimson clover, or vetch for additional forage and soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

The main crops are corn, roses, sweet potatoes, tomatoes, and watermelons. Good management practices, such as using contour farming, cover crops, high residue crops, and green manure crops, reduce erosion and maintain soil fertility.

Woodland areas are mainly mixed hardwoods and some pine trees. Shortleaf and loblolly pines are the main commercial trees. Loblolly and slash pine plantations have been established on some old cropland fields. A moderate rate of seedling mortality and droughtiness are the main limitations for timber production.

This Wolfpen soil is suited to most urban uses. Seepage and wetness are limitations affecting sanitary facilities. These limitations can be overcome by good design and careful installation.

This soil is in capability subclass IIIe. The woodland ordination symbol is 9S.

WoE—Wolfpen loamy fine sand, 5 to 15 percent slopes. This strongly sloping to moderately steep soil is on side slopes above drainageways. Surfaces are generally slightly convex. Areas are long and narrow and range from 10 to 200 acres in size.

Typically, the surface layer is moderately acid, brown loamy fine sand about 5 inches thick. The subsurface layer is moderately acid, pale brown loamy fine sand about 19 inches thick. The upper part of the subsoil, from a depth of 24 to 35 inches, is slightly acid, yellowish brown sandy clay loam with red and brownish yellow mottles. The next part, from a depth of 35 to 63 inches, is moderately acid, yellowish brown sandy clay loam with grayish brown and red mottles. The lower part, from a depth of 63 to 80 inches, is mottled red, gray, and yellowish brown sandy clay loam.

This soil is well drained. Surface runoff is low. Permeability is moderate and the available water capacity is moderate. The hazard of water erosion is severe. A water table is at a depth of 4 to 6 feet during winter and spring.

Included with this soil in mapping are areas of Bernaldo soils. The Bernaldo soils are on toe slopes and have a loamy surface layer. The included soils make up less than 10 percent of the map unit.

This soil is used mainly for pasture or woodland.

Coastal bermudagrass, common bermudagrass, and bahiagrass are the main pasture grasses on this soil. Some areas are overseeded with legumes, such as arrowleaf clover, crimson clover, or vetch, to provide additional forage and soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

Woodland areas are mainly mixed hardwoods and some pine trees. Shortleaf and loblolly pines are the main commercial trees on this soil. A moderate rate of seedling mortality and droughtiness are the main limitations affecting timber production.

A few moderately sloping areas of this soil are used for crops, mainly roses and watermelons. The main limitation is droughtiness, and erosion is a hazard. On moderately sloping areas, good management practices, such as using contour farming, cover crops, high residue crops, and green manure crops, can help to reduce erosion and maintain soil tilth. The hazard of erosion is too severe for crops on slopes of more than 8 percent.

This soil is suited to most urban uses. Slope is a limitation for streets, roads, and dwellings; and slope and seepage limit the use of this soil for sanitary facilities. With careful design and installation, these features can be overcome.

This soil is in capability subclass VIe. The woodland ordination symbol is 9S.

WtC—Woodtell loam, 2 to 5 percent slopes. This gently sloping soil is on uplands. Surfaces are smooth to slightly convex. Areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is strongly acid, very dark grayish brown loam about 5 inches thick. The subsurface layer is strongly acid, grayish brown loam about 3 inches thick. The upper part of the subsoil, from a depth of 8 to 14 inches, is strongly acid, dark red clay that has yellowish red mottles. The next part, from a depth of 14 to 30 inches, is strongly acid, red clay loam that has yellowish red and light gray mottles. The lower part, from a depth of 30 to 54 inches, is strongly acid, dark yellowish brown clay loam that has light gray and red mottles. The underlying material, from a depth of 54 to 80 inches, is slightly acid, stratified light olive gray and gray shale with yellowish brown loamy material.

This soil is well drained. Surface runoff is high. Permeability is very slow and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Freestone and Wolfpen soils. The Freestone soils are loamy and in lower, wetter positions on the landscape. The Wolfpen soils have a sandy surface layer. Also included are small areas of an eroded and stony Woodtell soil. The included soils make up less than 15 percent of the map unit.

This Woodtell soil is used mainly for pasture.

The main pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding legumes, such as crimson clover, arrowleaf clover, or vetch, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

Areas in cropland are planted mainly in small grains and vegetables. The hazard of erosion and droughty nature of the soil are the main limitations for cropland production. Good management practices, such as farming on the contour, terracing, and using cover crops and green manure crops, help to reduce erosion and maintain soil fertility.

This soil has severe limitations for urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength affects streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass IVe. The woodland ordination symbol is 8C.

WtC2—Woodtell loam, 2 to 5 percent slopes, eroded. This gently sloping soil is on convex ridges and side slopes next to drainageways. It has a thin surface layer or has rills and shallow gullies, which are 10 to 75 feet wide and 1 to 3 feet deep. They occur at 75 to 300 feet intervals. Most can be crossed with farm machinery. Areas are oval in shape and range from 10 to 100 acres in size.

Typically the surface layer is moderately acid, dark grayish brown loam about 4 inches thick. The upper part of the subsoil, from a depth of 4 to 20 inches, is very strongly acid, red clay that has brownish yellow mottles. The next part, from a depth of 20 to 32 inches, is very strongly acid, red clay that has brownish yellow, light brownish gray, and pale brown mottles. The lower part, from a depth of 32 to 50 inches, is very strongly acid, light brownish gray clay loam that has red and brownish yellow mottles. The underlying material, from a depth of 50 to 80 inches, is slightly acid, stratified light olive gray and gray shale and yellowish brown clay loam and sandy clay loam.

This soil is well drained. Surface runoff is high. Permeability is very slow and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Freestone and Wolfpen soils. The Freestone soils are in slightly lower positions on the landscape. The Wolfpen soils have a sandy surface layer. Also included on similar slopes are areas of a Woodtell soil that is not eroded. The included soils make up less than 10 percent of the map unit.

This Woodtell soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding legumes, such as crimson clover, arrowleaf clover, or vetch, into the grasses provides additional forage and improves soil fertility. Applications of fertilizer and lime are needed to maintain a higher level of production.

The slope, hazard of erosion, and past erosion make this soil poorly suited to crops.

This soil has severe limitations for most urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength is a limitation that affects streets and roads. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass IVe. The woodland ordination symbol is 8C.

WtD—Woodtell loam, 5 to 12 percent slopes. This strongly sloping soil is on uplands. Areas are mostly oblong to irregular in shape and range from about 10 to several hundred acres in size.

Typically, the surface layer is strongly acid, very dark grayish brown fine sandy loam about 4 inches thick. The subsurface layer is strongly acid, grayish brown fine sandy loam about 3 inches thick. The upper part of the subsoil, from a depth of 7 to 15 inches, is very strongly acid, dark red clay that has yellowish red mottles. The next part, from a depth of 15 to 28 inches, is very strongly acid, red clay that has yellowish red and gray mottles. The lower part, from a depth of 28 to 54 inches is strongly acid, dark yellowish brown clay loam that has gray and red mottles. The underlying material, from a depth of 54 to 80 inches, is slightly acid, stratified light olive gray and gray shale of clay loam texture and yellowish brown sandy clay loam.

This soil is well drained. Surface runoff is very high. Permeability is very slow and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Cuthbert, Kirvin, and Wolfpen soils. The Cuthbert and Kirvin soils are in higher positions on the landscape. The Wolfpen soils have a sandy surface layer. Also included are small areas of an eroded and very stony Woodtell soil. The included soils make up less than 15 percent of the map unit.

This Woodtell soil is used mainly for pasture.

The major pasture grasses are coastal bermudagrass and common bermudagrass. Overseeding legumes, such as crimson clover, arrowleaf clover, or vetch, into the grasses provides additional forage and improves soil tilth. Applications of fertilizer and lime are needed to maintain a higher level of production.

This soil is not used as cropland because of the steepness of slope and severe hazard of erosion.

This soil has severe limitations for urban uses. Shrinking and swelling are limitations affecting dwellings. Very slow permeability restricts use of this soil for septic tank absorption fields. Low strength affects streets and roads. Steepness of slope affects all urban uses. Special design and careful installation are needed to overcome these limitations.

This soil is in capability subclass VIe. The woodland ordination symbol is 8C.

WwC—Woodtell loam, 2 to 8 percent slopes, extremely bouldery. This gently sloping to moderately sloping soil is on oval, convex ridges that are in a chainlike pattern. The large boulders and stones on the surface are not part of any underlying bedrock. They range from 6 inches to 20 feet wide, but most are 3 to 10 feet long, 2 to 8 feet wide, and 1 to 2 feet thick. Boulders occupy about 40 percent of the surface. Areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is strongly acid, very dark grayish brown loam about 4 inches thick. The subsurface layer is strongly acid, grayish brown fine sandy loam about 3 inches thick. The upper part of the subsoil, from a depth of 7 to 15 inches, is very strongly acid, dark red clay that has yellowish red mottles. The next part, from a depth of 15 to 32 inches, is very strongly acid, red clay that has yellowish red and gray mottles. The lower part, from a depth of 32 to 54 inches is strongly acid, dark yellowish brown clay loam that has gray and red mottles. The underlying material, from a depth of 54 to 80 inches, is slightly acid, stratified light olive gray and gray shale with clay loam texture and yellowish brown sandy clay loam.

This soil is well drained. Surface runoff is high. Permeability is very slow and the available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Bernaldo, Freestone, and Wolfpen soils. The Bernaldo and Freestone soils are in slightly lower positions on the landscape. The Wolfpen soils have a sandy surface layer.

Also included are small areas of an eroded Woodtell soil. The included soils make up less than 15 percent of the map unit.

This Woodtell soil is used mainly as native pasture or wildlife habitat.

This soil is not suited to crops, improved pasture, or timber production because the many large boulders interfere with equipment use.

The main limitations for dwellings, streets, and roads are large boulders and the shrinking and swelling of the soil with changes in moisture. Low strength is an additional limitation for roads and streets. The very slow permeability and presence of stones and boulders restrict the use of this soil as septic tank absorption fields.

This Woodtell soil is in capability subclass VIIs. The woodland ordination symbol is 6C.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forest land, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. The slope ranges mainly from 0 to 5 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

Nearly 94,000 acres in the survey area, or about 17 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county.

The map units in the survey area that are considered prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

The map units that meet the requirements for prime farmland are:

BeB	Bernaldo fine sandy loam, 1 to 3 percent slopes
ErB	Elrose fine sandy loam, 1 to 3 percent slopes
FrB	Freestone fine sandy loam, 1 to 3 percent slopes
GaB	Gallime fine sandy loam, 1 to 3 percent slopes
OkB	Oakwood fine sandy loam, 1 to 3 percent slopes
Sd	Sandow loam, occasionally flooded

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Glen W. Lubke, agronomist, Natural Resources Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The estimated yields of the main crops and pasture plants are listed for each soil, the system of land capability classification used by the Natural Resources Conservation Service is explained, and prime farmland is described.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading “Detailed Soil Map Units.” Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

About 350,000 acres in the survey area is currently used for crops and pasture. Of this total, about 52,000 acres is used for crops and 298,000 acres is used for permanent pasture and hayland. Crops include small grains, sweet potatoes, field peas, cotton, roses, Christmas trees, peach orchards, blackberry orchards, tomatoes, watermelons, and trees and shrubs for nurseries. The small grains are grown mainly for livestock grazing.

The amount of land used for agriculture in Van Zandt County is slowly declining. As farms and ranches are subdivided into smaller units of 20 acres or less, they are converted to other uses.

The soils in Van Zandt County have good potential for increased food production. Several thousand acres of potentially good cropland are currently used as pasture. In addition to this potential cropland capacity, food production could be increased considerably by applying the latest crop production technology to all the cropland in the county. This soil survey can greatly facilitate the application of such technology.

Crops

Cotton and corn are the principal row crops grown in the county. Other row crops can be grown if economic conditions are favorable. The most common close-grown crops are wheat, oats, and forage sorghum, which are used mainly for grazing. Rye, barley, and vetch are grown to a lesser extent.

Grasses and legumes grown for seed production include bahiagrass, weeping lovegrass, arrowleaf clover, and vetch.

Garden produce is the primary cash crop in the county. Sweet potatoes and watermelons are the major vegetables grown commercially. Others include okra, onions, tomatoes, turnips, pumpkin, canteloupe, and

Figure 5.—A field of tomatoes growing on Bernaldo fine sandy loam, 1 to 3 percent slopes.

squash (fig. 5). Peaches and blackberries are also grown commercially. The kinds and amount of vegetables grown each year varies because of market supply and demand.

Other agricultural enterprises include Christmas tree farms and tree and shrub nurseries that supply nearby markets.

Some of the soils in Van Zandt County are especially well suited for growing vegetables and small fruits. Soils such as Bernaldo, Elrose, Freestone, and Gallime have good drainage and warm up early in the spring, so crops can usually be planted and harvested earlier.

Most of the well drained, loamy and sandy soils in the survey area are suitable for orchards, vineyards, and nursery plants. Soils in low areas, where frost is frequent or drainage is poor, are poorly suited to early vegetable crops, small fruits, and orchards.

The latest information and suggestions for growing specialty crops can be obtained from local offices of the Cooperative Extension Service and the Natural Resources Conservation Service.

Water erosion is the major concern on nearly all the cropland having a slope of more than 1 percent. Productivity is reduced as the more fertile topsoil is lost and part of the subsoil is incorporated into the plow layer. Soils that have a thin, loamy surface layer and a clayey subsoil are especially damaged when the surface layer is eroded.

Soil erosion on farmland causes sedimentation in areas downstream. Controlling erosion minimizes sediment pollution of streams, thereby improving the quality of water for municipal use, recreation, and for fish and wildlife.

Erosion control practices provide a protective surface cover that reduces runoff and soil blowing and increases the rate of water infiltration. A cropping system that keeps vegetative cover on the soil for extended periods helps reduce soil losses to a level that allows the soil's productive capacity to be maintained.

Tillage systems that leave crop residue on the soil surface help reduce runoff and control erosion. Soil compaction is reduced if tillage operations are kept to a minimum. Residue management with a minimum of soil disturbance reduces evaporation of moisture from the soil. Tillage systems also conserve energy because they require less fuel than conventional systems.

Terraces and diversions reduce the length of slope, slow runoff, and help control erosion. Approximately 12 million feet, more than 2,000 miles, of terraces have been built on cropland in Van Zandt County. Most of these terraces are now in pasture because of changes in land use. Some may be causing erosion problems because they have not been maintained.

Terraces are most practical on deep, well drained and moderately well drained soils that do not have irregular slopes and that are used as continuous cropland. When planning and installing terraces and diversions, adequate protective outlets are an important component. In many places, natural drainageways are used for terrace outlets. Drainageways that are deep or eroded must be stabilized before they are suitable for this purpose.

Wind erosion is considered to be a very minor problem on most soils in Van Zandt County, but it can occur, especially on the sandy soils. Wind erosion is rare because the unprotected distance is short in most areas, and the lack of cover is only temporary. In addition, the average annual rainfall is relatively high.

Information on erosion control practices for each kind of soil can be obtained at the local office of the Natural Resources Conservation Service.

Drainage is not a problem on most soils in Van Zandt County. Surface drainage may be necessary on some areas of poorly drained or very poorly drained soils that are used for crops and pasture if damage to plants is excessive.

The natural fertility of Van Zandt County soils varies greatly. The alluvial soils on flood plains are generally more fertile than the soils on uplands. The alluvial soils make up about 15 percent of the county.

Most of the loamy and sandy soils on uplands are low in natural fertility and require applications of a complete fertilizer to obtain adequate yields. However, most soils that have a calcareous surface layer are naturally high in potassium. Soils that have a sandy surface layer need a split application of a complete fertilizer during the crop year to keep fertility in balance and to reduce loss of nutrients by leaching. Acid soils require periodic applications of lime, since most plants grow best in neutral soils. The amount and type of fertilizer applied should be based on the results of soil tests, needs of the crop, expected level of yields, previous land use or cropping sequence, and the amount of available soil moisture. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer to apply.

Soil tilth is important for seed germination and water infiltration. Soils that have good tilth are granular and porous. High-residue producing crops, such as wheat and grain sorghum, tend to increase organic matter and improve tilth.

Soils that have a surface layer of fine sandy loam or loam texture, low content of organic matter, and weak structure are highly susceptable to crusting after heavy rains. Once the crust forms, it reduces infiltration and increases runoff. Regular additions of crop residue, manure, or other organic materials improve soil structure and reduce crust formation.

Some soils, such as Crockett and Wilson, have a surface layer that is difficult to work because it is sticky when wet and extremely hard when dry. A good seedbed is difficult to prepare on these soils. If plowed when wet, these soils tend to be very cloddy after drying. Plowing when wet also causes dense plowpans to develop which impede the downward movement of plant roots, air, and moisture.

Pasture and Hayland

Pasture management is important in Van Zandt County because raising livestock is the main farm enterprise. This county is also among the leading hay producing counties in the nation (fig. 6). The trend during the past 50 years has been to convert land from cropland to pasture and hayland. A light trend in recent years is to convert small areas of pasture to cropland to produce truck crops.

The most commonly grown pasture grasses are coastal bermudagrass, common bermudagrass, and bahiagrass. Land that is used for pasture and hay production generally is planted to introduced grasses that respond better to good management than most native grasses. Many varieties of improved bermudagrass grow well in this area. Management and fertilization generally have a greater influence on forage production than grass variety. Usually, the location and availability of bermudagrass seed, sprigs, and stolons determines the variety that is used.

Common bermudagrass, and bahiagrass are better suited to soils on the flood plains than to other soils in the county. However, if properly managed, these grasses produce an adequate amount of quality forage when grown on most of the soils in the county. Drought-tolerant grasses such as weeping lovegrass may be better adapted to the most sandy soils.

Forage legumes overseeded into permanent pasture grasses increase the level of available nitrogen, extend the grazing season, and improve pasture quality. The four most important legumes overseeded into permanent pastures are Dutch white clover, crimson clover, arrowleaf clover, and hairy vetch. The Dutch white clover is more suitable for the wetter soils on the flood plains. The crimson clover is more suitable on the upland soils that have a loamy surface texture, such as the Bernaldo and Freestone soils. Arrowleaf clover and hairy vetch are adapted to all soil types except the wetter soils on flood plains. Arrowleaf clover is best suited to soils that have a loamy or sandy surface texture and hairy vetch to soils with more clayey textures.

Best management practices for pasture are: Nutrient management (including fertilizer), rotational grazing between pastures to maintain proper grazing height, pest management (including weed and brush control), and an

Figure 6.—Round bales of coastal bermudagrass hay in an area of Bernaldo fine sandy loam, 1 to 3 percent slopes.

adequate water supply for livestock (including water wells, water troughs, and ponds).

Best management practices for hay are: Nutrient management (including fertilizer), cutting forage at the correct height, and cutting at the proper stage of growth.

Soil erosion is not generally a problem in pastures that are well managed.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Natural Resources Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded *(9)*. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are 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 or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that 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.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

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 hazard is the 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 very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 and IIIe-6.

The capability classification of each map unit is given in the section “Detailed Soil Map Units” and in the yields table.

Rangeland

Russell O. Castro, biologist, Natural Resources Conservation Service, helped prepare this section.

Rangeland is land on which native vegetation consists of a wide variety of grasses, grass-like plants, forbs, shrubs, and trees. Rangeland receives no regular or frequent cultural treatment.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

About 22,000 acres is used as rangeland in Van Zandt County. Areas of rangeland are in the western part of the county within the Texas Claypan and Texas Blackland Prairie Major Land Resource Areas. Soils used for rangeland are in general soil map units 5, 6, and 8.

The Blackland Prairie was originally a mostly treeless plain covered with indiangrass, little bluestem, big bluestem, switchgrass, native legumes, and forbs. Trees grew mainly along small creeks and on flood plains of the larger creeks and rivers.

The Texas Claypan was originally a post oak-blackjack oak savannah. The savannah typically was an open stand of individual trees or motts of trees along with indiangrass, little bluestem, big bluestem, switchgrass, beaked panicum, native legumes, and forbs.

Wildfire was a natural part of the ecosystem. Wildfires repeatedly burned the area, which helped to control the spread and thickening of the oaks and underbrush and to perpetuate growth of the tall grasses, legumes, and forbs.

Farming and ranching practices have caused a major change in the original vegetation. The suppression of wildfires and overgrazing by domestic livestock have decreased the most productive grasses and increased less desirable species of herbaceous and woody plants.

Table 6 shows, for each soil that supports rangeland vegetation suitable for grazing, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community or climax vegetation. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the climax vegetation on a particular range site. The more closely the existing community resembles the climax vegetation, the better the range condition. Range condition is an ecological rating only.

A primary objective of good range management is to keep the range in excellent or good condition to conserve water, improve yields, and protect the soil. The main management concern is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growing plants, encouraged by heavy rainfall, can lead to the conclusion that the range is in good condition when, actually, the cover consists of many undesirable plants. In fact, the long-term trend is toward lower production. Conversely, some rangeland that has been closely grazed for short periods under careful supervision can have a degraded appearance that temporarily conceals its quality and ability to recover.

Climax vegetation on the range site is the stabilized plant community that reproduces itself and changes very little as long as the environment remains unchanged. The climax vegetation consists of the plants that grew in the area when it was first settled. The most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that are the most palatable to livestock. They are generally the tallest and most productive perennial grasses and forbs. These plants decrease in relative amount when rangeland is overgrazed.

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

Invaders are plants that cannot compete with the climax vegetation for moisture, nutrients, and light. They become established after the more desirable plants have been reduced. They are generally lower in nutritional value and produce less forage for livestock.

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.

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, 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 25 or less.

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.

Following years of prolonged overuse of range, seed sources of desirable vegetation are eliminated. These plants can be reestablished by applying one or a combination of practices that include brush control, range seeding, fencing, water development, or other mechanical treatment to revitalize stands of native plants. Thereafter, deferred grazing, proper grazing use, and planned grazing systems can maintain and improve the range.

Good management generally results in the optimum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs.

The five range sites in the survey area are: Clayey Bottomland, Claypan Prairie, Claypan Savannah, Loamy Bottomland, and Sandy Loam.

Clayey Bottomland Range Site. The Aufco soils in map unit Au are in the Clayey Bottomland range site. The climax plant community is a tall grass savannah with a 30 percent canopy. The canopy generally is more dense adjacent to the stream. Cool-season grasses and sedges grow under the canopy, and warm-season grasses and forbs dominate the openings. The composition by weight is 70 percent grasses, 25 percent woody plants, and 5 percent forbs.

Sedges, Virginia wildrye, Canada wildrye, and rustyseed paspalum make up 35 percent of the climax plant community. Beaked panicum, switchgrass, indiangrass, little bluestem, big bluestem, eastern gamagrass, vine-mesquite, and Florida paspalum make up 25 percent. Buffalograss, longleaf uniola, knotroot bristlegrass, and other grasses make up 10 percent. Woody plants include oak, elm, cottonwood, hackberry, black willow, pecan, and hawthorn trees and woody vines. The forbs are tickclover, snoutbean, lespedeza, and gayfeather.

This is a range site preferred by livestock. Heavy grazing and suppression of fire reduce the warm-season grasses and forbs and allow the brush to form a dense canopy. Shade-tolerant grasses become dominant and total usable forage is drastically reduced.

Claypan Prairie Range Site. The Crockett, Normangee, and Wilson soils in map units CrA, CrB, CrC, CrC2, NoC2, and Wn are in the Claypan Prairie range site. The climax plant community is a tall grass prairie with a few scattered live oak, elm, and hackberry trees occurring along watercourses or in widely scattered motts. The composition by weight is 85 percent grasses, 5 percent woody plants, and 10 percent forbs.

Little bluestem and indiangrass make up 65 percent of the climax plant community. Switchgrass, big bluestem, Virginia wildrye, Canada wildrye, Florida paspalum, sideoats grama, meadow dropseed, Texas wintergrass, and vine-mesquite make up 15 percent. Purpletop, brownseed paspalum, longspike tridens, buffalograss, low panicums, fall switchgrass, and sedges make up 5 percent. Live oak, elm, hackberry, bumelia, coralberry, and a few post oak make up 5 percent of the total production. Forbs include Maximilian sunflower, Engelmann daisy, halfshrub sundrop, western indigo, and prairie clover.

Continued overgrazing by cattle decreases big bluestem, little bluestem, indiangrass, and switchgrass. Meadow dropseed, silver bluestem, sideoats grama, and Texas wintergrass increase. Finally, mesquite and pricklypear invade the site and buffalograss, Texas wintergrass, Texas grama, windmillgrass, and weedy forbs become the dominant plants.

Claypan Savannah Range Site. The Bazette, Edge, and Lufkin soils in map units BaD, EdC, EdD, Lk, and Lu are in the Claypan Savannah range site. The climax plant community is a post oak-blackjack oak savannah with trees shading 20 to 25 percent of the ground. The composition by weight is about 75 percent grasses, 20 percent woody plants, and 5 percent forbs.

About 60 percent of the climax vegetation is made up of little bluestem, indiangrass, and brownseed paspalum. The other grasses are switchgrass, Florida paspalum, purpletop, low panicums, low paspalums, silver bluestem, tall dropseed, and Texas wintergrass. Woody plants include post oak, blackjack oak, elm, yaupon, hawthorn, and American beautyberry. Forbs include dayflower, bundleflower, sensitive briar, tickclover, wildbean, and lespedeza.

If retrogression occurs as a result of heavy grazing or fire suppression, or both, little bluestem, indiangrass, and switchgrass are replaced by brownseed paspalum, silver bluestem, arrowfeather threeawn, tall dropseed, purpletop, and low panicums. Woody plants, such as post oak, elm, yaupon, and hackberry, increase and form a dense canopy that suppresses grass and forb production.

Loamy Bottomland Range Site. The Sandow and Whitesboro soils in map units Sd, Sf, and Wh are in the Loamy Bottomland range site. The climax plant community is a tall grass savannah with trees shading about 30 percent of the ground. Cool-season grasses and sedges dominate the shaded areas, while warm-season plants dominate the openings. The composition by weight is 70 percent grasses, 25 percent woody plants, and 5 percent forbs.

Virginia wildrye, sedges, and rustyseed paspalum grow in the shaded and wet areas. They make up 25 percent of the composition. Switchgrass, beaked panicum, indiangrass, big bluestem, little bluestem, eastern gamagrass, vine-mesquite, and purpletop grow in the open areas and make up 35 percent. Redtop panicum, gaping panicum, low panicums, uniolas, buffalograss, knotroot bristlegrass, Texas wintergrass, and other grasses make up 10 percent. The woody plants include oaks, pecan, hackberry, elm, cottonwood, black willow, sycamore, hickory, ash, and many other brushy plants. The forbs are tickclover, lespedeza, snoutbean, partridge pea, and gayfeather.

This is a range site preferred by livestock. Overgrazing and fire suppression reduce warm-season grasses and forbs and increase the tree and brush canopy. Shade-tolerant grasses and forbs then dominate the site and forage production is drastically reduced.

Sandy Loam Range Site. The Rader soils in map unit Lu are in the Sandy Loam range site. The climax vegetation is a post oak-blackjack oak savannah with a 20 to 25 percent canopy. Tall grasses fill the interspaces between the oak. The composition by weight is 80 percent grasses, 15 percent woody plants, and 5 percent forbs.

The predominant grass on this site is little bluestem, making up 50 percent of the composition. Indiangrass makes up about 10 percent; Eastern gamagrass, switchgrass, big bluestem, beaked panicum, and longleaf uniola make up 10 percent; and numerous other grasses make up another 10 percent. Woody plants include post oak, blackjack oak, elm, yaupon, greenbriar, American beautyberry, and berry vines. The forbs include Engelmann daisy, gayfeather, sensitive briar, and native legumes.

If wildfires are reduced and if overgrazing continues, this range site will deteriorate, with an increase in woody canopy and a decline in tall grasses, such as little bluestem, indiangrass, big bluestem, and eastern gamagrass. These plants are replaced by an increase in such plants as brownseed paspalum. If overgrazing persists, this site will deteriorate to a thicket of oak and brush, annual grasses, forbs, and carpetgrass.

Woodland Management and Productivity

Jim Stevens, forester, Natural Resources Conservation Service, helped prepare this section.

Van Zandt County has about 73,000 acres of woodland, much of which is used to produce commercial wood products. Recreation and wildlife habitat are additional uses for these woodlands.

Most of the timber that is commercially harvested is in the southeastern part of the county. Because of the lack of processing facilities, most of the harvested timber is transported to markets outside the county. Control of undesirable species and regeneration of pine are major management problems. Production could be greatly increased if all areas of woodlands were properly managed.

In upland areas, the woodlands are comprised mainly of mixed hardwoods with sweetgum, post oak, hickory, and red oak the predominant species. Loblolly is the major species of pine on upland sites and is mostly in small plantations. Bottom land sites are mostly hardwood and are predominantly water oak, willow oak, sweetgum, and red oak.

Soils vary in their ability to grow trees. Depth, fertility, texture, and the available water capacity influence tree growth. Soil permeability, drainage, and position on the landscape are also important. Soil properties that affect management include slope, texture, drainage, stoniness, and rooting depth.

Table 7 gives information on the productivity of soils for growing trees and limitations for woodland management. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species based on a site index. The larger the number, the greater the potential productivity. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, C, S, and F. In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment and season of use are not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, and effective rooting depth. In Van Zandt County, soils that have a sandy or clayey surface are generally the ones that have the greatest problem. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent. When planting seedlings on soils rated moderate or severe, it may be necessary to increase the planting rate, to use containerized or larger than usual planting stock, or to make special site preparations, such as bedding, furrowing, installing surface drainage, or providing artificial shade.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

Plant competition ratings indicate the degree to which undesirable species are expected to invade and grow when openings are made in the tree canopy. The main factors that affect plant competition are depth to the water table and the available water capacity. Plant competition is highest on soils that are droughty and on soils that are poorly drained. A rating of *slight* indicates that competition from undesirable plants is not likely to prevent natural regeneration or suppress the more desirable species. Planted seedlings can become established without undue competition. A rating of *moderate* indicates that competition may delay the establishment of desirable species. Competition may hamper stand development, but it will not prevent the eventual development of fully stocked stands. A rating of *severe* indicates that competition can be expected to prevent regeneration unless precautionary measures are applied.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as board feet (Doyle rule) per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand. These yields can be significantly higher if the timber is managed with sound forestry practices.

In the East Texas area, timber is sometimes sold on a weight basis. Volume to weight conversions vary greatly depending on log diameter, however an average conversion factor of 8 tons per 1000 board feet (Doyle rule) for pine sawlogs and 9 tons per 1000 board feet (Doyle rule) for hardwood can be used.

The first species listed under *common trees* for a soil is the indicator species for that soil. It generally is the most common and the most productive species on the soil and is the one that determines the ordination class.

Loblolly pine is the indicator species for soils that will grow pine in Van Zandt County. Soils that have a very high potential productivity have a site index of 92 or higher. They have a number that is 10 or more as the first part of the ordination symbol. Soils that have a low potential productivity have a site index of 70 or less. They have a number that is 6 or less as the first part of the ordination symbol.

Sweetgum is the indicator species for soils in which the climax vegetation includes only hardwoods. Soils that have a very high potential productivity have a site index for sweetgum of 91 or higher. They have a number that is 8 or more as the first part of the ordination symbol. Soils that have a low potential productivity have a site index below 80. They have a number that is 5 or less as the first part of the ordination symbol.

Trees to plant are those that are suitable for commercial wood production. They are the trees best adapted to soil conditions and are the ones recommended for reforestation or for natural regeneration.

Woodland Understory Vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. If well managed, some woodland can produce enough understory vegetation to support grazing of livestock or wildlife, or both, without damage to the trees.

On grazed woodland that is periodically burned, grasses make up as much as 80 percent of the understory vegetation; sedges, forbs, and shrubs make up the rest. With average rainfall, annual herbage yields on most of the soils will average between 1,500 and 3000 pounds (air dry) per acre. These yields are significantly higher on some of the better soils.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter.

The density of the canopy determines the amount of light that reaches the understory plants. Canopy cover is a major factor affecting the production of vegetation within reach of livestock and large game animals. Good silviculture practices, such as thinning of timber stands, removal of cull trees, and controlled burning are necessary to maintain moderate to good production of understory vegetation. If these practices are not used, the canopy cover increases drastically because of the growth of shrubs and hardwoods in the midstory. A site that has a closed canopy (75 percent or more cover) may not have sufficient carrying capacity for a profitable livestock operation. A closed canopy will also limit use of the area by big game animals because of the lack of browse plants.

Good livestock management is necessary in addition to woodland management to achieve a high level of forage production. Livestock management practices that are consistent with good forest management are discussed in the following paragraphs.

Proper woodland grazing uses no more than one-half, by weight, of the annual growth of key forage plants in preferred grazing areas. This grazing intensity maintains or improves the quantity and quality of forage by increasing the vigor and reproduction of desirable plants. Additional benefits include conservation of soil and water, reduction of the wildfire hazard, and preservation of the natural beauty of the woodland.

Deferred grazing consists of postponing or resting the site from grazing for a prescribed period. This rest period promotes the growth of natural vegetation by increasing the vigor of forage and permitting desirable plants to seed. It also provides food reserves for fall and winter grazing, improves the appearance of lands that have adequate cover, improves hydrologic conditions, and reduces the amount of soil loss.

Planned grazing systems are designed so that two or more grazing units are rested from grazing in a planned sequence throughout the year or during the growing season of key forage plants.

Prescribed burning is the controlled application of fire for the purpose of removing undesirable vegetation. It decreases competition for water, nutrients, and sunlight. In addition, removing part of the organic layer, reducing the hazard of wildfire, and removing old, unpalatable, rough growth results in an increase in forage production.

In some areas of Van Zandt County, all the timber has been removed from former woodlands. About 43,000 acres of these cleared areas are being used as native pasture. Forage consists of the native grasses and forbs which are allowed to grow. The grasses are mainly little bluestem, indiangrass, and switchgrass. With the canopy removed, there is less competition for sunlight, nutrients, and water. This has allowed forage yields to double on many of the soils. Management concerns on these cleared areas are about the same as for rangeland.

Table 8 shows, for each soil suitable for woodland, the potential for producing understory vegetation. The total production of understory vegetation includes the herbaceous plants and the leaves, twigs, and fruit of woody plants up to a height of 4.5 feet. It is expressed in pounds per acre of air-dry vegetation in favorable, normal, and unfavorable years. In a favorable year, soil moisture is above average during the optimum part of the growing season; in a normal year, soil moisture is average; and in an unfavorable year, it is below average.

Table 8 also lists the common names of the characteristic vegetation on each soil and the *composition*, by percentage of air-dry weight, of each kind of plant. The table shows the kind and percentage of understory plants expected under a canopy density that is most nearly typical of woodland in which the production of wood crops is highest.

Recreation

Jimmy Shelburn, district conservationist, Natural Resources Conservation Service, helped prepare this section.

Recreational opportunities are plentiful in Van Zandt County. About 85 to 90 percent of Van Zandt County is suited to some type of commercial or noncommercial recreation.

Many campgrounds in and around Canton and several historical sites throughout the county provide easy access to local activities.

Lake Tawakoni, Purtis Creek State Park, and Mill's Creek Lake provide excellent opportunities for water-related recreational activities such as boating, fishing, and swimming. Camping facilities are available at Purtis Creek State Park. The many creeks, private ponds, and small lakes provide habitat for aquatic species and recreation for the landowners (fig. 7). The Sabine River and Neches River provide habitat for many aquatic species, but public access for sport fishing is somewhat limited. Hunting opportunities in the county are limited because of excessive hunting pressure, loss of habitat, and lack of accessibility.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Jimmy Shelburn, Howard Sprague, and Russell O. Castro, Natural Resources Conservation Service, and Kay Flemming, Texas Parks and Wildlife Department, helped prepare this section.

Prime wildlife habitat throughout Van Zandt County has declined because of the division of sizable ranches and farms and increased home site development. The conversion of cropland to introduced pasture grasses, such as bermudagrass and bahiagrass, has further degraded wildlife habitat. The prime wildlife habitat that remains is mostly in wooded areas, especially those areas next to major rivers and streams.

There is a wide diversity of game and nongame wildlife species in the county. White-tailed deer are present but their numbers are low. The population has been declining because of excessive hunting and loss of habitat. The removal of forb and browse plants to make way for livestock forage has also decreased the quality of the eastern wild turkey habitat as well as habitat for quail and various other wildlife species. Eastern wild turkey have been released in areas near the county line adjacent to

Figure 7.—A farm pond used for recreation as well as a source of livestock water.

Henderson County and have been sighted in that vacinity over the past few years. The gray squirrel, fox squirrel, raccoon, opossum, skunk, small rodents, and raptors are numerous throughout the county. Various song birds, reptiles, and amphibians can also be found in abundant numbers. Predator species such as bobcat, coyote, and fox are common. The bald eagle is occasionally sighted during migrations through the area. The gray wolf and black bear may have inhabited the area at one time, but because of hunting and loss of habitat, they are no longer present. Currently, Van Zandt County has no federally listed threatened or endangered species of plants or animals.

Generally, the surface waters in the county are of good quality and well suited to recreational fish production. Habitat for numerous and varied aquatic species is provided by Lake Tawakoni, many smaller lakes and farm ponds, the Sabine and Neches Rivers, and the creeks and streams that are within the county. Lake Tawakoni and many of the private ponds and lakes have been stocked with largemouth bass, crappie, bluegill, redear sunfish, and channel catfish. Lake Tawakoni has also been stocked with hybrid striped bass, striped bass, and white bass. Green sunfish, bullhead catfish, gar, longear sunfish, carp, and various minnows are also in Lake Tawakoni as well as in the smaller lakes, and the Sabine and Neches Rivers.

Beaver and nutria are in many of these water bodies. They sometimes cause damage by burrowing in dams, stopping up pond drain pipes and spillways, and interfering with the free flow of water by constructing dams in stream channels.

Some of the soils of Van Zandt County are considered to be natural wetlands. These soils are mostly in low-lying areas of the Sabine and Neches Rivers and the various creeks and streams. In other areas wetlands occur as small inclusions within some soil map units and as components of complex map units. Wetlands are important to the ecosystem because they provide food, cover, and nesting areas for many wildlife species. Many migratory waterfowl use the ponds, lakes, and wetland areas as resting and feeding stops on their annual migrations.

Management practices that increase the food source for a desired species can aid in improving the quality and quantity of the animal. Such practices may include one or a combination of the following conservation measures.

Legumes and cool season annuals can be overseeded in improved pastures to provide a high quality forage for deer, turkey, and quail. Refraining from planting improved grasses or applying herbicides along the edge of pastures and wooded areas encourages forbs that attract deer, turkey, and quail. Allowing the areas along fencelines to grow up in forb and browse species improves quail habitat. Disking along the roadside and right-of-way also encourages forb production. Grazing management practices such as proper grazing use, deferred grazing, and planned grazing systems can be incorporated into farm and ranch operations to improve desirable vegetation.

In areas overgrown by undesirable woody plants, prescribed burning can be used to encourage the germination and growth of plants that will improve the habitat. However, extreme care must be taken when using prescribed burning as a management tool.

In areas of cropland, using conservation cropping systems and managing crop residue can improve the habitat for certain kinds of wildlife. Grasses and legumes can be included in crop rotations to provide food and cover. Residue from grain crops can be left on the surface so that wasted grain is available for various game and songbirds, as well as migratory waterfowl.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, grain sorghum, wheat, oats, millet, cowpeas, sunflowers, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bermudagrass, kleingrass, bahiagrass, fescue, lovegrass, clover, singletary peas, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, ragweed, lespedeza, vetch, panicums, Illinois sunflower, and Engelmann daisy.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, elm, black cherry, sweetgum, pecan, walnut, plum, persimmon, apple, hawthorn, dogwood, hickory, and blackberry.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine and eastern redcedar.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are American beautyberry, yaupon, greenbriar, sumac, coralberry, dewberry, blackberry, honeysuckle, and grape.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cattails, maidencane, giant plumgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include bobwhite quail, dove, meadowlark, field sparrow, cottontail, coyote, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, thrushes, woodpeckers, squirrels, fox, raccoon, deer, and coyote.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, nutria, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include rabbit, coyote, deer, quail, and meadowlark.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the “Soil Properties” section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as the final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair, or poor* as a source of roadfill and topsoil. They are rated as a *probable or improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, and sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind erosion or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts and sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3-bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; *high*, more than 6 percent; and *very high*, greater than 9 percent.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.64. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.
8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep and very deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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

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

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of flooding is more than 50 percent in any year). *Common* is used when the occasional and frequent classes are grouped for certain purposes. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on observations of the water table at selected sites and on the evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched, apparent, or artesian; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone. An *artesian* water table is under hydrostatic head, generally below an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Two numbers in the column showing depth to the water table indicate the normal range in depth to a saturated zone. Depth is given to the nearest half foot. The first numeral in the range indicates the highest water level. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. “More than 6.0” indicates that the water table is below a depth of 6 feet or that it is within a depth of 6 feet for less than a month.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 18 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section “Soil Series and Their Morphology.” The soil samples were tested by the Texas Department of Highways and Public Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 422 (ASTM), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 4318 (ASTM); Plasticity index—T 90 (AASHTO), D 4318 (ASTM); Moisture density—T 99 (AASHTO), D 698 (ASTM); Specific gravity—T 100 (AASHTO), D 854 (ASTM); California bearing ratio—T 193 (AASHTO), D 1883 (ASTM); and Shrinkage—T 92 (AASHTO), D 427 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(11)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 19 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalf (*Ud*, meaning humid, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Paleudalfs (*Pale*, meaning excessive horizonation, plus *udalf*, the suborder of the Alfisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Paleudalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle size, mineral content, soil temperature regime, soil depth, and reaction. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, siliceous, thermic, Typic Paleudalfs.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. An example is the Elrose series, a member of the fine-loamy, siliceous, thermic family of Typic Paleudalfs.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the “Soil Survey Manual” *(13)*. Many of the technical terms used in the descriptions are defined in “Soil Taxonomy” *(11)* and in “Keys to Soil Taxonomy” *(12)*. Unless otherwise indicated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section “Detailed Soil Map Units.”

Aufco Series

The Aufco series consists of very deep, somewhat poorly drained, clayey soils on flood plains. These soils formed under hardwood forests in recent sediments from adjacent uplands. Slopes range from 0 to 1 percent.

The soils of the Aufco series are fine, montmorillonitic, thermic Aquic Ustochrepts.

Typical pedon of Aufco clay, frequently flooded; from the intersection of Texas Highway 243 and Farm Road 47 about 9 miles west of Canton, 3 miles west on Texas Highway 243, and 100 feet south of road in a pasture.

A—0 to 5 inches; black (10YR 2/1) clay; moderate medium subangular blocky structure; extremely hard, very firm; many fine and medium roots; few fine pores; moderately acid; clear smooth boundary.

Bw1—5 to 20 inches; dark grayish brown (10YR 4/2) clay loam; few fine distinct light gray (10YR 7/2) mottles; moderate medium subangular blocky structure; very hard, firm; few fine roots; few brown concretions; strongly acid; diffuse boundary.

Bw2—20 to 34 inches; dark grayish brown (10YR 4/2) clay; common fine and medium faint and distinct light gray (10YR 7/2) and dark brown (10YR 4/3) mottles; moderate medium subangular blocky structure; very hard, firm; few fine roots; strongly acid; diffuse boundary.

Bw3—34 to 54 inches; dark grayish brown (10YR 4/2) clay; common medium distinct light gray (10YR 7/2) mottles; moderate medium subangular blocky structure; extremely hard, very firm; few fine roots; strongly acid; diffuse boundary.

Bw4—54 to 76 inches; dark grayish brown (10YR 4/2) clay; common fine faint and distinct yellowish brown (10YR 5/4) and gray (10YR 5/1) mottles; weak medium subangular blocky structure; extremely hard, very firm; few fine roots; strongly acid.

The solum is more than 60 inches thick. These soils are saturated in the winter and early spring of most years.

The A horizon is black, very dark grayish brown, dark grayish brown, or very dark gray with mottles in shades of gray, brown, or yellow. Reaction ranges from strongly acid to slightly acid. Some pedons have thin strata of loamy material.

The Bw horizon is dark grayish brown or grayish brown, with mottles in shades of gray or brown. It is clay loam or clay. The content of clay ranges from 35 to 45 percent in the control section. Reaction is very strongly acid or strongly acid; however, some pedons are slightly acid below the control section.

Bazette Series

The Bazette series consists of very deep, well drained, loamy soils on uplands. They formed in clayey alkaline sediments under mixed hardwoods and native grasses. Slopes range from 5 to 12 percent.

The soils of the Bazette series are fine, montmorillonitic, thermic Udic Haplustalfs.

Typical pedon of Bazette clay loam, 5 to 12 percent slopes; from the intersection of Farm Road 47 and Interstate 20 about 6 miles south of Wills Point, 0.3 mile north on Farm Road 47 and 200 feet west in a pasture.

A—0 to 6 inches; very dark grayish brown (2.5Y 3/2) clay loam; moderate fine and medium subangular blocky structure; very hard, friable; many fine and very fine roots; few fine pores; few wormcasts; few chert pebbles; neutral; clear smooth boundary.

Bt1—6 to 14 inches; olive brown (2.5Y 4/4) clay loam; moderate fine and medium subangular blocky structure; very hard, firm; common fine roots; few fine pores; few patchy clay films; few wormcasts; neutral; gradual smooth boundary.

Bt2—14 to 24 inches; light olive brown (2.5Y 5/4) clay; moderate medium subangular blocky structure; very hard, very firm; few fine roots; common fine and medium pores; few patchy clay films; common wormcasts; neutral; gradual smooth boundary.

BC—24 to 38 inches; light olive brown (2.5Y 5/4) clay loam; few fine faint grayish brown mottles; weak medium subangular blocky structure; very hard, firm; few fine roots; few fine pores; few wormcasts; common soft masses and few concretions of calcium carbonate; few fine chert pebbles; few shale fragments in lower part; calcareous; moderately alkaline; gradual smooth boundary.

C—38 to 60 inches; variegated light yellowish brown (2.5Y 6/4) and grayish brown (2.5Y 5/2) clay loam; massive; very hard, firm; few very fine roots; interbedded strata of weathered shale; few soft masses of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 25 to 40 inches in thickness. Depth to carbonates ranges from 20 to 40 inches. Siliceous pebbles range from none to few throughout.

The A horizon is very dark grayish brown, dark grayish brown, dark brown, or brown. Reaction ranges from moderately acid to neutral.

The Bt horizon is yellowish brown, light yellowish brown, olive brown, light olive brown, or olive yellow. It is clay loam, silty clay loam, silty clay, or clay. The content of clay ranges from 35 to 55 percent. Reaction ranges from moderately acid to neutral.

The BC horizon is light olive brown, olive yellow, or olive brown, or is mottled in these colors and in other shades of brown. Grayish colors are inherent from the parent material. The BC horizon is clay loam or clay. Reaction ranges from slightly acid to moderately alkaline.

The C horizon is variegated in shades of brown, yellow, olive, or gray. The interbedded shale has a clay loam or clay texture. Reaction ranges from slightly acid to moderately alkaline.

Bernaldo Series

The Bernaldo series consists of very deep, well drained, loamy soils on stream terraces. These soils formed in loamy unconsolidated sediments under mixed pine and hardwood forests. Slopes range from 1 to 8 percent.

The soils of the Bernaldo series are fine-loamy, siliceous, thermic Glossic Paleudalfs.

Typical pedon of Bernaldo fine sandy loam, 1 to 3 percent slopes; from the intersection of Texas Highway 243 and Texas Highway 198 in Canton, 5.6 miles southwest on Texas Highway 198, 4.4 miles west on Farm Road 1651, 1.25 miles north on county asphalt road, and 100 feet east in an area of cropland.

Ap—0 to 7 inches; brown (10YR 5/3) fine sandy loam; weak fine granular structure; slightly hard, very friable; common fine roots; slightly acid; abrupt smooth boundary.

E—7 to 16 inches; pale brown (10YR 6/3) fine sandy loam; weak fine granular structure; slightly hard, very friable; common fine roots; moderately acid; clear wavy boundary.

Bt—16 to 52 inches; yellowish brown (10YR 5/6) sandy clay loam; common fine prominent red (2.5YR 4/6) mottles; weak medium subangular blocky structure; slightly hard, friable; few fine roots; few patchy clay films; strongly acid; gradual wavy boundary.

Bt/E—52 to 80 inches; mottled yellowish brown (10YR 5/6), red (2.5YR 4/6) and light brownish gray (10YR 6/2) sandy clay loam; weak fine and medium subangular blocky structure; slightly hard, friable; 10 percent vertical streaks of pale brown (10YR 6/3) uncoated sand (E part); few patchy clay films; very strongly acid.

The solum ranges from 60 to more than 80 inches in thickness.

The A or Ap horizon is dark yellowish brown, yellowish brown, dark brown, pale brown, or brown. The E horizon is pale brown, very pale brown, yellowish brown, or light yellowish brown. The combined thickness of the A and E horizons is 10 to 20 inches. Reaction ranges from strongly acid to slightly acid.

The Bt horizon is yellowish brown, brownish yellow, or strong brown. Mottles in shades of brown or red range from none to many. The Bt horizon is sandy clay loam or loam. Reaction ranges from very strongly acid to slightly acid.

The B/E horizon is yellowish brown, brownish yellow, or strong brown, or is mottled in these colors and shades of red and gray. It is sandy clay loam or loam. Streaks and pockets of light gray, light yellowish brown, very pale brown, pale brown, or light brownish gray uncoated sand range from 5 to 15 percent. Reaction ranges from very strongly acid to moderately acid.

Crockett Series

The Crockett series consists of very deep, moderately well drained, loamy soils on uplands. They formed in alkaline shale and clay under mid and tall grass vegetation. Slopes range from 0 to 5 percent.

The soils of the Crockett series are fine, montmorillonitic, thermic Udertic Paleustalfs.

Typical pedon of Crockett loam, 1 to 3 percent slopes; from the intersection of U.S. Highway 80 and Farm Road 47 in Wills Point, 4.2 miles south on Farm Road 47, 0.8 miles west on county asphalt road, 0.15 mile north and 100 feet west in a cultivated field.

Ap—0 to 6 inches; dark brown (10YR 3/3) loam; massive; very hard, friable; few worm casts; few fine roots; moderately acid; abrupt wavy boundary.

Bt—6 to 15 inches; distinctly and coarsely mottled reddish brown (5YR 4/4) and dark brown (10YR 4/3) clay; few fine and medium prominent dark red (10R 3/6) mottles; moderate fine and medium angular blocky structure; extremely hard, very firm; few fine pores; thin patchy clay films and dark grayish brown stains on faces of peds; vertical cracks partly filled with darker soil; few fine black concretions; slightly acid; diffuse wavy boundary.

Btss1—15 to 28 inches; olive (5Y 5/4) clay; common medium and coarse distinct reddish brown (5YR 4/4), yellow (10YR 7/6), and grayish brown (10YR 5/2) mottles; moderate and coarse angular blocky structure; extremely hard, very firm; few fine pores; few thin patchy clay films on faces of peds; few fine pressure faces; few grooved slickensides; few fine black concretions; few black streaks or stains on faces of peds; neutral; gradual wavy boundary.

Btss2—28 to 40 inches; olive (5Y 5/4) clay; common medium distinct pale yellow (5Y 7/4) and light brownish gray (2.5Y 6/2) mottles; weak coarse angular blocky structure; extremely hard, very firm; few thin patchy clay films on faces of peds; few fine pressure faces; few grooved slickensides; few fine black concretions; few black streaks or stains on faces of peds; neutral; gradual wavy boundary.

BCtss—40 to 56 inches; distinctly and coarsely mottled light brownish gray (2.5Y 6/2) and pale olive (5Y 6/4) clay; weak coarse angular blocky structure; extremely hard, very firm; few thin patchy clay films on faces of peds; few pressure faces and cleavage planes; few grooved slickensides; few calcium carbonate concretions; few soft masses of calcium carbonate to 0.5 inch in diameter; few fine black concretions; few black streaks along pressure faces and cleavage planes; slightly alkaline; abrupt smooth boundary.

Ck1—56 to 70 inches; light yellowish brown (2.5Y 6/4) clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; massive; extremely hard, firm, friable when broken; about 25 percent by volume of weakly cemented shale fragments; about 20 percent white calcium carbonate masses and concretions; calcareous; moderately alkaline; diffuse smooth boundary.

Ck2—70 to 80 inches; pale yellow (2.5Y 7/4) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; extremely hard, very firm; about 35 percent by volume of weakly cemented shale fragments; about 10 percent by volume soft masses of calcium carbonate in the upper part grading to none in the lower part; soil matrix is calcareous in spots and shale is noncalcareous; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness.

The A horizon is dark grayish brown, dark brown, or very dark grayish brown. Reaction ranges from moderately acid to slightly alkaline.

The Bt horizon is prominently mottled in shades of brown, red, or olive or has a matrix of reddish brown with mottles in shades of brown or yellow. Reaction ranges from moderately acid to neutral.

The Btss horizon is mainly shades of brown or olive with mottles in shades of red or yellow. Gray mottles range from none to common below the Btss1 horizon. Reaction ranges from moderately acid to slightly alkaline.

The BCtss horizon is mottled in shades of light brownish gray, pale olive, or reddish brown. Reaction ranges from moderately acid to moderately alkaline.

The C horizon is shades of brown, gray, or yellow. It is clay loam, loam, or clay. Reaction is slightly alkaline or moderately alkaline with or without calcium carbonate concretions and masses.

Cuthbert Series

The Cuthbert series consists of very deep, well drained, loamy soils on uplands. They formed in weakly consolidated sandstone and interbedded loamy, clayey, and sandy sediments under mixed pine and hardwood forests. Slopes range mainly from 8 to 20 percent; but some graded areas have slopes as gentle as 3 percent, and some stony areas have slopes as steep as 25 percent.

The soils of the Cuthbert series are clayey, mixed, thermic Typic Hapludults.

Typical pedon of Cuthbert fine sandy loam, 8 to 20 percent slopes; from the intersection of Texas Highway 64 and Farm Road 314 in Edom, 4.2 miles east on Texas Highway 64, 1.7 miles north and west, and 100 feet north in mixed hardwood and pine woodland.

A—0 to 5 inches; dark brown (10YR 4/3) fine sandy loam; weak medium granular structure; soft, very friable; common fine roots; about 5 percent ironstone pebbles; moderately acid; clear wavy boundary.

E—5 to 10 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine granular structure; soft, very friable; few fine roots; about 5 percent ironstone fragments 1 to 3 inches across; moderately acid; clear wavy boundary.

Bt1—10 to 16 inches; red (2.5YR 4/6) clay; moderate medium angular blocky structure; hard, firm; few fine roots; few patchy clay films; strongly acid; gradual smooth boundary.

Bt2—16 to 28 inches; red (2.5YR 4/8) clay; common medium distinct yellow (10YR 7/6) mottles; moderate medium angular blocky structure; hard, firm; few fine roots; few patchy clay films on faces of peds; very strongly acid; clear wavy boundary.

B/C—28 to 36 inches; red (2.5YR 4/6) sandy clay loam; many fine, medium, and coarse yellowish red (5YR 5/8) mottles; weak coarse subangular blocky structure; hard, firm; few fine roots; few patchy clay films on faces of peds; common thin discontinuous strata of light gray (10YR 7/2) shale; very strongly acid; clear smooth boundary.

C—36 to 60 inches; mottled yellowish red (5YR 5/6), red (2.5YR 4/6) and yellowish brown (10YR 5/6) weakly consolidated sandstone of sandy clay loam and fine sandy loam texture interbedded with about 15 percent light gray (10YR 7/2) and red (2.5YR 4/8) shale and about 5 percent thin discontinuous layers of ironstone; extremely acid.

The solum ranges from 20 to 40 inches in thickness.

The A horizon is very dark grayish brown, dark brown, brown, or dark yellowish brown. The E horizon is yellowish brown, brown, pale brown, or very pale brown. The A and E horizons are fine sandy loam, gravelly fine sandy loam, very gravelly fine sandy loam, or stony fine sandy loam. Ironstone fragments range up to 35 percent by volume in the A and E horizons. Reaction ranges from very strongly acid to slightly acid.

The Bt horizon is dark red, red, or yellowish red. Mottles of strong brown, reddish yellow, yellow, yellowish brown, pale brown, and very pale brown are in the lower part of most pedons. Gray, light brownish gray, and light gray shale fragments are also in the lower part of most pedons. The Bt horizon is clay or sandy clay loam. Reaction ranges from extremely acid to strongly acid.

The B/C horizon is red, reddish yellow, yellowish red, or strong brown, and is stratified or mottled with these colors as well as grayish colors. It is sandy clay loam or clay loam with or without weathered sandstone and shale fragments. Reaction ranges from extremely acid to strongly acid.

The C horizon is interbedded weakly consolidated red, brown, yellow, and gray sandstone and shale. Strata of unconsolidated sandy, loamy, and clayey materials are in some pedons. The shale and other clayey materials are mostly gray. Most pedons contain thin discontinuous ironstone layers. The C horizon is extremely acid or very strongly acid.

Derly Series

The Derly series consists of very deep, poorly drained, loamy soils on old high stream terraces. These soils formed in clayey sediments under hardwood forests. Slopes range from 0 to 1 percent.

The soils of the Derly series are fine, montmorillonitic, thermic Typic Glossaqualfs.

Typical pedon of Derly silt loam, in an area of Derly-Raino complex, 0 to 1 percent slopes; from the intersection of Texas Highway 19 and Texas Highway 64 in Canton, 0.4 miles south on Texas Highway 19, and 200 feet east of road in a wooded area.

A—0 to 3 inches; dark grayish brown (10YR 4/2) silt loam; common medium faint very dark grayish brown (10YR 3/2) mottles; weak fine subangular blocky structure; slightly hard, friable; common medium coarse roots; few fine pores; moderately acid; clear smooth boundary.

Eg—3 to 9 inches; light brownish gray (10YR 6/2) silt loam; common medium distinct light yellowish brown (10YR 6/4) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable; common medium coarse roots; common fine pores; very strongly acid; clear wavy boundary.

Btg/E—9 to 16 inches; grayish brown (10YR 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles within the Btg material; moderate fine and medium subangular blocky structure; about 20 percent by volume, tongues and interfingering of white (10YR 8/2) silt loam (E); very hard, firm; common fine roots; common fine and medium pores; few patchy clay films on faces of peds; few wormcasts; very strongly acid; clear irregular boundary.

Btg1—16 to 32 inches; dark grayish brown (10YR 4/2) clay loam; moderate coarse angular blocky structure; extremely hard, very firm; about 10 percent tongues and interfingering of light brownish gray (10YR 6/2) silt loam in the upper part and about 4 percent in the lower part; common medium roots; few patchy clay films on faces of peds; very strongly acid; gradual wavy boundary.

Btg2—32 to 44 inches; dark grayish brown (10YR 4/2) clay loam; few medium distinct dark brown (10YR 4/3) mottles; moderate coarse angular blocky structure; extremely hard, very firm; few medium roots; few patchy clay films on faces of peds; few thin streaks of uncoated sand and silt grains; few fine white masses of salt; very strongly acid; gradual wavy boundary.

Btg3—44 to 50 inches; grayish brown (2.5Y 5/2) clay loam; few medium distinct yellowish brown (10YR 5/6) mottles; moderate coarse angular blocky structure parting to moderate medium angular blocky; extremely hard, very firm; few medium roots; few patchy clay films on faces of peds; few fine white masses of salt; strongly acid; gradual wavy boundary.

Btg4—50 to 68 inches; grayish brown (2.5Y 5/2) clay loam; few medium distinct light olive brown (2.5Y 5/4) mottles; moderate coarse angular blocky structure; extremely hard, very firm; few medium roots; few patchy clay films on faces of peds; few fine black concretions; slightly acid; diffuse wavy boundary.

Bg—68 to 80 inches; intermingled light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) clay loam; common medium distinct brownish yellow (10YR 6/6) mottles; moderate medium subangular blocky structure; extremely hard, very firm; few fine black concretions; slightly acid.

The solum is more than 80 inches thick.

The A horizon is dark brown, brown, grayish brown, or dark grayish brown. Mottles in shades of gray, brown, and yellow range from none to common. The E horizon is grayish brown, light gray, or light brownish gray. Mottles are in shades of gray, brown, or yellow. Reaction of the A and E horizons ranges from strongly acid to moderately acid.

The Btg/E horizon is dark grayish brown, grayish brown, or light brownish gray. Mottles in shades of brown, yellow, and red range from none to common. Tongues of E material comprise 15 to 25 percent of the horizon. The Btg/E horizon is clay loam or silty clay loam. Reaction is very strongly acid or strongly acid.

The Btg horizon is dark gray, gray, dark grayish brown, grayish brown, or light brownish gray. Mottles in shades of brown, yellow, and red range from few to common. The Btg horizon is clay or clay loam. Reaction ranges from very strongly acid to slightly acid.

The Bg horizon has mottles in shades of red, yellow, and brown that range from few to common in most pedons. It is clay or clay loam. Reaction ranges from moderately acid to neutral.

Edge Series

The Edge series consists of very deep, well drained loamy soils on uplands. These soils formed in stratified loamy and clayey sediments under hardwood trees and tall and mid grasses. Slopes range from 1 to 12 percent.

The soils of the Edge series are fine, mixed, thermic, Udic Paleustalfs.

Typical pedon of Edge fine sandy loam, 2 to 5 percent slopes; from intersection of US Highway 80 and Farm Road 751 in Wills Point, 6.1 miles north on Farm Road 751, and 0.75 miles west and north in a pasture.

A—0 to 6 inches; dark brown (10YR 4/3) fine sandy loam; weak fine granular structure; hard, friable; many fine and medium roots; few chert pebbles up to 2 inches across; moderately acid; clear smooth boundary.

E—6 to 8 inches; pale brown (10YR 6/3) fine sandy loam; massive; hard, friable; many fine to coarse roots; few chert pebbles up to 2 inches across; moderately acid; abrupt wavy boundary.

Bt1—8 to 18 inches; yellowish red (5YR 4/6) clay; few fine distinct pale brown (10YR 6/3) mottles; moderate fine and medium subangular blocky structure; extremely hard, very firm; common fine roots; continuous clay films on faces of peds; few chert pebbles up to 2 inches across; very strongly acid; clear wavy boundary.

Bt2—18 to 34 inches; mottled pale brown (10YR 6/3), brown (10YR 5/3), red (2.5YR 4/8), and strong brown (7.5YR 5/8) clay; moderate coarse prismatic structure parting to fine and medium angular blocky; extremely hard, very firm; common fine roots; continuous clay films on faces of peds; few chert pebbles up to 2 inches across; very strongly acid; gradual wavy boundary.

BCt—34 to 60 inches; light brownish gray (10YR 6/2) clay loam; many fine and medium distinct dark yellowish brown (10YR 4/4) and brownish yellow (10YR 6/8) mottles; moderate coarse prismatic structure parting to coarse subangular blocky; extremely hard, very firm; common fine roots; patchy clay films on surface of peds; common soft black masses; few fine gypsum crystals; few chert pebbles; slightly acid; gradual wavy boundary.

C—60 to 80 inches; brown (10YR 5/3) sandy clay loam interbedded with light gray (10YR 6/1) shale and light gray (10YR 7/1) and yellowish brown (10YR 5/8) soft sandstone; strata are 0.5 to 3.0 inches thick; extremely hard, very firm; common soft black masses; common gypsum crystals; calcareous; slightly alkaline.

The solum ranges from 40 to 60 inches in thickness. Some pedons have few to common chert pebbles.

The A horizon is brown, dark brown, grayish brown, or dark grayish brown. Reaction ranges from strongly acid to slightly acid.

The E horizon is pale brown, light brownish gray, or brownish gray. Reaction ranges from very strongly acid to slightly acid.

The Bt1 horizon is red or yellowish red. It is sandy clay or clay. Reaction is very strongly acid or strongly acid.

The Bt2 horizon is mottled in shades of red, yellow, or brown. It is sandy clay, clay loam, or clay. Reaction ranges from very strongly acid to neutral.

The BCt horizon is light brownish gray, light olive brown, yellowish brown, or pale brown. Mottles in shades of yellow and brown are few to many. The BCt horizon is sandy clay loam or clay loam. Reaction ranges from moderately acid to neutral.

The C horizon is brown, pale brown, brownish gray, or yellowish brown. It is sandy clay, sandy clay loam, or clay loam interbedded with shale and soft sandstone. Reaction ranges from slightly acid to moderately alkaline.

Elrose Series

The Elrose series consists of very deep, well drained, loamy soils on uplands. These soils formed in marine sediments mainly under a forest of mixed hardwoods and some pine. Slopes range from 1 to 12 percent.

The soils of the Elrose series are fine-loamy, siliceous, thermic Typic Paleudalfs.

Typical pedon of Elrose fine sandy loam, 1 to 3 percent slopes; from the intersection of Farm Road 279 and Farm Road 314 in the southeast corner of the county, 2.0 miles east of Farm Road 279, 0.15 mile south on Farm Road 2010 and 150 feet west.

A1—0 to 6 inches; reddish brown (5YR 4/4) fine sandy loam; weak fine granular structure; soft, very friable; many fine and medium roots; few pebbles up to 5 millimeters in diameter; strongly acid; clear smooth boundary.

A2—6 to 12 inches; yellowish red (5YR 5/8) fine sandy loam; weak fine granular structure; soft, very friable; many fine roots; few pebbles up to 5 millimeters in diameter; strongly acid; clear smooth boundary.

Bt1—12 to 21 inches; dark red (2.5YR 3/6) sandy clay loam; moderate medium subangular blocky structure; hard, friable; common fine roots; few patchy clay films on faces of peds and bridging of sand grains; few pebbles up to 5 millimeters in diameter; moderately acid; gradual wavy boundary.

Bt2—21 to 38 inches; red (2.5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; hard, firm; common fine roots; few patchy clay films on ped faces; few pebbles up to 5 millimeters in diameter; moderately acid; gradual wavy boundary.

Bt3—38 to 56 inches; red (2.5YR 5/8) clay loam; moderate medium subangular blocky structure; hard, firm; few fine roots; few patchy clay films on faces of peds; few pebbles 5 to 15 millimeters in diameter; few fine and medium fragments of yellowish weathered glauconitic material up to 1 centimeter in diameter; strongly acid; diffuse wavy boundary.

Bt4—56 to 80 inches; red (2.5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; hard, firm; few patchy clay films on faces of peds and bridging of sand grains; few pebbles up to 5 millimeters in diameter; few fine soft black masses; 10 percent yellow weathered glauconitic fragments up to 5 millimeters in diameter; strongly acid.

The solum ranges from 60 to more than 80 inches in thickness.

The A horizon is red, reddish brown, yellowish red, brown, dark brown, or dark reddish brown. Where values are less than 3.5, the horizon is less than 6 inches thick. Reaction ranges from very strongly acid to slightly acid.

The upper part of the Bt horizon is dark red, red, dark reddish brown, reddish brown, or yellowish red. It is sandy clay loam, clay loam, or loam. Reaction ranges from strongly acid to slightly acid.

The lower part of the Bt horizon is red, dark red, or yellowish red. Weathered glauconitic materials in shades of yellow range from few to common. Reaction ranges from very strongly acid to slightly acid.

Freestone Series

The Freestone series consists of very deep, moderately well drained, loamy soils on old high stream terraces. These soils formed in clayey unconsolidated sediments mainly under a hardwood forest. Slopes range from 1 to 3 percent.

The soils of the Freestone series are fine-loamy, siliceous, thermic Glossaquic Paleudalfs.

Typical pedon of Freestone fine sandy loam, 1 to 3 percent slopes; from the intersection of Texas Highway 198 and Farm Road 316 in Phalba, 2.7 miles south on Farm Road 316, 0.9 mile east on county asphalt road, and north 100 feet.

Ap—0 to 5 inches; dark brown (10YR 4/3) fine sandy loam; weak fine granular structure; hard, very friable; many fine roots; slightly acid; clear smooth boundary.

E—5 to 16 inches; brown (10YR 5/3) fine sandy loam; weak fine granular structure; hard, very friable; many fine roots; slightly acid; clear wavy boundary.

Bt—16 to 24 inches; strong brown (7.5YR 5/6) sandy clay loam; common medium prominent red (2.5YR 4/6) mottles, with few medium pockets of grayish brown (10YR 5/2) uncoated sand in lower 3 inches of horizon; weak fine and medium subangular blocky structure; very hard, friable; few patchy clay films on faces of peds; many fine roots; few black concretions; strongly acid; gradual wavy boundary.

Bt/E—24 to 32 inches; yellowish brown (10YR 5/4) sandy clay loam; common fine and medium prominent red (2.5YR 4/6) and few medium distinct grayish brown (10YR 5/2) mottles; moderate medium and fine subangular blocky structure; very hard, firm; common fine roots; common fine pores; few patchy clay films on faces of peds; few black concretions; light gray (10YR 6/1) uncoated sand and silt grains on vertical faces of prisms, streaks and pockets 2 to 10 millimeters wide and 15 to 25 centimeters long make up about 10 percent of the mass (E); strongly acid; diffuse wavy boundary.

Btg/E—32 to 46 inches; light gray (10YR 6/1) clay; many fine and medium distinct dark red (2.5YR 3/6) and few fine distinct yellowish brown (10YR 5/4) mottles; moderate coarse angular blocky structure; very hard, firm; common fine roots; few patchy clay films on faces of peds; few black concretions; uncoated sand and silt grains on vertical faces of peds, streaks and pockets 4 to 10 millimeters wide and 10 to 20 centimeters long make up less than 15 percent of mass (E); strongly acid; diffuse wavy boundary.

Btg1—46 to 60 inches; light gray (10YR 6/1) clay; common fine and medium distinct yellowish brown (10YR 5/4) and common fine distinct dark red (2.5YR 3/6) mottles; moderate coarse angular blocky structure; extremely hard, very firm; few fine roots; common clay films on faces of peds; few black concretions; few streaks of uncoated sand and silt on faces of some peds; moderately acid; diffuse wavy boundary.

Btg2—60 to 72 inches; grayish brown (2.5Y 5/2) clay; common fine distinct yellowish red (5YR 5/6) and few fine distinct yellowish brown (10YR 5/4) mottles; weak coarse angular blocky structure; common clay films on faces of peds; few streaks of uncoated sand and silt; slightly acid; diffuse wavy boundary.

BCtg—72 to 84 inches; mottled light gray (10YR 6/1), yellowish brown (10YR 5/4) and dark brown (7.5YR 4/4) clay loam; weak coarse angular blocky structure; extremely hard, very firm; few patchy clay films; few masses of barite; few black concretions; moderately acid.

The solum is more than 60 inches thick.

The A or Ap horizon is dark brown, dark yellowish brown, or dark grayish brown. The E horizon is yellowish brown, brown, pale brown, or light yellowish brown. Faint mottles in shades of brown and red range from none to common in the A and E horizons. Reaction ranges from strongly acid to slightly acid.

The Bt horizon is strong brown, yellowish brown, or brownish yellow. Mottles of strong brown, yellowish red, or red range from few to common. Mottles in shades of gray are within a depth of 30 inches. The Bt horizon is loam or sandy clay loam. Reaction is strongly acid or moderately acid.

The Bt/E horizon has the same colors and reaction as the Bt horizon except it is light gray in the lower part of many pedons and texture is loam, sandy clay loam, clay loam, or clay. In addition, this horizon contains 5 to 15 percent streaks and pockets of light gray, light brownish gray, or pale brown uncoated sand. Some pedons have as much as 3 percent plinthite.

The Btg horizon is gray, grayish brown, or light gray, with many mottles of red, strong brown, and yellowish brown. Depth to this horizon ranges from 40 to 58 inches. It is clay loam, sandy clay, or clay. Reaction ranges from very strongly acid to slightly acid.

The BC horizon is similar to the Btg horizon. Reaction ranges from very strongly acid to slightly acid.

Gallime Series

The Gallime series consists of very deep, well drained, loamy soils on stream terraces. These soils formed in loamy unconsolidated sediments under mixed hardwood and pine forests. Slopes range from 1 to 3 percent.

The soils of the Gallime series are fine-loamy, siliceous, thermic Glossic Paleudalfs.

Typical pedon of Gallime fine sandy loam, 1 to 3 percent slopes; from the intersection of Texas Highway 64 and Interstate Highway 20 northwest of Canton, 1.5 miles east on Interstate 20 access road, 0.2 mile northeast on county road, 0.3 mile northwest on county road, and 100 feet north of road.

Ap—0 to 8 inches; brown (10YR 5/3) fine sandy loam; weak fine granular structure; slightly hard, very friable; many fine roots; moderately acid; abrupt smooth boundary.

E—8 to 26 inches; light yellowish brown (10YR 6/4) fine sandy loam; weak medium subangular blocky structure; slightly hard, very friable; many fine roots; slightly acid; clear smooth boundary.

Bt—26 to 48 inches; yellowish brown (10YR 5/8) sandy clay loam; common medium prominent red (2.5YR 4/6) mottles; weak medium subangular blocky structure; hard, friable; common fine roots; few patchy clay films; moderately acid; gradual wavy boundary.

Bt/E1—48 to 68 inches; yellowish brown (10YR 5/8) sandy clay loam; common medium distinct yellowish red (5YR 5/6) and yellow (10YR 7/6) mottles; moderate medium subangular blocky structure; hard, friable; 8 percent streaks and pockets of light brownish gray (10YR 6/2) uncoated sand grains; common fine roots; few patchy clay films; strongly acid; gradual wavy boundary.

Bt/E2—68 to 80 inches; mottled red (2.5YR 4/8), light gray (10YR 6/1) and yellow (10YR 7/6) sandy clay loam; weak medium subangular blocky structure; hard, friable; 5 percent streaks and pockets of light brownish gray (10YR 6/2) uncoated sand grains; few fine roots; few patchy clay films; very strongly acid.

The solum ranges from 60 to more than 80 inches in thickness.

The A or Ap horizon is brown, dark brown, yellowish brown, or dark grayish brown. The E horizon is yellowish brown, light yellowish brown, or pale brown. Combined thickness of the A and E horizons is 20 to 40 inches. Reaction of the A and E horizons ranges from strongly acid to slightly acid, unless lime has been added.

The Bt horizon is yellowish brown, brownish yellow, or strong brown. Mottles in shades of red range from none to common. It is sandy clay loam or loam. Reaction ranges from very strongly acid to moderately acid.

The Bt/E horizon is yellowish brown, brownish yellow, or is mottled in those colors and shades of red and gray. It is sandy clay loam or loam. Streaks and pockets of light brownish gray, pale brown, or light yellowish brown uncoated sand make up from 5 to 15 percent of this horizon. Reaction ranges from very strongly acid to moderately acid.

Gladewater Series

The Gladewater series consists of very deep, somewhat poorly drained, clayey soils on flood plains. These soils formed in clayey alluvium under native vegetation consisting of hardwood trees and water-tolerant grasses. Slopes range from 0 to 1 percent.

The soils of the Gladewater series are very fine, montmorillonitic, thermic Chromic Endoaquerts.

Typical pedon of Gladewater clay, frequently flooded; from the intersection of U.S. 80 and Texas Highway 19 about 10 miles north of Canton, 6.7 miles north on Texas Highway 19, 50 feet west of highway on the Sabine River flood plain.

A—0 to 8 inches; black (10YR 2/1) clay; moderate fine subangular blocky structure; extremely hard, very firm, very plastic; many fine roots; slightly acid; clear smooth boundary.

Bg—8 to 22 inches; gray (10YR 5/1) clay; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and very fine angular blocky structure; extremely hard, very firm, very plastic; few fine roots; slightly acid; gradual wavy boundary.

Bssg1—22 to 42 inches; gray (10YR 5/1) clay; few fine distinct yellowish brown (10YR 5/6) mottles; moderate coarse angular blocky structure; extremely hard, very firm, very plastic; few fine roots; common slickensides; moderately acid; gradual wavy boundary.

Bssg2—42 to 63 inches; dark gray (10YR 4/1) clay; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate coarse angular blocky structure; extremely hard, very firm, very plastic; few fine roots; common slickensides; thin strata of light gray (10YR 6/1) clay loam with brownish mottles; slightly acid.

The solum is more than 80 inches thick.

The A horizon is black or very dark gray. Some pedons have mottles in shades of brown. Reaction ranges from moderately acid to neutral.

The Bg horizon is dark gray, gray, or light brownish gray. Mottles in shades of brown or gray range from few to many. Reaction ranges from strongly acid to slightly acid.

The Bssg horizon is dark gray or gray. Mottles in shades of brown range from few to common. Some pedons have thin strata of sandier soil in the lower part. Reaction ranges from strongly acid to slightly acid.

Kirvin Series

The Kirvin series consists of very deep, well drained, loamy soils on uplands. These soils formed in sandstone and interbedded loamy and clayey sediments under mixed pine and hardwood forests. Slopes range from 2 to 5 percent.

The soils of the Kirvin series are clayey, mixed, thermic Typic Hapludults.

Typical pedon of Kirvin fine sandy loam, 2 to 5 percent slopes; from the intersection of Texas Highway 64 and Farm Road 858 in Ben Wheeler, 4.5 miles east on Texas Highway 64, 1.3 miles north on county asphalt road, 0.3 mile east, and 500 feet south.

A—0 to 6 inches; dark brown (10YR 4/3) fine sandy loam; weak fine granular structure; soft, very friable; common medium roots; about 5 percent by volume ironstone pebbles; moderately acid; clear smooth boundary.

E—6 to 11 inches; pale brown (10YR 6/3) fine sandy loam; weak fine granular structure; soft, very friable; common medium roots; about 5 percent by volume ironstone pebbles; strongly acid; clear wavy boundary.

Bt1—11 to 26 inches; red (2.5YR 4/6) clay; moderate fine and medium angular blocky structure; hard, firm; few fine roots; thin continuous clay films on faces of peds; about 4 percent by volume ironstone pebbles; very strongly acid; clear wavy boundary.

Bt2—26 to 34 inches; red (2.5YR 4/6) clay; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium angular blocky structure; hard, firm; few fine roots; thin continuous clay films on faces of peds; very strongly acid; clear wavy boundary.

BCt—34 to 55 inches; yellowish red (5YR 5/8) clay loam; common medium distinct red (2.5YR 4/6) and strong brown (7.5YR 5/6) mottles; moderate coarse angular blocky structure; hard, firm; few fine roots; patchy clay films on faces of peds; few flakes of mica; few weathered sandstone and shale fragments; very strongly acid; clear wavy boundary.

C—55 to 70 inches; stratified red (2.5YR 4/6) and strong brown (7.5YR 5/6) sandy clay loam and gray (10YR 5/1) shale with strata mostly less than 1 inch thick; hard, firm; few fine roots; few mica flakes; very strongly acid.

The solum ranges from 40 to 60 inches in thickness. Ironstone pebbles range from a few to 50 percent by volume in the A and E horizons and up to 5 percent by volume in the B and C horizons. Coarse fragments 3 to 20 inches across are on, or imbedded in the surface of some pedons, occupying less than 1 percent of the surface area.

The A horizon is brown, dark brown, yellowish brown, or dark grayish brown. It is fine sandy loam or very gravelly fine sandy loam. Reaction ranges from strongly acid to slightly acid.

The E horizon is pale brown, light yellowish brown, brownish yellow, light brown, or brown. It is fine sandy loam or very gravelly fine sandy loam. Reaction ranges from strongly acid to slightly acid.

The Bt horizon is red, dark red, or yellowish red. Mottles in shades of yellow or brown range from none to common. Gray shale fragments are in the lower part of the Bt horizon of some pedons. The Bt horizon is clay or clay loam. Reaction ranges from extremely acid to strongly acid.

The BCt horizon is in shades of red, yellow, brown, and gray. Some pedons are mottled in these colors. The BCt horizon is clay loam or sandy clay loam. Thin strata and fragments of sandstone and shaly materials range from few to common. Reaction is extremely acid or very strongly acid. Some pedons do not have a BCt horizon.

The C horizon is stratified, weakly consolidated sandy clay loam, fine sandy loam, weakly cemented sandstone, and shaly materials. The loamy materials and sandstone are in shades of red, yellow, or brown and the shale materials are mainly in shades of gray. The amount of sandstone or shale materials is variable and either may be absent in some pedons. Roots penetrate the materials but are concentrated along fractures. Most pedons have clay flows along some vertical fractures. Some pedons have a discontinuous, fractured, strongly cemented or indurated sandstone layer or stone line about 1 to 4 inches thick. Reaction is extremely acid or very strongly acid.

Leagueville Series

The Leagueville series consists of very deep, poorly drained, sandy soils on uplands. These soils formed in sandy and loamy sediments. Native vegetation consists of hardwood trees, sedges, and mid and tall grasses. Slopes range from 0 to 3 percent.

The soils of the Leagueville series are loamy, siliceous, thermic Arenic Paleaquults.

Typical pedon of Leagueville loamy fine sand, 0 to 3 percent slopes; from the intersection of Texas Highway 64 and Farm Road 16 about 3 miles east of Canton, 5.0 miles east on Farm Road 16, 1.8 miles south on county asphalt road, 100 feet west.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) loamy fine sand; common fine and medium distinct brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; soft, very friable; common fine and medium roots; strongly acid; clear wavy boundary.

A2—4 to 14 inches; dark grayish brown (10YR 4/2) loamy fine sand; common fine and medium brown (7.5YR 5/4) mottles; weak coarse subangular blocky structure; soft, very friable; common fine and medium roots; very strongly acid; clear wavy boundary.

E—14 to 30 inches; pale brown (10YR 6/3) loamy fine sand; common medium distinct brown (7.5YR 5/4) mottles; massive; soft, very friable; common fine and medium roots; very strongly acid; clear wavy boundary.

Btg—30 to 50 inches; gray (10YR 5/1) sandy clay loam; many medium distinct yellowish brown (10YR 5/4) and reddish brown (2.5YR 5/4) mottles; weak medium subangular blocky structure; very hard, friable; few fine roots; patchy clay films on faces of peds; very strongly acid; clear wavy boundary.

Btg/E—50 to 80 inches; light gray (10YR 6/1) sandy clay loam; many medium distinct reddish brown (5YR 4/4) and yellowish brown (10YR 5/6) mottles; about 15 percent streaks and spots of clean light gray (10YR 7/2) sand (E); weak coarse subangular blocky structure; very hard, friable; few fine roots; patchy clay films on faces of peds; common streaks and pockets of uncoated sand; very strongly acid.

The solum ranges from 60 inches to more than 80 inches in thickness.

The combined thickness of the A and E horizons is 20 to 40 inches. The A horizon is very dark gray, very dark grayish brown, dark gray, dark grayish brown, grayish brown, or brown. Where color value is less than 3.5 the A horizon is less than 10 inches thick. The E horizon is grayish brown, light brownish gray, pale brown, or light gray. Reaction ranges from very strongly acid to slightly acid.

The Btg horizon is gray, light brownish gray, or light gray. There are common to many medium and coarse mottles in shades of brown, yellow, and red. The matrix of some pedons is mottled in all these colors. Some pedons contain a few streaks and pockets of grayish clean sand. The Btg horizon is sandy clay loam or fine sandy loam. Reaction ranges from extremely acid to strongly acid.

The Btg/E horizon is similar to the Btg horizon except the E part makes up 15 to 50 percent of the horizon. The E part is gray, light gray, or light brownish gray loamy fine sand or fine sandy loam. The B part is yellowish brown, strong brown, or reddish brown sandy clay loam. Reaction ranges from extremely acid to strongly acid.

Lufkin Series

The Lufkin series consists of very deep, somewhat poorly drained, loamy soils on high stream terraces. These nearly level soils formed in acid to alkaline sediments under post oak savannah vegetation. Slopes range from 0 to 1 percent.

The soils of the Lufkin series are fine, montmorillonitic, thermic Oxyaquic Vertic Paleustalfs.

Typical pedon of Lufkin loam from an area of Lufkin-Rader complex, 0 to 1 percent slopes; from junction of Farm Road 751 and Farm Road 47 in Wills Point, 8.7 miles north and west on Farm Road 751, 1.0 mile south on county asphalt road, and 250 feet west.

A—0 to 5 inches; dark grayish brown (10YR 4/2) loam; massive; very hard, friable; common fine roots; strongly acid; clear smooth boundary.

Eg—5 to 8 inches; grayish brown (10YR 5/2) loam; massive; very hard, friable; common fine roots; strongly acid; abrupt wavy boundary.

Btg1—8 to 22 inches; dark grayish brown (10YR 4/2) clay loam; moderate coarse prismatic structure parting to moderate medium angular blocky; extremely hard, very firm; few fine roots; few patchy clay films; few pressure faces; strongly acid; gradual wavy boundary.

Btg2—22 to 42 inches; dark grayish brown (10YR 4/2) clay loam; common medium distinct yellowish brown and strong brown mottles; weak medium angular blocky structure; extremely hard, very firm; few fine roots; few patchy clay films; few pressure faces; slightly acid; gradual wavy boundary.

Btg3—42 to 80 inches; gray (10YR 5/1) clay loam; weak medium angular blocky structure; extremely hard, very firm; few fine roots; few dark concretions 4 to 6 millimeters in diameter; slightly alkaline.

The solum ranges from 60 to more than 80 inches in thickness. When dry, cracks up to 1 inch wide extend from the surface to a depth of more than 38 inches.

The A horizon is dark grayish brown, very dark grayish brown, grayish brown, or gray. Reaction ranges from strongly acid to slightly acid.

The E horizon is gray, grayish brown, light gray, or light brownish gray. Reaction ranges from strongly acid to slightly acid.

The Btg horizon is dark gray, gray, dark grayish brown, grayish brown, light gray, or light brownish gray. In some pedons, mottles are in shades of brown, olive, red and yellow. The Btg horizon is clay loam or clay. The content of clay ranges from 35 to 45 percent. Some pedons contain concretions of calcium carbonate and gypsum crystals. Reaction ranges from very strongly acid to slightly alkaline.

Manco Series

The Manco series consists of very deep, somewhat poorly drained, loamy soils on flood plains. These soils formed in loamy alluvial sediments. Native vegetation consists mainly of hardwood trees. Slope ranges from 0 to 1 percent.

The Manco soils are fine-silty, siliceous, acid, thermic Aeric Fluvaquents.

Typical pedon of Manco loam, frequently flooded; from the intersection of Interstate Highway 20 and Farm Road 314 in Van, 0.7 mile south on Farm Road 314, 1.2 miles east on Farm Road 1995, 0.6 mile south, and 300 feet west in a pasture.

Ap—0 to 6 inches; dark brown (10YR 4/3) loam; weak fine subangular blocky structure; slightly hard, friable; many fine roots; very strongly acid; abrupt smooth boundary.

A—6 to 12 inches; mottled brown (10YR 5/3), grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) loam; weak fine subangular blocky structure; slightly hard, friable; many fine roots; very strongly acid; clear wavy boundary.

Bw—12 to 17 inches; mottled brown (10YR 5/3), grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; hard, friable; common fine roots; very strongly acid; clear wavy boundary.

Bg1—17 to 22 inches; grayish brown (10YR 5/2) loam; many medium distinct dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; hard, friable; common fine roots; very strongly acid; gradual wavy boundary.

Bg2—22 to 30 inches; mottled light brownish gray (10YR 6/2), yellowish brown (10YR 5/4), and grayish brown (10YR 5/2) loam; weak coarse subangular blocky structure; hard, friable; few fine roots; very strongly acid; gradual wavy boundary.

Bg3—30 to 48 inches; grayish brown (10YR 5/2) loam; common medium distinct yellowish red (5YR 4/6) and strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; hard, friable; few fine roots; very strongly acid; gradual wavy boundary.

Bg4—48 to 64 inches; gray (10YR 5/1) loam; many medium distinct strong brown (7.5YR 4/6) and yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; hard, friable; common medium black masses; very strongly acid.

The A and Ap horizons are dark grayish brown, grayish brown, brown, or dark brown. In most pedons there are few to common mottles in shades of brown, gray, and red. Reaction is extremely acid or very strongly acid.

The Bw horizon is brown, grayish brown, or dark yellowish brown. In most pedons, the Bw horizon has few to many mottles in shades of red, brown, yellow, and gray. Some pedons have a matrix that is mixed with these colors. The Bw horizon is silt loam, clay loam, or loam. Few to common black masses are in some pedons. Reaction is extremely acid or very strongly acid.

The Bg horizon is dark gray, gray, light brownish gray, grayish brown or light gray. Mottles in shades of yellow, brown, and red are in most pedons. Some pedons have a matrix that is mixed with these colors. The Bg horizon is silt loam, clay loam, or loam. Some pedons have strata of silty clay loam or fine sandy loam. Few to common black masses are in most pedons. Reaction is extremely acid or very strongly acid.

Nahatche Series

The Nahatche series consists of very deep, somewhat poorly drained, loamy soils on flood plains. These soils formed in loamy alluvial sediments. Native vegetation consists mainly of hardwood trees. Slopes are 0 to 1 percent.

The soils of the Nahatche series are fine-loamy, siliceous, nonacid, thermic Aeric Fluvaquents.

Typical pedon of Nahatche loam, frequently flooded; from the intersection of Texas Highway 19 and Interstate 20 at Canton, 3.2 miles north on Texas Highway 19, 1.2 miles southeast on county asphalt road, and 100 feet north.

A—0 to 8 inches; dark brown (10YR 4/3) loam; few fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; hard, friable; common fine roots; moderately acid; clear smooth boundary.

Bg1—8 to 18 inches; grayish brown (10YR 5/2) clay loam; few fine faint light brownish gray (10YR 6/2) and common medium faint brown (10YR 5/3) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm; common fine roots; moderately acid; clear smooth boundary.

Bg2—18 to 30 inches; light brownish gray (10YR 6/2) loam; common coarse distinct brown (10YR5/3) and common coarse faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; hard, friable; few fine roots; moderately acid; gradual smooth boundary.

Bg3—30 to 48 inches;light brownish gray (10YR 6/2) clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few brown concretions; moderately acid; gradual wavy boundary.

Bg4—48 to 52 inches; mottled gray (10YR 6/1) and strong brown (7.5YR 5/6) sandy clay loam; weak medium subangular blocky structure; hard, friable; few lenses of sandier material; few fine roots; slightly acid; clear wavy boundary.

Agb—52 to 66 inches; dark gray (10YR 4/1) clay loam; many medium and coarse distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/4) mottles; weak coarse angular blocky structure; extremely hard, very firm; few fine roots; slightly alkaline.

The solum is more than 80 inches thick. Reaction ranges from moderately acid to slightly alkaline.

The A horizon is dark grayish brown, dark brown, brown, grayish brown, or very dark grayish brown. In most pedons, it has few to common mottles in shades of brown and gray.

The Bg horizon is loam, sandy clay loam, or clay loam. Some pedons have thin strata of fine sandy loam or silty clay loam. Color is grayish brown, dark grayish brown, gray, dark gray, strong brown, and light brownish gray. Mottles in shades of brown or yellow range from few to many. A few soft black masses are in some pedons.

Some pedons have a buried horizon below a depth of 40 inches.

Normangee Series

The Normangee series consists of very deep moderately well drained, gently sloping to moderately sloping loamy soils. These soils formed in clayey marine sediments. Native vegetation is prairie grasses. Slopes range from 3 to 8 percent.

The soils of the Normangee series are fine, montmorillonitic, thermic Udertic Haplustalfs.

Typical pedon of Normangee clay loam, 3 to 8 percent slopes, severely eroded; from the intersection of Texas Highway 243 and Farm Road 47 about 9 miles west of Canton, 2.7 miles south on Farm Road 47, 3.8 miles southwest on Farm Road 90, 1.25 miles southeast on county road, and 250 feet north of road.

Ap—0 to 4 inches; very dark grayish brown (10YR 3/2) clay loam; weak medium subangular blocky structure; very hard, firm; common fine roots; slightly acid; abrupt smooth boundary.

Bt1—4 to 12 inches; dark brown (10YR 4/3) clay; few fine distinct brownish yellow (10YR 6/6) and yellowish brown, (10YR 5/4) mottles; moderate medium subangular blocky structure; extremely hard, very firm; common fine roots; common clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—12 to 26 inches; dark brown (10YR 4/3) clay; few fine faint yellowish brown and olive brown mottles; moderate fine and medium angular blocky structure; extremely hard, very firm; few fine roots; common clay films on faces of peds; neutral; gradual smooth boundary.

Bt3 —26 to 41 inches; light olive brown (2.5Y 5/4) clay; common fine distinct yellowish brown (10YR 5/6) and few fine faint olive yellow mottles; weak coarse subangular blocky structure; extremely hard, very firm; few patchy clay films on faces of peds; few fine roots; few fine calcium carbonate concretions; moderately alkaline; gradual smooth boundary.

C—41 to 72 inches; stratified light olive brown (2.5Y 5/4), yellowish brown (10YR 5/8), and dark gray (10YR 4/1) clay; massive; extremely hard, very firm; few fine roots; interbedded strata of weathered shale; few calcium carbonate concretions; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. In most pedons, calcium carbonate concretions are in the lower part.

The A horizon is very dark grayish brown, dark brown, dark grayish brown, or brown. Reaction ranges from moderately acid to neutral.

The upper part of the Bt horizon is dark brown, brown, or dark yellowish brown. Reaction ranges from moderately acid to neutral. The lower part of the Bt horizon is dark brown, olive brown, or light olive brown. In some pedons, it is mottled with gray, grayish brown, yellowish brown, olive yellow, and brownish yellow. Reaction ranges from neutral to moderately alkaline.

The C horizon is stratified shale and clay. It is shades of brown, gray, yellow, and olive.

Oakwood Series

The Oakwood series consists of very deep, moderately well drained, loamy soils on uplands. These soils formed in loamy unconsolidated sediments mainly under a hardwood forest with scattered pine. Slopes range from 1 to 8 percent.

The soils of the Oakwood series are fine-loamy, siliceous, thermic, Fragic Glossudalfs.

Typical pedon of Oakwood fine sandy loam, 1 to 3 percent slopes; from the intersection of Texas Highway 64 and Farm Road 314 about 18 miles southeast of Canton, 5.1 miles southeast on Texas Highway 64, 0.1 mile north and west on county road, and 50 feet south of road.

A—0 to 7 inches; dark brown (10YR 4/3) fine sandy loam; common fine faint brown mottles; weak fine and medium subangular blocky structure; hard, very friable; many fine and medium roots; slightly acid; clear wavy boundary.

E—7 to 15 inches; light yellowish brown (10YR 6/4) fine sandy loam; common fine faint brownish yellow mottles; massive; hard, very friable; common fine and medium roots; many very fine pores; common wormcasts; slightly acid; clear wavy boundary.

Bt1—15 to 34 inches; yellowish brown (10YR 5/6) sandy clay loam; few fine distinct yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; very hard, friable; common fine roots; few patchy clay films on faces of peds; few fine pebbles; strongly acid; gradual wavy boundary.

Bt2—34 to 39 inches; brownish yellow (10YR 6/6) sandy clay loam; common medium prominent red (2.5YR 4/8) mottles; weak coarse subangular blocky structure; very hard, friable; few fine roots; about 3 percent streaks and pockets of light yellowish brown (10YR 6/4) uncoated sand; few patchy clay films on faces of peds; few medium black masses; few fine pebbles; moderately acid; gradual wavy boundary.

Btvx—39 to 52 inches; brownish yellow (10YR 6/6) sandy clay loam; many medium prominent red (2.5YR 4/8) mottles; moderate coarse prismatic structure parting to weak coarse subangular blocky; very hard, friable; few fine roots; about 4 percent streaks and pockets of very pale brown (10YR 7/3) uncoated sand; few patchy clay films on faces of peds; common medium black masses; 25 to 30 percent of matrix is brittle; about 8 percent plinthite nodules; few fine pebbles; moderately acid; gradual wavy boundary.

Btvx/E—52 to 72 inches; brownish yellow (10YR 6/8) sandy clay loam; many medium prominent red (2.5YR 4/8) mottles; moderate coarse prismatic structure parting to weak medium subangular blocky; very hard, friable; few fine roots; about 20 percent streaks, pockets, and coats on prisms of very pale brown (10YR 7/3) uncoated sand (E); 30 to 35 percent of matrix is brittle; about 5 percent plinthite nodules; few patchy clay films on faces of peds; few fine pebbles; moderately acid; gradual wavy boundary.

Btg—72 to 80 inches; grayish brown (10YR 5/2) clay loam; common medium prominent red (2.5YR 4/6) and few medium distinct brownish yellow (10YR 6/6) mottles; very coarse prismatic structure parting to moderate coarse angular blocky; very firm, extremely hard; few fine roots; continuous thin clay films on faces of prisms; about 2 percent plinthite nodules; strongly acid.

The solum ranges from 60 to more than 80 inches in thickness.

The A horizon is dark yellowish brown, yellowish brown, dark brown, or brown. The E horizon is pale brown, yellowish brown, or light yellowish brown. Reaction of the A and E horizons ranges from moderately acid to neutral.

The Bt horizon is yellowish brown, dark yellowish brown, brownish yellow, or strong brown. Mottles in shades of red range from none to many. Reaction ranges from very strongly acid to slightly acid.

The Btv and Btv/E horizons are yellowish brown, brownish yellow, or strong brown, or are mottled in these colors and shades of gray and red. Streaks and pockets of light gray, light yellowish brown, very pale brown, pale brown, or light brownish gray uncoated sand make up from 5 to 12 percent of these horizons. Plinthite ranges from 5 to about 8 percent. These horizons are loam or sandy clay loam. Reaction ranges from very strongly acid to moderately acid.

The Btg horizon is grayish brown, gray, or light brownish gray, with red, brown, or yellow mottles. It is clay loam or sandy clay loam. Reaction ranges from very strongly acid to moderately acid.

Pickton Series

The Pickton series consists of very deep, well drained, sandy soils on uplands (fig. 8). These soils formed in unconsolidated sandy and loamy sediments mainly under a hardwood forest with scattered pine. Slopes range from 1 to 15 percent.

The soils of the Pickton series are loamy, siliceous, thermic Grossarenic Paleudalfs.

Typical pedon of Pickton fine sand, 1 to 5 percent slopes; from the intersection of Texas Highway 243 and Texas Highway 19 in Canton, 1.0 mile south on Texas Highway 19, 2.5 miles southeast on Farm Road 2909, 0.5 mile east on county asphalt road, and 100 feet south of road.

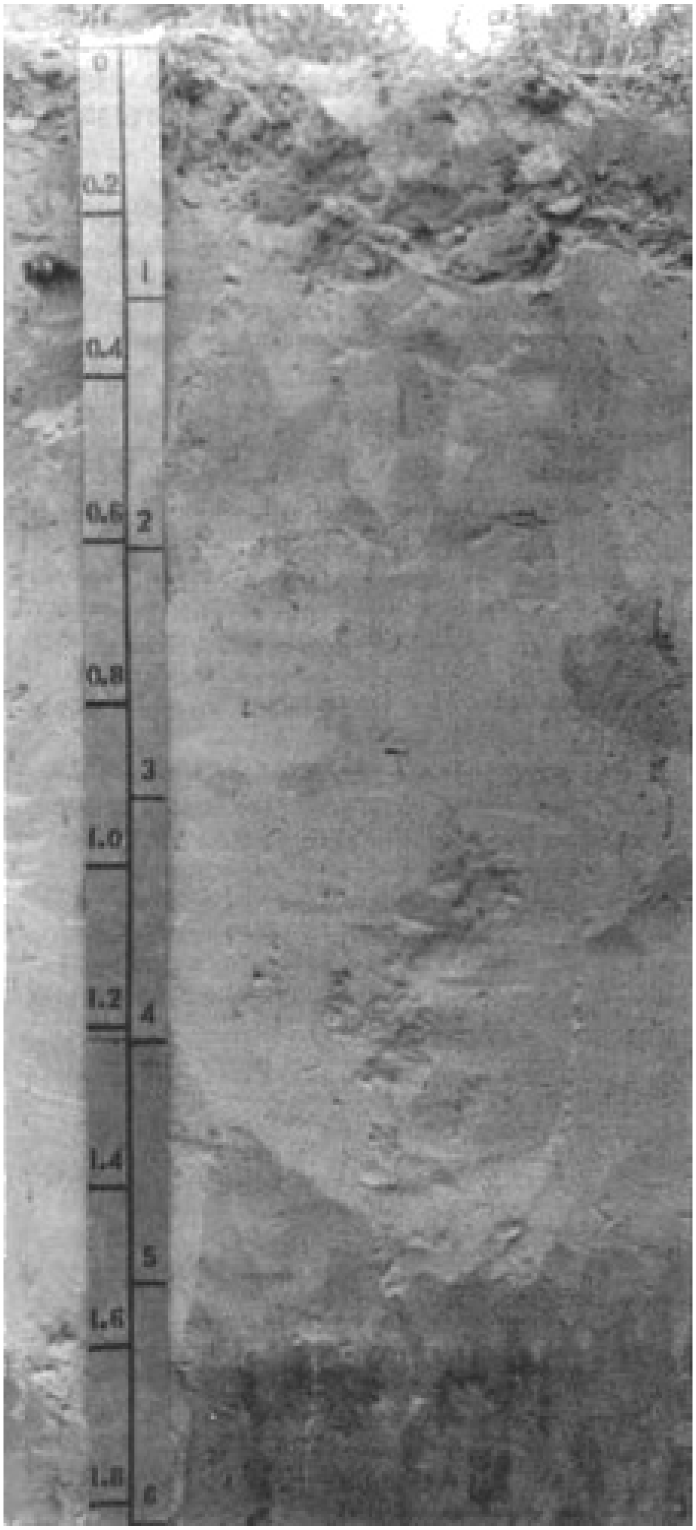


Figure 8.—Profile of Pickton fine sand. The sandy surface layer is more than 6 feet thick and is underlain by a sandy clay loam subsoil.

A—0 to 7 inches; brown (10YR 5/3) fine sand; single grained; loose; few fine roots; slightly acid; gradual smooth boundary.

E—7 to 60 inches; light yellowish brown (10YR 6/4) fine sand; single grained; loose; few fine roots; slightly acid; clear smooth boundary.

Bt1—60 to 72 inches; yellowish brown (10YR 5/8) sandy clay loam; common medium distinct dark yellowish brown (10YR 4/4) and few medium distinct reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; hard, friable; few fine roots; few patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—72 to 80 inches; prominently and coarsely mottled light gray (10YR 6/1), strong brown (7.5YR 5/8), and red (10R 4/6) sandy clay loam; moderate medium subangular blocky structure; hard, friable; few fine roots; few patchy clay films on faces of peds; strongly acid.

The solum is more than 80 inches thick. The clay content of the control section ranges from 12 to 25 percent.

The A horizon is dark brown, brown, yellowish brown, dark yellowish brown, dark grayish brown, grayish brown, or pale brown. The E horizon is yellowish brown, light yellowish brown, brownish yellow, pale brown, or very pale brown. The combined thickness of the A and E horizons is 40 to 72 inches. Reaction of the A and E horizons ranges from moderately acid to neutral.

The Bt horizon is yellowish brown, brownish yellow, strong brown, or reddish yellow, or is mottled in these colors as well as red and gray. The texture is fine sandy loam or sandy clay loam. In some pedons, the lower part has up to 10 percent streaks and pockets of very pale brown uncoated sand. Reaction ranges from very strongly acid to slightly acid.

Rader Series

The Rader series consists of very deep, moderately well drained, loamy soils on stream terraces. These nearly level soils formed in slightly acid to slightly alkaline sediments under a post oak savannah. Slopes are 0 to 1 percent.

The soils of the Rader series are fine-loamy, mixed, thermic Aquic Paleustalfs.

Typical pedon of Rader fine sandy loam, in an area of Lufkin-Rader complex, 0 to 1 percent slope; from the intersection of Farm Road 751 and Farm Road 47 in Wills Point, 8.7 miles north and west on Farm Road 751, 1.0 mile south on county asphalt road, and 250 feet west of road.

A—0 to 5 inches; dark brown (10YR 4/3) fine sandy loam;

weak fine subangular blocky structure; slightly hard, very friable; common fine roots; moderately acid; gradual smooth boundary.

E1—5 to 16 inches; light brownish gray (10YR 6/2) fine sandy loam; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; strongly acid; gradual wavy boundary.

E2—16 to 24 inches; very pale brown (10YR 7/3) fine sandy loam; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; strongly acid; gradual wavy boundary.

Bt/E—24 to 30 inches; mottled yellowish brown (10YR 5/6) strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) sandy clay loam; weak medium subangular blocky structure; hard, friable; about 15 percent streaks and pockets of pale brown and light brownish gray fine sandy loam (E); few fine roots; very strongly acid; clear wavy boundary.

Bt1—30 to 38 inches; grayish brown (10YR 5/2) sandy clay; common medium prominent red (2.5YR 4/6) and yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; extremely hard, very firm; few patchy clay films; few fine roots; very strongly acid; gradual smooth boundary.

Bt2—38 to 50 inches; yellowish brown (10YR 5/4) sandy clay; common medium distinct strong brown (7.5YR 5/6) and olive yellow (2.5Y 6/6) and grayish brown (10YR 5/2) mottles; moderate coarse angular blocky structure; extremely hard, very firm; few patchy clay films; very strongly acid; gradual smooth boundary.

Btg—50 to 66 inches; mottled light brownish gray (10YR 6/2), strong brown (7.5YR 5/6), and yellowish red (5YR 5/6) sandy clay loam; weak coarse angular blocky structure; extremely hard, very firm; few patchy clay films; few dark concretions 4 to 8 millimeters in diameter; strongly acid; gradual smooth boundary.

BC—66 to 80 inches; mottled grayish brown (10YR 5/2), red (2.5YR 4/6) and yellowish red (5YR 5/6) sandy clay loam; weak coarse angular blocky structure; extremely hard, very firm; slightly acid.

The solum ranges from 60 to more than 80 inches in thickness. Clay content of the control section is 28 to 35 percent.

The A horizon is brown, dark brown, or yellowish brown. The E horizon is pale brown, light brownish gray, light yellowish brown, or very pale brown. Reaction of the A and E horizons ranges from strongly acid to slightly acid.

The Bt/E horizon is 70 to 85 percent Bt material. The Bt part is yellowish brown, strong brown, grayish brown, or brownish yellow. It is sandy clay loam or loam. The E part is light gray, light brownish gray, grayish brown, pale brown, or very pale brown. It is fine sandy loam or loam. Some pedons have mottles in shades of red and yellow that range from few to common. Reaction is very strongly acid or strongly acid.

The Bt1 and Bt2 horizons are gray, light brownish gray, grayish brown, yellowish brown, or light gray. Mottles in shades of red, gray, brown, or yellow range from few to many. These horizons are clay, sandy clay, or clay loam with 35 to 50 percent content of clay. Reaction is very strongly acid or strongly acid.

The Btg and BC horizons are mottled in shades of gray, yellow, brown, and red. They are clay, sandy clay, or sandy clay loam. Reaction ranges from strongly acid to moderately alkaline.

Raino Series

The Raino series consists of very deep, moderately well drained, loamy soils on old stream terraces. These soils formed in loamy and clayey sediments under mixed hardwood and pine forest. Slopes are 0 to 1 percent.

The soils of the Raino series are fine-loamy over clayey, siliceous, thermic Aquic Glossudalfs.

Typical pedon of Raino loam, in an area of Derly-Raino complex, 0 to 1 percent slope; from the intersection of Texas Highway 19 and Farm Road 859 in Canton; 0.4 mile south on Texas Highway 19, and 100 feet east of road in woodland.

A—0 to 6 inches; dark yellowish brown (10YR 4/4) loam; moderate fine subangular blocky structure; hard, friable; many fine roots; strongly acid; clear smooth boundary.

E—6 to 10 inches; yellowish brown (10YR 5/4) loam; common fine faint dark brown (7.5YR 4/4) mottles; massive; slightly hard, very friable; common fine and medium roots; moderately acid; gradual wavy boundary.

EB—10 to 26 inches; light yellowish brown (10YR 6/4) loam; moderate fine and medium subangular blocky structure; hard, very friable; few pores; many fine roots; strongly acid; gradual irregular boundary.

Bt/E1—26 to 36 inches; strong brown (7.5YR 5/6) loam; common medium faint yellowish red and few fine distinct light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; hard, friable; about 20 percent pale brown (10YR 6/3) uncoated sand around some peds with a few 0.25 to 0.50 inch wide streaks that extend into next layer (E); few black concretions; few fine roots; few patchy clay films; strongly acid; clear irregular boundary.

Bt/E2—36 to 44 inches; mottled yellowish brown (10YR 5/4), red (2.5YR 4/6), and light brownish gray (2.5Y 6/2) clay; moderate medium subangular blocky structure; very hard, firm; about 30 percent pale brown (10 YR 6/3) and light gray (10YR 7/2) uncoated sand

and silt around peds and as streaks and pockets (E); clay films on faces of some peds are light brownish gray (2.5YR 6/2); few fine roots; strongly acid; abrupt wavy boundary.

Btg—44 to 60 inches; gray (10YR 5/1) clay; many medium prominent red (2.5YR 4/6) and common medium faint light brownish gray (10YR 6/2) and common medium distinct yellowish brown (10YR 5/4) mottles; moderate medium angular blocky structure; very hard, firm; few thin streaks of uncoated sand grains; thin clay films on faces of some peds; few fine roots; strongly acid; diffuse smooth boundary.

B’t—60 to 72 inches; mottled brownish yellow (10YR 6/6), light gray (10YR 6/1) and red (2.5YR 4/6) clay; moderate medium angular blocky structure; very hard, firm; few peds have shiny surfaces; few fine roots; strongly acid; gradual smooth boundary.

BCg—72 to 84 inches; light gray (10YR 6/1) sandy clay loam, many coarse distinct yellowish brown (10YR 5/6) mottles; weak medium angular blocky structure; very hard, firm; few black concretions; few fine roots; few masses of white crystals; moderately acid.

The solum is more than 80 inches thick.

The A horizon is brown, dark brown, or dark grayish brown. The E horizon is pale brown, brown or yellowish brown. Some pedons have faint mottles in shades of brown. Reaction of the A and E horizons is strongly acid or moderately acid.

The EB horizon is brown, yellowish brown, or light yellowish brown. Some pedons have faint yellowish mottles. Reaction is strongly acid or moderately acid.

The Bt part of the Bt/E horizon is yellowish brown, brownish yellow, light yellowish brown, strong brown, or reddish yellow or is mottled in these colors and shades of red and gray. The Bt/E horizon is loam or sandy clay loam. The E part has vertical streaks and pockets of light yellowish brown, pale brown, or light gray sandier material that makes up 15 to 30 percent of the horizon. Reaction is very strongly acid or strongly acid.

The Btg and B’t horizons are mottled in shades of gray, red, brown, and yellow. Reaction ranges from very strongly acid to moderately acid. These horizons are clay loam or clay.

The BCg horizon is gray, light gray, or light brownish gray, or is mottled in shades of gray, yellow, brown, and red. It is sandy clay loam, sandy clay, or clay. Reaction ranges from very strongly acid to slightly acid.

Redsprings Series

The Redsprings series consists of very deep, well drained, loamy soils on uplands. They formed in sediments of glauconitic materials interbedded with shale and sandy materials under a mixed hardwood forest with scattered pine. Slopes range from 2 to 15 percent.

The soils of the Redsprings series are fine, kaolinitic, thermic Ultic Hapludalfs.

Typical pedon of Redsprings very gravelly fine sandy loam, 5 to 15 percent slopes; from the intersection of Texas Highway 64 and Farm Road 314 about 18 miles southeast of Canton, 1.9 miles east on Texas Highway 64, 1.3 miles north on county road, and 200 feet east of road.

A—0 to 6 inches; dark reddish brown (2.5YR 3/4) very gravelly fine sandy loam; weak fine granular structure; hard, friable; many fine, medium, and coarse roots; about 45 percent ironstone pebbles; moderately acid; clear wavy boundary.

Bt1—6 to 25 inches; red (2.5YR 4/6) clay; moderate medium subangular blocky structure; very hard, firm; common fine, medium, and coarse roots; continuous clay films on faces of peds; few fine remnants of weathered glauconitic materials; about 5 percent ironstone pebbles; strongly acid; gradual wavy boundary.

Bt2—25 to 36 inches; red (2.5YR 4/6) clay; moderate medium subangular blocky structure; very hard, firm; few fine and medium roots; continuous clay films on faces of peds; few fine remnants of weathered glauconitic materials; about 4 percent light brownish gray shale fragments; about 5 percent horizontally oriented fragments of glauconitic ironstone 1 to 3 inches thick and 10 to 15 inches across; strongly acid; gradual wavy boundary.

B/C—36 to 48 inches; red (2.5YR 4/6) clay; weak coarse subangular blocky structure; very hard, firm; few fine roots; continuous clay films on faces of peds; about 30 percent weathered glauconitic materials (C); about 10 percent horizontally oriented glauconitic ironstone 0.5 to 2.0 inches thick and 1 to 10 inches across; about 5 percent light brownish gray discontinuous shale strata less than 1 inch thick; very strongly acid; gradual wavy boundary.

C—48 to 66 inches; strong brown (7.5YR 5/8) weathered glauconitic materials with texture of sandy clay loam; massive; very hard, friable; about 10 percent glauconitic ironstone fragments, most less than 3 inches across; very strongly acid.

The solum ranges from 40 to 60 inches in thickness. Glauconitic ironstone fragments 0.5 to 3.0 inches thick and 3 to 10 inches across range from 0 to 10 percent by volume throughout the B and C horizons. Base saturation ranges from 35 to 60 percent at a depth of 50 inches from the top of the Bt horizon.

The A horizon is dark reddish brown, dark red, or reddish brown. Ironstone pebbles range from 35 to 60 percent. Reaction ranges from moderately acid to neutral.

The Bt horizon is red or dark red. It is clay or clay loam, with clay content ranging from 35 to 60 percent. This horizon contains up to 10 percent ironstone pebbles, as well as up to 10 percent glauconitic material. Reaction ranges from very strongly acid to slightly acid.

The B/C horizon, where present, is sandy clay loam, clay loam, or clay. It has up to 35 percent glauconitic material and up to 15 percent ironstone pebbles. Grayish shale fragments range from none to common. Reaction ranges from very strongly acid to moderately acid.

The C horizon has interbedded layers of weakly consolidated red sandy clay loam, grayish shale, and glauconite ironstone fragments in some pedons. Roots penetrate the materials but are concentrated along fractures or cleavage planes. Most pedons have clay flows along some vertical fractures. Reaction is very strongly acid or strongly acid.

Sandow Series

The Sandow series consists of very deep, moderately well drained, loamy soils on flood plains. They formed in stratified loamy alluvium under a mixed hardwood forest. Slopes are less than 1 percent.

The soils of the Sandow series are fine-loamy, siliceous, thermic Udifluventic Ustrochrepts.

Typical pedon of Sandow loam, frequently flooded; from the intersection of Farm Road 751 and Farm Road 47 on the north side of Wills Point, 0.3 mile north on city street, 0.4 mile northeast and north on county road, and 100 feet east of road.

A—0 to 8 inches; dark brown (10YR 4/3) loam; weak medium subangular blocky structure; hard, friable; many fine and medium roots; common fine pores; common fine wormcasts; neutral; gradual smooth boundary.

Bw—8 to 28 inches; dark grayish brown (10YR 4/2) loam; weak medium subangular blocky structure; hard, friable; many fine and medium roots; common fine pores; common fine wormcasts; few thin strata of fine sandy loam; slightly acid; gradual smooth boundary.

Ab—28 to 34 inches; dark brown (10YR 3/3) loam; few fine faint olive brown mottles; weak medium subangular blocky structure; hard, friable; few fine roots; few fine pores; few fine wormcasts; slightly acid; clear smooth boundary.

Bwb1—34 to 56 inches; dark grayish brown (10YR 4/2) clay loam; few distinct dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/6) mottles; weak medium angular blocky structure; extremely hard, very firm; few fine roots; thin patchy clay films on faces of some peds; neutral; gradual smooth boundary.

Bwb2—56 to 63 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 angular blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of some peds; neutral; gradual smooth boundary.

Recent sediments over the buried soil range in thickness from 20 to 40 inches. Reaction of the recent alluvium ranges from moderately acid to neutral.

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

The Bw horizon is light gray, brown, dark grayish brown, pale brown, grayish brown, or light yellowish brown. The Bw horizon is loam, clay loam, or sandy clay loam. Mottles in shades of gray, brown, and yellow range from none to common.

The Ab horizon is not recognizable in all pedons. Where present, it is very dark brown, dark grayish brown, or dark brown. It is fine sandy loam, sandy clay loam, or loam. Mottles in shades of gray, olive, brown, and yellow are few to common. Reaction is slightly acid or neutral.

The Bb horizon is dark gray, strong brown, very dark gray, or pale brown. Mottles in shades of gray, brown, and yellow range from few to many. The Bb horizon is sandy clay loam or clay loam. Reaction ranges from moderately acid to neutral.

Tenaha Series

The Tenaha series consists of very deep, well drained, sandy soils on uplands. These soils formed under mixed pine and hardwood forests. Slopes range from 8 to 20 percent.

The soils of the Tenaha series are loamy, siliceous, thermic, Arenic Hapludults.

Typical pedon of Tenaha loamy fine sand, 8 to 20 percent slopes; from the intersection of Farm Road 773 and Farm Road 858 southwest of Ben Wheeler, 2.3 miles south on Farm Road 773, and 100 feet east of road.

A—0 to 5 inches; dark grayish brown (10YR 4/2) loamy fine sand; weak fine granular structure; soft, loose; many fine roots; moderately acid; clear smooth boundary.

E1—5 to 20 inches; light yellowish brown (10YR 6/4) loamy fine sand; few fine faint pale brown and brownish yellow mottles; single grained; soft, loose; many fine roots; few ironstone pebbles; moderately acid; gradual smooth boundary.

E2—20 to 32 inches; yellowish brown (10YR 5/4) loamy fine sand; single grained; soft, loose; common fine roots; few ironstone pebbles; moderately acid; gradual smooth boundary.

BE—32 to 38 inches; mottled yellowish red (5YR 5/6) and strong brown (7.5YR 5/8) fine sandy loam; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; strongly acid; gradual smooth boundary.

Bt—38 to 50 inches; mottled yellowish red (5YR 5/6), red (2.5YR 4/6), and strong brown (7.5YR 5/6) sandy clay loam; weak coarse subangular blocky structure; very hard, firm; patchy clay films on faces of peds; few fine roots; very strongly acid; gradual smooth boundary.

C—50 to 68 inches; mottled red (2.5YR 4/6), yellow (10YR 7/6), and gray (10YR 5/1) soft sandstone with fine sandy loam texture; massive; common discontinuous strata of ironstone fragments up to 2 centimeters thick; very strongly acid.

The solum ranges from 40 to 60 inches in thickness. Ironstone pebbles range from none to 15 percent by volume.

The A horizon is very dark grayish brown, dark grayish brown, brown, and dark yellowish brown. The E horizon is brown, pale brown, yellowish brown, light yellowish brown, and light brown. Reaction of the A and E horizons is strongly acid or moderately acid.

The BE horizon has colors similar to the Bt horizon, but is much less clayey. Some pedons do not have a BE horizon.

The Bt horizon is yellowish red, strong brown, and yellowish brown. Some pedons are mottled in shades of red, brown, and yellow. The content of clay in the upper 20 inches of the horizon is 22 to 35 percent. Pockets or fragments of gray weathered shale and mica are in some pedons. Reaction of the Bt horizon is very strongly acid or strongly acid.

The C horizon is soft sandstone that has layers of gray shale in some pedons. Some pedons have many mica flakes. The C horizon is red, yellow, or brown, and the shale layers are mainly gray. Reaction is very strongly acid or strongly acid.

Tonkawa Series

The Tonkawa series consists of very deep, excessively drained, sandy soils on uplands. These soils formed in thick sandy deposits. Native vegetation is mainly short grasses and sparse hardwood trees with scattered pines. Slopes range from 1 to 3 percent.

The soils of the Tonkawa series are thermic, coated Typic Quartzipsamments.

Typical pedon of Tonkawa fine sand, 1 to 3 percent slopes; from the intersection of Farm Road 279 and Farm Road 858 in Ben Wheeler, 2.3 miles south on Farm Road 279, 0.1 mile south on county asphalt road, and 200 feet west of road.

Ap—0 to 7 inches; brown (10YR 5/3) fine sand; single grained; loose; common fine roots; moderately acid; abrupt smooth boundary.

C1—7 to 56 inches; pale brown (10YR 6/3) fine sand; single grained; loose; few fine roots; strongly acid; gradual wavy boundary.

C2—56 to 80 inches; light yellowish brown (10YR 6/4) fine sand; single grained; loose; few fine roots; strongly acid.

The sandy soil material exceeds a depth of 80 inches. Thin lamellae are below a depth of 70 inches in some pedons.

The A horizon is brown, dark brown, yellowish brown, or dark gray. Reaction is strongly acid or moderately acid.

The C horizon is brown, strong brown, yellowish brown, light yellowish brown, reddish yellow, pale brown, very pale brown, light gray, or white. Reaction is very strongly acid or strongly acid.

Whitesboro Series

The Whitesboro series consists of very deep, moderately well drained, loamy soils on flood plains. These soils formed in loamy alluvial sediments. Native vegetation is mainly hardwood trees. Slopes range from 0 to 1 percent.

The soils of the Whitesboro series are fine-loamy, mixed, thermic, Cumulic Haplustolls.

Typical pedon of Whitesboro loam, frequently flooded; about 9.5 miles west of Canton on Texas Highway 243, 6.5 miles south on Farm Road 47, and 200 feet west in a pasture.

A1—0 to 12 inches; very dark grayish brown (10YR 3/2) loam; moderate fine and medium subangular blocky structure; hard, friable; common fine and medium roots; common fine and medium pores; very thin strata of sandy material in lower part; neutral; clear smooth boundary.

A2—12 to 38 inches; very dark gray (10YR 3/1) clay loam; moderate fine and medium subangular blocky structure; hard, firm; common fine and medium roots; many fine and medium pores; many discontinuous strata of sandy material in lower part; neutral; gradual smooth boundary.

A3—38 to 56 inches; dark brown (7.5YR 3/2) clay loam; few medium faint yellowish brown (10YR 5/6) mottles; moderate medium and coarse subangular blocky structure; very hard, firm; thin strata of yellowish brown (10YR 5/4) loamy material; few fine roots; common fine pores; neutral; gradual wavy boundary.

Bw—56 to 80 inches; dark yellowish brown (10YR 4/4) loam; few medium distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky

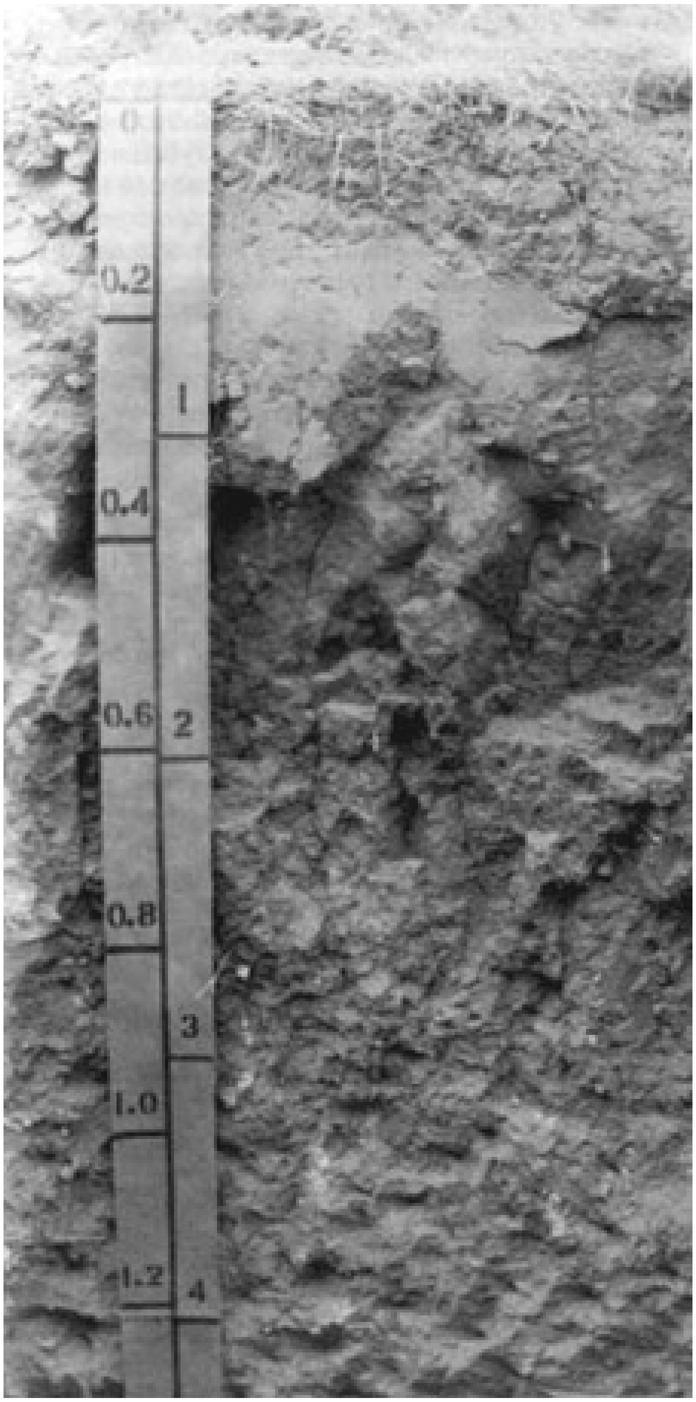


Figure 9.—Profile of Wilson silt loam. The soil is a dense silty clay which is very slowly permeable.

structure; hard, friable; few fine roots; few pockets of sandy material in the upper part; few black concretions; neutral.

The mollic epipedon ranges from 24 to 60 inches in thickness. Content of clay in the control section ranges from 22 to 35 percent.

The A horizon is very dark brown, very dark grayish brown, very dark gray, black, or dark brown. Reaction is neutral or slightly alkaline.

The Bw horizon is dark yellowish brown, dark brown, dark grayish brown, or very dark grayish brown. It is loam, silt loam, silt, or clay loam. Reaction ranges from neutral to moderately alkaline.

Wilson Series

The Wilson series consists of very deep, moderately well drained, loamy soils on uplands (fig. 9). These soils formed in alkaline clay under prairie grasses. Slopes are 0 to 1 percent.

The soils of the Wilson series are fine, montmorillonitic, thermic, Oxyaquic Vertic Haplustalfs.

Typical pedon of Wilson silt loam, 0 to 1 percent slopes; from the intersection of U.S. Highway 80 and Farm Road 47 in Wills Point, 0.45 mile north on Farm Road 47, 1.4 miles northwest on Farm Road 751, 1.8 miles west on county asphalt road, and 50 feet east of road.

Ap—0 to 6 inches; dark gray (10YR 4/1) silt loam; weak fine granular structure, massive when dry; very hard, firm; common fine roots; slightly acid; abrupt wavy boundary.

Bt—6 to 22 inches; very dark gray (10YR 3/1) silty clay; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; few fine pores; thin continuous clay films on faces of peds; vertical cracks filled with material from Ap horizon; slightly acid; gradual wavy boundary.

Btg1—22 to 32 inches; dark grayish brown (2.5Y 4/2) silty clay; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; few fine pores; thin continuous clay films on faces of peds; few medium pressure faces; vertical cracks partly filled with material from above; few fine calcium carbonate concretions; slightly alkaline; diffuse wavy boundary.

Btg2—32 to 54 inches; grayish brown (2.5Y 5/2) silty clay; weak coarse angular blocky structure; extremely hard, very firm; few fine pores; patchy clay films on faces of peds; few soft bodies of calcium carbonate; slightly alkaline; gradual smooth boundary.

BCk—54 to 80 inches; olive gray (5Y 5/2) silty clay; weak medium angular blocky structure; extremely hard, very firm; few fine soft masses of calcium carbonate; few small fragments of shale; calcareous; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness. Cracks about 0.5 inch wide form on the surface and extend to a depth of 24 inches or more during dry periods.

The A horizon is black, very dark gray, very dark grayish brown, or dark gray. Reaction ranges from moderately acid to neutral. The A horizon is massive and hard to very hard when dry but is weak granular when moist. Some pedons have a light gray E horizon less than 1 inch thick.

The Bt horizon is very dark gray or dark gray. Some pedons have a few brownish and yellowish mottles. The Bt horizon is clay loam, silty clay, or clay. Clay content is 35 to 60 percent. Reaction ranges from moderately acid to moderately alkaline.

The Btg and BC horizons are dark gray, dark grayish brown, grayish brown, light brownish gray, olive gray, or gray. Some pedons have olive, brown, or yellow mottles. These horizons are clay, silty clay, or clay loam. Pressure faces range from few to common. Gypsum crystals and calcium carbonate concretions are common in most pedons. Reaction ranges from neutral to moderately alkaline.

Wolfpen Series

The Wolfpen series consists of very deep, well drained, sandy soils on uplands. These soils formed in sandy and loamy sediments mainly under a hardwood forest with scattered pine. Slopes range from 1 to 15 percent.

The soils of the Wolfpen series are loamy, siliceous, thermic, Arenic Paleudalfs.

Typical pedon of Wolfpen loamy fine sand, 1 to 5 percent slopes; from the intersection of State Highway 243 and State Highway 64 in Canton, 0.9 miles southeast on State Highway 64, and 600 feet south in a cultivated field.

Ap—0 to 5 inches; dark brown (10YR 4/3) loamy fine sand; weak medium granular structure; loose; many very fine and common fine roots; moderately acid; clear smooth boundary.

E—5 to 28 inches; pale brown (10YR 6/3) loamy fine sand; single grained; loose; many fine roots; slightly acid; clear wavy boundary.

Bt1—28 to 35 inches; yellowish brown (10YR 5/6) sandy clay loam; common medium faint yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) mottles; moderate fine and medium subangular blocky structure; hard, friable; common very fine roots; few clay films on faces of peds; slightly acid; clear wavy boundary.

Bt2—35 to 42 inches; yellowish brown (10YR 5/4) sandy clay loam; common medium and coarse faint strong brown (7.5YR 5/6) and few medium distinct grayish brown (10YR 5/2) and yellowish red (5YR 4/8) mottles; moderate medium subangular blocky structure; hard, friable; common very fine roots; few clay films on faces of peds; moderately acid; gradual wavy boundary.

Bt/E—42 to 65 inches; yellowish brown (10YR 5/6) sandy clay loam; common coarse distinct red (2.5YR 4/6) mottles; moderate coarse subangular blocky structure; hard, friable; common very fine roots; 0.5 to 1.0 inch wide vertical streaks of light gray (10YR 6/1) uncoated sand grains extend throughout the horizon 10 to 16 inches apart, few pockets of uncoated sand grains in the lower part (E); few patchy clay films on faces of peds; few black concretions; slightly acid; gradual wavy boundary.

B’t—65 to 80 inches; prominently mottled light gray (10YR 6/1), red (2.5YR 4/6), and yellowish brown (10YR 5/8) sandy clay loam; weak medium subangular blocky structure; hard, firm; thin patchy clay films on faces of peds; slightly acid.

The solum is more than 80 inches thick. Content of clay in the control section ranges from 15 to 30 percent.

The A horizon is dark brown, brown or yellowish brown. The E horizon is pale brown, very pale brown, light yellowish brown, yellowish brown, or brown. The combined A and E horizons are 20 to 40 inches thick. Reaction of the A and E horizons ranges from very strongly acid to slightly acid.

The Bt horizon is yellowish brown, brownish yellow, or strong brown. Mottles in shades of red, yellow, and brown range from none to common. The Bt horizon is mainly sandy clay loam, but is fine sandy loam in the upper part of some pedons. Reaction ranges from very strongly acid to slightly acid.

The Bt/E horizon is similar in all respects to the Bt horizon, except that it has from 1 to 15 percent clean sand and silt in streaks and pockets.

The B’t horizon is mottled in shades of gray, yellow, red, and brown. Small amounts of plinthite are in some pedons.

Woodtell Series

The Woodtell series consists of very deep, well drained, loamy soils on uplands. Native vegetation is hardwood trees and mid and tall grasses. Slopes range from 2 to 12 percent.

The soils of the Woodtell series are fine montmorillonitic, thermic, Vertic Hapludalfs.

Typical pedon of Woodtell loam, 2 to 5 percent slopes, from the intersection of State Highway 19 and Farm Road 1256 about 2.6 miles north of Walton, 4.4 miles west on Farm Road 1256, and 50 feet south of road.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) loam; weak fine granular structure; hard, friable; common fine roots; strongly acid; clear smooth boundary.

E—5 to 8 inches; grayish brown (10YR 5/2) loam; weak fine granular structure; hard, friable; common fine roots; strongly acid; clear smooth boundary.

Bt—8 to 14 inches; dark red (2.5YR 3/6) clay, few fine distinct streaks and mottles of yellowish red; moderate fine subangular blocky structure; very hard, very firm; common fine roots; continuous clay films on faces of peds; few pressure faces; strongly acid; clear smooth boundary.

Btss1—14 to 30 inches; red (2.5YR 4/6) clay loam; many medium distinct yellowish red (5YR 4/8) and light gray (10YR 6/1) mottles; weak fine angular blocky structure; very hard, very firm; continuous clay films on faces of peds; few slickensides and pressure faces; strongly acid; gradual wavy boundary.

Btss2—30 to 54 inches; dark yellowish brown (10YR 4/6) clay loam, many medium prominent light gray (10YR 6/1) and few coarse prominent red (2.5YR 4/8) mottles; weak coarse angular blocky structure; very hard, firm; few fine roots; few patchy clay films; few slickensides and pressure faces; strongly acid; gradual smooth boundary.

C—54 to 80 inches; stratified light olive gray (5Y 6/2) and gray (10YR 5/1) shale and loamy materials of yellowish brown (10YR 5/6); hard, firm; few fine roots; slightly acid.

The solum ranges from 40 to 60 inches in thickness. Clay content of the upper 20 inches of the Bt horizon averages 40 to 50 percent. Some areas are very bouldery on the surface.

The A horizon is very dark grayish brown, dark grayish brown, grayish brown, or light yellowish brown. It is 4 to 9 inches thick. Reaction is strongly acid or moderately acid.

The E horizon is pale brown, yellowish brown, grayish brown, or light brownish gray. It is fine sandy loam or loam. The E horizon is less than 4 inches thick. Reaction ranges from very strongly acid to slightly acid. Some pedons do not have an E horizon.

The Bt and upper part of the Btss horizons are reddish brown, red, or dark red. Mottles in shades of brown, yellow, red, and gray range from none to common. Reaction is very strongly acid or strongly acid.

The lower part of the Btss horizon is mottled in shades of red, yellow, brown, and gray. The amount of gray increases with depth. The Btss horizon is clay or clay loam. Reaction ranges from very strongly acid to moderately acid.

Some pedons have a BC horizon that is mottled in shades of red, yellow, and gray, or is dominantly gray. It is clay loam or sandy clay loam. Reaction ranges from strongly acid to slightly acid.

The C horizon is gray, light gray, light brownish gray, light olive gray, or olive gray. Mottles range from few to common in shades of yellow, brown, and red. The C horizon is stratified shale and clay loam or sandy clay loam. Reaction ranges from very strongly acid to neutral.

Formation of the Soils

This section relates the factors of soil formation to the soils in Van Zandt County and explains the processes of soil formation.

Factors of Soil Formation

A soil is a three-dimensional natural body consisting of mineral and organic material that can support plant growth. The nature of any soil at a given site is the result of the interaction of five general factors: Parent material, climate, plants and animals, relief, and time. Climate, plants, and animals have an effect on parent material that is modified by relief over time. Theoretically, if all these factors were identical at different sites, the soils at these sites would be identical. Differences among the soils are caused by variations in one or more of these factors.

Parent Material

Parent material is the unconsolidated mass from which a soil forms. It has a major influence on the chemical and mineral composition of the soil. In Van Zandt County, the parent material consists of unconsolidated sandy, loamy, and clayey sediments deposited by waters of the Paleocene, Eocene, Pleistocene, and Holocene Epochs.

The relationship between parent material and the different soils in the county is described in detail under the heading “Surface Geology.”

Climate

The climate of Van Zandt County is warm and humid; summers are hot. The climate is fairly uniform, but the rainfall decreases slightly from east to west and evaporation increases. Because of this difference in climate, the soils are divided into two groups based on average moisture content. The soils in the eastern part of the county are in the wetter or humid group and soils in the western part are in the drier, subhumid group. This division is evident on the general soil map where soils of the Crockett General Soil Map Unit and soils of the Edge General Soil Map Unit comprise the subhumid group.

The high temperatures and adequate rainfall favor soil development by supporting a relatively high rate of microbial activity and chemical and physical processes within the soil. This has resulted in the formation of very deep soils in the county.

The microclimate in a given area also affects soil formation. Gladewater soils, which are in low-lying flood plains, receive runoff from adjacent slopes as well as floodwater from upstream. The extra water creates a wet microclimate that results in prolonged saturation, reduction of iron, and a gray subsoil. Sloping soils, such as Oakwood soils, formed under a drier microclimate because of runoff. This better external drainage results in better aeration, oxidation of iron, and a brownish yellow subsoil.

Plant and Animal Life

The vegetation under which a soil forms influences soil properties, such as color, structure, reaction, content, and distribution of organic matter. Vegetation extracts water from the soil, recycles nutrients, and adds organic matter to the soil. Gases derived from root respiration combine with water to form acids that influence the weathering of minerals. Because of a lower content of organic matter, soils that formed under forest vegetation are generally lighter colored than those that formed under grasses.

Bacteria, fungi, and many other micro-organisms decompose organic matter and release nutrients to growing plants. They influence the formation of soil structure. Soil properties, such as drainage, temperature, and reaction, influence the type of micro-organisms that live in the soil. Fungi are generally more active in the more acid soils, while bacteria are more active in the less acid and more alkaline soils.

Earthworms, insects, and small burrowing animals mix the soil and create small channels that aid in soil aeration and water movement. Earthworms help to incorporate crop residue or other organic matter into the soil. The organic matter improves tilth. In areas that are well populated with earthworms, the leaf litter that accumulates on the soil in the fall is generally incorporated into the soil by the following spring. If the earthworm population is low, part of the leaf fall can remain on the soil surface for several years.

Human activity can significantly influence soil formation. The clearing of native forests followed by continuous farming may drastically change activities within the soil. Cultivation generally accelerates erosion on sloping soils, affects soil structure and compacting, and lowers the content of organic matter. Drainage of wet soils changes soil formation. Fertilizers, lime, and pesticides also affect soil formation. Developing land for urban uses or for mining significantly influences soil development.

Relief

Relief, or topography, influences soil development through its effect on drainage, runoff, and depth of penetration of soil moisture.

The relief of the survey area is nearly level to steep. The nearly level areas consist of bottom lands and terraces. The more sloping areas are mostly higher in the landscape.

If other factors are equal, the degree of soil profile development depends on the amount, depth, and penetration of soil moisture. The more often a soil passes through a wetting and drying cycle, the greater and more distinct is the soil development.

Soils on a nearly level landscape tend to have marked differences in soil development. Nearly level areas that are poorly drained and that remain saturated much of the time generally do not have pronounced soil horizonation. Nearly level soils that are well drained generally are distinctly developed to a depth of more than 80 inches.

Most of the gently sloping and moderately sloping soils are developed to a depth of more than 80 inches. As the slope increases above 8 percent, the depth of water penetration generally decreases. Since much of the water is removed by runoff, the solum of the more sloping soils tends to be more thinly developed.

Time

A great length of time is required for the formation of soils with distinct horizons. The differences in the length of time that the parent material has been in place are commonly reflected in the degree of development of soil horizons. Young soils have very little horizon development, and old soils have well expressed horizons.

Nahatche and Hatliff soils are young soils. They are on flood plains where sediment is continuously added. These soils have little soil horizon development.

Advanced stages of development are evident in many of the soils in Van Zandt County. The Kirvin soils, for example, formed over a longer period of time. They have been leached of most bases and have distinct horizonation.

Processes of Soil Formation

Soil forms through complex processes that are grouped into four general categories. These are additions, removals, transfers, and transformations. These processes affect soil formation in differing degrees and account for the presence of soil layers or horizons.

The accumulation of organic matter in the A horizon of the soils in Van Zandt County is an example of an addition. This accumulation is the main reason for the dark color of the A horizon. The color of the raw parent material is uniform with increasing depth.

The leaching of lime, or bases, from the upper few feet in many of the soils is an example of removal. The parent materials of these soils contain more lime or bases than the soil itself. This indicates leaching of the soil profile by percolating water.

The movement of clay and other materials from the A horizon to the B horizon is an example of transfer. The E horizon is a zone of maximum eluviation, or loss. The B horizon is a zone of illuviation, or gain. Crockett, Edge, Woodtell, and many other soils have maximum clay content in the B horizon. An indication of a transfer of clay is thin clay films in pores and on faces of peds.

An example of a transformation is the reduction of ferrous iron. This process takes place under wet, saturated conditions in which there is no oxygen. Gleying, or the reduction of iron, is evident in Derly, Gladewater, Leagueville, Lufkin, and Wilson soils, which have a dominantly gray subsoil. The gray color indicates the presence of reduced iron, which, in turn, implies wetness. In some soils, such as Lufkin and Wilson, the gray color is considered to be relict because the wetness condition is no longer present. Reduced iron is soluble, but it commonly has been moved only short distances in the soils in the survey area, stopping in a lower part of the horizon where it originated or in an underlying horizon. Part of this iron, under certain conditions, can be reoxidized and segregated in the form of stains, concretions, or bright yellow and red mottles.

Surface Geology

Max D. Bircket, geologist, Natural Resources Conservation Service prepared this section.

Van Zandt County is in the Coastal Plain physiographic region of Texas. All of the geological formations are sedimentary. They dip toward the Gulf of Mexico at low angles, which average less than 1 degree or 75 feet per mile, and crop out as northeast-southwest striking bands across the county *(14, 15, 16)*.

The normal sequence in which these formations outcrop from the northwest to the southeast are the Midway Group of the Paleocene; the Wilcox Group, the Carrizo Sand, Reklaw, Queen City, Weches, and Sparta Sand of the Eocene; all members of the Claiborne Group; Fluviatile terrace deposits of the Pleistocene; and alluvium of the Holocene or Recent Epoch *(7)*.

The Midway Group is composed of the Kincaid Formation and the Wills Point Formation. The Kincaid Formation is exposed in the extreme northwest part of Van Zandt County. It is made up mostly of layers of weakly consolidated sandstone, shale, and in some places, marl. Soils that have formed in these sediments are common to the Edge general soil map unit.

The Wills Point Formation is exposed along the western side of the county. It is made up mostly of clay and shale. Soils that have formed in these sediments are common to the Crockett general soil map unit.

The Wilcox Group is not divided into formations. It is composed of mudstone, with some sandstone and ironstone. Fossils, petrified wood, and lignite are common. The Wilcox is exposed over the greater part of central Van Zandt County from south to north. Soils that have formed in the more clayey sediments are common to the Woodtell-Freestone general soil map unit, and those that formed in the more sandy sediments are common to the Wolfpen-Pickton general soil map unit.

The Carrizo Sand forms a narrow band from the south-central part of the county northeastward to the Sabine River. The formation is made up mostly of fine grained sand with partings of silty clay and carbonaceous clay. Soils that have formed in these sediments are common to the Wolfpen-Pickton general soil map unit, especially the Pickton and Tonkawa soils. This formation produces good quality ground water *(17)*.

The Reklaw Formation forms a narrow band along the southeast side of the Carrizo Sand. It is made up of weakly consolidated interbedded shale, sandstone, and ironstone. Because of the iron, the sediments weather to a reddish color and are common to the Cuthbert-Oakwood-Kirvin general soil map unit.

The Queen City Formation outcrops in much of the southeastern corner of Van Zandt County. This formation is made up of fine grained quartz sand interbedded with clay, silt, and lentils of glauconitic greensand. Soils that have formed in these sediments are common to the Wolfpen-Pickton, Woodtell-Freestone, and Cuthbert-Oakwood-Kirvin general soil map units. This formation produces good quality ground water.

The Weches Formation is a thin band that is exposed on hills in areas known as “redlands.” It is made up of greensand, sand, and clay. Soils that have formed in these sediments are common to the Redsprings-Elrose general soil map unit.

The Sparta Sand is exposed on the top of only a few of the redland hills in the southeast part of the county. This formation is similar to the Carrizo Sand. Soils that have formed in these sediments are mainly the Wolfpen and Pickton soils. However, because of the small size of the soil areas, they are a part of the Redsprings-Elrose general soil map unit.

The Fluviatile terrace deposits of Pleistocene age are in all parts of the county, but are dominantly along the stream systems above the present-day flood plains. In places, the sediment deposits are several feet thick and in other places they are only a thin veneer over older geological sediments.

Loamy sediments thick enough for the development of the very deep, well drained loamy Bernaldo and Gallime soils are most common in the Woodtell-Freestone general soil map unit, and less common in the Wolfpen-Pickton and Cuthbert-Oakwood-Kirvin general soil map units.

Loamy sediments deposited over older more clayey materials give rise to much of the Freestone soils. These moderately well drained soils have a subsoil that is loamy in the upper part and clayey in the lower part. Freestone soils are most common in the Woodtell-Freestone general soil map unit and less common in the Wolfpen-Pickton, Cuthbert-Oakwood-Kirvin, Crockett, and Edge general soil map units.

Clayey sediments thick enough for the development of soils with a thick clayey subsoil underlie the Derly and Lufkin soils. However, a thin veneer of loamy sediments was deposited over most of these clayey sediments and then reworked by wind. The wind-mounded materials were the parent materials of the Rader and Raino soils. The Rader and Raino soils have a subsoil that is loamy in the upper part and clayey in the lower part. The poorly drained Derly soil is in a complex with the moderately well drained Raino soil. They are most common in the Woodtell-Freestone general soil map unit, and less common in the Wolfpen-Pickton and Edge general soil map units. Most of the somewhat poorly drained Lufkin soil is in a complex with the moderately well drained Rader soil. They are most common in the Edge general soil map unit, and less common in the Woodtell-Freestone and Crockett general soil map units.

The youngest geologic unit in the county is the Holocene alluvium on the flood plains of the modern streams. The clayey flood plain deposits along the Sabine River are represented by the Gladewater general soil map unit. The loamy and clayey sediments along the streams in the western part of the county that drain the prairies and savannahs are represented by the Sandow-Whitesboro-Aufco general soil map unit. The loamy sediments along streams draining the woodlands of the county are represented by the Nahatche-Manco general soil map unit.

An important geological area of Van Zandt County that does not give rise to any particular soil is near Grand Saline. This is a salt dome 200 to 300 feet below the surface. This huge dome wells up from thousands of feet below ground. In the vicinity of the dome, the exposed Wilcox geology has outward, radial dips and a topographic depression occupied by a salt marsh of about 340 acres *(6, 4)*. Part of this depression is mapped as Salt flats in this survey. The remainder is a part of the Nahatche loam, saline, map unit.

The salt dome is yielding large amounts of rock salt and is economically important.

References

(1) American Association of Petroleum Geologists. 1973. Geological highway map of Texas. Map 7: H.B. Renfro Memorial Ed., Tulsa, OK.

(2) American Association of State Highway and Transportation Officials. 1986. Standard specifications for highway materials and methods of sampling and testing. Ed. 14, 2 vols.

(3) American Society for Testing and Materials. 1993. Standard classification of soils for engineering purposes. ASTM Stand. D 2487.

(4) Collins, O.B. and G. Lane, 1976. Vegetation of the Grand Saline Salt Marsh. Sixth Midwest prairie conference, Ames, Iowa, 1977. (Unpublished paper, 19 pp.)

(5) Hall, M.E. 1976. A History of Van Zandt County.

(6) Mulchberger, W.R., P.S. Clabough, and M.L. Hightower. 1962. Palestine and Grand Saline salt domes, Eastern Texas. Univ. of Tex. Dep. Geol. field excursion No. 6, (Nov. 15). Austin, TX.

(7) Sellards, E.H., W.S. Adkins and F.B. Plummer. 1932. Geology of Texas, Vol. 1, Stratigraphy. Univ. Tex. Bull. 3232.

(8) Texas Almanac. 1994-1995. The Dallas Morning News, 1993, Dallas, TX.

(9) United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210.

(10) United States Department of Agriculture, Bureau of Chemistry and Soils. 1928. Soil Survey of Van Zandt County, Texas.

(11) United States Department of Agriculture, Soil Conservation Service. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. U.S. Dep. Agric. Handb. 436.

(12) United States Department of Agriculture, Soil Conservation Service. 1992. Keys to soil taxonomy. 5th ed. Soil Surv. Staff, Soil Manage. Support Serv. Tech. Monogr. 19.

(13) United States Department of Agriculture, Soil Conservation Service. 1993. Soil survey manual. Soil Surv. Staff, U.S. Dep. Agric. Handb. 18.

(14) University of Texas, Bureau of Economic Geology. 1987. Geologic atlas of Texas, Dallas sheet.

(15) University of Texas, Bureau of Economic Geology. 1966. Geologic atlas of Texas, Texarkana sheet.

(16) University of Texas, Bureau of Economic Geology. 1965. Geologic atlas of Texas, Tyler sheet.

(17) White, D.E. 1973. Ground-water resources of Rains and Van Zandt Counties, Texas. Tex. Water Dev. Board Rep. 169.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Animal unit month (AUM). The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (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 moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine strata, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediment.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breast height. An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management. Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

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

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Chemical treatment. Control of unwanted vegetation through the use of chemicals.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

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 depletions. Low-chroma zones having a low content of iron, manganese, and clay because of the chemical reduction of iron and manganese and the removal of iron, manganese, and clay. A type of redoximorphic depletion.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax plant community. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Cemented bodies with crude internal symmetry organized around a point, a line, or a plane. They typically take the form of concentric layers visible to the naked eye. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up concretions. If formed in place, concretions of iron oxide or manganese oxide are generally considered a type of redoximorphic concentration.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cropping system. Growing crops according to a planned system of rotation and management practices.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained* . These classes are defined in the “Soil Survey Manual.”

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sodium (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, or clay.

Firebreak. Area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers; produced by river action, as a fluvial plain.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai. Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water. Water filling all the unblocked pores of the material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

High-residue crops. Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin. —Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border. —Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding. —Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation. —Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle). —Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow. —Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler. —Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation. —Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding. —Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lamella. A thin, discontinuous or continuous, generally horizontal layer of fine material (especially clay and iron oxides) that has been illuviated within a coarser, eluviated layer.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low-residue crops. Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Low strength. The soil is not strong enough to support loads.

Masses. Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

Mechanical treatment. Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

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 the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. 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 of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules. Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affects the specified use.

Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as “saturated hydraulic conductivity,” which is defined in the “Soil Survey Manual.” In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as “permeability.” Terms describing permeability, measured in inches per hour, are as follows:

Extremely slow	0.0 to 0.01 inch
Very slow	0.01 to 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting (in tables). Pits caused by melting around ice. They form on the soil after plant cover is removed.

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 semisolid to plastic.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid or very rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Potential native plant community. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning. Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill generally is a few inches deep and not wide enough to be an obstacle to farm machinery.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Salty water (in tables). Water that is too salty for consumption by livestock.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Second bottom. The first terrace above the normal flood plain (or first bottom) of a river.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

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

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil generally is silty or clayey, is slippery when wet, and is low in productivity.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey, classes for simple slopes are as follows:

Nearly level	0 to 1 percent
Very gently sloping	1 to 3 percent
Gently sloping	3 to 5 percent
Moderately sloping	5 to 8 percent
Strongly sloping	8 to 12 percent
Moderately steep	12 to 20 percent
Steep	20 to 45 percent
Very steep	45 percent and higher

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and 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, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. 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 without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the E horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

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 water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

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 (in tables). Otherwise suitable soil material that is too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland. Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such 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 ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The uprooting and tipping over of trees by the wind.

NRCS Accessibility Statement

The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at helpdesk@helpdesk.itc.nrcs.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.